Curriculum

School:	**SOS**
Program Code:	**163**
Program Name:	**Bachelors of Science (Life Science)**
Academic Year:	**2021-2022**

GLOSSARY:

Programme Outcomes (POs): POs are statements that describe what the students graduating from any of the educational Programmes of the institution should be able to do on completion.

Programme Specific Outcomes (PSOs): PSOs are statements that describe what the graduates of a specific educational Programme should be able to do on completion.

Course Outcomes (COs): COs are statements that describe what students should be able to do on completion of the course.

NOTE:

Programme Outcomes (POs): Programme Outcomes (POs) are what knowledge, skills and attitudes a graduate should have at the time of graduation. While as at present, no agency has formally defined the POs of General Higher Education in a 3-year degree Programmes in India, POs of all professional Programmes in engineering and other areas are identified at the national level, by the concerned accrediting agency. POs are not specific to a discipline.

Course Outcomes (COs): COs are statements that describe what students should be able to do at the end of a course. They can be 6±2 for courses with 2 to 4 credits, and 8±2 for courses with 5 to 6 credits.

Vision of School: A premier Science School of Excellence in Research and Innovation

Mission of School:

- To focus on developing UG, PG and Doctoral Research
- Faculty Development and Empowerment
- Push for Innovation and Entrepreneurship through Industry and Academia connect
- To focus on social issues and society concerns through various activities at SOS and NUCERI

Programme Outcomes (POs):

PO1:	**Critical Thinking**: Take informed actions after identifying the assumptions that frame our thinking and actions, checking out the degree to which these assumptions

	are accurate and valid, and looking at our ideas and decisions (intellectual, organizational, and personal) from different perspectives.
PO2:	**Effective Communication**: Speak, read, write and listen clearly in person and through electronic media in English and in one Indian language, and make meaning of the world by connecting people, ideas, books, media and technology.
PO3:	**Social Interaction:** Elicit views of others, mediate disagreements and help reach conclusions in group settings
PO4:	**Effective Citizenship**: Demonstrate empathetic social concern and equity centered national development, and the ability to act with an informed awareness of issues and participate in civic life through volunteering
PO5:	**Ethics:** Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them.
PO6:	**Environment and Sustainability:** Understand the issues of environmental contexts and sustainable development.
PO7:	**Self-directed and Life-long Learning:** Acquire the ability to engage in independent and life-long learning in the broadest context socio-technological changes

Program Specific Outcome (PSO):

PSOs of BSc Life sciences

PSO1:	Understand the nature and basic concepts of cell biology, Biochemistry, Taxonomy, ecology and some basics aspects of Chemistry. Critically evaluate the concepts of life science courses. Analyse the relationships among animals, plants and microbes.
PSO2:	It aims at the holistic development of the student and empowers them with sufficient overall knowledge and Perform procedures as per laboratory standards in the areas of Biochemistry, Bioinformatics, Taxonomy, Zoology/ Botany and Ecology
PSO3:	To prepare graduates possessing communication skills, management skills and contribute as a member of multidisciplinary team, appreciates and respects diversity of opinion, considerate global, societal, environmental, and ethical issues

Course Structure

L = Lecture	**T = Tutorial**	**P = Practical**	**C = Credit**
number of hours per week	number of hours per week	number of hours per week	Total Credits

Semester	**I**	**II**	**III**	**IV**	**V**	**VI**	**Total**
Credits	22	24	23	27	27	26	**149**

Total Credit of Program =	149	Credits
Core Courses =	134	Credits
Elective Courses =	15	Credits

Academic year 2021 – 22

Semester - I

Teaching Scheme

Course Code	Course Name	L	T	P	C	Theory		Practical		Total	Elements of Employability (Emp)/ Entrepreneurship (Ent)/ Skill Development (SD)	Relevance to Local (L)/ National (N)/ Regional(R)/ Global developmental needs (G)	Relation to Gender (G)/ Environment and Sustainability (ES)/ Human Values (HV)/ Professional Ethics (PE)
						Internal	**End-sem**	**Internal**	**End-sem**				
LS177	Living world and diversity	3	0	0	3	60	40	NA	NA	**100**		L, N, R, G	ES
LS178	Microbial, Plant and Animal Physiology	3	0	0	3	60	40	NA	NA	**100**		L, N, R, G	ES
LS103	Life Science Laboratory I	0	0	4	2	NA	NA	60	40	**100**	Emp	L, N, R, G	ES
LS104	Life Science Laboratory II	0	0	2	1	NA	NA	60	40	**100**	Emp	L, N, R, G	ES
CH104	Inorganic Chemistry	3	0	0	3	60	40	NA	NA	**100**		L, N, R, G	ES
CH105	Chemistry Laboratory II	0	0	2	1	NA	NA	60	40	**100**	Emp	L, N, R, G	ES
MA110	Foundation Course in Mathematics I	3	0	0	3	60	40	NA	NA	**100**	SD	L, N, R, G	
LC119	Communication I	3	0	0	3	60	40	NA	NA	**100**	Emp, SD	L, N, R, G	HV, PE
MG117	Principles of Management, Accounts	3	0	0	3	60	40	NA	NA	**100**	Ent, SD	L, N, R, G	
	Total Credits	**18**	**0**	**8**	**22**								

Semester - II

Teaching Scheme

Course Code	Course Name	L	T	P	C	Theory		Practical		Total	Elements of Employability (Emp)/ Entrepreneurship (Ent)/ Skill Development (SD)	Relevance to Local (L)/ National (N)/ Regional(R)/ Global developmental needs (G)	Relation to Gender (G)/ Environment and Sustainability (ES)/ Human Values (HV)/ Professional Ethics (PE)
						Internal	**End-sem**	**Internal**	**End-sem**				
LS179	Biochemistry-I	3	0	0	3	60	40	NA	NA	100		L, N, R, G	
LS180	Cytology and Genetics	3	0	0	3	60	40	NA	NA	100		L, N, R, G	
LS138	Life Science Laboratory III	0	0	4	2	NA	NA	60	40	100	Emp	L, N, R, G	
LS139	Life Science Laboratory IV	0	0	2	1	NA	NA	60	40	100	Emp	L, N, R, G	

CH109	Conceptual Organic Chemistry	3	0	0	3	60	40	NA	NA	100		L, N, R, G	
CH108	Chemistry Laboratory IV	0	0	2	1	NA	NA	60	40	100	Emp	L, N, R, G	
HS106	Humanities	2	0	0	2	60	40	NA	NA	100	Emp	L, N, R, G	PE, HV
MA117	Foundation Course in Mathematics II	3	0	0	3	60	40	NA	NA	100	SD	L, N, R, G	
LC120	Communication II	3	0	0	3	60	40	NA	NA	100	Emp, SD	L, N, R, G	PE
MG108	Economics and Finance	3	0	0	3	60	40	NA	NA	100	Ent, SD	L, N, R, G	ES
	Total Credits	**20**	**0**	**8**	**24**								

Semester - III

Teaching Scheme

Course Code	**Course Name**	**L**	**T**	**P**	**C**	Theory		Practical		Total	Elements of Employability (Emp)/ Entrepreneurship (Ent)/ Skill Development (SD)	Relevance to Local (L)/ National (N)/ Regional(R)/ Global developmental needs (G)	Relation to Gender (G)/ Environment and Sustainability (ES)/ Human Values (HV)/ Professional Ethics (PE)
						Internal	**End-sem**	**Internal**	**End-sem**				
LS273	Ethno and Economic Biology	3	0	0	3	60	40	NA	NA	100		L, N, R, G	HV, ES
LS274	Plant Morphology and Anatomy	3	0	0	3	60	40	NA	NA	100		L, N, R, G	ES
LS275	Biochemistry-II	3	0	0	3	60	40	NA	NA	100		L, N, R, G	
LS234	Life Science Laboratory V	0	0	6	3	NA	NA	60	40	100	Emp	L, N, R, G	
LS235	Life Science Laboratory VI	0	0	4	2	NA	NA	60	40	100	Emp	L, N, R, G	
CH203	Molecules of Life	3	0	0	3	60	40	NA	NA	100		L, N, R, G	
CH205	Chemistry Laboratory VI	0	0	4	2	NA	NA	60	40	100	Emp	L, N, R, G	
ID	Interdisciplinary course	2	0	0	2	60	40	NA	NA	100	SD	L, N, R, G	PE
HR226	HR and Marketing 1	2	0	0	2	60	40	NA	NA	100	Emp, Ent	L, N, R, G	PE, HV
	Total Credits	**16**	**0**	**14**	**23**								

Semester - IV

Teaching Scheme

	Course Name	**L**	**T**	**P**	**C**	Theory	Practical	Total	Elements of Employability (Emp)/	Relevance to Local (L)/ National (N)/	Relation to Gender (G)/

Course Code						Internal	End-sem	Internal	End-sem		Entrepreneurship (Ent)/ Skill Development (SD)	Regional(R)/ Global developmental needs (G)	Environment and Sustainability (ES)/ Human Values (HV)/ Professional Ethics (PE)
LS150	Biophysics, Biostatistics and Biochemical Techniques	3	0	0	3	60	40	NA	NA	100	SD	L, N, R, G	
LS151	Comparative functional Anatomy and Physiology	3	0	0	3	60	40	NA	NA	100		L, N, R, G	
PAT201	Parasitology, Histopathology and Plant Pathology	3	0	0	3	60	40	NA	NA	100		L, N, R, G	
LS153	Life Science Laboratory VII	0	0	6	3	NA	NA	60	40	100	Emp, SD	L, N, R, G	
LS154	Life Science Laboratory VIII	0	0	4	2	NA	NA	60	40	100	Emp, SD	L, N, R, G	
CH208	Physical Chemistry	3	0	0	3	60	40	NA	NA	100		L, N, R, G	
CH210	Chemistry Laboratory VIII	0	0	4	2	NA	NA	60	40	100	Emp, SD	L, N, R, G	
ES201	Environmental Studies	3	0	2	4	60	40	NA	NA	100	Emp, SD	L, N, R, G	ES
ID	Interdisciplinary course	2	0	0	2	60	40	NA	NA	100	SD	L, N, R, G	PE
HR311	Introduction to HR and Marketing II	2	0	0	2	60	40	NA	NA	100	Ent, SD	L, N, R, G	HV
	Total Credits	**20**	**0**	**14**	**27**								

Semester - V

Teaching Scheme											Elements of Employability (Emp)/ Entrepreneurship (Ent)/ Skill Development (SD)	Relevance to Local (L)/ National (N)/ Regional(R)/ Global developmental needs (G)	Relation to Gender (G)/ Environment and Sustainability (ES)/ Human Values (HV)/ Professional Ethics (PE)
Course Code	**Course Name**	**L**	**T**	**P**	**C**	Theory		Practical		Total			
						Internal	**End-sem**	**Internal**	**End-sem**				
LS303	Biotechnology and Bioinformatics	3	0	0	3	60	40	NA	NA	100	SD	L, N, R, G	
LS301	Molecular biology, Endocrinology and Phytohormones	3	0	0	3	60	40	NA	NA	100		L, N, R, G	

LS302	Defence mechanisms in plants and animals	3	0	0	3	60	40	NA	NA	100		L, N, R, G	
LS305	Life Science Laboratory IX	0	0	8	4	NA	NA	60	40	100	Emp	L, N, R, G	
LS306	Life Science Laboratory X	0	0	8	4	NA	NA	60	40	100	Emp	L, N, R, G	
PS322	Scientific Enquiry and Research Methodology	3	0	0	3	60	40	NA	NA	100	SD	L, N, R, G	
PS310	KHOJ	3	0	0	3	60	40	NA	NA	100	SD	L, N, R, G	ES, HV, PE
Any two Electives													
SE201	Essential Laboratory Practices	2	0	0	2	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	PE, ES, HV
SE202	Food and Nutrition I	2	0	0	2	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	PE, ES, HV
SE302	Medicinal Chemistry I	2	0	0	2	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	PE, ES, HV
Total Credits		**19**	**0**	**16**	**27**								

Semester - VI

Teaching Scheme

Course Code	**Course Name**	**L**	**T**	**P**	**C**	Theory		Practical		Total	Elements of Employability (Emp)/ Entrepreneurship (Ent)/ Skill Development (SD)	Relevance to Local (L)/ National (N)/ Regional(R)/ Global developmental needs (G)	Relation to Gender (G)/ Environment and Sustainability (ES)/ Human Values (HV)/ Professional Ethics (PE)
						Internal	**End-sem**	**Internal**	**End-sem**				
EMB601	Plant and Animal Molecular Embryology	3	0	0	3	60	40	NA	NA	100		L, N, R, G	
TAX601	Taxonomy of Plants and Animals	3	0	0	3	60	40	NA	NA	100		L, N, R, G	ES
CON601	Wildlife and Conservation Biology	3	0	0	3	60	40	NA	NA	100		L, N, R, G	ES
LAB601	Life Science Laboratory XI	0	0	8	4	NA	NA	60	40	100	Emp	L, N, R, G	
LAB602	Life Science Laboratory XII	0	0	8	4	NA	NA	60	40	100	Emp	L, N, R, G	
	Project Work	2	0	0	2	60	40	NA	NA	100	SD	L, N, R, G	
MG321	Entrepreneurship	3	0	0	3	60	40	NA	NA	100	Emp, SD, Ent	L, N, R, G	
Any two Electives													
SE314	Conservation Biology	2	0	0	2	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	PE, ES, HV

SE210	Foods and Nutrition II	2	0	0	2	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	PE, ES, HV
SE310	Introduction to Pharmacognosy	2	0	0	2	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	PE, ES, HV
SE313	Green Chemistry	2	0	0	2	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	PE, ES, HV
Total Credits		**16**	**0**	**20**	**26**								

Articulation Matrix COs and POs Mapping

Semester-I	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**
Evolutionary Biology, Taxonomy, Adaptation and Association	✓					✓	✓
Classification of Animals	✓						✓
Life Science Laboratory I	✓					✓	
Life Science Laboratory II	✓						
Inorganic Chemistry	✓						
Chemistry Laboratory II	✓						
Foundation Mathematics I	✓						
Communication I		✓					
Principles of Management and Accounts	✓						
Semester-II	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**
Basics of Biomolecules	✓						✓
Classification of plants	✓						✓
Life Science Laboratory III	✓						
Life Science Laboratory IV	✓						
Conceptual Organic Chemistry	✓						✓
Chemistry Laboratory IV	✓						
Humanities					✓		
Foundation Mathematics II	✓						
Communication II		✓					
Economics and Finance	✓						
Semester-III	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**
Cell biology & genetics	✓						
Ecology, Environmental Biology and Biogeography	✓						✓
Plant Structure, Morphology & Functional Anatomy	✓						✓

Introduction to Microbiology	✓						✓
Life Science Laboratory V	✓						
Life Science Laboratory VI	✓						
Molecules of Life	✓						
Chemistry Laboratory VI	✓						
Interdisciplinary course	✓	✓	✓	✓	✓	✓	
Marketing	✓			✓			
Semester-IV	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**
Biophysics, Biostatistics and Biochemical Techniques	✓						✓
Comparative functional Anatomy and Physiology	✓						✓
Bio catalyst, Catalysis and Metabolism	✓						✓
Introduction to Microbiology- II	✓						
Life Science Laboratory VII	✓						
Life Science Laboratory VIII	✓						
Microbiology Laboratory I	✓						
Physical Chemistry	✓						
Chemistry Laboratory VIII	✓						
Environment Science	✓					✓	
Interdisciplinary course	✓	✓	✓	✓	✓	✓	
Introduction to HR and Marketing II	✓			✓			
Semester-V	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**
Molecular Biology and Endocrinology	✓						✓
Biotechnology	✓						✓
Taxonomy, Ethology and Economic Zoology	✓						
Zoology Laboratory IX	✓						
Zoology Laboratory X	✓						
Khoj	✓		✓	✓	✓	✓	✓
Essential Laboratory Practices	✓				✓		
Food and Nutrition	✓						
Introduction to Neuroscience and Cognition	✓						

Introduction to cell/tissue culture	✓						
Semester-VI	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**
Medical Microbiology	✓						
Industrial & Food Microbiology	✓						
Biofertilizers and Biopesticides	✓					✓	
Microbiology Laboratory – IV	✓						
Microbiology Laboratory - V	✓						
Medical Microbiology	✓	✓	✓	✓	✓	✓	✓
Research	✓			✓	✓		
Entrepreneurship	✓						
Foods and Nutrition II	✓						
Conservation Biology	✓						
Introduction to forensic science	✓						
Herbal Cosmetics	✓						

PSO's - PO's Mapping

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
PSO1	✓			✓		✓	✓
PSO2	✓					✓	✓
PSO3		✓	✓	✓	✓	✓	

<table>
<tr><td colspan="3">School: School of Science</td><td colspan="3">Program: BSc – Life Science</td></tr>
<tr><td colspan="3">Course Code: LS177</td><td colspan="3">Course Name: Living world and diversity</td></tr>
<tr><td>Year</td><td>I</td><td>Core Subject(Yes/No):</td><td>Yes</td><td>Lecture:</td><td>3</td></tr>
<tr><td>Semester</td><td>I</td><td>Elective Subject(Yes/No):</td><td>No</td><td>Tutorial</td><td>0</td></tr>
<tr><td rowspan="3">Typology of Course</td><td rowspan="3">Lectures</td><td>Foundation Subject(Yes/No):</td><td>No</td><td>Practical:</td><td>0</td></tr>
<tr><td>Year of Syllabus Revision:</td><td></td><td>Total Credit:</td><td>3</td></tr>
<tr><td>Year of Introduction</td><td>2021</td><td>Prerequisites (If any)</td><td>No</td></tr>
</table>

Course Description:
The course discusses the concepts of microbial taxonomy, classification of microorganisms based on classical and advanced methods; general characters and classification of non-chordates and chordates and the classification of plants from evolutionary lower plants to higher plants like gymnosperms and angiosperms.

Course Objectives:
The students will be able to understand the different characteristics of microbes, animals and plants

Course Outcome (CO):

CO1 gain knowledge about classification and general characteristics of animals
CO2 understand the classification and general characteristics of plants
CO3 learn about microbial diversity and classification of microbes
CO4 learn about the 5-kingdom, 6-kingdom and three domain classification
CO5 help in identifying organisms based on their different features

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	Whittaker's five-kingdom concept. Three-domain concept of Carl Woese. Characters used in microbial taxonomy (morphological, physiological, ecological, genetics protein content, nucleic acid sequence and base composition) Bacteriology: General characters and structure of Eubacteria, Archaeobacteria, Cyanobacteria General comparison. Virology: General structure of Viruses, Detailed structure of animal viruses (pox virus, polio Virus, HIV), Plant virus (TMV) & Bacteriophages. Fungi: Range of thallus organization and reproduction, Important genera of Fungi, Economics Importance of Fungi Algae: General characteristics, classification and economic importance.	15	1,2,3	CO3. CO4 CO5	PSO1 PSO2
2	Non Chordates: General account of Non chordate body organization; General account of Protozoa, Porifera, Cnidaria, Nematoda, Mollusca, Annelida,	15	1,2,3	CO1 CO5	PSO1 PSO2

	Arthropoda and Echinodermata. Chordates: General characters of Chordata, Protochordata, Vertebrata, Pisces, Amphibia, Reptilia and Aves.				
3	Evolutionary Lower Plants- Algae, Fungi and Lichens: General characters, classification and economic importance, important features and life history Introduction to Archegoniate with emphasis on general characters and adaptation to land habit. Classification, general morphology, anatomy and reproduction of Bryophytes, Pteridophytes, Gymnosperms and Angiosperms.	15	2, 3, 4	CO2 CO5	PSO1 PSO2

Reference Books

1.	Prescot, M.J., Harley, J.P. and Klein, D.A. Microbiology. 5th Edition WCB Mc Graw Hill, New York, (2002).
2.	Tortora, G.J., Funke, B.R. and Case, C.L. Microbiology: An Introduction. Pearson Education, Singapore, (2004).
3.	Black J.G. Microbiology- Principles and Explorations. John Wiley & Sons Inc. New York, (2002).
4.	Pelczar, MJ Chan ECS and Krieg NR, Microbiology McGraw-Hill.
5.	B. R. Vasishtha, Botany for Degree Students: Vol. – II Fungi, 1962.
6.	B. R. Vasishtha, Botany for Degree Students: Vol. III Bryophyta, 1963.
7.	P. C. Vasishtha, Botany for Degree Students: Vol.IV Pteridophyta, 1971.
8.	Moore, J. (2006). An Introduction to the Invertebrates (2nd ed.). Cambridge: Cambridge University Press. doi:10.1017/CBO9780511754760
9.	Kotpal, R. L. (2010). Modern Text Book of Zoology Vertebrates. New Delhi: Rastogi Publications.
10.	Hickman, C. P., Roberts, L. S., & Larson, A. (1997). Integrated principles of zoology. Boston, Mass: WCB/McGraw-Hill.

School: School of Science			**Program: BSc – Life Science**		
Course Code: LS178			**Course Name:** Microbial, Plant and Animal Physiology		
Year	**I**	**Core Subject(Yes/No):**	**Yes**	**Lecture:**	**3**
Semester	**I**	**Elective Subject(Yes/No):**	**-**	**Tutorial**	**-**
Typology of Course	Lectures	**Foundation Subject(Yes/No):**	**-**	**Practical:**	**-**
		Year of Syllabus Revision:		**Total Credit:**	**3**
		Year of Introduction	**2021**	**Prerequisites (If any)**	**-**

Course Description:
This course introduces to the physiological systems in Microbes, Plants and Animals. The varied physiological aspects pertaining to the diverse group of living organisms is dealt in the present course. The course helps to get knowledge of different physiological system helping in maintenance of homeostasis. Physiological systems related to Digestion, Respiration, Circulation, Excretion etc in animal system will be essential part of the course. Besides within microbial world, growth and nutritive required shall be covered. Plant physiological systems will be also considered as part of the course

Course Objectives:
To get insight of the types of transport: active/ passive within cell. Knowledge of cell membrane and cell organelles. Digestive system, circulatory system, respiratory system etc and plant physiological systems will be the main objective of the course.

Course Outcome (CO):

CO1. Growth characteristics of microorganisms
CO2. Nutritional variations in microorganisms
CO3. Physiological responses in animals
CO4. General account of different physiologies
CO5. Physiology of plants such as water relations, transpiration and effect of nutrients and minerals on plant growth and development

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	**Unit I** Microbial Nutritional types: Requirement of Nutrients for microbes and classification of microorganisms based on carbon, energy and electron sources viz. Photoautotrophs; Photo organotrophs; Chemo-lithotrophs (ammonia, nitrate Sulphur, hydrogen, iron oxidizing bacteria); Chemo-organotrophs. Primary and secondary active transport; Passive and facilitated diffusion. Definitions of growth, measurement of microbial growth, Batch culture, Continuous culture, generation time and specific growth rate, synchronous growth, diauxic growth curve.	15	1,2,3	CO1,CO2,	PSO1

2	**Unit II** Levels of Physiological response- Molecular, Membrane, Organ and Organism Membrane physiology- Functional consequences of molecular composition and arrangement, Transport across cell membrane- Diffusion, active transport, ports- uniports, symports and antiport; Physiology of digestion- Nutritive patterns, feeding patterns: large particle feeding, surface nutrient and absorption; Circulation: Circulating fluids- cytoplasm, hydrolymph, hemolymph, lymph and blood, open and closed systems, respiration and gas exchange; homeostasis: osmotic regulation, excretion and thermoregulation.	15	1,2,3	CO3,CO4	PSO1
3	**Unit III** Physical aspects of water absorption – Diffusion, Imbibition, Osmosis – Exosmosis, Endosmosis, Plasmolysis, Water potential and its components, Mechanism of water absorption by root – active and passive absorption, Movement of water towards xylem by apoplast and symplast pathway, Ascent of sap, Root pressure, Transpiration and types, Mechanism of transpiration and stomatal movement, Significance and factors affecting transpiration. Mineral nutrition, brief account on Micro and macro nutrients, Function and deficiency symptoms of the following mineral nutrients: N, P, K, Mg, B, Fe, Zn, growth movements: Phototropism, Gravitropism and their reaction mechanism. Respiration: Process, types, measurement of respiration, R.Q., substrates, mechanism (Glycolysis, TCA Cycle, HMP shunt and oxidative phosphorylation).	15	1,2,3	CO5	PSO1

Reference Books

1.	Caldwell, D.R. (1995). Microbial Physiology and Metabolism, Wm. C. Brown Publishers, USA.
2.	Principles of anatomy and physiology, Grabowski, S. R., & Tortora, G. J. (2000). New York, NY: Wiley.
3.	Biology of Animals, C. P. Hickman, L. S. Roberts, and A. Larson, McGraw Hill Company, New York
4.	Animal Physiology, Knut Schmidt-Nielsen, Cambridge University Press, UK
5.	Animal Physiology, R. W. Hill, G. A. Wyse & M. Anderson, Sinauer, New York
6.	F.B. Salisbury & C.W. Ross - (1974) Plant Physiology.
7.	L. Taiz & E. Zeiger – (2002) Plant Physiology

School: School of Science			**Program: BSc – Life Science**		
Course Code: LS103			**Course Name:** Life Science Laboratory – I		
Year	**I**	**Core Subject(Yes/No):**	**Yes**	**Lecture:**	**0**
Semester	**I**	**Elective Subject(Yes/No):**	**No**	**Tutorial**	**0**
Typology of Course	Laboratory	**Foundation Subject(Yes/No):**	**No**	**Practical:**	**4**
		Year of Syllabus Revision:		**Total Credit:**	**2**
		Year of Introduction	**2014**	**Prerequisites (If any)**	**No**

Course Description:
The course illustrates the understanding of classification of various life forms including animals, plants and microbes. Along with this, the subject also teaches the diversification of living forms, both past and present, and the relationships among living things through time which forms a part of systematics.

Course Outcome (CO):

CO1 Understand the classification of animals
CO2 Understand the classification of microbes
CO3 Understand the economic importance of animals
CO4 Understand the basics of dissection of animals
CO5 Understand the classification of plants

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	Classification of Bacteria	6	1,2,3	CO2 CO4	PSO1 PSO2
2	Classification of animals: Invertebrates	6	1,2,3	CO1 CO2	PSO1 PSO2
3	Classification of animals: Vertebrates	6	2, 3, 4	CO1	PSO1 PSO2
4	General body organization of animals	6	1,2,3	CO1	PSO1 PSO2
5	Classification of Protists	6	1,2,3	CO2	PSO1 PSO2
6	Classification of Fungi	6	1,2,3	CO2	PSO1 PSO2
7	Study of Locomotory organ of animals	6	1,2,3	CO1, CO4	PSO1 PSO2
8	Mounting of earthworm: Setae, nephridia and spermatheca	6	1,2,3	CO1, CO4	PSO1 PSO2
9	Mounting of fish scales and gill racker	6	1,2,3	CO1, CO4	PSO1 PSO2
10	Mounting of prawn appendages	6	1,2,3	CO1, CO4	PSO1 PSO2

Reference Books	
1.	Moore J.- An introduction to the invertebrates- CUP
2.	R.L.Kotpal- Modern Text Book of Zoology Vertebrates- Rastogi Publications
3.	E. A. Bessey, Morphology and Taxonomy of Fungi
4.	Prescott, L.M J.P. Harley and C.A. Klein 1995. Microbiology 2nd edition Wm, C. Brown publishers.
5.	Michael J. Pelczar, Jr. E.C.S. Chan, Moel : Microbiology Mc Graw Hill Book R. Krieg, 1986 Company
6.	Stainer R.Y. Ingraham J.L. Wheolis H.H and Painter P.R. 1986 The Microbial world, 5th edition. Eagle Works Cliffs N.J. Prentica Hall

School: School of Science	**Program: BSc – Life Science**
Course Code: LS104	**Course Name: Life Science Laboratory II**

Year	**I**	**Core Subject(Yes/No):**	**Yes**	**Lecture:**	**-**
Semester	**I**	**Elective Subject(Yes/No):**	**No**	**Tutorial**	**NA**
Typology of Course	practical	**Foundation Subject(Yes/No):**	**No**	**Practical:**	**4**
		Year of Syllabus Revision:	**2021**	**Total Credit:**	**2**
		Year of Introduction	**2016**	**Prerequisites (If any)**	**NIL**

Course Description: The basic concepts of microbial, animal and plant physiology are addressed in this course.

Course Objectives: Basic ecology , microbiological methods, Animal physiology and Plant physiology

Course Outcome (CO):

After completing this course, students will be able to:

•calculate the species diversity

•check the effects of physical parameters on microbial growth

•demonstrate transpiration and plamolysis

- CO1 To learn the technique of microbiology
- CO2To study physiological changes in plant tissues.
- CO3To Measure the osmosis and tonicity of red blood cell

Unit No.		**Contact Hours**	**BT Level**	**CO**	**PSO**
1	Calculation of species diversity using "Shannon-Wiener" ecological index	15	1,2	CO1	PSO3
2	To determine the effect of pH on bacterial growth	15	1,2	CO2,3	PSO3
3	To determine the temperature of pH on bacterial growth	15	1,2	CO 1,2,3	PSO3
4	Effect of osmotic pressure (salt concentration) on bacterial growth	15	1,2	CO 1,2,3	PSO3
5	Measuring osmosis and tonicity of red blood cells	15	1,2	CO 1,2,	PSO3
6	Study of transpiration in leaves	15	1,2	CO 1,,3	PSO3
7	Study of plasmolysis	15	1,2	CO 1,2,3	PSO3

Reference Books

1	Esau, K. (1953). *Plant anatomy* (Vol. 75, No. 5, p. 407). LWW.
2	Waller, D. M. (1988). Plant morphology and reproduction. *Plant reproductive ecology: patterns and strategies*, 203-227.

School: School of Science			**Program: BSc – Life Science**		
Course Code: CH 104			**Course Name: Inorganic Chemistry**		
Year	**I**	**Core Subject(Yes/No):**	-Yes	**Lecture:**	**3**
Semester	**I**	**Elective Subject(Yes/No):**		**Tutorial**	**-**
Typology of Course	Lectures	**Foundation Subject(Yes/No):**		**Practical:**	**-**
		Year of Syllabus Revision:	**2021**	**Total Credit:**	**3**
		Year of Introduction	**2014**	**Prerequisites (If any)**	**-**

Course Description:

This course explains the basics of chemical bonding in a molecule. It mainly involves VBT and VSEPR model in detail for the prediction of shapes of molecules and ions containing lone pairs, sigma and pi bonds. It also explains about the Weak Chemical Forces that exist in molecules. In the second part it explains about ionic equilibria concept in solution. It gives an idea about electrolytes and their properties. It also explains the term buffer solution and their application in biochemical process. Further, it explains the term indicator and focuses on the acid-base indicators and their applications in acid-base titrations. The last part of the course deals with the fundamentals of coordination chemistry. It gives an idea about the structure of metal complexes. Nature of ligand based on their splitting of d-orbitals.

Course Objectives:

Gain an understanding of the concept of pH, Buffer solution, and different electrolytes. Further exploring the application of VBT and VESPER theory to understand the structure of molecules. Students will also undergo detailed understanding of different type titrations. Last, they will also undergo a detailed understanding of metal complex formation and their properties.

Course Outcome (CO):

CO1 Acquire knowledge of theories pertaining Chemical bonding.
CO2 Comprehend principles underlying ionic equilibrium.
CO3 Exploring the use of Metal–Ligand Bonding theories in transition Metal complexes.
CO4 Detail understanding of weak forces of interaction.
CO5 Comprehend knowledge on use of different indicators used in acid-base titration.
CO6 Understanding magnetic properties of metal complexes.

Unit No.	**Topic/Unit**	**Contact Hours**	**BT Level**	**CO**	**PSO**
1	**Unit-I: Chemical bonding:** *Ionic bond*: (General characteristics, types of ions, size effects, radius ratio rule and its limitations.), *Covalent bond:* Valence bond approach, concept of resonance in various organic and inorganic compounds, hybridisation and structure, equivalent and non – equivalent hybrid orbitals, Bent's rule and its applications, VSEPR model for predicting the shapes of molecules and ions containing lone pairs, sigma and pi bonds. LCAO method, symmetry and overlap for s – s , s – p and p – p combinations, MO treatment of homonuclear diatomic molecules of 2nd period (B_2, C_2 ,N_2, O_2 ,F_2) and heteronuclear di – atomic molecules (CO, NO) and their ions. *Weak Chemical Forces:* van der	15	1,2,3,4,5	CO1 CO2	PSO1 PSO3

	Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interactions, Instantaneous dipole-induced dipole interactions. Repulsive forces, Hydrogen bonding (theories of hydrogen bonding, valence bond treatment).				
2	**Unit-II: Ionic Equilibrium** Strong, moderate and weak electrolytes, degree of ionization, factors affecting the degree of ionization, ionization constant and ionic product of water. Theories of acids and bases. Ionization of weak acids and bases, pH scale, common ion effect; dissociation constants of mono-, di- and triprotic acids (exact treatment). Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions; derivation of Henderson equation and its applications; buffer capacity, buffer range, buffer action and applications of buffers in biochemical processes. Solubility and solubility product of sparingly soluble salts-applications of solubility product principle. Qualitative treatment of acid-base titration curves (calculation of pH at various stages). Theory of acid–base indicators; selection of indicators and their limitations.	15	1,2,3,4,5	CO1 CO5	PSO1 PSO3
3	**Unit-III: Coordination Chemistry** Werner's theory, IUPAC nomenclature of coordination compounds, isomerism in coordination compounds. Stereochemistry of complexes with 4 and 6 coordination numbers. Chelate effect, polynuclear complexes, Labile and inert complexes. valence bond theory (inner and outer orbital complexes), electroneutrality principle and back bonding. Crystal field theory, measurement of $10\ Dq_{(octahedral\ (o)\ and\ tetrahedral\ (t))}$, CFSE in weak and strong fields, pairing energies, factors affecting the magnitude of $10\ Dq_{(o,t)}$. Applications of CFT: Special reference to colour of the metal complexes, Magnetic properties of the metal complexes.	15	1,2,3,4,5	CO3 CO6	PSO1 PSO3

Reference Books

1.	J. D. Lee, *Concise Inorganic Chemistry*, 5th Ed., Blackwell Science, London, 1996.
2.	F. A. Cotton, G. Wilkinson & P. L. Guas, *Basic Inorganic Chemistry*, 3rd Ed., John Wiley, 1994.
3.	B. Douglas, D. McDaniel & J. Alexander, *Concepts and Models of Inorganic Chemistry*, 3rd Ed., John Wiley, 1994.
4.	B. R. Puri, L. R. Sharma & K. C. Kalia, *Principles of Inorganic Chemistry*, Shoban Lal Nagin Chand and Co., 1996.
5.	J. E. Huheey, E. A. Kieter& R. L. Keiter, *Inorganic Chemistry*, 4th Ed., Harper Collins, New York, 1993.
6.	D. F. Shriver & P. W. Atkins, *Inorganic Chemistry*, 3rd Ed., W. H. Freeman and Co, London, 1999.
7.	T. Moeller, *Inorganic Chemistry: A Modern Introduction*, Wiley, New York, 1990.

School: School of Science			**Program: BSc – Life Science**		
Course Code: CH 105			**Course Name: Chemistry laboratory-II**		
Year	**I**	**Core Subject(Yes/No):**	No	**Lecture:**	**0**
Semester	**I**	**Elective Subject(Yes/No):**		**Tutorial**	**0**
Mode of Transaction	Laboratory	**Foundation Subject(Yes/No):**		**Practical:**	**4**
		Year of Syllabus Revision:		**Total Credit:**	**2**
		Year of Introduction	**2014**	**Prerequisites (If any)**	

Course Description:
student understanding of important concepts in Quantitative chemistry using volumetric analysis through hands-on experiments. In the chemistry laboratory, students will examine, test, and establish for themselves the chemical principles studied in class and from textbooks; will collect experimental data; and will use their reasoning to draw logical conclusions about the meaning of these date.

Course Outcome (CO):

CO1 To understand the fundamentals of volumetric titrations specifically Acidimetry – Alkalimetry titrations.

CO2 Describe the knowledge of the fundamentals of Redox Titrations, complexometric titrations in volumetric analysis.

CO3 comprehended the titration related to Argentometry titrations, Iodometry and Iodimetry titration using volumetric analysis.

CO4 Record observations and write laboratory reports according to disciplinary standards.

No.	Experiment	Contact Hours	BT Level	CO	PSO
	Volumetric Titrations				
1	Acid-base Titration	2	1, 2, 3, 4, 5, 6	CO1, CO4	PSO1, PSO3
2	Redox Titration	2	1, 2, 3, 4, 5, 6	CO2, CO4	PSO1, PSO3
3	Redox Titration using External Indicator	2	1, 2, 3, 4, 5, 6	CO2, CO4	PSO1, PSO3
4	Redox titration using internal indicator	2	1, 2, 3, 4, 5, 6	CO2, CO4	PSO1, PSO3
5	Complexometric titration	2	1, 2, 3, 4, 5, 6	CO1, CO2, CO4	PSO1, PSO3
6	Argentometry titration	2	1, 2, 3, 4, 5, 6	CO2, CO3, CO4	PSO1, PSO3
7	Iodometry Titration	2	1, 2, 3, 4, 5, 6	CO2, CO3, CO4	PSO1, PSO3
8	Iodimetry Titration	2	1, 2, 3, 4, 5, 6	CO2, CO3, CO4	PSO1, PSO3

Reference Books

1.	O. P. Pandey, D. N. Bajpai, S. Giri, Practical Chemistry, Revised Edition.
2.	R. C. Shah, Inorganic Analysis Part I Qualitative Analysis, Baroda Book Depot, Vadodara, 2001.

School: School of Science			**Program: BSc – Life Science**		
Course Code: MA110			**Course Name: Foundation Mathematics-I**		
Year	**I**	**Core Subject(Yes/No):**	**No**	**Lecture:**	**3**
Semester	**I**	**Elective Subject(Yes/No):**	**No**	**Tutorial**	**0**
Typology of Course	Lectures	**Foundation Subject(Yes/No):**	**Yes**	**Practical:**	**0**
		Year of Syllabus Revision:	**-**	**Total Credit:**	**3**
		Year of Introduction	**2014**	**Prerequisites (If any)**	**None**

Course Description: The study contains introduction to functions of several variables, Differentiation of multivariate functions, concepts of limits and continuity and their application in Life science. It also gives the introductory data computation, computational methods involved in the calculations of simple and compound interest, profit-loss, discount, tax, variations (direct and inverse) etc.

Course Objectives: The objective of the course is to
- Introduce the concept of functions of single and multiple variables
- Teach the concept of differentiability and it’s applications to biological/chemical sciences
- Teach the arithmetical methods involved in the calculations of simple and compound interest, profit and loss, discount, taxes, direct and inverse variations etc.

Course Outcome (CO):

CO1	Understand the concept of functions of single and multiple variables
CO2	Internalize definitions of Limits, Continuity and Differentiability
CO3	Differentiate functions of single and multiple variables
CO4	Apply concepts of percentage, profit loss, discount and taxes to real life problems
CO5	Understand direct and inverse variations and solve problems
CO6	Understand growth in terms of simple and compound interest
CO7	Solve time and work problem

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	Functions of two variables, Domain and range of functions of two variables	6	1,2,3	CO1	PSO1
2	Limits and Continuity functions of two variables.	5	1,2,3,4	CO2	PSO1
3	Differentiability, Chain rule, Implicit differentiation	10	1,2,3,5	CO3	PSO1
4	Taylor’s theorem for functions of two variables.	6	1,4,5	CO3	PSO1
5	Slightly advanced problems involving applications on percentages, profit & loss, overhead expenses, Discount, tax, Difference between simple and compound interest, Arriving at the formula for compound interest through patterns and using it for simple problems	10	1,3,4,5	CO4, CO5, CO6	PSO1
6	Direct variation, Inverse variation, Time & work problems	8	1,3,4,5	CO6, CO7	PSO1

Reference Books

1.	Apostol T.M., 1967, *Calculus,* Vol. II, IInd Edition, John Willey, New York
2.	Narayan Shanti and Mittal P.K., 1979, *A Course of Mathematical Analysis*, 12th Edition. S. Chand and Co
3.	Spiegel M.R., *Advanced Calculus*, Schaum Series
4.	Widder D.V., 1944, *Advanced Calculus,* IInd Edition, Prentice Hall of India, New Delhi.
5.	James T. Shea, 1991.*Basic Essentials of Mathematics, Book 2: Percent, Measurement & Formulas, Equations, Ratio & Proportion,* sold by Amazon.com
6.	Silvio Belli, Stephen R. Wassell, Kim Williams.,2007. *On ratio and proportion: the common properties of quantity Nexus, architecture and mathematics*. Kim Williams Books, 2002

School: School of Science			**Program: BSc – Life Science**		
Course Code: LC 119			**Course Name: Communication I**		
Year	**I**	**Core Subject(Yes/No):**	**Yes**	**Lecture:**	**2**
Semester	**I**	**Elective Subject(Yes/No):**		**Tutorial**	**-**
Typology of Course	Lectures	**Foundation Subject(Yes/No):**		**Practical:**	**-**
		Year of Syllabus Revision:		**Total Credit:**	**02**
		Year of Introduction	**2014**	**Prerequisites (If any)**	**Knowledge of basic grammar components and vocabulary.**

Course Description:
This Communication course is conceptualized as a course aimed at enhancing English language as a tool of learning and English language as a tool of communication in a professional context. It offers a framework for English language proficiency required of a student in academic work in general as well as in discipline specific perspective. As a tool of learning, the four skills of language and learning: listening, speaking, reading and writing are practiced. The practice of communication in the professional context deals with understanding the mechanics of language. The focus is on building the language skills required in discipline specific areas. It is a workshop based course providing hands-on experience to learners. This course focuses largely on training the students in writing and speaking proficiency, usage of English language in academic context as well as preparing them for the outside world of work.

Course Objectives:
This course will enable students to ….
- Develop their overall listening, speaking, reading and writing skills,
- Develop knowledge of vocabulary and grammar,
- Read and comprehend texts of varying length at basic/low intermediate level.
- Understand and use effective writing skills to express ideas/give information.
- Develop students' general capacity to a level that enables them to use English for their academic and professional requirements.

Course Outcome (CO):
CO1 Explain the prerequisites of effective communication
CO2 Identify people's communication styles and needs
CO3 Summarize a passage of text in their own words highlighting the embedded ideas, facts, supportive arguments
CO4 Describe the need for Emotional Intelligence in professional settings.
CO5 Make effective presentations with appropriate verbal and non-verbal communication.
CO6 Explain the importance of information acquisition, processing and dissemination.
CO7 Justify the importance of Knowing and upholding the policies, laws and regulations relevant to professional practice regardless of personal views.

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	Comprehension Paragraphs writing including all grammar Paraphrasing and notetaking Revision of all Communication skills – LSRW with activities Communication skills - Precis / Abstract writing Letter Writing – formal, informal. Digital Literacy, Use of social media Report Writing	10	1 2 3 4 5	CO1 CO2 CO3 CO4 CO5 CO6 CO7	PSO1 PSO3
2	Professional skills - A Resume writing, Interview and Group Discussion	5	1,2,3,4,5	CO1 CO2 CO4	PSO3
3	**Professional skills B –** Presentation, Oral presentation • Preparation • Using the report as guideline • Formulating the central message • Arranging the ideas, facts and supportive arguments • Making a positive impact (appearance, gestures, eye contact, body language, style of speaking) • Effective use of visual aids y (types of visual aid equipment, using the equipment correctly) • Maximizing delivery (fielding questions, managing answers, handling difficult situations, short talk guidelines, impromptu sessions) • Practical Session: Delivery of a two-minute presentation (each delegate delivers a presentation on a particular aspect of the technical report)	10	1,2, 3, 4,5	CO1 CO2 CO3 CO4 CO5 CO6	PSO2 PSO3
4	SOCIAL SKILLS Leadership and Management skills	5	1, 2, 3,4	CO1 CO2 CO4 CO7	PSO3

Reference Books:

1. John Seely; Oxford Guide to Effective Writing and Speaking; Oxford University Press; 2009 Ed.

2. L. Gartside; Modern Business Correspondence; The English Language Book Society and Macdonald and Evans Ltd.
3. Lester and Beason; The McGraw Hill Handbook of English Grammar and Usage; Tata McGraw Hill Education Private Limited; 2010 Ed.
4. Ellet, William; The case Study Handbook; Harvard Business Review Press
5. Bovee, Thill and Chaturvedi; Business Communication Today; Pearson Education; 2009 9TH ed.
6. Scot Ober; Contemporary Business Communication; Biztantra Publications; 2009 5th ed.
7. Inch. E.S. & Warnick Barbara; Critical Thinking and Communication; Perason;2011 ed.
8. Herrmann Robert Ned; The Whole Business Brain; McGraw-Hill, 1998.
9. Clemen, T Robert; Making Hard Decisions ; Duxbury Press, 1996

School: School of Science			**Program: BSc – Life Science**		
Course Code: MG117			**Course Name:** Principles of Management and Accounting		
Year	**I**	**Core Subject(Yes/No):**	**Yes**	**Lecture:**	**3**
Semester	**I**	**Elective Subject(Yes/No):**	**No**	**Tutorial**	
Typology of Course	Lectures	**Foundation Subject(Yes/No):**	**Yes**	**Practical:**	
		Year of Syllabus Revision:	**2021**	**Total Credit:**	**3**
		Year of Introduction	**2009**	**Prerequisites (If any)**	**-**

Course Description:
The course outline has been designed to serve the purpose of understanding basics of management and accounting

Course Objectives:
The overall all objective of this course is to educate students about the management as an activity and have a holistic approach to the concept. Accountancy basics are the requirement of the generation.

Course Outcome (CO):

- *CO1 Become an efficient learner of management*
- *CO2 Develop and understand methods of management.*
- *CO3 Gain knowledge managing finance through Accounts*

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	Unit 1- Management Basics, Management theories, Process of management, Managers qualities	11	1,2	CO1	PSO1
2	Unit 2- Evolution of Management, Functions - Planning Planning process, Decicion making, PRINCIPLES OF ORGANISATIONS, COORDINATION AND CONTROLLING, Directing	11	1,2,3	CO1, CO2	PSO1, PSO2
3	Unit 3- Accounting Basics, Rules of accounting, Principles Accounting process, Journal, Journal enteries, Ledger, Trial Balance	11	2, 3, 4	CO1,CO3	PSO1, PSO2
4	Unit 4- Financial Statements, Books of accounts, Profit and loss statement, Balance sheet, Analysis	12	1, 2, 3	CO3	PSO1, PSO2, PSO4

Reference Books

1.	Principles of Management Book by Dan Voich and Daniel A. Wren
2.	ICAI ONLINE PDF

<table>
<tr><td colspan="3">School: School of Science</td><td colspan="3">Program: BSc – Life Science</td></tr>
<tr><td colspan="3">Course Code: LS179</td><td colspan="3">Course Name: Biochemistry -I</td></tr>
<tr><td>Year</td><td>I</td><td>Core Subject(Yes/No):</td><td>Yes</td><td>Lecture:</td><td>3</td></tr>
<tr><td>Semester</td><td>II</td><td>Elective Subject(Yes/No):</td><td>-</td><td>Tutorial</td><td>-</td></tr>
<tr><td rowspan="3">Typology of Course</td><td rowspan="3">Lectures</td><td>Foundation Subject(Yes/No):</td><td>-</td><td>Practical:</td><td>-</td></tr>
<tr><td>Year of Syllabus Revision:</td><td></td><td>Total Credit:</td><td>3</td></tr>
<tr><td>Year of Introduction</td><td>2021</td><td>Prerequisites (If any)</td><td>-</td></tr>
</table>

Course Description:
This course introduces with the types of biomolecules, with significance of water for life and buffer and its role in biological system. It also focuses on basic introduction and classification of carbohydrates like cellulose, chitin, agar, pectin, proteoglycans, blood group polysaccharides, glycogen and starch, bacterial cell wall polysaccharides. And, biological significance of fats and fatty acids like glycerophospholipids, sphingomyelins, glycolipids-cerebrosides, gangliosides. Moreover, it gives an introduction and classification of amino acids, stating the biological significance of fibrous proteins.

Course Objectives: Student Should be able to classify biomolecules and have detail understanding of the basic and complex biomolecule structure. Biomolecules sources and their function in human body will be one of the objective of course

Course Outcome (CO):
CO1. learn the elements present in biomolecules and the difference monomers and polymers.
CO2. explain the role of water in the synthesis and breakdown of polymers.
CO3. list the four major complex biomolecules found in living cells, three of which are found on food labels and the basis for grouping of biomolecules into those four groups.
CO4. for each group of biomolecules learn the names of its generic monomer (simple unit) and polymer (complex structure) and their function.

Unit No.	**Topic/Unit**	**Contact Hours**	**BT Level**	**CO**	**PSO**
1	Unit-I: Basics of biological chemicals & Biomolecules: Introduction to biomolecules, Types of bonds in molecules of life and chemical foundation. Acid – Base chemistry. Study of structural properties of water, significance of water for life and buffer and its role in biological system. Carbohydrates: Introduction to carbohydrates, Occurrence and Classification of Carbohydrates, and Physiological properties of Carbohydrates. Occurrence and biological importance of carbohydrates like Cellulose, Chitin, agar, pectin, proteoglycans, blood group polysaccharides, glycogen and starch, bacterial cell wall polysaccharides- Glycoprotein etc. Fatty acids: Introduction, classification, nomenclature, structure and properties of saturated and unsaturated fatty acids. Examples of essential fatty acids and their nomenclature, physical,	15	1,2,3	CO1, CO2, CO3, CO4	PSO1, PSO2

	chemical and biological properties and significance. Biological significance of Fats like Glycerophospholipids, sphingomyelins, glycolipids-cerebrosides, gangliosides.				
2	Unit- II: Proteins and Nucleic acid: Introduction and classification of amino acids. Physical and chemical properties of amino acids. Study of Essential amino acids. Protein structure: primary, secondary, tertiary and quaternary structure of proteins. Denaturation and renaturation of proteins. Behaviour of proteins in solutions. Biological significance of fibrous proteins (keratins, collagen and elastin), globular proteins (hemoglobin, myoglobin), lipoproteins, metalloproteins, glycoproteins and nucleoproteins. Composition of RNA and DNA, generalized structural plan of nucleic acids, nomenclature and major features of DNA double helix. Properties and types of DNA and RNA. Size of DNA and packaging in Eukaryotic and Prokaryotic cells	15	1,2,3	CO3, CO4	PSO1, PSO2
3	Unit- III: Basics of Bio-catalysts – The Enzyme: Introduction, concept. Classification, lock and key model, induced fit model, active site, enzyme specificity and types. Enzyme kinetics, factors affecting the velocity of enzyme action. Enzyme concentration, temperature, pH, substrate concentration. Enzyme inhibition, reversible and irreversible, competitive, non-competitive and uncompetitive inhibition, allosteric enzymes. Isoenzymes, Zymogen form of enzyme and its activation. Applications of various enzymes. AB Enzymes.	15	2, 3, 4	CO4	PSO1, PSO2

Reference Books

1.	Lehninger Principles of Biochemistry by David L. Nelson, Michael M. Cox, 6th edition
2.	Biochemistry, 4th Edition Donald Voet, Judith G. Voet
3.	Harper's Biochemistry (30th edition) by Peter A Mayes and Victor W Rodwell
4.	Cell Biology, P.K. Gupta, 1998.
5.	Genetics, P.K. Gupta, , 1998.
6.	P.S. Verma & V.K. Agarwal, Cell biology, molecular biology, genetics and evolution, 1968.

School: School of Science	**Program: BSc – Life Science**
Course Code: LS180	**Course Name:** Cytology and Genetics

Year	**I**	**Core Subject(Yes/No):**	**Yes**	**Lecture:**	**3**
Semester	**II**	**Elective Subject (Yes/No):**	**-**	**Tutorial**	**-**
Typology of Course	Lectures	**Foundation Subject (Yes/No):**	**-**	**Practical:**	**-**
		Year of Syllabus Revision:		**Total Credit:**	**3**
		Year of Introduction	**2021**	**Prerequisites (If any)**	**-**

Course Description:
The course starts with an introduction to cellular biology focusing on various types of cells, comparative study prokaryotic and eukaryotic cells along with the understanding of simple and complex tissues specially in plants. It also focuses on various cell organelles- membrane bound and non-membrane bound, found in living cells, their detailed structure and function and basics of protein trafficking. The course helps to get knowledge of genetics and Mendalian inheritance, concept of alleles and cytogenetics overview of chromosomes and various abnormalities and mutations.

Course Objectives:
Types of cells- prokaryotic and eukaryotic and their structure, cell organelles- ribosomes, endoplasmic reticulum, golgi bodies, mitochondria and others, cell cycle and its regulation will be covered in this course. Moreover, concepts of genetics such as Mendelian genetics, chromosome structure, chromosomal abnormalities are the key course objectives of this course.

Course Outcome (CO):
I. Types of cells found in the living world
II. Cell organelles, their structure, and functions
III. Cytological structures
IV. Cell cycle- mitosis and meiosis
V. Mendelian genetics and cytogenetics
VI. Chromosomal abnormalities, diseases and mutations

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	**Unit I** Cytology - I: A brief introduction to Cell Biology, History, and concept of Cell Theory. Various types of cells and comparative study Prokaryotic (archaea and eubacteria) and eukaryotic cell (animal and plant cells).	15	1,2,3	CO1, CO2,	PSO1

	Simple tissues: Living (collenchyma and parenchyma) and dead (sclerenchyma) cell types Complex Tissues: Xylem and Phloem elements structure and function. Cell wall: Layers, function, formation of cell wall Intercellular communications: Plasmodesmata, pits - structure, types and functions. An introduction to Cell Organelles: cell wall, cell membrane, nucleus, endoplasmic reticulum, Golgi apparatus, vacuoles, lysosomes, mitochondria, plastids, and chloroplasts. Protein trafficking: Targeting proteins to ER, smooth ER and lipid synthesis. Export of proteins and lipids from ER. Protein import and mitochondrial assembly.				
2	**Unit II** Cytology-II: Non-membrane bound organelles: Ribosomes, centrioles, basal bodies, Cytoskeleton– Microtubules: structure and function. Structure of cilia and flagella. Microfilaments. Introduction to cell cycle and cell division: Mitosis, Meiosis I and Meiosis II. Cell death and cell renewal: Cell cycle regulation, Restriction point, and checkpoints. Apoptosis and necrosis - brief outline. Salient features of a transformed cell/cancer cell.	15	1,2,3	CO3, CO4	PSO1
3	**Unit III** Genetics: Introduction to genetics and Mendalian inheritance, Gene interactions: allelic and nonallelic, modified dihybrid ratios, Modified Mendalian ratios: allelic and nonallelic interactions- complementary genes, epistasis, additive, inhibitory, lethal genes, pleiotropy, polygenic inheritance, cytoplasmic inheritance. Cytogenetics: Chromosome morphology, karyotype and idiogram, Special types of chromosomes. Giant chromosome (Polytene chromosome, lampbrush chromosome). Chromosomal abnormality: numerical disorder; structural abnormalities. e.g. Down syndrome; Turner syndrome; Wolf-Hirschhorn syndrome. Genetic mutations.	15	1,2,3	CO5, CO6	PSO1

Reference Books	
1.	The Cell: A Molecular Approach (7th Edition) by Geoffrey M. Cooper, Robert E. Hausman
2.	Essential Cell Biology (4th Edition) Bruce Alberts, Dennis Bray, Karen Hopkin, Alexander D.Johnson, Julian Lewis, Martin Raff, Keith Roberts, and Peter Walter.
3.	Cell Biology, Genetics, Molecular Biology (1st Edition) P.S.Verma, 2004
4.	Cell and Molecular Biology (8th edition) by E. M. F. De Robertis and Eduardo de Robertis
5.	Cell Biology, P.K. Gupta, 1998.
6.	Genetics, P.K. Gupta, , 1998.
7.	Cytology, Genetics and Molecular Genetics by B.N. Pandey
8.	Lewin's Genes XII (12th edition) by Jones & Bartlett
9.	E.J. Gardner, Principles of genetics, 1968.
10.	G.B. Wilson & J.H. Morrison, Cytology, 1968.

<table>
<tr><td colspan="3">School: School of Science</td><td colspan="3">Program: BSc – Life Science</td></tr>
<tr><td colspan="3">Course Code: LS138</td><td colspan="3">Course Name: Life Science Laboratory III</td></tr>
<tr><td>Year</td><td>I</td><td>Core Subject(Yes/No):</td><td>Yes</td><td>Lecture:</td><td></td></tr>
<tr><td>Semester</td><td>II</td><td>Elective Subject(Yes/No):</td><td>-</td><td>Tutorial</td><td></td></tr>
<tr><td rowspan="3">Mode of Transaction</td><td rowspan="3">Laboratory</td><td>Foundation Subject(Yes/No):</td><td>-</td><td>Practical:</td><td>6</td></tr>
<tr><td>Year of Syllabus Revision:</td><td></td><td>Total Credit:</td><td>3</td></tr>
<tr><td>Year of Introduction</td><td>2020</td><td>Prerequisites (If any)</td><td></td></tr>
</table>

Course Description:

The course is designed to introduce laboratory fundamentals of human anatomy and physiology. Clinical physiology concepts and experiments such as blood and urine analysis are included in detail. The course also includes basic qualitative estimations of carbohydrates, proteins and lipids and their significance in context to human physiology.

Course Outcome (CO):

1. gain understanding of anatomy and physiology of humans
2. understand concepts and mechanisms associated with various physiological systems
3. understand the relationship between anatomical structure, functions and their clinical observations.

No.	Experiment	Contact Hours	BT Level	CO	PSO
1	Understand and solve basic problems of normality, molarities, % solution preparation	12	1,2,3,5	CO1	PSO2, PSO3
2	Qualitative analysis of Carbohydrates: a) Test for carbohydrates: Molisch's test b) Test for reducing sugar: Fehling's Test, Barfoed's Test, Seliwanoff's Test, Bial's Test c) Action of Alkali on Sugars d) To perform Inversion of Sucrose e) Test for Polysaccharide: Iodine Test f) Test for aldose and ketose: Osazone Test	12	1,2,4,5	CO1,	PSO2, PSO3
3	Qualitative analysis of Amino acids and Proteins: a) Test for amino acids and proteins : Solubility test, Ninhydrine test, Biuret test, Precipitation test b) Specific Reactions for Individual Amino Acids: Xanthoproteic test, Millon's Test, Sakaguchi Test, Nitroprusside Test, Hopkin's Cole Test, Folin test	12	1,2,3,5	CO1	PSO2, PSO3
4	Qualitative analysis of Lipids: a) Test for solubility of lipids in polar & non-polar solvents : Solubility test b) Translucent	12	1, 2, 3	CO1	PSO2, PSO3

	Spot Test c) Emulsification Test d) Free fatty acid test e) Sudan red IV test f) Saponification test- Soap preparation g) Test for Glycerol :Dichromate Test Test for Cholesterol : Salkowski test to detect the presence of unsaturated fatty acids				
Reference Books					
1.	The Science of Laboratory Diagnosis 2nd Edition by John Crocker (Editor), David Burnett (Editor)				
2.	Advanced Practical Zoology by Dr. P.S.Verma, 2012				

<table>
<tr><td colspan="3">School: School of Science</td><td colspan="3">Program: BSc – Life Science</td></tr>
<tr><td colspan="3">Course Code: LS139</td><td colspan="3">Course Name: Life Science Laboratory IV</td></tr>
<tr><td>Year</td><td>I</td><td>Core Subject (Yes/No):</td><td>Yes</td><td>Lecture:</td><td>-</td></tr>
<tr><td>Semester</td><td>II</td><td>Elective Subject (Yes/No):</td><td>-</td><td>Tutorial</td><td>-</td></tr>
<tr><td rowspan="3">Typology of Course</td><td rowspan="3">Practical</td><td>Foundation Subject (Yes/No):</td><td>-</td><td>Practical:</td><td>4</td></tr>
<tr><td>Year of Syllabus Revision:</td><td></td><td>Total Credit:</td><td>2</td></tr>
<tr><td>Year of Introduction</td><td>2021</td><td>Prerequisites (If any)</td><td>-</td></tr>
</table>

Course Description:
This course introduces the study of cell, cell organelles and cell division. Students will gain the knowledge regarding how to differentiate blood cells by preparation blood smear and performing cell count techniques. They will learn the interaction of biotic and abiotic components practically. They will gain the knowledge regarding plants and animal distribution throughout the world, India as well as in Gujarat.

Course Objectives:
Students will be able to correlate various abnormalities in the human body with the blood practical. Various physiochemical parameters will also help the students to learn about the abnormalities in the human system.

Course Outcome (CO):
CO1. Gain understanding the cell components and cytology
CO2. To analyze genetic disorders
CO3. To gain an understanding of animal and plant distribution internationally, nationally and regionally.
CO4. Understand the abnormalities in the blood cells due to various physiological effects

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	To study General laboratory instruments and compound microscope handling technique	6	1,2,3	CO1	PSO1
2	To prepare temporary mount slide of onion peel as a study model of plant cell	6	2,3,4	CO2, CO4	PSO1 PSO2
3	To prepare temporary mount slide of cheek cells (Human buccal cavity epithelial cells) as a study model of animal cell	6	2,3,4	CO2 CO4	PSO1 PSO2
4	To study mitotic stages of cell division through observing permanent slides under compound microscope	6	2,3,4,5	CO2 CO4	PSO1 PSO2
5		6	2,3,4	CO2 CO4	PSO1 PSO2

	To prepare temporary mount slide for mitotic stages study in Onion root tip cells (in Meristematic tissue)				
6	To study meiotic stages of cell division through observing permanent slides under compound microscope	6	1,2,3	CO3 CO4	PSO1 PSO2
7	To study pipette handling, Pipette calibration and solution preparation	6	1,2,3	CO1	PSO1
8	To observe and study plasmolysis process in Tredescetia and onion leaves with using different solutions	6	1,2,3	CO1 CO4	PSO1 PSO2
9	To prepare blood smear on slide of own blood	6	1,2,3	CO1 CO4	PSO1 PSO2
10	To observe and study white blood cells by performing differential staining through leishman's stain in blood cells smear of own blood	6	1,2,3	CO1 CO2 CO4	PSO1 PSO2

Reference Books

1.	Cell biology Practical Manual by by Dr. Renu Gupta (Author), Dr. Seema Makhija (Author), Dr. Ravi Toteja (Author) – 2018
2.	Basic Histopathology. A Colour Atlas and Text. Paul Wheater, George Burkitt, Alan Stevens and James Lowe. ELBS with Churchill Livingstone 4th edition, 2002
3.	Ecology Lab Manual , Book by Darrell S. Vodopich , 2009

School: School of Science			**Program: BSc – Life Science**		
Course Code: CH 109			**Course Name: Conceptual Organic Chemistry**		
Year	**I**	**Core Subject(Yes/No):**	**Yes**	**Lecture:**	**3**
Semester	**II**	**Elective Subject(Yes/No):**	**No**	**Tutorial**	**0**
Typology of Course	Lectures	**Foundation Subject(Yes/No):**	**No**	**Practical:**	**0**
		Year of Syllabus Revision:	**2019**	**Total Credit:**	**3**
		Year of Introduction	**2014**	**Prerequisites (If any)**	**HSC Science**

Course Description:

This paper provides the student with the necessary background to understand the chemistry of carbon-containing compounds. Topics will include structure, stereochemistry, nomenclature, synthesis, properties, and reactions of the major classes of organic compounds.

Course Objectives:

The student will be able to learn and understand a systematic study of the compounds of carbon, including methods of synthesis and correlation of chemical and physical properties with structure. Introduction to certain theoretical concepts

Course Outcome (CO):

CO1 understands the basics of synthesis, reactions, properties and applications of Alkanes and alkyl halides, Alkenes, Alkynes

CO2 interprets the synthesis, reactions, properties, and applications of alcohols and phenols.

CO3 comprehends details of synthesis, reactions, properties and application Aldehyde, ketones, carboxylic acid and their functional derivatives, Amines

CO4 understands the reactivity and stability of an organic molecule based on structure, including conformation and stereochemistry and their significance

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	Unit-I: Alkanes and alkyl halides, Alkenes, Alkynes: Alkanes and alkyl halides: Introduction, Preparation of alkanes, hydrogenation of alkenes and alkynes, Reduction of alkyl halide (Metal & mineral acid, Grignard reagent) and Corey House synthesis. Introduction, synthesis of alkyl halides from alcohols, hydrocarbons, alkenes, alkynes. Reactions: SN1 and SN2 reactions (concept of substrate, nucleophile, leaving group). Alkenes: Introduction, geometric isomerism and nomenclature, preparation of alkenes from alkyl halides, alcohols and dehalogenation of vicinal dihalides, E1 and E2 mechanism of dehydrohalogenation (Saytzeff's rule). Electrophillic addition reactions and orientation (Markovnikov's and anti-Markovnikov's addition); mechanism of addition of H2, X2, HX, H2SO4, H2O and X2/H2O, addition of alkene, oxymercuration-demercuration, hydroboration, hydroxylation Alkynes: Introduction, structure of acetylene, Preparation of	15	1, 2, 3, 4, 5	CO1, CO4	PSO1, PSO3

	alkynes (from alkyl halides and metal acetylides), reaction of alkynes with H2, X2, HX and H2O, acidity of alkynes.				
2	Unit-II: Alcohols, ethers and phenols: Alcohols: Introduction, Preparation: oxymercuration-demercuration, hydroboration-oxidation, hydroxylation of alkenes, Grignard reaction, hydrolysis of alkyl halides. Reactions with HX, PX3, dehydration and oxidation. Esterification. Ethers: Nomenclature, preparations: Williamson synthesis and alkoxymercuration-demercuration, cleavage by acids. Phenols: Nomenclature, Industrial source (from cumene), Reactions: Nitration, sulfonation, halogenations, Friedel-Craft alkylation and acylation.	8	1, 2, 3, 4, 5	CO2, CO4	PSO1, PSO3
3	Unit-III: Aldehyde, ketones, carboxylic acid and their functional derivatives, Amines: Aldehydes and ketones: Structure and nomenclature, Tollens' test, Haloform reaction (iodoform test), addition of cyanide, derivatives of ammonia and Grignard reagent. Carboxylic acid: Structure and Nomenclature, Preparation: oxidation of primary alcohols, alkylbenzenes, carbonation of Grignard reagents, hydrolysis of nitriles. Functional derivatives of carboxylic acid: Structure and Nomenclature, conversion into acid chlorides, anhydrides, esters and amides, mechanism of esterification and decarboxylation. Amines: Structure and Nomenclature, Hofmann rearrangement, Diazonium salts preparation and reactions (only Sandmeyer and coupling reaction)	7	1, 2, 3, 4, 5	CO3, CO4	PSO1, PSO3
4	Unit-IV: Stereochemistry: Fischer projection, Newman and Sawhorse projection, Wedge formula. Interconversion of one type of structural representation into another type of formula. Conformations: Various conformations of ethane, butane and cyclohexane. Relative stability of different conformations in terms of energy difference is to be discussed for all these compounds. Geometrical Isomerism: Requirements for a molecule to show geometrical isomerism, cis-trans and E/Z notation along with CIP rules for naming geometrical isomers. Optical Isomerism: Optical activity, chirality, enantiomerism, diastereoisomerism, meso compound, racemic mixtures. Difference between d/l and D/L notations. Threo and Erythro designation. R- and S-configuration (upto two chiral centres).	15	1, 2, 3, 4, 5	CO4	PSO1 PSO3

Reference Books	
1.	P. S. Kalsi, Stereochemistry: Conformation and Mechanism, 2nd Ed., Wiley Eastern Ltd., 1993
2.	R. T. Morrison, R. N. Boyd and S. K. Bhattacharjee, Organic Chemistry, 7th Ed., Pearson New Delhi, 2012.
3.	T. W. Graham Solomons and C. B. Fryhle, Organic Chemistry, 10th Ed., John Wiley and Sons, 2012.
4.	ArunBahl and B. S. Bahl, A Textbook of Organic Chemistry, S. Chand and Sons, New Delhi, 2005.
5.	D. Nasipuri, Stereochemistry of Organic Compounds: Principles and Applications, 3rd Ed., New Age International Publishers, New Delhi, 2011.

6.	Bhupendra Mehta, Manju Mehta, Organic Chemistry, 2nd Ed., PHI Learning Pvt. Ltd, New Delhi, 2015.
7.	Jonathan Clayden, Nick Greeves, Stuart Warren, Peter Wothers, Organic Chemistry, 1st Edition, Oxford University Press Inc., New York, USA, 2001.

<table>
<tr><td colspan="3">School: School of Science</td><td colspan="3">Program: BSc – Life Science</td></tr>
<tr><td colspan="3">Course Code: CH 108</td><td colspan="3">Course Name: Chemistry Laboratory-IV</td></tr>
<tr><td>Year</td><td>I</td><td>Core Subject(Yes/No):</td><td>Yes</td><td>Lecture:</td><td>0</td></tr>
<tr><td>Semester</td><td>II</td><td>Elective Subject (Yes/No):</td><td>No</td><td>Tutorial</td><td>0</td></tr>
<tr><td rowspan="3">Mode of Transaction</td><td rowspan="3">Laboratory</td><td>Foundation Subject (Yes/No):</td><td>No</td><td>Practical:</td><td>4</td></tr>
<tr><td>Year of Syllabus Revision:</td><td>2018</td><td>Total Credit:</td><td>2</td></tr>
<tr><td>Year of Introduction</td><td>2014</td><td>Prerequisites (If any)</td><td></td></tr>
</table>

Course Description:

An essential element of experimental organic chemistry is the identification of unknown organic compounds from the given mixture. This course covers the following topics: separation and purification of organic molecules; synthesis using diverse techniques; and functional group identification using organic methods.

Course Outcome (CO):

(Note: COs can be 6±2 for courses with 2 to 4 credits, and 8±2 for courses with 5 to 6 credits)

CO1 Students will explore the concept of Inorganic qualitative analysis for the identification of cations and anions.

CO2 Students will explore the experiments with qualitative analysis of inorganic salt by following the test in a sequential manner and will gain knowledge to identify acid and basic radicals from the mixture.

No.	Experiment	Contact Hours	BT Level	CO	PSO
	Inorganic Spotting (Salt Analysis)				
1	NH4Cl	2	1, 2, 3, 4, 5	CO1, CO2	PSO1, PSO2, PSO3
2	CuSO4	2	1, 2, 3, 4, 5	CO1, CO2	PSO1, PSO2, PSO3
3	KCl	2	1, 2, 3, 4, 5	CO1, CO2	PSO1, PSO2, PSO3
4	CdCl2	2	1, 2, 3, 4, 5	CO1, CO2	PSO1, PSO2, PSO3
5	MnCl2	2	1, 2, 3, 4, 5	CO1, CO2	PSO1, PSO2, PSO3
6	MgCO3	2	1, 2, 3, 4, 5	CO1, CO2	PSO1, PSO2, PSO3
7	NaBr	2	1, 2, 3, 4, 5	CO1, CO2	PSO1, PSO2, PSO3
8	Pb (NO3)2	2	1, 2, 3, 4, 5	CO1, CO2	PSO1, PSO2, PSO3
9	Na3PO4	2	1, 2, 3, 4, 5	CO1, CO2	PSO1, PSO2, PSO3
10	CaCl2	2	1, 2, 3, 4, 5	CO1, CO2	PSO1, PSO2, PSO3
11	Sr (NO3)2	2	1, 2, 3, 4, 5	CO1, CO2	PSO1, PSO2, PSO3
12	BaCl2	2	1, 2, 3, 4, 5	CO1, CO2	PSO1, PSO2,

					PSO3
13	FeSO4	2	1, 2, 3, 4, 5	CO1, CO2	PSO1, PSO2, PSO3
Reference Books					
1.	G. Svehla, Vogel's Qualitative Inorganic Analysis, 6th Ed., Orient Longman, 1989				
2.	R. C. Shah, Inorganic Analysis Part I Qualitative Analysis, Baroda Book Depot, Vadodara, 2001.				

<table>
<tr><td colspan="3">School: School of Science</td><td colspan="3">Program: BSc – Life Science</td></tr>
<tr><td colspan="3">Course Code: HS106</td><td colspan="3">Course Name: Humanities</td></tr>
<tr><td>Year</td><td>I</td><td>Core Subject(Yes/No):</td><td>Yes</td><td>Lecture:</td><td>2</td></tr>
<tr><td>Semester</td><td>II</td><td>Elective Subject(Yes/No):</td><td></td><td>Tutorial</td><td>NA</td></tr>
<tr><td rowspan="3">Typology of Course</td><td rowspan="3">Lectures</td><td>Foundation Subject(Yes/No):</td><td></td><td>Practical:</td><td>NA</td></tr>
<tr><td>Year of Syllabus Revision:</td><td>2020</td><td>Total Credit:</td><td>2</td></tr>
<tr><td>Year of Introduction</td><td>2019</td><td>Prerequisites (If any)</td><td>NA</td></tr>
</table>

Course Description:
The Course on Humanities entails the study of the human world and society from a critical perspective. The Humanities Course provides a broad understanding of the world in which we live, and how people can participate as active and informed citizens with the skills needed for the 21st century. The course focuses on the relationship between education, technology and society. The course also makes students aware about the theories and approaches to learning in view of 21^{st} century requirements. The Course highlights the need to develop an understanding of ethical considerations and the implications of decisions that are made for individuals, society, the economy and the environment.

Course Objectives:

1. To enable students to understand the impact of education on the Individual and society.
2. To enable students to understand the interdependence between education and society.
3. To make students aware about the theories and approaches to learning in view of 21^{st} century requirements.
4. To enable students to identify the impact of technology on their life and society.
5. To enable students to develop the skill of ethical reasoning and/or ethical decision making.

Course Outcome (CO):

CO1	Describe the necessity of education and its impact on society
CO2	Explain various theories of learning and their implications
CO3	Relate the theories of learning with the present societal contexts (eg Make in India/Digital India/ Skill India)
CO4	Justify the need for EQ to achieve career and professional goals
CO5	Explain the inter-dependence between education and technology in shaping society.
CO6	Explain the importance of ethical decision making and academic integrity.

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	- Necessity of Education for human life, Impact of Education on society. - Necessity of education in Human life - UNESCO 4 Pillars of Education - Impact of education on society - Make in India/Digital India/ Skill India. - Necessity: Individual vs. citizen. (Russel - Ability to read & write, Decent livelihood, Better communication, Use of technology, Secure transactions,	8	2,3,4,5	CO1 CO3	PSO3

	Serve society, Knowledge Propagation, Social harmony)				
2	- Knowledge of the different types of education - Formal, Informal & Non formal education; Liberal, Professional, Vocational & Technical education - Emotional Intelligence: Models of Emotional Intelligence. - Domains of Learning: Cognitive, Effective & Psychomotor - Approaches to Learning: Behaviorism; Constructivism. - Theories of Learning: Multiple Intelligence; Information processing theory.	10	2,3,4,5	CO2 CO4	PSO3
3	- Impact of technology on education and society (Technology and Social Change; Technological Determinism; Technology and Inequality; Technology & Human Well-being; Technology and Environmental Change,..)	6	2,3,4,5	CO5	PSO3
4	– Ethical and value implications of education and technology on individual and society; – Professional ethics, Plagiarism. – Professional ethics (Durkheim), Positive & Negative Thinking, Assertiveness, Assertive rights	6	2,3,4	CO6	PSO3

Suggested Reading

1.	Bucchi, Massimiano (2004) *Science in society: An introduction to social studies of science.* London & NY: Routledge Taylor & Francis group.
2.	Durkheim, Emile (1957/2003) *Professional ethics and civic morals*. (Tr.) Cornelia Brookfield (Prefaced by) Bryan S. Turner. London & NY: Routledge (2nd Edition)
3.	Matthew H. Olson, Julio J. Ramirez (2020), *An Introduction to Theories of Learning,* London & NY: Routledge Taylor & Francis group, (10th Edition)
4.	Rethinking education: Towards a global common good? by UNESCO publishing.
5.	Richard Paul Janaro & Thelma C. Altshuler (2011). The Art of Being Human: Humanities as a Technique for Living Person. Pearson Publication.
6	Rohan Dsouza. Environment, Technology and Development. Orient Blackswan, 2012.
7	Russel, Bertrand (1932/2010) *Education and social order.* London & NY: Routledge Classics
8	R.V.G. Menon. Technology and Society. Pearson, 2011

School: School of Science	**Program: BSc – Life Science**
Course Code: MA117	**Course Name:** Foundation Mathematics-II

Year	**I**	**Core Subject(Yes/No):**	**No**	**Lecture:**	**3**
Semester	**II**	**Elective Subject(Yes/No):**	**No**	**Tutorial**	**0**
Typology of Course	Lectures	**Foundation Subject(Yes/No):**	**Yes**	**Practical:**	**0**
		Year of Syllabus Revision:		**Total Credit:**	**3**
		Year of Introduction	**2014**	**Prerequisites (If any)**	

Course Description:

The study contains Introduction of Integration and its application in Life science. Its also gives the introductory statistics.

Course Objectives:

1. Develop understanding of fundamentals of Integral Calculus
2. Understand the importance of Calculus
3. Understand and apply different statistical methods for data analysis

Course Outcome (CO):

CO1	Able to understand the fundamentals of Integral Calculus
CO2	Able to calculate integration for different types of functions
CO3	Able to calculate Area, volume for 2D, 3D figures
CO4	Able to apply different statistical methods for data analysis

Unit No.	**Topic/Unit**	**Contact Hours**	**BT Level**	**CO**	**PSO**
1	Unit 1 Simple Integrations Introduction to Integration Formulas in Integration Simple sums related to Integration	15	1	CO1, CO2	PSO1
2	Unit 2 Area and Volume Finding areas and surface areas for two dimensional figures Finding Volume for three dimensional figures	10	2	CO3	PSO2
3	Unit 3 Introduction to Statistics Bar Graph, Histogram, Box plot, Scatter plot, Mean, Median, Mode, Range, Variance, Standard deviation, Skewness, Kurtosis	20	3, 4	CO4	PSO3 PSO4

Reference Books

1.	Spiegel M.R., Advanced Calculus, Schaum Series.
2.	Hogg R. V. & Craig A. T. 1988) : Introduction to Mathematical Statistics, Mcmillan.
3.	Mood A. M & Graybill F. A & Boes D. G (1974) : Introduction to theory of Statistics, Mcgraw Hill.

<table>
<tr><td colspan="3">School: School of Science</td><td colspan="3">Program: BSc – Life Science</td></tr>
<tr><td colspan="3">Course Code: LC 120</td><td colspan="3">Course Name: Communication II</td></tr>
<tr><td>Year</td><td>I</td><td>Core Subject(Yes/No):</td><td>Yes</td><td>Lecture:</td><td>3</td></tr>
<tr><td>Semester</td><td>II</td><td>Elective Subject(Yes/No):</td><td></td><td>Tutorial</td><td>-</td></tr>
<tr><td rowspan="3">Typology of Course</td><td rowspan="3">Lectures</td><td>Foundation Subject(Yes/No):</td><td></td><td>Practical:</td><td>-</td></tr>
<tr><td>Year of Syllabus Revision:</td><td>2020</td><td>Total Credit:</td><td>03</td></tr>
<tr><td>Year of Introduction</td><td>2018</td><td>Prerequisites (If any)</td><td>Knowledge of basic grammar components and vocabulary.</td></tr>
</table>

Course Description:

This Communication course is conceptualized as a course aimed at enhancing English language as a tool of learning and English language as a tool of communication in a professional context. It offers a framework for English language proficiency required of a student in academic work in general as well as in discipline specific areas. As a tool of learning, the four skills of language and learning: listening, speaking, reading and writing are practiced. The focus is on building language skills required in discipline specific areas.

The practice of communication in the professional context deals with understanding hierarchy, tone and appropriate vocabulary.

This Course focuses largely on training the students in writing and speaking proficiency, usage of English language in academic context as well as preparing them for the world of work.

Course Objectives:

This course will enable students to:

1. Develop their overall listening, speaking, reading and writing skills,
2. Develop knowledge of vocabulary and grammar,
3. Read and comprehend texts of varying length at basic/low intermediate level.
4. Understand and use effective writing skills to express ideas/give information.
5. Develop students' general capacity to a level that enables them to use English for their academic and professional requirements.

Course Outcome (CO):

CO1 Describe the Communication cycle, types of communication, barriers and ways to address these.

CO2 Read and analyze texts and evaluate ideas therein

CO3 Express oneself clearly while communicating with others (reports, letters, …)

CO4 Participate constructively in class discussions

CO5 Illustrate communication and techno skills while making presentations

CO6 Refer to authentic sources of information and cite the same ethically.

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	**Communication Skills –** – Comprehension (including all grammar components) – Essay writing – Precis writing / Abstract writing – Report Writing (Compiling the report & Report structure) – Importance of Digital Literacy; Use of social media – Capstone Paper and presentation	15	1,2,3,4,5,6	CO1 CO2 CO3 CO4 CO5 CO6	PSO1 PSO5
2	**Professional Skills - A** – Letter Writing – Resume writing, – Interview – Group Discussion skills.	5	1,2,3,4,5	CO3 CO4 CO6	PSO1 PSO5
3	**Professional Skills - B** – Designing the KWL Chart - Formulating the central message – Arranging the ideas, facts & supportive arguments – Making a positive impact (appearance, gestures, eye contact, body language, style of speaking) – Effective use of visual aids (types of visual aid equipment, using the equipment correctly) – Maximizing delivery (fielding questions, managing answers, handling difficult situations, short talk guidelines, impromptu sessions) – Practical Session: Delivery of a two-minute presentation (each student delivers a presentation on the KWL Chart) **Professional Ethics** – Understanding academic integrity – Plagiarism rules	10	1,2, 3, 4,5	CO4 CO5 CO6	PSO1 PSO5
4	**Social Skills** – Leadership and Management skills	5	1,2,3,4,5	CO4 CO5 CO6	PSO1 PSO5

5	**Critical thinking skills** – Significance of Critical thinking skills – Concept map designing – Fishbone Diagram	10	1,2,3,4,5,6	CO2 CO3 CO4 CO5	

Reference Books

1.	John Seely; **Oxford Guide to Effective Writing and Speaking**; Oxford University Press; 2009 Ed.
2.	L. Gartside; **Modern Business Correspondence**; The English Language Book Society and Macdonald and Evans Ltd.
3.	Lester and Beason; **The McGraw Hill Handbook of English Grammar and Usage**; Tata McGraw Hill Education Private Limited; 2010 Ed.
4.	Ellet, William; **The case Study Handbook**; Harvard Business Review Press
5.	Bovee, Thill and Chaturvedi; **Business Communication Today;** Pearson Education; 2009 9TH ed.
6.	Scot Ober; **Contemporary Business Communication**; Biztantra Publications; 2009 5th ed.
7.	Inch. E.S. & Warnick Barbara; **Critical Thinking and Communication**; Perason;2011 ed.
8.	Herrmann Robert Ned; **The Whole Business Brain**; McGraw-Hill, 1998
9.	Clemen, T Robert; **Making Hard Decisions**; Duxbury Press, 1996

School: School of Science			**Program: BSc – Life Science**		
Course Code: MG108			**Course Name: Economics and Finance**		
Year	**I**	**Core Subject(Yes/No):**	**Yes**	**Lecture:**	**3**
Semester	**II**	**Elective Subject(Yes/No):**	**No**	**Tutorial**	**-**
Typology of Course	Lectures	**Foundation Subject(Yes/No):**	**Yes**	**Practical:**	**-**
		Year of Syllabus Revision:	**2021**	**Total Credit:**	**3**
		Year of Introduction	**2009**	**Prerequisites (If any)**	

Course Description:
The course outline has been designed to serve the purpose of understanding basics of management and accounting

Course Objectives:
The overall all objective of this course is to educate students about the management as an activity and have a holistic approach to the concept. Accountancy basics are the requirement of the generation.

Course Outcome (CO):
- CO1 Efficiency in concept of Micro and Macro economics
- CO2 Develop and understand methods of Financial management.
- CO3 Identify sources and application of Finance

Unit No.	**Topic/Unit**	**Contact Hours**	**BT Level**	**CO**	**PSO**
1	Unit 1- Economics: Basics, Concept of scarcity, Opportunity Costs, Relation with other disciplines, Microeconomics – Demand, Supply, Diminishing utility	11	1,2	CO1	PSO1
2	Unit 2- Economics: Macro Economics, National Income, Unemployment, GDP	11	1,2,3	CO1,CO2	PSO1, PSO2
3	Unit 3- Finance: Basic concepts, Relation with other disciplines	11	2, 3, 4	CO2,CO3	PSO1, PSO2
4	Unit 4- Finance: Sources of Finance, Long, Medium, Short Term, Application of finance	12	1, 2, 3	CO2,CO3	PSO1, PSO2,PSO3, PSO4
Reference Books					

1.	Economics for Beginners				
2.	Financial Management by Prasanna Chandra				

School: School of Science			**Program: BSc – Life Science**		
Course Code: LS273			**Course Name:** Ethno and Economic Biology		
Year	**II**	**Core Subject(Yes/No):**	**Yes**	**Lecture:**	**3**
Semester	**III**	**Elective Subject(Yes/No):**	**No**	**Tutorial**	**0**
Typology of Course	Lectures	**Foundation Subject(Yes/No):**	**No**	**Practical:**	**0**
		Year of Syllabus Revision:		**Total Credit:**	**3**
		Year of Introduction	**2021**	**Prerequisites (If any)**	**No**

Course Description:
Ethnobiology is the study of the interaction between plants, animals and people. It deals with the scientific study of the way living things are treated or used by different human cultures and the dynamic relationships between people, biota, and environments. Ethology explains the science of animal behavior under natural conditions and viewing behavior as an evolutionarily adaptive trait. Economic biology deals with the application of botanical and zoological knowledge for the benefit of mankind

Course Objectives:
The course will enable to comprehend the animal behavior as well as understand the importance of Ethno Biology and Economic Biology

Course Outcome (CO):

CO1 Explore the way living things are treated or used by different human cultures

CO2 understand the ethology /system and social organization of animal

CO3 explore into the world of economic benefits procured from animals like poultry bird, honeybees, cattle – Dairy industry etc.

CO4 describe how the use of plants as medicines contribute to human well-being and survival

Unit No.	**Topic/Unit**	**Contact Hours**	**BT Level**	**CO**	**PSO**
1	Ethnobotany: Folk medicines of ethnobotany, ethnic communities. Application of natural products to certain diseases- Jaundice, cardiac, infertility, diabetics, Blood pressure and skin diseases. Medico-ethnobotanical sources in India; Significance of the following plants in ethno botanical practices (along with their habitat and morphology) a) *Azadiractha indica* b) *Ocimum sanctum* c) *Vitex negundo*. d) *Gloriosa superba* e) *Tribulus terrestris* f) *Pongamia pinnata* g) *Cassia auriculata* h) *Indigofera tinctoria* i) *Tinospora cordifolia*. Ethnobotany as a tool to protect interests of ethnic groups. Sharing of wealth concept with few examples from India. Biopiracy, Intellectual Property Rights and Traditional Knowledge	20	1,2,3,6	CO1 CO4	PSO1 PSO2

2	Ethology: History and overview of ethology, Behavioral Patterns, Hormones and behavior, biological rhythms, Orientation behavior, social organization of Lion, Deer, Monkey and Honeybees.	10	1,2,3	CO2 CO3	PSO1 PSO2
3	Economic Zoology: Basic concepts in dairy science: Semen collection & preservation; artificial insemination; multiple ovulation and embryo transfer, Poultry science: Maintenance and management Economic Entomology: Apiculture, Lac culture & Sericulture, Study of aquaculture profile of freshwater carps and fish farm layout. Economic Botany: Origin of cultivated plants, Vavilov's centers of origin. Botanical name, family, part used, morphology and uses of the following: Cereals: Wheat; Legumes: Gram, soybean; Spices: Clove, black pepper; Beverages: Tea; Oils and Fats: Groundnut; Fibre yielding plants: Cotton.	15	1,2, 3, 4	CO1 CO3	PSO1 PSO2 PSO3

Reference Books

1.	Daniel, M. (2009) Taxonomy: Evolution at Work, Narosa Publishers, New Delhi
2.	Heywood, V.H. & Moore D.M. (1984). Current concepts in Plant Taxonomy
3.	Kochhar, S.L. (2011). Economic Botany in the Tropics, MacMillan Publishers India Ltd., New Delhi. 4th edition.
4.	Trivedi P C, 2006. Medicinal Plants: Ethnobotanical Approach, Agrobios, India.
5.	Animal Behavior, by Michael D. Breed (Author), Janice Moore, Academic Press
6.	Economic Zoology, Jaiswal V, Phi Learning Pvt.
7.	Animal Behaviour (Ethology), V.K. Agarwal, S Chand.
8.	Systematics and Economic Zoology.
9.	Mechanism of Animal Behaviour, Peter Marler and J. Hamilton; John Wiley & Sons, USA

School: School of Science	**Program: BSc – Life Science**
Course Code: LS274	**Course Name: Plant Morphology and Anatomy**

Year	**II**	**Core Subject(Yes/No):**	**Yes**	**Lecture:**	**3**
Semester	**III**	**Elective Subject(Yes/No):**	**No**	**Tutorial**	**NA**
Typology of Course	Lectures	**Foundation Subject(Yes/No):**	**No**	**Practical:**	**NA**
		Year of Syllabus Revision:	**2021**	**Total Credit:**	**3**
		Year of Introduction	**2016**	**Prerequisites (If any)**	NIL

Course Description: The course concentrates on the histological and anatomical aspects in plants on an evolutionary basis from lower plant organisms like bacteria, mycoplasma, algae, fungi to the normal and anomalous secondary growth in different angiosperms. It will also give an idea on the shoot and root systems, nodal anatomy, epidermal tissues, secretory tissues, vascular tissues, etc

Course Objectives:

To prepare students for successful career in industry and research institutes.
To enable students to develop a good career in the field of taxonomy
To provide students with fundamental strength in doing their work ethically.

Course Outcome (CO):

CO1 Gain knowledge of morphology of angiosperms
CO2 Be trained to identify and classify plants
CO3 Gain knowledge about organization of the higher plant organization and tissue systems
CO4 Understand the different modes of reproduction in plants

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	Simple and complex tissues: Collenchyma, parenchyma, sclerenchyma, Xylem, Phloem; structure and function. Cell wall, Intercellular communications: plasmodesmata and pits. Meristems: Shoot apical meristem, root apical meristem, lateral meristems and their functions. Periderm, phellem and phelloderm-structure and development and lentices. Nodal Anatomy: Leaf trace; leaf gaps, Root-Stem transition. Epidermal tissues – general organization, cuticle, trichomes, stomata; Secretory tissues – gum and resin ducts, laticifers, floral and extrafloral nectaries and hydathodes. Secondary growth: Vascular cambium, secondary xylem and phloem. Anomalous growth.	15	1,2	CO1	PSO1

2	Vegetative morphology: Roots: Different regions and general functions, types of root systems. Stems: Various parts, normal functions (Different types of buds, vegetative and reproductive, branching of stem and forms of stem. Leaf: Structure, duration and normal functions. Simple and compound leaves and morphological variation in parts of leaves.	15	1,2	CO2,CO3	PSO1
3	Reproductive morphology: Bracts, peduncle and inflorescence: Basic types and functions. Flowers: Structure of a typical flower, definition and examples of different types of flowers. Introduction to the floral whorls and their significance. Diversity of forms in different floral whorls. Fruits: Definitions of true, false and parthenocarpic fruits. Major types of fruits. Seeds: Definition, structure and types.	15	1,2	CO4	PSO1
Reference Books					
1	A.C. Dutta, Botany for degree students, 1964.				
2	Biswas, C., & Johri, B. M. (2013). The gymnosperms. Springer Science & Business Media.				
3	Verma, B. K. (2011). Introduction to taxonomy of angiosperms. Phi Learning Pvt. Ltd..				
4	S. C. Gangulee, K. S. Das, C. D. Dutta & A. K. Kar, College Botany Vol. – II & III, 1968.				
5	K. R. Sporne, The morphology of vascular plants, 1968.				
6	M. Daniel, Taxonomy – Evolution at work, 2009				
7	N.S. Subramanyam, Modern Plant Taxonomy, 1968				
8	Sharma, O. P. (1993). Plant taxonomy. Tata McGraw-Hill Education				
9	P.C. Vashishta,Taxonomy of Angiosperms, 1968.				
10	P.C. Vashishta, Gymnosperms, 1976				
11	Y.D. Tyagi & S. Kshetrapal, An Introduction to Taxonomy of Angiosperms, 1973				
12	Beck, C. B. (2010). An introduction to plant structure and development: plant anatomy for the twenty-first century. Cambridge University Press				

<table>
<tr><td colspan="3">School: School of Science</td><td colspan="3">Program: BSc – Life Science</td></tr>
<tr><td colspan="3">Course Code: LS275</td><td colspan="3">Course Name: Biochemistry -II</td></tr>
<tr><td>Year</td><td>II</td><td>Core Subject(Yes/No):</td><td>Yes</td><td>Lecture:</td><td>3</td></tr>
<tr><td>Semester</td><td>III</td><td>Elective Subject(Yes/No):</td><td>-</td><td>Tutorial</td><td>0</td></tr>
<tr><td rowspan="3">Typology of Course</td><td rowspan="3">Lectures</td><td>Foundation Subject(Yes/No):</td><td>-</td><td>Practical:</td><td>0</td></tr>
<tr><td>Year of Syllabus Revision:</td><td>-</td><td>Total Credit:</td><td>3</td></tr>
<tr><td>Year of Introduction</td><td>2021</td><td>Prerequisites (If any)</td><td>LS179</td></tr>
</table>

Course Description:
The course introduces the fundamentals of biochemistry like the introduction and concept of biocatalysts, enzyme kinetics, isoenzymes and its applications. Additionally, it gives an idea on the energy generating mechanisms in different organisms, and an overview on the intermediary metabolism. It also includes an in-depth understanding on the biochemistry of photosynthesis and plant secondary metabolites.

Course Objectives:
The course objectives include, detail understanding on enzymes, enzyme kinetics and its application. Also, course objective includes intermediary metabolism and photosynthetic process understanding in detail.

Course Outcome (CO):
After completing this course, students will be able to:

CO1. introduced to fundamentals of biochemistry
CO2. able to understand the different types of biomolecules and their important physiological roles in a living system
CO3. Able to understand biochemistry of photosynthesis
CO4. Studying various secondary metabolites in plants and their functions

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	Unit I Basics of Bio-catalysts – The Enzyme: Introduction, concept. Classification, lock and key model, induced fit model, active site, enzyme specificity and types. Enzyme kinetics, factors affecting the velocity of enzyme action. Enzyme concentration, temperature, pH, substrate concentration. Enzyme inhibition, reversible and irreversible, competitive, non-competitive and uncompetitive inhibition, allosteric enzymes. Isoenzymes, Zymogen form of enzyme and its activation. Applications of various enzymes Energy generating mechanisms in organisms: Energy generation-based organism classification (e.g., Autotroph's heterotrophs), aerobic and an-aerobic energy generations (e.g., Fermentation), catabolism,	15	1,2,3	CO1, CO2	PSO1

	anabolism, ATP as energy currency, reducing power of the cell.				
2	Unit II Intermediary metabolism: Overview of Glucose metabolism: Glycolysis, Gluconeogenesis and pentose phosphate pathway. Glycogenesis and glycogenolysis. Fatty acid oxidation. Citric acid cycle, reactions of citric acid cycle, anaplerotic reactions, amphibolic role, regulation of citric acid cycle, glyoxylate pathway, coordinated regulation of glyoxylate and citric acid pathways, biosynthesis and degradation of glycogen, sucrose, starch and cellulose. Overview of amino acids and nucleic acids: Biosynthesis of amino acids, Catabolism of amino acids. Precursor functions of amino acids Biosynthesis of purine and pyrimidine nucleotides. De novo synthesis of purines and pyrimidines. Degradation of purine and pyrimidine nucleotides. Integration of metabolism. Amino acid biosynthesis in plants; GS/GOGAT cycle; transamination; peptide bond and polypeptide chain; protein targeting; protein degradation.	15	1,2,3	CO2	PSO1
3	Unit III Photosynthesis: Photosynthesis: Process, significance, structure and composition of the photosynthetic apparatus, PS I & II composition & functions, pathways of carbon fixation C3, C4/CAM, Pseudo cyclic, photorespiration - significance, distribution of reactions in space and time including mechanism, factors affecting photosynthesis. Transport of organic substances: Transport of photosynthate; source-sink relationship; the mechanism of translocation in phloem; assimilate partitioning. Special features of secondary plant metabolism, terpenes (classification, biosynthesis), lignin, tannins, pigments, phytochrome, waxes, alkaloids, biosynthesis of nicotine, functions of alkaloids, cell wall components. Toxins of plant origin – mycotoxins, phytohemagglutinin, lathyrogens, nitriles, protease inhibitors, protein toxins.	15	1,2,3	CO3, CO4	PSO1

Reference Books

1.	Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York).
2.	Textbook of Biochemistry with Clinical Correlations (2011) 7th ed., Devlin, T.M., John Wiley & Sons, Inc. (New Jersey).
3.	Biochemistry (2012) 7th ed., Berg, J.M., Tymoczko, J.L. and Stryer L., W.H. Freeman and Company (New York).
4.	Fundamentals of Enzymology (1999) 3rd ed., Nicholas C.P. and Lewis S., Oxford University Press Inc. (New York), ISBN:0 19 850229 X.
5.	Biochemistry And Molecular Biology of Plants by Buchanan, w and Jones.
6.	Plant Biochemistry: An Introduction (Pb) Paperback – 2016, by Dharmapalan B
7.	P.S. Verma & P.K. Agarwal, Plant Physiology, 1977.

<table>
<tr><td colspan="3">School: School of Science</td><td colspan="3">Program: BSc – Life Science</td></tr>
<tr><td colspan="3">Course Code: LS234</td><td colspan="3">Course Name: Life Science Laboratory V</td></tr>
<tr><td>Year</td><td>II</td><td>Core Subject(Yes/No):</td><td>Yes</td><td>Lecture:</td><td></td></tr>
<tr><td>Semester</td><td>III</td><td>Elective Subject(Yes/No):</td><td>-</td><td>Tutorial</td><td></td></tr>
<tr><td rowspan="3">Mode of Transaction</td><td rowspan="3">Laboratory</td><td>Foundation Subject(Yes/No):</td><td>-</td><td>Practical:</td><td>6 Hr</td></tr>
<tr><td>Year of Syllabus Revision:</td><td></td><td>Total Credit:</td><td>3</td></tr>
<tr><td>Year of Introduction</td><td>2020</td><td>Prerequisites (If any)</td><td></td></tr>
</table>

Course Description:

Students will gain knowledge regarding action mechanism of enzyme during the laboratory hours through performing colorimetric assays. Students can compare different parameters on enzyme activity. Furthermore, they will observe the different behaviors of organisms like paramecium when exposed to varying stimuli.

Course Outcome (CO):

At the end of the course, students will:

1. understand action mechanism of different enzymes via colorimetric assay
2. understand activity of enzymes and factors affecting on enzyme activity
3. gain knowledge on the various behaviours of organisms when exposed to different stimuli
4. understand the basics of economic biology

No.	**Experiment**	**Contact Hours**	**BT Level**	**CO**	**PSO**
1	To prepare solutions and buffers.		1,2,3,5	CO1	PSO2, PSO3
2	Enzymology: • To determine the effect of different temperatures on the activity of salivary content, amylase on starch • To determine the effect of different pH on the activity of salivary content, amylase on starch • To estimate the amount of carbohydrate present in the given sample by using Anthrone method • To plot standard curve of maltose 6. To analyze the effect of substrate concentration on the activity of enzyme	CO1,CO2	1,2,4,5	CO1,	PSO2, PSO3

	• To analyze the effect of Enzyme concentration on the activity of enzyme • To analyze the effect of substrate concentration on catalase enzyme activity • To perform and study various protein precipitation methods in laboratory (Acid precipitation, salting precipitation, alcohol precipitation)				
3	Ethology • Effect of darkness on fish color • Respiratory behavior in fish • Territorial behavior in fish • Stickleback fish behavior	CO3	1,2,3,5	CO1	PSO2, PSO3
4	Economic Biology • Basics of Apiculture, Sericulture, Lac culture and Pisciculture • Determination of adulteration in spices. Zoogeography realms and its fauna • Biogeography zones of India and its fauna	CO4	1, 2, 3	CO1	PSO2, PSO3
Reference Books					
1.	1. Cell Biology: A Laboratory Handbook, Volumes 1, 2, 3; Edited by Julio E. Celis, Academic Press; San Diego, New York, Boston, London, Sydney, Tokyo, Toronto, 1994; 1714 pp. ISBN 0-12-164714-5				
2.	2. Fundamentals of Enzymology (1999) 3rd ed., Nicholas C.P. and Lewis S., Oxford University Press Inc. (New York), ISBN:0 19 850229 X.				
3	3. Ethology practical by Vilmos Altbäcker, Márta Gácsi, András Kosztolányi, Ákos Pogány, Gabriella Lakatos, and Péter Pongrácz. Eötvös Loránd University, 2013. 4. Ecology Lab Manual, Book by Darrell S. Vodopich, 2009.				

School: School of Science	**Program: BSc – Life Science**
Course Code: LS235	**Course Name:** Life Science Laboratory VI

Year	**II**	**Core Subject(Yes/No):**	**Yes**	**Lecture:**	-
Semester	**III**	**Elective Subject(Yes/No):**	**-**	**Tutorial**	-
Mode of Transaction	Laboratory	**Foundation Subject(Yes/No):**	**-**	**Practical:**	**4 Hrs**
		Year of Syllabus Revision:		**Total Credit:**	**2**
		Year of Introduction	**2020**	**Prerequisites (if any)**	

Course Description:
This course covers the study of morphology, anatomy, reproduction and developmental changes therein through typological study should create a knowledge base in understanding plant diversity, economic values, taxonomy of lower group of plants.

Course Outcome (CO):
At the end of the course, students will have understanding of

- CO1. representative members of phylogenetically important groups
- CO2. process of evolution in a broad sense
- CO3. anomalies in plant secondary growth
- CO4. regional diversity in food crops and other plants
- CO5. ethnobotanical significance of plants
- CO6. preliminary phytochemical investigation

No.	Experiment	Contact Hours	BT Level	CO	PSO
1	Study of tissues and diversity in shapes and sizes of plant cells	8	1, 2, 3	CO1, CO2	PSO1, PSO2
2	Anatomy of dicot stem (*Wedelia trilobata*) and monocot stem (*Pennisetum glaucum*)	8	1, 2	CO1, CO4	PSO1, PSO2
3	Anomalous secondary growth (*Bignonia* and *Salvadora*)	8	1, 2, 3	CO3	PSO1
4	Nodal anatomy	8	1, 2, 3	CO2	PSO1
5	Types of stomata in dicot and monocot	8	1, 2	CO1, CO2, CO5	PSO1, PSO2
6	Secretory structures (internal and external)	8	1, 2, 3	CO1, CO4	PSO1
7	Determination of chlorophyll content	8	1, 2, 4, 5	CO6	PSO1
8	Preliminary qualitative phytochemicals estimation	8	1, 2, 4, 5	CO6	PSO1

Reference Books

1.	Plant Anatomy by Pandey, B.P. published by S.Chand & Company Pvt Ltd.
2.	Angiosperms by Singh, S. K., Srivastava and Seema published by Campus Books, New Delhi.

School: School of Science	**Program: BSc – Life Science**
Course Code: CH203	**Course Name: Molecules of Life**

Year	**II**	**Core Subject(Yes/No):**	**Yes**	**Lecture:**	**3**
Semester	**III**	**Elective Subject(Yes/No):**	**No**	**Tutorial**	**0**
Typology of Course	Lectures	**Foundation Subject(Yes/No):**	**No**	**Practical:**	**0**
		Year of Syllabus Revision:	**2020**	**Total Credit:**	**3**
		Year of Introduction	**2014**	**Prerequisites (If any)**	**High School Chemistry**

Course Description:

This course deals with the chemistry of carbohydrates, amino acids, enzymes, nucleic acid. In the first unit classification of carbohydrates with example and applications along with linkage between different monosaccharides are included. Second unit deals with the detail study of amino acid and peptide linkages, mechanism of enzyme action, drug action-receptor theory, binding role of –OH group, -NH_2 group, double bond and aromatic ring. Third unit deals with Nucleic acids and lipids and their biological applications. Unit four describes the importance of bio-inorganic system and its application in day-to-day life.

Course Objectives:

- The course is intended to meet the needs of students wishing to gain appreciation of how the biochemistry of important molecules emerge from its structure.
- The later part of the course ideals with the role of metal ion in biological systems

Course Outcome (CO):

CO1: Gain insight in to the role of some essential macromolecules their chemical properties and organization in to higher order functional structures like enzymes,

CO2: Structure and Function of Biomolecules like Peptides, carbohydrates, Lipids and Nucleotides

CO3:. Fundamentals of metal ions in Biology

CO4: The chemistry of metals ions in many critical biological processes like respiration, muscle contraction et

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	**Carbohydrates** Classification of carbohydrates, reducing and non-reducing sugars, General Properties of Glucose and Fructose, their open chain structure. Epimers, mutarotation and anomers. Cyclic structure of glucose. Haworth projections. Cyclic structure of fructose. Linkage between monosaccharides, structure of disaccharides (sucrose, maltose, lactose) and polysaccharides (only structures of starch and cellulose).	15	1,2,3,4,5	CO1 CO2	PSO1
2	**Nucleic Acids and Lipids** *Nucleic acids*: Components of Nucleic acids: Adenine, Guanine, Thymine, Cytosine and Uracil (Structures only), Nucleosides and nucleotides (nomenclature),	15	1,2,3,4,5	CO2	PSO1

	Structure of polynucleotides; Structure of DNA (Watson-Crick model) and RNA(types of RNA). *Lipids*: Introduction to lipids, classification, Hydrogenation, Saponification, Iodine number. Biological importance of triglycerides, phospholipids, glycolipids and steroids (cholesterol).				
3	**Bioinorganic Chemistry** Metal ions present in biological systems. Classification of elements as essential, non-essential, trace and toxic. Bioinorganic chemistry of toxic metals-lead, cadmium, mercury and arsenic. Detoxification using chelating agent. Role of iron in human system with reference to Hemoglobin. Role of globin in Hemoglobin. Role of alkali and alkaline earth metals (sodium, potassium, calcium and magnesium) in biological system (Sodium – Potassium pump).	15	1,2, 3, 4	CO3 CO4	PSO1 PSO2 PSO4 PSO7 PSO8

Reference Books	
1.	Organic chemistry, 12 Edition, Solomons, T. W. Graham, author. | Fryhle, Craig B. | Snyder, S. A. (Scott A.), John -Wiley, 2016.
2.	U. Satyanarayana, *Biochemistry*, 2nd Edition, Books and Allied (P) Ltd., Kolkata, 2002.
3.	Biological Inorganic chemistry: A New Introduction to Molecular Structure and Function, Third Edition, Elsevier-Academic press, 2019

<table>
<tr><td colspan="4">School: School of Science</td><td colspan="3">Program: BSc – Life Science</td></tr>
<tr><td colspan="4">Course Code: CH 205</td><td colspan="3">Course Name: Chemistry Laboratory-VI</td></tr>
<tr><td>Year</td><td>II</td><td>Core Subject(Yes/No):</td><td>Yes</td><td>Lecture:</td><td>0</td></tr>
<tr><td>Semester</td><td>III</td><td>Elective Subject(Yes/No):</td><td>No</td><td>Tutorial</td><td>0</td></tr>
<tr><td rowspan="3">Mode of Transaction</td><td rowspan="3">Laboratory</td><td>Foundation Subject(Yes/No):</td><td>No</td><td>Practical:</td><td>4</td></tr>
<tr><td>Year of Syllabus Revision:</td><td></td><td>Total Credit:</td><td>2</td></tr>
<tr><td>Year of Introduction</td><td>2014</td><td>Prerequisites (If any)</td><td></td></tr>
</table>

Course Description:

It includes determination of organic compounds having different nature such as acid, base and neutral organic compound and includes analysis of water samples as well as quantitative analysis of using redox, complexometric and precipitation titration

Course Outcome (CO):

CO1 detail idea about different functional group and identification method of different functional group as well as other identifications methods

CO2: gain knowledge of organic qualitative analysis

CO3: identify given unknown organic compound

No.	**Experiment**	**Contact Hours**	**BT Level**	**CO**	**PSO**
1	Organic spotting (Benzoic acid)	2	1,2,3,4,5	CO1, CO2, CO3	PSO2
2	Organic spotting (Urea)	2	1,2,3,4,5	CO1, CO2, CO3	PSO2
3	Organic spotting (Beta – naphthol)	2	1,2,3,4,5	CO1, CO2, CO3	PSO2
4	Organic spotting (Napthalene)	2	1,2,3,4,5	CO1, CO2, CO3	PSO2
5	Organic spotting (Salicylic Acid)	2	1,2,3,4,5	CO1, CO2, CO3	PSO2
6	Organic spotting (Thiourea)	2	1,2,3,4,5	CO1, CO2, CO3	PSO2
7	Organic spotting (Bromo Benzene)	2	1,2,3,4,5	CO1, CO2, CO3	PSO2
8	Organic spotting (Para nitro aniline)	2	1,2,3,4,5	CO1, CO2, CO3	PSO2
9	Organic spotting (Aniline)	2	1,2,3,4,5	CO1, CO2, CO3	PSO2
10	Organic spotting (m- nitro Aniline)	2	1,2,3,4,5	CO1, CO2, CO3	PSO2
11	Organic spotting (p- nitro Aniline)	2	1,2,3,4,5	CO1, CO2, CO3	PSO2
12	Organic spotting(Sulfanilic acid)	2	1,2,3,4,5	CO1, CO2, CO3	PSO2
13	Organic spotting(Acetalide)	2	1,2,3,4,5	CO1, CO2, CO3	PSO2

14	Organic spotting(Ethhyl Acetate)	2	1,2,3,4,5	CO1, CO2, CO3	PSO2
15	Organic spotting (Benzaldehyde)	2	1,2,3,4,5	CO1, CO2, CO3	PSO2
Reference Books					
1.	J. Mendham, R. C. Denney, J. B. Barnes & M. J. K. Thomas, Vogel's Textbook of Quantitative Chemical Analysis, 6th Ed., Pearson Education, New Delhi, 2003.				
2.	R. C. Shah, Organic Qualitative Analysis, 5 th Ed., Baroda Book Depot, Vadodara, 1996				

<table>
<tr><td colspan="3">School: School of Science</td><td colspan="3">Program: B.Sc. Microbiology</td></tr>
<tr><td colspan="3">Course Code: HR226</td><td colspan="3">Course Name: HR and Marketing I</td></tr>
<tr><td>Year</td><td>II</td><td>Core Subject (Yes/No):</td><td>Yes</td><td>Lecture:</td><td>2</td></tr>
<tr><td>Semester</td><td>III</td><td>Elective Subject (Yes/No):</td><td>No</td><td>Tutorial</td><td>0</td></tr>
<tr><td rowspan="3">Typology of Course</td><td rowspan="3">Lectures</td><td>Foundation Subject (Yes/No):</td><td>No</td><td>Practical:</td><td>0</td></tr>
<tr><td>Year of Syllabus Revision:</td><td></td><td>Total Credit:</td><td>2</td></tr>
<tr><td>Year of Introduction</td><td>2016</td><td>Prerequisites (If any)</td><td></td></tr>
</table>

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	Unit 1: Introduction to Business: · Manufacturing and service sectors; Small and medium enterprises · Forms of Business Organisation: Sole Proprietorship, Joint Hindu Family Firm, Partnership firm, Joint Stock Company, Cooperative society; Limited Liability Partnership; · Public Enterprises. International Business. Multinational Corporations · Technological innovations and skill development. · Social responsibility and ethics. Emerging opportunities in business; Franchising, Outsourcing	15	1, 2, 3, 4	CO1, CO2, CO3	PSO1
2	Unit 2: Introduction to HR: · Role of HRM: Nature – Scope – Objective –Importance of HRM · Job Analysis: Meaning – Uses of Job Analysis – Process of Job Analysis – Concept of Job Description & Job Specification. · Human Resource Planning: Meaning HR Planning – Objectives of HRP – Importance – process of HRP · Recruitment & Selection: Sources & Methods of Recruitment - Meaning & process of selection · The Process of Management: Planning; Decision-making · Delegation and Decentalisation of Authority · Leadership: Concept and Styles · Motivation: Concept and Importance; Maslow Need Hierarchy Theory; Herzberg Two Factors Theory. Communication: Process and Barriers; Control: Concept and Process	15	1, 2, 3, 4	CO1, CO2, CO3	PSO2

Reference Books

1	Human Resource Management by V. S. P. Rao (Author), Excel Books
2	Gary Dessler, Human Resource Management, 11/e, Pearson Education, 2008
3	Kotler& Armstrong, Principles of Marketing, Pearson Education/PHI, New Delhi.
4	Philip Kotler, Keller, Koshy&Jha, Marketing Management, Pearson Education, New Delhi.
5	Ramaswamy&Namkumari, A Text Book of Marketing Management, Macmillan.
6	H. J. Bernardin, Human Resource Management: An Experiential Approach, TMH, 2007

School: School of Science				**Program: BSc – Life Science**	
Course Code: LS150				**Course Name: Biophysics, Biostatistics & Biochemical techniques**	
Year	**II**	**Core Subject(Yes/No):**	Yes	**Lecture:**	**3**
Semester	**IV**	**Elective Subject(Yes/No):**	No	**Tutorial**	**-**
Typology of Course	Lectures	**Foundation Subject(Yes/No):**	No	**Practical:**	**-**
		Year of Syllabus Revision:		**Total Credit:**	**3**
		Year of Introduction	2021	**Prerequisites (If any)**	**NA**

Course Description:

The course basically introduces with the methods of analysis, both physical and chemical and to statistically analyse the data. Additionally, it also comprehends the principles and application of different instruments used in laboratories.

Course Objectives:

After completing this course student will be able to:

- be introduced to methods of analysis, both physical and chemical and to statistically analyse the data
- comprehend the principles and application of different instruments used in laboratories

Course Outcome (CO):

CO1Explain models of biological systems and models dealing with statistical mechanics and transport phenomena

CO2Solve qualitative and quantitative problems, using appropriate statistical mechanics and computing techniques

CO3Recognize the importance of data collection and its role in determining scope of inference

CO4Choose and apply appropriate statistical methods for analyzing variables

CO5Recognize potential laboratory safety concerns and address them using appropriate techniques

CO6Apply modern instrumentation theory and practice to biochemical problems

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	Biophysics: Physics of biomembrane; Role of Thermodynamics in biophysics, Biomechanics. Membrane biophysics: Lipid polymorphism, lipid-protein interaction, lipid raft structure and function, membrane proteins, transport of nutrients across the membrane and regulation of transport through transport proteins. Principles of Microscopy - Structure, operations and applications of various advanced microscopes. General Principles and operation of various laboratory equipment - Spectrophotometer, pH meter, Magnetic stirrer, Shakers. Types of PCRs.	15	1, 2, 3, 4	CO1, CO2	PSO1
2	Biostatistics: What is statistics? Biostatistics – Definition, History and Scope. Sampling, Sampling methods, Population, data collection and presentation of data. Measures of Central tendency: Mean, Median, Mode.	15	1, 2, 3, 4, 5	CO3, CO4	PSO1

	Measures of Dispersion: Standard deviation (SD), Standard error mean (SEM), Introduction to testing of hypothesis: Null hypothesis, t-test, chi-test, statistical inference, analysis of variance, correlation, regression techniques, and non-parametric statistical methods. Application of Biostatistics: In medicine, Biotechnology, Environmental biology, Genetics.				
3	Biochemical techniques: Basics of solution concentration (Molarity, Normality, Molality), saturated solutions. Concept of a buffer, Henderson-Hasselbach equation, Working principles and instrumentation of UV-visible and fluorescence spectroscopy. Working principles of Centrifugation techniques (Density gradient method, cell fractionation). Purification and characterization of a molecule or protein from a complex mixture (native or heterologously expressed) involving the chromatographic techniques: (Paper chromatography, thin layer chromatography, gas chromatography, Ion exchange chromatography, Gel filtration chromatography, Affinity chromatography, High Performance Liquid Chromatography (HPLC). Electrophoresis: SDS-Polyacrylamide gel electrophoresis (SDS-PAGE); Agarose gel electrophoresis.	15	1, 2, 3, 4, 5	CO5, CO6	PSO1

Reference Books

1. E.S. Lenhoff, Tools of Biology.
2. G.W. Snedcor & W.G. Cochran, Statistical methods.
3. M. Daniel, Basic Biophysics for Biologists, 1989.
4. M.A. Pallniswamy, Basic statistics for biologist.
5. P. N. Arora & P. K. Mohan, Biostatistics.
6. Wilson & Walker, Principles and Techniques of Biochemistry and Molecular Biology, 1975.
7. Zar, Biostatistical Analysis, 2006.

<table>
<tr><td colspan="3">School: School of Science</td><td colspan="3">Program: BSc – Life Science</td></tr>
<tr><td colspan="3">Course Code: LS151</td><td colspan="3">Course Name: Comparative functional Anatomy and Physiology</td></tr>
<tr><td>Year</td><td>II</td><td>Core Subject(Yes/No):</td><td>Yes</td><td>Lecture:</td><td>3</td></tr>
<tr><td>Semester</td><td>IV</td><td>Elective Subject(Yes/No):</td><td>-</td><td>Tutorial</td><td>0</td></tr>
<tr><td rowspan="3">Typology of Course</td><td rowspan="3">Lectures</td><td>Foundation Subject(Yes/No):</td><td>-</td><td>Practical:</td><td>0</td></tr>
<tr><td>Year of Syllabus Revision:</td><td>-</td><td>Total Credit:</td><td>3</td></tr>
<tr><td>Year of Introduction</td><td>2016</td><td>Prerequisites (If any)</td><td>-</td></tr>
</table>

Course Description:
The course gives a general idea on the comparative functional anatomical and physiological systems like integumentary System, skeletal and muscular system, digestive system, respiratory system, circulatory system, nervous system, excretory system and reproductive system from lower invertebrates to higher vertebrates.

Course Objectives: Objective includes description and explanation of each physiological system. Details of anatomy and physiological mechanism in different group of organisms

Course Outcome (CO):
After completing this course, students will be able to:

- CO1. to gain a complete and comprehensive knowledge of morphology of evolutionary higher chordates
- CO2. to understand the anatomy of evolutionary higher chordates
- CO3. explore into the world of animal physiology
- **CO4.** understand the life processes of animals ranging from unicellular protozoa to mammals

Unit No.	**Topic/Unit**	**Contact Hours**	**BT Level**	**CO**	**PSO**
1	Unit-I: Comparative functional Anatomy and Physiology – I: Integumentary System, Skeletal and muscular System and Modes of Locomotion, Dentition and Digestive System.	15	1,2,3	CO1,CO2, CO3, CO4	PSO1
2	Unit-II: Comparative functional Anatomy and Physiology – II: Respiratory System, Circulatory and Immune Systems and Thermoregulation, Nervous System. Endocrine System.	15	1,2,3	CO1,CO2, CO3, CO4	PSO1
3	Unit- III: Comparative functional Anatomy and Physiology – III: Excretory System and Osmoregulation, Modes of Reproduction and Reproductive System and Chemical Coordination.	15	1,2,3	CO1,CO2, CO3, CO4	PSO1

Reference Books

1.	Vertebrates: Comparative Anatomy Kenneth V Kardong
2.	Comparative Anatomy of the Vertebrates George Kent, Robert Carr
3.	Schmidt-Nielsen K., Animal Physiology: Adaptation and Environment, Cambridge Univ Press
4.	Dr Ian Kay-Introduction to Animal Physiology-Garland Science (1998)

5.	David J. Randall, Warren W. Burggren, Kathleen French, Roger Eckert-Eckert Animal Physiology_ Mechanisms and Adaptations (Fourth Edition) -W.H. Freeman & Company (1997)
6.	Michael A. Singer-Comparative Physiology, Natural Animal Models and Clinical Medicine_ Insights into Clinical Medicine from Animal Adaptations-Imperial College Press (2007) 7. Pat Willmer, Graham Stone, Ian Johnston-Environmental Physiology of Animals-WileyBlackwell (2004).
7.	Pat Willmer, Graham Stone, Ian Johnston-Environmental Physiology of Animals-WileyBlackwell (2004).

School: School of Science	**Program: BSc – Life Science**
Course Code: PAT201	**Course Name:** Parasitology, Histopathology and Plant Pathology

Year	**II**	**Core Subject(Yes/No):**	**Yes**	**Lecture:**	**3**
Semester	**IV**	**Elective Subject(Yes/No):**	**-**	**Tutorial**	**-**
Typology of Course	Lectures	**Foundation Subject(Yes/No):**	**-**	**Practical:**	**-**
		Year of Syllabus Revision:	**-**	**Total Credit:**	**3**
		Year of Introduction	**2021**	**Prerequisites (If any)**	-

Course Description: This course examines diseases in relation to the healthy body and the pathophysiological processes that occur when disease is present. It also includes the defensive, compensating and adaptive responses to the presence of disease by various body systems. The uses of techniques like microscopy and histology are also included in the course in order to understand its uses in detection of diseases.

Course Objectives:

- To study the pathophysiological processes of various disease.
- To understand the defensive, compensating and adaptive responses to the presence of disease
- To study the uses of techniques like microscopy and histology for diagnosis of diseases.

Course Outcome (CO):

CO1 Gain understanding of host-parasite interactions
CO2 Understand the pathophysiology of the protozoan parasites.
CO3 Understand the mechanism of several diseases and current remedial or preventive measures.
CO4 Understand usage of histochemistry and microscopy in detection and study of pathological conditions.
CO5 To study the plant pathogenesis and its molecular mechanistic approach.

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	Introduction to parasitic protozoans, Classification of protozoa and definition of key concepts –*Entamoeba Histolytica* and other *Amoebae* inhabiting the alimentary canal, *Giardia Lamblia, Trichomonas vaginalis* and other important flagellates, *Plasmodium falciparum* other Plasmodia species, *Toxoplasma gondii* and	15	1,2,3,4	CO1,CO2,	PSO1

	Trypanosoma species, *Schistosomiasis, Leishmaniasis,* Emerging protozoan diseases, Diagnostic Methods applied in parasitology.				
2	Histochemistry, histological techniques – theory and practice, Function and components of the compound light microscope, Ultrastructure of different tissues, Routine stains, and staining processes in pathology, Fixation of tissues, Embedding, and cutting, Frozen and cryostat sectioning of fresh tissues; Immunohistochemistry.	15	1,2,3,4	CO3, CO4	PSO1
3	General Account of Plant Pathogens: Historical developments, general account of diseases caused by plant pathogens. Pathogen attack and defense mechanisms: Plant-microbe interactions, Physical, physiological, biochemical and molecular aspects. Plant disease epidemiology: Transmission and spread of plant pathogens; disease cycles Major Plant Diseases: Differentiation between bacterial, viral and fungal diseases using morphological symptoms.	15	1,2,3,4	CO5	PSO1

Reference Books

1.	Microbiology by Prescott; 9th edition
2.	Parasitology, Protozoology & Helminthology by K.D Chatterjee
3.	Textbook of Microbiology by Ananthanarayan and Paniker; 7th edition
4.	Medical Microbiology by Jawetz, Melnick, & Adelberg; 27th Edition
5.	Human Histology by Stevens and Lowe's; 4th edition
6.	Veterinary Histology by Jennings and Premanand

School: School of Science			**Program: BSc – Life Science**		
Course Code: LS153			**Course Name:** Life Science Laboratory VII		
Year	**II**	**Core Subject(Yes/No):**	**Yes**	**Lecture:**	
Semester	**IV**	**Elective Subject(Yes/No):**	**-**	**Tutorial**	
Mode of Transaction	Laboratory	**Foundation Subject(Yes/No):**	**-**	**Practical:**	**6 Hr**
		Year of Syllabus Revision:		**Total Credit:**	**3**
		Year of Introduction	**2020**	**Prerequisites (If any)**	

Course Description:
Students will gain the knowledge regarding the working of various lab instruments like centrifuge, pH meter, autoclave etc. Also the students will be exposed to hand on working of various biochemical techniques like chromatography, gel electrophoresis and colorimetric assays. They will also be solving basic problems of bioinformatics along with understanding and application of various types of graphs used in data presentation.

Course Outcome (CO):
At the end of the course, students will:

1. the principles and application of different instruments used in laboratories
2. gain hands on the biochemical techniques
3. solve basic problems of biostatistics
4. understand the basics of histological slide observations and preparations, uses of different stains

No.	Experiment	Contact Hours	BT Level	CO	PSO
1	**Biochemical techniques**: 1. To study the working principle of weighing balance, autoclave, light microscope, centrifuge, hot air oven, visible spectrophotometer, magnetic starrier and vortex. 2. Preparation of buffer 3. Paper chromatography and Thin layer chromatography 4. Agarose gel Electrophoresis	8	1,2,3,5	CO1,CO2	PSO2, PSO3
2	**Biostatistics**: 5. To solve the problems regarding mean, median, mode, standard deviation and standard error. 6. Sampling methods and its analysis 7. To study the types of graphs for data analysis	8	1,2,4,5	CO3	PSO2, PSO3
3	**Histology**: 8. Basics of Slide Preparation 9. Basics of different stains used in fixation: Hematoxylin And Eosin (HE Stain), Leishman Staining, Giemsa Staining, Nissl Stain, Wright's stain 10. Study of permanent slides of different types of Epithelial cells, Muscle tissue, Nerve cells	8	1,2,3,5	CO4	PSO2, PSO3

	11. Study of permanent slides of different body organs 12. Fixation of tissues, Embedding and cutting, Frozen and cryostat sectioning of fresh tissues, Immunohistochemistry				
4	**Parasitology**: 13. Study of different stages of infection of Liver flukes, Fasciola hepatica, Taenia solium 14. Diagnostic Methods applied in parasitology	8	1,2,3,5	CO4	PSO2, PSO3
5	**Plant Pathology**: 15. Isolation of plant pathogens from different resources 16. Economic important plant diseases	8	1,2,4,5	CO4	PSO2, PSO3

Reference Books

1.	Biochemistry, U.Satyanarayana, Books and Allied Publication.,2011
2.	Biochemical methods by Sadasivam and A.Manickam, New Age International Pvt.Publication.,2010
3	Textbook of Biochemistry with Clinical Correlations (2011) 7thed., Devlin, T.M., John Wiley & Sons, Inc. (New Jersey)
4	Biochemistry (2012) 7thed., Berg, J.M., Tymoczko, J.L. and Stryer L., W.H. Freeman and Company (New York)
5	Fundamentals of Enzymology (1999) 3rded., Nicholas C.P. and Lewis S., Oxford University Press Inc. (New York), ISBN:0 19 850229 X.

School: School of Science			**Program: BSc – Life Science**		
Course Code: LS154			**Course Name: Life Science Laboratory VIII**		
Year	**II**	**Core Subject(Yes/No):**	**Yes**	**Lecture:**	**0**
Semester	**IV**	**Elective Subject(Yes/No):**	**No**	**Tutorial**	**0**
Mode of Transaction	**Laboratory**	**Foundation Subject(Yes/No):**	**No**	**Practical:**	**4 hrs**
		Year of Syllabus Revision:	**-**	**Total Credit:**	**2**
		Year of Introduction	**2017**	**Prerequisites (If any)**	**NA**

Course Description: The course deals with the laboratory practices involved in histology, identification of mammalian tissues and features of tissues and organs. It also examines the general biology, life cycles, modes of transmission, and pathogenesis of major parasites on global human and livestock health and explores a number of important diseases, along with the diverse protozoans, worms, and arthropods responsible for them.

Course Outcome (CO):

1. To explore into the world of animal physiology.
2. To give the students an in-depth knowledge of how the tests are performed in clinical labs.

No.	**Experiment**	**Contact Hours**	**BT Level**	**CO**	**PSO**
1	Estimation of serum alkaline phosphatase	2	1,2, 3, 4, 5	CO2	PSO1, PSO2
2	Estimation of serum acid phosphatase	2	1,2, 3, 4, 5	CO2	PSO1, PSO2
3	Estimation of blood glucose	2	1,2, 3, 4, 5	CO2	PSO1, PSO2
4	Estimation of hemoglobin	2	1,2, 3, 4, 5	CO2	PSO1, PSO2
5	Comparative physiology of invertebrates and vertebrates	2	1,2	CO1	PSO2
6	Quantitative estimation of amylase activity	2	1,2, 3, 4, 5	CO2	PSO1, PSO2
7	Quantitative estimation of ammonia	2	1, 2, 3, 4, 5	CO2	PSO1, PSO2
8	Quantitative estimation of urea	2	1, 2, 3, 4, 5	CO2	PSO1, PSO2
9	Estimation of rate of salt loss in fish	2	1, 2, 3, 4, 5	CO2	PSO1, PSO2

10	Estimation of rate of salt gain in fish	2	1, 2, 3, 4, 5	CO2	PSO1, PSO2

Reference Books	
1	Comprehensible Viva & Practical Biochemistry – Dr. A.C. Deb
2	Basic Concepts in Clinical Biochemistry - A Practical Guide - Vijay Kumar & Karan Gill
3	Practical Clinical Biochemistry - Mohanty & Verma
4	Invertebrate Zoology – Jordan and Verma

School: School of Science			**Program: BSc – Life Science**		
Course Code: CH 208			**Course Name: Physical Chemistry**		
Year	**II**	**Core Subject(Yes/No):**	**Yes**	**Lecture:**	**3**
Semester	**IV**	**Elective Subject(Yes/No):**		**Tutorial**	**0**
Typology of Course	Lectures	**Foundation Subject(Yes/No):**		**Practical:**	**0**
		Year of Syllabus Revision:		**Total Credit:**	**3**
		Year of Introduction	**2014**	**Prerequisites (If any)**	**High school chemistry**

Course Description:
This course describes the basics of physical chemistry and covers thermodynamics, electrochemistry, chemical kinetics, phase equilibrium and photochemistry. Unit I deal with all the three laws of thermodynamics including thermo-chemistry. In second unit, basics of chemical and ionic equilibrium is discussed. In addition, Le Chatelier's principle, pH scale, buffer solutions are dealt with. In electrochemistry, mainly the definition of different terminologies used followed by Kohlrausch law of independent migration are discussed. Basics of chemical kinetics and the detailed study of zero order and first order kinetics with problems are discussed in the unit. Course shall also describe different spectroscopic techniques, specifically, the UV-Visible and IR spectroscopy.

Course Objectives:
To gain understanding of Thermodynamics and equilibrium with examples relevant to biological systems.
Gain understanding of kinetic systems and reaction rate
Develop preliminary understanding of different spectroscopic techniques.

Course Outcome (CO):
(Note: COs can be 6±2 for courses with 2 to 4 credits, and 8±2 for courses with 5 to 6 credits)
CO1: Appreciation of Chemical Thermodynamics and its application to relevant systems
CO2: Application of Thermodynamics to equilibrium systems and redox systems
CO3: Basic idea of Reaction rate
CO4: Spectroscopic techniques and its principle.

Unit No.	Topic/Unit	**Contact Hours**	**BT Level**	**CO**	**PSO**
1	**Unit I- Thermodynamics** State of a system, state variables, intensive and extensive variables, concept of heat and work, thermodynamic equilibrium, First Law of thermodynamics. Calculation of work (w), heat (q), changes in internal energy (ΔU) and enthalpy (ΔH) for expansion or compression of an ideal gas under isothermal conditions for both reversible and irreversible processes. Calculations of w, q, ΔU and ΔH for processes involving changes in physical states. Thermochemistry, enthalpy of combustion, enthalpy of neutralization and Integral enthalpies of solution. Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data. Statements of Second Law of thermodynamics, concept of entropy, Gibbs energy and Helmholtz energy, criteria of spontaneity. Gibbs–Helmholtz equation. Statement of Third	15	1,2,3,4,5	CO1 CO2	PSO1

	Law of thermodynamics. Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Qualitative treatment of Le Chatelier's principle. Relationships between Kp, Kc and Kx. Strong and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water, pH scale. Ionization of weak acids and bases, common ion effect, Salt hydrolysis and simple calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions, buffer capacity and buffer range. Solubility and solubility product of sparingly soluble salts – applications of solubility product principle.				
2	**Unit II-Electrochemistry**: Metallic and electrolytic conductance, conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. Kohlrausch law of independent migration B. Sc. Chemistry (Subsidiary) Academic year: 2019-2022 School of Science Navrachana University Vadodara Page 14 of 15 of ions. Applications of conductance measurements: determination of degree of ionization of weak electrolyte, Reversible and irreversible cells. Concept of EMF of a cell, measurement of EMF of a cell. Nernst equation and its importance. Types of electrodes, standard electrode potential, electrochemical series. Thermodynamics of a reversible cell. Calculation of equilibrium constant	10	1,2,3,4,5	CO2	PSO1
3	Unit III –Chemical Kinetics: The concept of reaction rates. Effect of temperature, pressure, catalyst and other factors on reaction rates. Order and molecularity of a reaction. Derivation of integrated rate equations for zero and first order reactions. Half–life of a reaction. General methods for determination of order of a reaction. Concept of activation energy and its calculation from Arrhenius equation.	10	1,2,3,4,5	CO3	PSO1
4	Unit 1V-Photochemistry: Laws of photochemistry. Fluorescence and phosphorescence. Quantum efficiency and reasons for high and low quantum yields. Primary and secondary processes in photochemical reactions. Photochemical and thermal reactions. Spectroscopy: Spectroscopy and its importance in chemistry. Electromagnetic radiation and its interaction with matter. Types of spectroscopy. Beer-Lambert's Law, Limitations of Beer-Lambert Law. UV-Visible Spectroscopy. Theory, Instrumentation and applications. InfraRed Spectroscopy (vibrational spectroscopy): Theory, Instrumentation and applications.	10	1,2,3,4,5	CO4	PSO1

Reference Books

1.	B. R. Puri& L. R. Sharma, Principles of physical chemistry, Shoban Lal Nagin Chand and Co. 33rd Ed., 1992.
2.	S. H. Maron& J. B. Lando, Fundamentals of physical chemistry, Macmillan limited, New York, 1966.
3.	Gilbert. W. Castellan, Physical chemistry, 3rd Ed., Narosa publishing house, 1985.

4.	K. K. Rohatgi Mukherjee, Fundamentals of photochemistry, Revised Ed., Wiley Eastern Ltd., 1996
5.	S. H. Maron& J. B. Lando, Fundamentals of Physical Chemistry, Macmillan limited, New York, 1966.

School: School of Science			**Program: BSc – Life Science**		
Course Code: CH 210			**Course Name:** Chemistry Laboratory-VIII		
Year	**II**	**Core Subject(Yes/No):**	**Yes**	**Lecture:**	**0**
Semester	**IV**	**Elective Subject(Yes/No):**	**No**	**Tutorial**	**0**
Mode of Transaction	Laboratory	**Foundation Subject(Yes/No):**	**No**	**Practical:**	**4**
		Year of Syllabus Revision:		**Total Credit:**	**2**
		Year of Introduction	**2014**	**Prerequisites (If any)**	

Course Description:
Basic concepts of Physical chemistry and determination of physical properties of a liquid. Understand the basic concepts of reaction kinetics and determination of rate constant of a chemical reaction, analyse water sample, Physical Chemistry experiments based on surface tension, viscosity and chemical kinetics. Chromatographic experiments based on TLC

Course Outcome (CO):
CO1 *understand the basic concepts of Physical chemistry and determination of physical properties of a liquid.*
CO2 *Understand the basic concepts of reaction kinetics and determination of rate constant of a chemical reaction*
CO3 *analyse water sample as well as quantitative analysis using complexometric titrations*
CO4 Physical Chemistry experiments based on surface tension, viscosity and chemical kinetics. Chromatographic experiments based on TLC.
CO5 Volumetric analysis based on complexometric titration, Iodometry

No.	Experiment	Contact Hours	BT Level	CO	PSO
1	Preparations of TLC plates	2	1,2,3,4,5	CO4	PSO2
2	TLC to separate an unknown mixture and also to calculate the Rf values	2	1,2,3,4,5	CO4	PSO2
3	To determine the viscosity of given liquid	2	1,2,3,4,5	CO4	POS2
4	To determine the surface tension of given liquid	2	1,2,3,4,5	CO4	PSO2
5	Determination of λmax and concentration of given potassium permanganate solution using visible spectrometry	2	1,2,3,4,5	CO1	PSO2
6	Inversion of cane sugar by polarimeter	2	1,2,3,4,5	CO3	PSO2
7	Estimation of glucose	2	1,2,3,4,5	CO5	PSO2
8	Chemical kinetics	2	1,2,3,4,5	CO5	PSO2
9	Complexometric titration	2	1,2,3,4,5	CO5	PSO2
10	Iodometric titration	2	1,2,3,4,5	CO5	PSO2

Reference Books

1. R. C. Shah, *Inorganic Quantitative Analysis,* 5th Ed., Baroda Book Depot, Vadodara, 1996
2. J. Mendham, R. C. Denney, J. B. Barnes & M. J. K. Thomas, *Vogel's Textbook of Quantitative Chemical Analysis*, 6th Ed., Pearson Education, New Delhi, 2003
3. A. M. Halpern & G. C. McBane, *Experimental Physical Chemistry*, 3rd Ed., W.H. Freeman & Co., New York, 2003
4 B. D. Khosla, V. C. Garg & A. Gulati, *Senior Practical Physical Chemistry*, R. Chand

	& Co., New Delhi, 2011
5	C. W. Garland, J. W. Nibler, & D. P. Shoemaker, *Experiments in Physical Chemistry*, 8th Ed., McGraw – Hill, New York, 2003
6	V.D. Athawale and P. Mathur, *Experimental Physical Chemistry*, 1st Edition, New Age International Publications, New Delhi 2001

School: School of Science			**Program: BSc – Life Science**		
Course Code: ES201			**Course Name: Environment Science**		
Year	**II**	**Core Subject(Yes/No):**	**Yes**	**Lecture:**	**3**
Semester	**IV**	**Elective Subject(Yes/No):**	**No**	**Tutorial**	**-**
Typology of Course	Lectures and Practical	**Foundation Subject(Yes/No):**	**No**	**Practical:**	**1**
		Year of Syllabus Revision:		**Total Credit:**	**4**
		Year of Introduction	**2021**	**Prerequisites (If any)**	**NA**

Course Description:

Through interdisciplinary academic courses and co-curricular activities, the students shall become passionate stewards of the environment, scholars in sustainability and environmental management, and experts in environmental studies. The students will gain an in-depth knowledge of the different components of Environment. They will be able to recognize the components of Environment and different components of Environment. Field studies are as essential as class work and form an irreplaceable synergistic tool in the entire learning process.

Course Objectives:

- Students will be sensitized towards Environment and its concepts.
- Students will develop an understanding of environment and its types.
- To help the students develop their abilities to engage in discussions.
- To develop the logical and analytical reasoning capabilities.

Course Outcome (CO):

CO1 Gaining in-depth knowledge on natural processes that sustain life and govern economy

CO2 Recognize the physical, chemical, and biological components of the earth's systems and show how they function

CO3 Developing critical thinking for shaping strategies (scientific, social, economic and legal) for environmental protection and conservation of biodiversity, social equity and sustainable development

CO4 Understand core concepts and methods from ecological and physical sciences and their application in environmental problem-solving

CO5 Adopting sustainability as a practice in life, society and industry

CO6 Acquiring values and attitudes towards understanding complex environmental economic-social challenges, and participating actively in solving current environmental problems and preventing the future ones

CO7 Predicting the consequences of human actions on the web of life, global economy and quality of human life

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	Multidisciplinary nature of environmental studies (Definition, scope and importance) Need for public awareness. Renewable and non-renewable resources: Natural resources and associated problems. a) Forest resources: Use and over-exploitation, deforestation. Timber extraction, mining, dams and their effects on forest and tribal people. b) Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems. c) Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources. d) Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity. e) Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. f) Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification. Role of an individual in conservation of natural resources. Equitable use of resoureces for sustainable lifestyles.	15	1, 2	CO1 CO2	PSO1
2	**Ecosystems** Concept of an ecosystem. Structure and function of an ecosystem. Producers, consumers and decomposers. Energy flow in the ecosystem. Ecological succession. Food chains, food webs and ecological pyramids. Introduction, types, characteristic features, structure and function of the following ecosystem: a. Forest ecosystem, b. Grassland ecosystem, c. Desert ecosystem, d. Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries).	10	1, 2	CO2 CO3	PSO1
3	**Biodiversity and its conservation** Introduction - Definition: genetic, species and ecosystem diversity. Biogeographical classification of India. Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values. Biodiversity at global, National and local levels. India as a mega-diversity nation. Hot-sports of biodiversity. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts. Endangered and endemic species of India. Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.	10	1, 2, 5	CO3	PSO1
4	**Environmental Pollution** Definition. Cause, effects and control measures of: a. Air pollution, b. Water pollution, c. Soil pollution, d. Marine pollution, e. Noise pollution, f. Thermal pollution, g. Nuclear hazards, Solid waste Management: Causes, effects and control measures of	10	1, 2, 4	CO6 CO7	PSO1

	urban and industrial wastes. Role of an individual in prevention of pollution. Pollution case studies. Disaster management: floods, earthquake, cyclone and landslides.				
5	**Field work (on working Saturdays)** • Visit to a local area to document environmental assets: river/forest/grassland/hill/mountain • Visit to a local polluted site-Urban/Rural/Industrial/Agricultural • Floristic studies (Study of common trees, herbs, climbers, shrubs, etc.) • Faunal studies (Study of common insects, birds, butterflies, etc.) • Study of simple ecosystems- pond, river, hill slopes, etc.	30	2, 3, 4, 6	CO3 CO4 CO5	PSO1

Reference Books	
1.	Agarwal, K.C. 2001 Environmental Biology, Nidi Publ. Ltd. Bikaner.
2.	Bharucha Erach, The Biodiversity of India, Mapin Publishing Pvt. Ltd., Ahmedabad – 380 013, India.
3.	Miller T.G. Jr. Environmental Science, Wadsworth Publishing Co.
4.	Odum, E.P. 1971. Fundamentals of Ecology. W.B. Saunders Co. USA.
5.	Heywood, V.H & Waston, R.T. 1995. Global Biodiversity Assessment. Cambridge Univ.
6.	Townsend C., Harper J, and Michael Begon, Essentials of Ecology, Blackwell Science.
7.	Wanger K.D., 1998 Environmental Management. W.B. Saunders Co. Philadelphia.

School: School of Science			**Program: BSc – Life Science**		
Course Code: HR311			**Course Name:** **Introduction to HR and Marketing II**		
Year	**II**	**Core Subject(Yes/No):**	**Yes**	**Lecture:**	**2**
Semester	**IV**	**Elective Subject(Yes/No):**	**No**	**Tutorial**	**0**
Mode of Transaction	Laboratory	**Foundation Subject(Yes/No):**	**No**	**Practical:**	**0**
		Year of Syllabus Revision:		**Total Credit:**	**2**
		Year of Introduction	**2014**	**Prerequisites (If any)**	

Unit No.	**Topic/Unit**	**Contact Hours**	**BT Level**	**CO**	**PSO**
1	Introduction to Marketing Nature, scope and importance of marketing; Company orientation towards the market place (production concept, product concept, selling concept, marketing concept) Marketing Mix – Concept of STP Product – Classification of product – Product Life Cycle Distribution - Meaning – Types of Intermediaries – Functions of Intermediaries - Levels of distribution channels Promotion – Meaning & Types of Promotion Mix	15	1, 2, 3, 4	CO1, CO2, CO3	PSO1
2	Introduction to HR Role of HRM: Nature – Scope – Objective –Importance of HRM Job Analysis: Meaning – Uses of Job Analysis – Process of Job Analysis – Concept of Job Description & Job Specification. Human Resource Planning: Meaning HR Planning – Objectives of HRP – Importance – process of HRP Recruitment & Selection: Sources & Methods of Recruitment - Meaning & process of selection	15	1, 2, 3, 4	CO1, CO2, CO3	PSO2
Reference Books					

1.	Ramaswamy & Namkumari, A Text Book of Marketing Management, Macmillan.
2.	H. J. Bernardin, Human Resource Management: An Experiential Approach, TMH, 2007
3	Human Resource Management by V. S. P. Rao (Author), Excel Books
4	Gary Dessler, Human Resource Management, 11/e, Pearson Education, 2008
5	Kotler & Armstrong, Principles of Marketing, Pearson Education/PHI, New Delhi
6	Philip Kotler, Keller, Koshy&Jha, Marketing Management, Pearson Education, New Delhi

<table>
<tr><td colspan="3">School: School of Science</td><td colspan="3">Program: BSc – Life Science</td></tr>
<tr><td colspan="3">Course Code: LS303</td><td colspan="3">Course Name: Biotechnology and Bioinformatics</td></tr>
<tr><td>Year</td><td>III</td><td>Core Subject(Yes/No):</td><td>Yes</td><td>Lecture:</td><td>3</td></tr>
<tr><td>Semester</td><td>V</td><td>Elective Subject(Yes/No):</td><td>No</td><td>Tutorial</td><td>NA</td></tr>
<tr><td rowspan="3">Typology of Course</td><td rowspan="3">Lectures</td><td>Foundation Subject(Yes/No):</td><td>No</td><td>Practical:</td><td>NA</td></tr>
<tr><td>Year of Syllabus Revision:</td><td>2021</td><td>Total Credit:</td><td>3</td></tr>
<tr><td>Year of Introduction</td><td>2016</td><td>Prerequisites (If any)</td><td>NIL</td></tr>
</table>

Course Description:
Through this course, students apply their knowledge of biochemistry courses to biotechnology, which also refers to genetic engineering. Students will learn about the research and advances pertaining to DNA cloning and modification are addressed, and students will learn the agricultural, medical, industrial and other applications of biotechnology research. This course also includes in depth knowledge of use of bioinformatics studies in research and development

Course Objectives:
To prepare students for successful career in industry and research institutes.
To develop the ability of applying the bioengineering techniques in research and academia.
To enable students to work in a team with multidisciplinary approach.
To provide students with fundamental strength in analysing, designing and solving industry related problems.

Course Outcome (CO):
CO1 Identify the advent of modern biotechnology from ancient biotechnology
CO2 Understand the type of vectors and the type of cloning methods
CO3 Describe different type of GMOs
CO4 To be able to understand the analytical techniques in Biotechnology
CO5 Apply various applications of biotechnology in research and development
CO6 Learn the basics of bioinformatics and its tools for understanding clinical and biological data

Unit No.	**Topic/Unit**	**Contact Hours**	**BT Level**	**CO**	**PSO**
1	Introduction to Biotechnology, definition and scope, Historical perspectives, and importance, Commercial potential, Biotechnology in India and Global trends. Recombinant DNA technology: Restriction - modification system, restriction enzymes, types, nomenclature, properties and examples (EcoRI, BamHI, SmaI) Cloning Vectors, Prokaryotic cloning and expression vectors- Bacteriophage-λ vectors replacement & insertional vectors cosmid, phagemid. BAC, Eukaryotic cloning and expression vectors-yeast vectors-YEP, YIP, YCP,	15	1,2	CO1,2,3	PSO2

	SV-40, retroviral vector, MAC; plasmid-based vectors- co-integrate & binary vectors. Introduction into eukaryotic expression system, Applications of Recombinant DNA technology - Genetically modified organism (GMOs). Recombinant vaccines. Applications in agriculture, medicine and industry. Gene therapy, DNA fingerprinting, Single Cell Protein (SCP).				
2	Techniques: Polymerase chain reaction (PCR): Principle and applications, primer-design, brief overview of various PCR techniques: inverse-, multiplex-, hotstart-, touchdown, nested PCR; RT-PCR, Construction of genomic and cDNA libraries, Screening & Selection of Recombinants, immunochemical methods of screening, nucleic acid hybridization (Colony and Plaque hybridisation), gene probes, southern, northern and western blot, Sequencing of DNA Sanger sequencing, Maxam Gilbert method, next generation sequencing.	15	1,2	CO4,5	PSO2
3	Bioinformatics: Significance of Bioinformatics in Biological Science- Biological Databases (Accession codes & identifications) Examples of Biological. Database (A) Nucleotide sequence Databases (B) Protein sequence databases (EMBL, Gene Bank). Primary Nucleotide sequence, databases, protein sequences, databases), Genetic DataBases, sequence similarity and gene identification, Construction of phylogenetic trees, Computational tools for genome analysis. Biotechnology and Society - Public perception, Biopesticides, Biofuels and Biological Control, Medical Biotechnology, Patenting and IPR issues, Ethical and Biosafety issues.	15	1,2,5	CO6	PSO2

Reference Books	
1.	Textbook of Biotechnology by Lydell Norris, 2016
2.	Textbook of Biotechnology by R.C.Dubey, 2014.
3.	Advanced Biotechnology by R.C.Dubey, 2014.
4.	Essentials of Bioinformatics by Jin Xiong
5.	Bioinformatics Basics by Hooman Rashidi, Lukas K. Buehler
6.	Introduction to Bioinformatics: A Theoretical and Practical Approach by Stephen A. Krawetz, David D. Womble

School: School of Science			**Program: BSc Life Science**		
Course Code: LS301			**Course Name: Molecular Biology, Endocrinology and Phytohormones**		
Year	**III**	**Core Subject(Yes/No) :**	**Yes**	**Lecture:**	**3**
Semester	**V**	**Elective Subject(Yes/No) :**	**-**	**Tutorial**	**-**
Typology of Course	Lectures	**Foundation Subject(Yes/No) :**	**-**	**Practical:**	**-**
		Year of Syllabus Revision:	**-**	**Total Credit:**	**3**
		Year of Introduction	**2016**	**Prerequisites (If any)**	**-**

Course Description:
The course highlights the molecular basis of biological activity in and between cells, including molecular synthesis, modification, mechanisms and interactions. Basic concepts such as replication, transcription and translation, and the regulation of gene expression. The course also includes an in-depth review of animal and plant hormones and their significance in organism's developmental.

Course Objectives:
This course will provide understanding of molecular biology and its significance. Basic concepts of the molecular biology including central dogma understanding will be main objective of the course. Additionally understanding phytohormones and endocrine system their role will be also prime objective

Course Outcome (CO):
After completing this course, students will be able to:

CO1. Acquired knowledge of gene, their expression and regulation of expression.
CO2. Understanding mechanisms of genetic exchange, mutations and their implications
CO3. Understand hormonal regulation of physiological processes in vertebrates.
CO4. Appreciate the role of Phytohormones as signal molecules and their functions in all aspects of plant growth and development

Unit No.	**Topic/Unit**	**Contact Hours**	**BT Level**	**CO**	**PSO**
1	**Unit-I: Molecular Biology I** DNA structure. Replication in pro- and eukaryotes - Gene concept, mechanisms of DNA replication, inhibitors of DNA replication. Transfer of genetic information in pro- and eukaryotes: Transcription — Structure and Types of RNA, role of polymerase, initiation, elongation and termination of transcription, posttranscriptional modifications and inhibitors; splicing mechanisms. Translation – Code-features and deciphering of genetic code, inhibitors of protein synthesis. Post translational modifications and protein targeting.	15	1,2,3	CO1, CO2	PSO1

2	Regulation of gene expression - Prokaryotes inducible and repressible systems, positive and negative controls, Molecular basis of recombination - Holliday model, role of rec genes in genetic recombination. Oncogenes and cancer - Types of cancers — sarcomas, carcinomas, leukemias and lymphomas. Oncogenes and Tumor Suppressor Genes	15	1,2,3	CO2	PSO1
3	**Endocrine System and Endocrine Organs**, Hormones – Structure, Classification and mechanism of action, Hormones and Behaviour, Hormones and Diseases. Local hormones. **Phytohormones:** Phytohormones: Structure, distribution, bioassay, role in plant growth and practical applications of auxin, cytokinin, gibberellic acid, ethylene, abscisic acid, jasmonic acid, brassinosteroids and polyamines. Auxins: Natural and synthetic, metabolism, transport, mode of action, physiological effects. Cytokinins: Natural and synthetic analogues, mode of action, metabolism. Gibberellins: Structure, occurrence and physiological activity. Abscisic acid: Structure, occurrence and physiological activity. Ethylene: Structure, occurrence and physiological activity. Applications of hormones in tissue culture.	15	1,2, 3	CO3, CO4	PSO1
Reference Books					
1. 1.	The Cell, A molecular Approach, Geoffery M.Cooper, Robert, E. Hauman, ASM Press, 2009				
2. 2.	Molecular Biology of the Cell, 4th edition. Bruce Alberts				
3.	Molecular Biology of the gene by James Watson; 6th edition				
4.	Cell and molecular biology by Gerald Karp; 6th edition				
5.	Endocrinology by Mac. E Hadley; 6th edition				
6.	Textbook of medical Physiology Guyton				
7.	Fundamentals of Physiology Lauralee Sherwood				
8.	P.S. Verma & P.K. Agarwal, Plant Physiology, 1977.				
9.	R.M. Devlin, Plant Physiology, 1974.				
10.	S.N. Pandey & B.K. Sinha, Plant Physiology, 1972.				

School: School of Science	**Program: BSc Life Science**
Course Code: LS302	**Course Name:** Defense mechanisms in plants and animals

Year	**III**	**Core Subject(Yes/No):**	**Yes**	**Lecture:**	**3**
Semester	V	**Elective Subject(Yes/No):**	**No**	**Tutorial**	**0**
Typology of Course	Lectures	**Foundation Subject(Yes/No):**	**No**	**Practical:**	**0**
		Year of Syllabus Revision:		**Total Credit:**	**3**
		Year of Introduction	**2021**	**Prerequisites (If any)**	**NA**

Course Description:
A study of the molecular and cellular interactions and principles of the immune system. Topics include immune system development, humoral & cell-mediated immunity, disease and treatments involving immunization, immunodeficiency, and autoimmunity. The course also deals with plant defense responses which develop in response to biological stress or attack of a broad range of pathogens (viruses, bacteria, fungi, or nematodes) at incompatible combination of partners.

Course Objectives:
After completing this course student will be able to:

- Gain Knowledge of Plant and animal defence mechanisms.
- Will be able to understand a clear cut difference between different types of immune cells in Humans.
- Will understand the difference between bacteria, virus and fungi diseases

Course Outcome (CO):
CO1 gain knowledge about principles of the immune system
CO2 understand the immune responses against various infections and pathogens
CO3 learn about plant defense mechanisms
CO4 Difference between an antigen and antibody
CO5 Understanding of Physical, physiological, biochemical and molecular approach aspects of plant pathogen

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	**Immunology I** Historical perspectives in Immunology, Early theories of Immunology. Introduction, basic concepts in immunology, components of the immune system, principles of innate and adaptive immunity. Cells and Organs of the Immune system: T cells, B cells, Macrophages, B Cells, Dendritic Cells, Granulocytes, Megakaryocytes, Monocytes/Macrophages, Natural Killer (NK) Cells, Platelets, Thymocytes, Lymphoid organs- Thymus and bone marrow. Role and diversity of Immunoglobulins: IgA, IgM, IgE, IgD, IgG. Inflammatory response.	15	1,2,3,4	CO1 CO2 CO4	PSO1 PSO2

2	**Immune responses against microbes**: immunity to bacteria, viruses, fungi, protozoa. Passive and active immunity. Cell-mediated immunity: phases of T cell responses; APCs and T cell interactions; T cell activation; decline of immune responses; TH 1 and TH 2 subsets; effector mechanisms of CMI. Humoral immunity: Initiation of B cell responses by antigen, TH and B cell interactions; B cell activation and antibody production; affinity maturation; TI and T D antigens; effector mechanisms of humoral immunity; mucosal immunity. Immunologic tolerance and autoimmunity, Immune responses against tumors and transplants. Hypersensitivity reactions: Type I, II, III and IV hypersensitivity. Immunodeficiency diseases; HIV infection and AIDS.	15	1,2,3,4	CO1 CO2 CO4	PSO1 PSO2
3	**Stress metabolism in plants** – Environmental stresses, salinity, water stress, heat, chilling, anaerobiosis, pathogenesis, heavy metals, radiation and their impact on plant growth and metabolism, criteria of stress tolerance. Antioxidative defense system in plants – reactive oxygen species and their generation, enzymic and non-enzymic components of antioxidative defense mechanism. **General Account of Plant Pathogens**: Historical developments, general account of diseases caused by plant pathogens. Pathogen attack and defense mechanisms: Plant-microbe interactions, Physical, physiological, biochemical and molecular aspects. Plant disease epidemiology: Transmission and spread of plant pathogens; disease cycles Major Plant Diseases: Differentiation between bacterial, viral and fungal diseases using morphological symptoms.	15	2, 3, 4	CO3 CO4	PSO1 PSO2

Reference Books	
1.	The Elements of Immunology, FH, Khan. Pearson Education. 2009
2.	Immunology, Theortical and practical Concepts in laboratory medicine. H.D. Zane and W.B. Saunders. 2001.
3.	Immunology by Kuby.
4.	Singh R.S. (2008) Plant diseases. Oxford and IBH Pub, Delhi
5.	Mehrotra R.S., Aggarwal A. (2003) Plant Pathology McGraw Hil

School: School of Science	**Program: BSc Life Science**
Course Code: LS305	**Course Name: Life Science Laboratory IX**

Year	**III**	**Core Subject(Yes/No):**	**Yes**	**Lecture:**	**0**
Semester	**V**	**Elective Subject(Yes/No):**	**No**	**Tutorial**	**0**
Typology of Course	Laboratory	**Foundation Subject(Yes/No):**	**No**	**Practical:**	**8**
		Year of Syllabus Revision:		**Total Credit:**	**4**
		Year of Introduction	**2021**	**Prerequisites (If any)**	**NA**

Course Description:
This course will cover the biotechnology and molecular biological techniques like Nucleic acid and protein isolation and characterization. Students will learn some basic biological databases and their applications. This course will also cover the experiments related to endocrine glands like histology study, 3D visualization through online software and live demonstration of animal dissection (Fish model).

Course Outcome (CO):
CO1 techniques used in RNA, DNA and protein analysis
CO2 basic biological databases
CO3 histology and function of endocrine glands
CO4 Estimation of genetic material

Unit No.	**Topic/Unit**	**Contact Hours**	**BT Level**	**CO**	**PSO**
1	To isolate genomic DNA from via phenol/Chloroform/Isoamyl alcohol method	12	1,2,3,4	CO1 CO2 CO4	PSO1 PSO2
2	To isolate genomic DNA from insect tissue by CTAB method	12	1,2,3,4	CO1 CO2 CO4	PSO1 PSO2
3	To estimate the amount of DNA by qualitative and quantitative method (Spectrophotometer)	12	2, 3, 4	CO3 CO4	PSO1 PSO2
4	To isolate RNA from bacteria by Trizol method	12	2,4	CO3 CO5	PSO1 PSO2
5	To perform agarose gel electrophoresis for isolated genomic DNA	12	2,3	CO1 CO2	PSO1 PSO2
6	To perform Protein estimation via Bradford method	12	2,3,4	CO1 CO2	PSO1 PSO2
7	To perform Native PAGE for Protein	12	1,2,3	CO1	PSO1 PSO2
8	To perform SDS-PAGE technique for fish tissue protein	12	1,2	CO2	PSO1 PSO2
9	Demonstration of End point PCR Technique	12	1,2	CO1 CO2	PSO1 PSO2
10	To study biological database (NCBI, EMBL)	12	1,2	CO2	PSO1 PSO2

Reference Books

1. Lab manual on Molecular Biology;1st Edition by Ruhi Dixit, Kartikay Bisen., et.al;2016.

2.	Basic Histopathology: A Colour Atlas and Text. By Paul Wheater, George Burkitt, Alan Stevens and James Lowe. ELBS with Churchill Livingstone 4th edition,2002.
3.	Practical Manual of Biotechnology by Sharma, 2010.

School: School of Science			**Program: BSc Life science**		
Course Code: LS306			**Course Name:** Life Science Laboratory X		
Year	**III**	**Core Subject(Yes/No):**	**Yes**	**Lecture:**	
Semester	**V**	**Elective Subject(Yes/No):**	**-**	**Tutorial**	
Mode of Transaction	Laboratory	**Foundation Subject(Yes/No):**	**-**	**Practical:**	**8 hr**
		Year of Syllabus Revision:		**Total Credit:**	**4**
		Year of Introduction	**2020**	**Prerequisites (If any)**	

Course Description:

This course will cover the study of immunological techniques in which students will learn blood cells through staining techniques and about antigen-antibody interaction through ELISA method. Students will study the different plant parts which have been developed for defense mechanism during field studies. Students will also learn the action of different phytohormones on plant samples during laboratory sessions.

Course Outcome (CO):

After completing this course, students will be able to learn:

1. analyses antigen antibody interaction through immunological techniques. different part which has developed for defence mechanism
2. provide different hormones to plants and study their effects

No.	Experiment	Contact Hours	BT Level	CO	PSO
1	To study the immune organs using permanent slides	4	1,2,3,5	CO1	PSO2, PSO3
2	To perform differential staining to identify and quantify the WBCs	4	1,2,4,5	CO1,	PSO2, PSO3
3	To identify blood group of given sample (AB and RH both)	4	1,2,3,5	CO1	PSO2, PSO3
4	To determine the antigen concentration by quantitative precipitation assay	4	1, 2, 3	CO1	PSO2, PSO3
5	Technique of Ouchterlony double diffusion (Antibody titration)	4	1,2,3,5	CO1	PSO2, PSO3
6	Study of morphological plant defence related structures (spines, thorns, serrated spine-tipped leaves, prickles)	4	1,2,3,5	CO2	PSO2, PSO3
7	Study of chemical plant defence: Testing for the presence of compounds like alkaloids, Terpenes, tannins, glycosides and understanding their role in defence.	4	1,2,3,5	CO2	PSO2, PSO3
8	Study of chemical plant defence: Testing for the presence of compounds like	4	1,2,3,5	CO2	PSO2, PSO3

	alkaloids, Terpenes, tannins, glycosides and understanding their role in defence.				
9	Study of alternate and distichous, alternate and superposed, opposite and superposed; opposite and decussate leaf arrangement.	4	1,2,3,5	CO2	PSO2, PSO3
10	Examination of rosette plants (Launaea, Mullugo, Raphanus, Hyocyamus etc) and induction of bolting under natural condition as well as by GA treatment.	4	1,2,3	CO2	PSO2, PSO3
11	Study of epidermal peels of leaves such as Coccinia, Gaillardia, Tradescantia, Notonea, etc. to study the development and final structure of stomata and prepare stomatal index. Demonstration of the effect of ABA on stomatal closure.	4	1,2,3,5	CO2	PSO2, PSO3
Reference Books					
1.	Manual of Molecular and Clinical Laboratory Immunology, 7th Edition, Barbara Detrick, Robert G. Hamilton, James D. Folds, 2006.				
2.	Li, W., Khan, M. A., Yamaguchi, S., & Kamiya, Y. (2005). Effects of heavy metals on seed germination and early seedling growth of Arabidopsis thaliana. Plant growth regulation, 46(1), 45-50.				

<table>
<tr><td colspan="3">School: School of Science</td><td colspan="3">Program: BSc Life science</td></tr>
<tr><td colspan="3">Course Code: PS322</td><td colspan="3">Course Name: Scientific Enquiry and Research Methodology</td></tr>
<tr><td>Year</td><td>III</td><td>Core Subject(Yes/No):</td><td>Yes</td><td>Lecture:</td><td>3</td></tr>
<tr><td>Semester</td><td>V</td><td>Elective Subject(Yes/No):</td><td></td><td>Tutorial</td><td>-</td></tr>
<tr><td rowspan="3">Typology of Course</td><td rowspan="3">Lectures</td><td>Foundation Subject(Yes/No):</td><td></td><td>Practical:</td><td>-</td></tr>
<tr><td>Year of Syllabus Revision:</td><td></td><td>Total Credit:</td><td>03</td></tr>
<tr><td>Year of Introduction</td><td>2021</td><td>Prerequisites (If any)</td><td>Students must have an understanding of basic math concepts; Students must be familiar with the use of MS Office tools</td></tr>
</table>

Course Description:

This course is designed to orient students to Research Methodology and develop a research aptitude in them. Topics included are an understanding of basic research methodology - problem identification; importance of literature review; types of research designs; tool and techniques of data collection; techniques of data analysis; reporting of findings; scientific and research writing. Section on review of different types of researches provides the understanding to carry out the research work independently. Once equipped with this knowledge, students would have the requisite knowledge and understanding to conduct research in an area of their choosing

Course Objectives:

At the end of this course, students should be able to -

- Read, interpret and critically evaluate 'research'.
- Explain and apply research terminologies; describe the research process and the principle activities, skills and ethics associated with the research process.
- Identify and explain the difference between quantitative, qualitative & mixed methods research.
- Explain components of a research study and justify the theory as well as the methodological decisions, including sampling, measurement and analysis.
- Critically review a research study including an abstract, introduction, literature review, objectives of the study, research design and ethical considerations.

Course Outcome (CO):

CO1 Explain key research concepts and issues
CO2 Explain the difference between quantitative, qualitative & mixed methods research.
CO3 Relate the type of Study with methodology to be adopted
– research design, tools / techniques of data collection and analysis.
CO4 Evaluate critically a research study and its various components
CO5 Read, comprehend, and explain research articles in their academic discipline
CO6 Explain the ethical issues that need to be addressed in the conducting of research

Unit No.	**Topic/Unit**	**Contact Hours**	**BT Level**	**CO**	**PSO**

1	Definition of research and its importance; Steps in the process of research Identifying a research problem; Discussion on importance, feasibility… Quantitative & Qualitative research characteristics	8	1,2,3,4,5	**CO1** **CO2** **CO4**	PSO1
2	Reviewing related literature Understanding Concepts, Variables. Understanding Research questions Understanding Hypothesis, types of hypothesis; Framing of Objectives.	8	2,3,4,5	**CO1** **CO3** **CO4**	PSO1 PSO3
3	Research design – Experimental, Correlational Research design – Survey, Field study Research design – Mixed method Research design - Action research	9	2, 3, 4,5	**CO2** **CO3** **CO4**	PSO1 PSO3
4	Understanding Population, Sample, Sampling techniques Tools and techniques of data collection Designing tools with Reliability, Validity, Objectivity, Sensitivity Understanding Normal Probability curve; Implications.	10	2,3,4,5	**CO1** **CO3**	PSO1 PSO2 PSO3
5	Data Analysis - Qualitative Research. Data Analysis – Quantitative Research (Central Tendency – calculating Mean, Median, Mode)	4	1,2,3,4,5	**CO1** **CO3**	PSO1 PSO2 PSO3
6	Critically review a research proposal - including an abstract, introduction, literature review, objectives of the study, research design and ethical considerations. Ethical issues in conducting research Skills needed to design and conduct research	6	2,3,4,5	**CO4** **CO5** **CO6**	PSO1 PSO3 PSO6

Reference Books	
1.	1) Anthony, M., Graziano, A.M. and Raulin, M.L., 2009. Research Methods: A Process of Inquiry, Allyn and Bacon.
2.	2) Best J.W., and Kahn J.V., (2003) Research in education Ninth edition, New Delhi: Prentice Hall of India
3	3) Cresswell J.W. (2011) Educational Research New Delhi: PHI learning Pvt. Ltd.
4	4) Day, R.A., 1992.How to Write and Publish a Scientific Paper, Cambridge University Press.
5	5) Fink, A., 2009. Conducting Research Literature Reviews: From the Internet to Paper. Sage Publications.
6	6) Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers.
7	7) Kothari C.R., (2008), Research Methodology- Methods and Techniques, Wiley and Eastern Ltd., New Delhi,
8	8) Koul Lokesh., (2009) Methodology of educational research fourth edition., New Delhi: Vikas publishing
9	9) Leedy, P.D. and Ormrod, J.E., 2004 Practical Research: Planning and Design, Prentice Hall.
10	10) Marshall Stephen D, Nick Green (2010) Your Ph.D companion New Delhi: Viva books

11	11) Mc Burney H. Donald., (2001) “Research Methodology “fifth edition., Australia: Thomson -Wadsworth
12	12) Pandya Shefali., (2010) Educational Research New Delhi: APH Publishing corporation
13	13) Panneerselvam R., (2010) Research Methodology New Delhi: Anmol Publication
14	14) Satarkar, S.V., 2000. Intellectual property rights and Copy right. Ess Ess Publications.
15	15) Sharma R. N., (2008) Statistical techniques in educational research Delhi: Surjeet publication.

School: School of Science			**Program: BSc Life science**		
Course Code: SE201			**Course Name: Essential Laboratory Practices**		
Year	**III**	**Core Subject(Yes/No):**	**No**	**Lecture:**	**2**
Semester	**V**	**Elective Subject(Yes/No):**	**Yes**	**Tutorial**	**-**
Typology of Course	Lectures	**Foundation Subject(Yes/No):**	**-**	**Practical:**	**-**
		Year of Syllabus Revision:	**-**	**Total Credit:**	**2**
		Year of Introduction	**2016**	**Prerequisites (If any)**	Basic knowledge about lab apparatus handling and SOPs which students have learned in their previous year laboratory sessions.

Course Description:

This Essential Laboratory Practice course provides an essential grounding in the way all types of non-clinical health and environmental safety studies should be planned, performed, monitored, recorded, archived and reported.

Course Objectives:

To provide students with good laboratory practice

To prepare student for Quality control training

To prepare students for Clinical Studies

Course Outcome (CO):

After completing this course, students will be able to learn:

1. the role of Essential Laboratory Practices in the Biotechnology industry
2. the regulatory aspects of laboratories
3. importance of quality control
4. Food and Drug Regulations
5. In-vitro and In Vivo techniques principle and application

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	**Unit I** In vivo studies, In vitro studies, regulatory affairs, drug development, preclinical studies, clinical studies	15	1,2,3,5	CO1, CO5,	PSO1
2	**Unit II** Quality System Regulations (QSR), Good Clinical Practice (GCP), Good Laboratory Practices	15	1,2,3,4	CO1, CO2, CO3,	PSO1

	(GLP), Good Manufacturing Practice (GMP), FDA inspections			CO4	

Reference Books	
1.	Weinberg, S. (Ed.). (2003). Good laboratory practice regulations. Marcel Dekker.
2.	Seiler, J. P. (2006). Good Laboratory Practice: The why and the how. Springer Science & Business Media.
3.	McPherson, R. A., & Pincus, M. R. (2017). Henry's Clinical Diagnosis and Management by Laboratory Methods E-Book. Elsevier Health Sciences.
4.	Ezzelle, J., Rodriguez-Chavez, I. R., Darden, J. M., Stirewalt, M., Kunwar, N., Hitchcock, R., ... & D'souza, M. P. (2008). Guidelines on good clinical laboratory practice: bridging operations between research and clinical research laboratories. Journal of pharmaceutical and biomedical analysis, 46(1), 18-29.

<table>
<tr><td colspan="3">School: School of Science</td><td colspan="3">Program: BSc Life science</td></tr>
<tr><td colspan="3">Course Code: SE202</td><td colspan="3">Course Name: Food and Nutrition</td></tr>
<tr><td>Year</td><td>III</td><td>Core Subject(Yes/No):</td><td>Yes</td><td>Lecture:</td><td>2</td></tr>
<tr><td>Semester</td><td>V</td><td>Elective Subject(Yes/No):</td><td>No</td><td>Tutorial</td><td>NA</td></tr>
<tr><td rowspan="3">Typology of Course</td><td rowspan="3">Lectures</td><td>Foundation Subject(Yes/No):</td><td>No</td><td>Practical:</td><td>NA</td></tr>
<tr><td>Year of Syllabus Revision:</td><td></td><td>Total Credit:</td><td>2</td></tr>
<tr><td>Year of Introduction</td><td>2016</td><td>Prerequisites (If any)</td><td>NIL</td></tr>
</table>

Course Description:

Nutrition refers to the science which deals with the role of nutrients and other substances in health, growth, physiology and disease of an individual. A proper diet, is determined by the proper proportions, requisite quantities, availability, method of cooking and palatability of the food.

Course Objectives:

To prepare students for successful career in industry and research institutes.
To enable students to work in a team with multidisciplinary approach.
To provide students with fundamental strength in analysing, designing and solving health related problems.

Course Outcome (CO):

CO1 Identify nutrition and health problems associated with diet
CO2 Importance of eating patterns and dietary needs both for people of different ages and for different groups within society
CO3 Understand the basis for different methods of cooking

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	An understanding of the terms used in nutrition and the concept of diet and nutrition Balanced diet, My plate, Nutrition and dietetics. Nutritive value of foods - The sources and functions of: proteins, carbohydrates, fats, vitamins, Mineral elements, water, Sources and uses of food energy, Sources and functions of dietary fibre. Dietary guidelines - Factors affecting food requirements, Planning and serving of family meals. Meals for all ages and occupations. Special needs of pregnant and lactating women, convalescents, Vegetarians, Use of herbs, spices	15	1,2	CO1	PSO3

	and garnishes. Composition and value of the main foods in the diet - Milk, meat, fish, cheese, eggs, margarine and Butter, Cereals, fruits and vegetables.				
2	Cooking of food Transfer of heat by conduction, convection and radiation. Principles involved in the different methods of cooking – boiling, stewing, grilling, baking, roasting, frying, steaming, pressure cooking, Preparation and cooking of food to preserve nutritional value and flavour. Traditional methods of cooking. Economical use of food, equipment, fuel and labour. Food spoilage, and hygiene in the handling and storage of food, Food preservation.	15	1,2	CO2,3	PSO3

Reference Books	
1	N.W. Desrosier & J. N. Desrosier, The Technology of Food Preservation, Westport: Connecticut, Publishing Company, 1997. 2. Deaton, A., & Drèze, J. (2009).
2	Food and nutrition in India: facts and interpretations. Economic and political weekly, 42-65. 3. Duyff, R. L. (2012).
3	American dietetic association complete food and nutrition guide. Houghton Mifflin Harcourt. 4. Curry, K. R. (2000).
4	Multicultural competence in dietetics and nutrition. Journal of the Academy of Nutrition and Dietetics, 100(10), 1142.
5	E. Whitney, E. Hamiliton & S. Rolfes, Understanding Nutrition, St. Paul, MN: West Publishing Company, 1990. 6. Mahan, L. K. (2004).
6	Krause's food, nutrition, & diet therapy (Vol. 11). S. Escott-Stump (Ed.). Philadelphia: Saunders.

School: School of Science	**Program: BSc Life science**
Course Code: SE213	**Course Name:** Introduction to Neuroscience and Cognition

Year	**III**	**Core Subject (Yes/No):**	**-**	**Lecture:**	**2**
Semester	**V**	**Elective Subject (Yes/No):**	**Yes**	**Tutorial**	**-**
Typology of Course	Lectures	**Foundation Subject (Yes/No):**	**-**	**Practical:**	**-**
		Year of Syllabus Revision:		**Total Credit:**	**2**
		Year of Introduction	**2016**	**Prerequisites (If any)**	**-**

Course Description:
This course introduces basic neuroanatomy, neurophysiology, neural plasticity, functional imaging techniques. It also explains cognitive and neural processes that support attention, vision, language, motor control, navigation, and memory. Course explores behavioral measures of cognition and discusses methods by which inferences about the brain bases of cognition are made along with various neurological disorders.

Course Objectives:
Development and organization of nervous system, types of cells in CNS and PNS, understanding concept of neurophysiology, electric firing of neurons, and types of synapses- chemical and electrical. The course also describes neurobiology of sleep, memory and attention along with the various neurological disorders.

Course Outcome (CO):

I. Concepts of neuroanatomy, neurophysiology, development, and sensation/ perception
II. Principle of cognitive science, cognitive control, plasticity
III. Modes of learning and memory, attention and action, sleep, emotion and language
IV. Various neurological disorders

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	**Unit I:** Nervous Physiology and Functions: Introduction to neuroscience, History of neuroscience and Introduction to Neurons, Neurology of biological cycle and techniques to study neurology, Types of Neurons, Circadian rhythm, Action Potential, Evolution of Neurons, Evolution of nervous system, Neuroanatomy- Structure of brain, spinal cord, medulla oblongata, Neurophysiology, Neurotransmitters	15	1,2,3	CO1	PSO1
2	**Unit II:** Cognition and Defects Sleep cycle and disorders, Neurology of Learning, Neurology of Memory, Neurology of Attention and Action, Neurology of Emotions and Language, Development of neurons, Plasticity of Neurons, Methods in Cognitive Science, Sensation and	15	1,2,3	CO2, CO3, CO4	PSO1

	perception, Cognitive control, Object recognition, Neurological Disorder.				

Reference Books

1.	Bear, Connors, Paradiso-Neuroscience '16 58
2.	Development of the nervous system second edition dan h. Sanes thomas a. Reh, william a. Harris amsterdam, Academic Press is an imprint of Elsevier 3
3.	Basic Neurochemistry: Principles of Molecular, Cellular, and Medical Neurobiology (2011) Scott Brady. Elsevier Science & Technology
4.	Basic Neurochemistry: Molecular, Cellular and Medical Aspects (1994) George J. Siegel, Bernard W. Agranoff, R. Wayne Albers, Perry B. Molinoff. Raven Press
5.	Handbook of Neurochemistry (1969) A. Lajtha. Plenum Press
6.	Selected Topics from Neurochemistry (1985) N. N. Osborne. Elsevier Science Limited.

<table>
<tr><td colspan="3">School: School of Science</td><td colspan="3">Program: BSc Life science</td></tr>
<tr><td colspan="3">Course Code: SE305</td><td colspan="3">Course Name: Introduction to Cell and Tissue Culture</td></tr>
<tr><td>Year</td><td>III</td><td>Core Subject (Yes/No):</td><td>-</td><td>Lecture:</td><td>2</td></tr>
<tr><td>Semester</td><td>V</td><td>Elective Subject (Yes/No):</td><td>Yes</td><td>Tutorial</td><td>-</td></tr>
<tr><td rowspan="3">Typology of Course</td><td rowspan="3">Lectures</td><td>Foundation Subject (Yes/No):</td><td>-</td><td>Practical:</td><td>-</td></tr>
<tr><td>Year of Syllabus Revision:</td><td></td><td>Total Credit:</td><td>2</td></tr>
<tr><td>Year of Introduction</td><td>2021</td><td>Prerequisites (If any)</td><td>-</td></tr>
</table>

Course Description:
This course provides an expertise in animal and plant tissue culture theory and practice. It introduces the student to the theory and practice of plant tissue culture and their role from modifying plants in plant biotechnology to the propagation of endangered plants and from modifying cell lines to the propagation of all lines for use in medical, microbiological, and biochemical research. It also emphasizes on the importance and applications of stem cells.

Course Objectives:
To understand the concept of cell and tissue culture. The course describes various methods and aspects of plant tissue culture such as sterilization and media preparation, the composition of media for different cultures, types of tissue cultures and the creation of hybrid plants through micropropagation. The course also highlights the basics of animal cell culture, media sterilization, biology of cells in culture and various assays done to test compounds as a method of drug development studies.

Course Outcome (CO):

CO1. Understand the methods for plant and animal tissue culture and characterization.
CO2. Study the applications of plant and animal tissue cultures
CO3. Understand different types and methods of cell culture.
CO4. To study the culture and characterization of animal cell lines.

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	**Unit I:** Plant Tissue Culture History and scope of plant tissue culture. Laboratory requirements and organization. Sterilization methods. Media preparation-inorganic nutrients, organic supplements, carbon source, vitamins, gelling agents, phytohormones and growth regulators; composition of commonly used culture media. Types of tissue culture-plantlets, seedlings, callus, somatic embryogenesis. Micropropagation: Factors affecting morphogenesis and proliferation rate; technical problems in micropropagation. Organogenesis: formation of shoots and roots,	15	1,2,3	CO1, CO2	PSO1

	production of virus free plants by meristem and shoot tip culture Hybrid plants: protoplast isolation, culture and fusion, selection of hybrid cells and regeneration of hybrid plants, symmetric and asymmetric hybrid, cybrid. Production of haploid plants: anther, pollen, and ovary cultures for production of haploid plants and homozygous lines.				
2	**Unit II:** Animal Cell Culture Introduction to Mammalian Cell Culture and its history, Application of cell culture, Equipments and materials for animal cell culture technology, Media composition for cell culture (Basal media and supplements), Characteristics of cells in culture: Contact inhibition, anchorage dependence (adherent and non-adherent, way to passage it), cell-cell communication (cell junction basics, co-culture), Cell senescence (telomerase and ageing), Types of culture (cell/tissue/organ). Various systems of tissue culture, their distinguishing features, advantages and limitations, applications, measurement of viability and cytotoxicity, various cell cultures: primary, cell lines immortalized, transformed, haploid and diploid cell lines and Stem cells (based on potency- totiptent, multipotent, pleuripotent, oligopotent and based on their origin-embryonic, hematopoietic, somatic), iPSC (mechanism of its generation with eg. Human fibroblast to pluripotent-beta cell of pancrease), transfection methods (lipofection, calcium mediated, electroporation), Tissue engineering	15	1,2,3	CO3, CO4	PSO1

Reference Books	
1.	Introduction to plant tissue culture (1993) M. K. Razdan. Science Publishers Inc.
2.	Plant Cell and Tissue Culture (1994), Indra K. Vasil, Trevor A. Thorpe. Springer
3.	R. Ian Freshney -Culture of Animal Cells_ A Manual of Basic Technique and Specialized Applications, Sixth Edition- Wiley-Blackwell (2010)
4.	Masters, J. R. W. (Ed): Animal Cell Culture – Practical Approach, Oxford Univ. Press.
5.	Basega, R. (Ed): Cell Growth and Division: A Practical Approach. IRL Press.
6.	Clynes, M. (Ed.). (2012). Animal cell culture techniques. Springer Science & Business Media.
7.	Knoepfler, P. (2013). Stem cells: an insider's guide. World Scientific.
8.	Turksen, K. (Ed.). (2012). Adult and Embryonic Stem Cells. Springer Science & Business Media.
9.	Lanza, R., Gearhart, J., Hogan, B., Melton, D., Pedersen, R., Thomas, E. D., & West, M. (Eds.). (2005). Essentials of stem cell biology. Elsevier.

School: School of Science			**Program: BSc Life science**		
Course Code: EMB601			**Course Name:** **Plant and Animal Molecular Embryology**		
Year	**III**	**Core Subject(Yes/No):**	**Yes**	**Lecture:**	**3**
Semester	**VI**	**Elective Subject(Yes/No):**	**-**	**Tutorial**	**0**
Typology of Course	Lectures	**Foundation Subject(Yes/No):**	**-**	**Practical:**	**0**
		Year of Syllabus Revision:		**Total Credit:**	**3**
		Year of Introduction	**2021**	**Prerequisites (If any)**	**-**

Course Description:

The course aims to discuss the basics of embryology, concept of totipotency, pleuripotancy with respect to embryonic development in plants and animals. Students will be exposed to concepts of animal developments- gametogenesis, types of fertilizations, germ layers and the initial and late events of development. Further, plant gametogenesis, fertilization, apomixes and polyembryony will be discussed.

Course Objectives:

This course aims to provide a broad, comprehensive look at embryology with special emphasis on vertebrate models, focusing on both classical experiments and modern molecular and genetic techniques. It also focuses on the development of different plant organs and emphasizes on the different systems involved in plant development.

Course Outcome (CO):

After completing this course, students will be able to understand:

CO1.	Understand the life cycle and evolution of different developmental patterns.
CO2.	basics of embryonic and postembryonic development of organisms.
CO3.	events of embryogenesis, fertilization, and the progression of development
CO4.	Gain knowledge on the process of metamorphosis and ageing.
CO5.	Understand the organization of different meristems in plants.
CO6.	Study the different stages in the development of plants
CO7.	concept of apomixis and polyembryony in plants

Unit No.	**Topic/Unit**	**Contact Hours**	**BT Level**	**CO**	**PSO**
1	Unit I: History and classical experiments in embryology – classical embryology, experimental embryology; concepts of nucleo-cytoplasmic contribution, genomic equivalence, developmental potencies, differential gene expression.	15	1,2,3	CO1, CO2	PSO1, PSO2

2	Unit II: Gametogenesis Early embryonic development: Gametogenesis: Spermatogenesis and oogenesis w.r.t. mammals, vitellogenesis in birds; Fertilization: external (amphibians), internal (mammals), blocks to polyspermy; Early development of frog, chick and humans (structure of mature egg and its membranes, patterns of cleavage, fate map, up to formation of gastrula); types of morphogenetic movements; Fate of germ layers; Neurulation in frog embryo. Concepts of Regeneration and Metamorphosis. Late embryonic development: Implantation of embryo in humans, Formation of human placenta and functions, other types of placenta on the basis of histology; Metamorphic events in frog life cycle and its hormonal regulation.	15	1,2,3	CO2,CO3, CO4	PSO1
3	Unit III: Plant Embryology Gametogenesis and Fertilization in plants Gametogenesis in Plants, Development of male and female Gametophyte, Process of fertilization in Angiosperm. Development of Embryo and Endosperm Development of embryo and endosperm, Types of endosperm in Angiosperm. Apomixis-Introduction, Definition, Types. Polyembryony-Introduction, Definition, Types		2, 3, 4	CO5,CO6, CO7	PSO1 PSO2

Reference Books

1.	Gilbert, S. F. (2006). Developmental Biology, VIII Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA.
2.	Balinsky, B.I. (2008). An introduction to Embryology, International Thomson Computer Press.
3.	Carlson, Bruce M (1996). Patten's Foundations of Embryology, McGraw Hill, Inc.

School: School of Science	**Program: Bachelor of Science**
Course Code: TAX601	**Course Name: Taxonomy of Plants and Animals**

Year	**III**	**Core Subject(Yes/No):**	Yes	**Lecture:**	**3**
Semester	**VI**	**Elective Subject(Yes/No):**	No	**Tutorial**	**-**
Typology of Course	Lectures	**Foundation Subject(Yes/No):**	No	**Practical:**	**-**
		Year of Syllabus Revision:		**Total Credit:**	**3**
		Year of Introduction	2021	**Prerequisites (If any)**	**NA**

Course Description:
Taxonomy provides a framework of identifying organisms. The classification system also called as taxonomic hierarchy names organisms through various levels ranging from domain, kingdom, phylum, class, order, family, genus, and species. The course also covers detailing of major angiosperm families. Topics of animal systematics, types of taxonomy, and species concept will be covered in detail.

Course Objectives:

After completing this course student will be able to:

- recognize and describe plant characteristics (plant composition, function, and diversity)
- understand the principles of animal systematics and nomenclature

Course Outcome (CO):

CO1Understanding of plant morphology terminologies and identifying morphological peculiarities

CO2Recognize members of the major angiosperm families by identifying their diagnostic features and economic importance

CO3With the study of this paper students gain knowledge in the areas of responses to Systematic position, general organization and affinities of Ctenophora and Nemertea

CO4Understand the systems of classification, nomenclature and interdisciplinary approaches

CO5The students will be well equipped to become very competent in research or teaching fields after completion of this course

Unit No.	**Topic/Unit**	**Contact Hours**	**BT Level**	**CO**	**PSO**
1	Plant Taxonomy: Plant identification and nomenclature: methods of identification, taxonomic keys (dichotomous and polyclave), written description, specimen comparison, image comparison, expert determination. Practical identification. An overview of the International Code of Nomenclature for algae, fungi, and plants (ICN). Scientific names, ranks, authorship, nomenclature types, priority of publication, conservation of names, name changes, valid publication, synonyms. Plant collecting and documentation. Herbaria, Floras, Monographs and Synopsis.	15	1, 2	CO1 CO4 CO5	PSO1
2	Major Angiosperm Families: Asteraceae, Rubiaceae, Poaceae, Orchidaceae, Liliaceae, Fabaceae, Annonaceae, Malvaceae, Meliaceae, Anacardiaceae, Myrtaceae,	15	1, 2	CO2	PSO1

	Cucurbitaceae, Apiaceae, Amaranthaceae, Euphorbiaceae, Cannaceae and Bignoniaceae.				
3	Animal Taxonomy: Principles of animal systematics and nomenclature, Species concepts and speciation, Taxonomic procedures and macromolecular taxonomy, Cladistic classification of animals. Levels of taxonomy (alpha, beta and gamma taxonomy, micro and macro taxonomy), scope of taxonomy, Classification (Phenetic and Cladistics), Concept of dendogram and cladogram, Biological Species concept, Subspecies, Polytypic species, Sibling species and Ring species, Isolation and its role in speciation (pre mating and post mating), Modes of speciation – Sympatric, Allopatric and Parapatric, Basic principle and use of DNA bar coding in species identification, International Code of Zoological Nomenclature (ICZN)	15	1, 2	CO3 CO4 CO5	PSO1

Reference Books	
1.	Reproduction in Wild Mammalia & Conservation by Arora, B.M
2.	Essentials of Conservation Biology by Primack, R.B
3.	Daniel, M. (2009) Taxonomy: Evolution at Work, Narosa Publishers, New Delhi
4.	Heywood, V.H. & Moore D.M. (1984). Current concepts in Plant Taxonomy
5.	Kapoor, V. C. 1998. Theory and Practice of Animal Taxonomy. Oxford and IBH publishing
6.	Mayr, E and P. D. Ashlock. 1991. Principles of Systematic Zoology. McGraw-Hill, Inc., New Delhi
7.	Narendran, T. C. 2006. An Introduction to Taxonomy. Zoological Survey of India, Kolkata

School: School of Science			**Program: BSc**		
Course Code: CON601			**Course Name:** Wildlife and conservation biology		
Year	**III**	**Core Subject(Yes/No):**	**Yes**	**Lecture:**	**3**
Semester	**VI**	**Elective Subject(Yes/No):**	**-**	**Tutorial**	**0**
Typology of Course	Lectures	**Foundation Subject(Yes/No):**	**-**	**Practical:**	**0**
		Year of Syllabus Revision:	**-**	**Total Credit:**	**3**
		Year of Introduction	**2014**	**Prerequisites (If any)**	-

Course Description:
This course seeks to meet the increasing interest for research and monitoring of wildlife habitats and further the cause of wildlife conservation. It also includes the various national and international laws and legislations that have been framed for wildlife protection and conservation.

Course Objectives:
The course objectives include, detail understanding Wildlife : Flora and fauna found in India, To gain knowledge on conservation steps taken for endangered animals.

Course Outcome (CO):
After completing this course student will be able to:

CO1. To gain understanding of wildlife biology and conservation
CO2. To gain knowledge of difference between national park, Wild life sanctuaries and zoo
CO3. To understand various wildlife habitats and animal-human interactions, Wild life corridors, buffer zones
CO4. To learn about various wildlife laws and legislations in trade

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	**Unit I: Wildlife management and conservation:** Wildlife management practices, Forms and elements of wildlife management, Scope of wildlife biology, Physiological basis of hibernation, aestivation, awakening, migration, Circadian rhythms, Day- length influences on Phenology; Conservation in national parks and wildlife sanctuaries, Exsitu & in-situ conservation, Management of Zoo animals, Conservation Breeding (e.g. Vulture, Pygmy hog, Gharial etc.), International NGOs- UNEP, GEF, WCS, Bird Life International; National NGOs- WWF, ATREE, BNHS, WTI, Chipko movement, Narmada Bachao Andolan	15	1,2,3	CO1, CO2	PSO1
2	**Unit II: Wildlife Habitat:** Concept of Home range, Familiar areas, Manipulating Home ranges to increase population density, Territoriality and Habitat utilization in animals,	15	1,2,3	CO3	PSO1

	Concept of niches, Micro-Habitats: Fallen Log, Treetop-puddles etc., Conservation Vs protection, Concept of Buffer zones, Wildlife corridors, Strategies to reduce human-wildlife interactions, Wildlife Sanctuaries and National Parks of India, Project Tiger, Project Elephant				
3	**Unit III: Wildlife Trade and Legislation:** Wildlife Protection Act (WPA), Wildlife crime control bureau, Areas of law, CITES, TRAFFIC, RED Data Book, IUCN Red-list, Measures to control poaching & wildlife trade, Committee on trade and environment, Trade in India	15	1,2,3	CO4	PSO1

Reference Books

1.	Wildlife ecology by Aaron, N.M. and W.H. Freeman
2.	Wildlife Ecology, Conservation and Management by Anthony R.E. Sinclair and Graeme Caughly
3.	Reproduction in Wild Mammalia & Conservation by Arora, B.M
4.	The Temple Tiger by Jim Corbett
5.	Fundamentals of Wildlife Management by Gopal, Rajesh
6.	Concepts in Wildlife Management by Hosetti, B.B.
7.	Essentials of Conservation Biology by Primack, R.B

<table>
<tr><td colspan="3">School: School of Science</td><td colspan="3">Program: B.Sc. Life Science</td></tr>
<tr><td colspan="3">Course Code: LAB601</td><td colspan="3">Course Name: Life Science Laboratory XI</td></tr>
<tr><td>Year</td><td>III</td><td>Core Subject(Yes/No):</td><td>Yes</td><td>Lecture:</td><td>0</td></tr>
<tr><td>Semester</td><td>VI</td><td>Elective Subject(Yes/No):</td><td>No</td><td>Tutorial</td><td>0</td></tr>
<tr><td rowspan="3">Mode of Transaction</td><td rowspan="3">Laboratory</td><td>Foundation Subject(Yes/No):</td><td>No</td><td>Practical:</td><td>8 hrs</td></tr>
<tr><td>Year of Syllabus Revision:</td><td>-</td><td>Total Credit:</td><td>4</td></tr>
<tr><td>Year of Introduction</td><td>2017</td><td>Prerequisites (If any)</td><td>NA</td></tr>
</table>

Course Description:

This course is about the experimentation related to conservation biology and Plant and animal taxonomy. Students will get a knowledge about the conservation. The nomenclature and classification rules for plants and animals. Through campus visit and field visits, students will learn the nomenclature pattern of plants and animals. In this course, through permanent slides as well as some lab experiments, student will learn the soil and water parameters which affect the wild life/Living system.

Course Outcome (CO):

After completing this course, students will be able to:

1. conserve biotic and abiotic components of surrounding environment
2. study the classification and nomenclature of plant and animal
3. To understand the soil and water analysis

No.	**Experiment**	**Contact Hours**	**BT Level**	**CO**	**PSO**
1	Visits to local conservation/research organizations, ecosystems and protected areas	4	1, 2	CO1	PSO3
2	To study animal Hair and pug mark analysis	4	1, 2	CO1	PSO2
3	To study different quadrant techniques	4	1, 2	CO1	PSO2
4	To study various transect method used for animal census	4	1, 2	CO1	PSO2
5	To carry out line transect method for counting of animal at given area	4	1, 2	CO1	PSO2
6	To study various wild life protected area of India	4	1, 2	CO1	PSO2

7	To study IUCN Red List assessments	4	1, 2	CO1	PSO2
8	To visit the ponds or river nearer to university and study flora and fauna of aquatic system.	4	1, 2	CO2, CO4	PSO2, PSO3
9	To collect water sample of different aquatic system (Vadodara city) and determine water parameters: Acidity, Basicity, pH, DO, BOD and COD.	4	1, 2, 3, 4, 5	CO4	PSO2, PSO3
10	To collect water sample of different aquatic system (Vadodara city) and determine inorganic content of water sample: Total Chloride, Carbonate, Bicarbonate, ions	4	1, 2, 3, 4, 5	CO4	PSO2, PSO3
11	To collect soil sample of different areas of Vadodara city and determine inorganic content of soil sample: Total Chloride, Carbonate, Bicarbonate, Nitrate, Sulphate ions	4	1, 2, 3, 4, 5	CO4	PSO2, PSO3
12	Mounting of a properly dried and pressed specimen of any wild plant with herbarium label	4	1 2, 6	CO1, CO2	PSO2
13	Study of vegetative and floral characters of the following families (Description, V.S. flower, section of ovary, floral diagram/s, floral formula/e and systematic position according to Bentham & Hooker's system of classification): Malvaceae- Hibiscus; Asteraceae- Wedelia/Tridax; Poaceae- Zea mays; Liliaceae- Crinum; Fabaceae- Clitoria; Meliaceae- Azadirachta/Melia; Orchidaceae- Dendrobium; Euphorbiaceae- Euphorbia/Phyllanthus; Amaranthaceae- Alternanthera/Amaranthus; Cannaceae- Canna indica; Bignoniaceae- Tabebuia.	4	1, 2	CO1, CO2	PSO2
14	To study the process of DNA barcording of unknown species (Plant/Animal)	4	1, 2		PSO2

15	To study the principle of RFLP and RAPD in unique species identification on the basis of Molecular level studies.	4	1, 2		PSO2

Reference Books

1	Hubert, N., & Hanner, R. (2015). DNA barcoding, species delineation and taxonomy: a historical perspective. DNA barcodes, 3(1), 44-58.
2	Hawksworth, D. L. (2015). Books on biodiversity and conservation.
3	Singh, G. (2012). Plant Systematics: Theory and Practice. Oxford & IBH Pvt. Ltd., New Delhi. 3rd edition.
4	Sambamurty, A. V. S. S. (2010). Taxonomy of angiosperms. IK International Pvt Ltd.

<table>
<tr><td colspan="4">School: School of Science</td><td colspan="3">Program: B.Sc. Life Science</td></tr>
<tr><td colspan="4">Course Code: LAB602</td><td colspan="3">Course Name: Life Science Laboratory XII</td></tr>
<tr><td>Year</td><td>III</td><td>Core Subject(Yes/No):</td><td>Yes</td><td>Lecture:</td><td>0</td></tr>
<tr><td>Semester</td><td>VI</td><td>Elective Subject(Yes/No):</td><td>No</td><td>Tutorial</td><td>0</td></tr>
<tr><td rowspan="3">Mode of Transaction</td><td rowspan="3">Laboratory</td><td>Foundation Subject(Yes/No):</td><td>No</td><td>Practical:</td><td>8 hrs</td></tr>
<tr><td>Year of Syllabus Revision:</td><td>-</td><td>Total Credit:</td><td>4</td></tr>
<tr><td>Year of Introduction</td><td>2017</td><td>Prerequisites (If any)</td><td>NA</td></tr>
</table>

Course Description:
After completing this course, students will be able to learn the difference between reproductive organs of plants and also sexual and asexual reproduction in case of different plant. Students will gain the knowledge about the different stages of seed formation and gametes. In case of animal, student will learn some processes like embryogenesis, metamorphosis, regeneration, breeding etc. by performing experiments in laboratory through different animal models for e.g., Drosophila, Fish, and chick.

Course Outcome (CO):
After completing this course, students will be able to:

1. To study Embryogenesis of vertebrates via different animal models
2. To gain knowledge of reproductive organs of plants
3. To acquire knowledge about gametes formation and fertilization in animals and plants
4. To study the developmental stages of plant and animal

No.	Experiment	Contact Hours	BT Level	CO	PSO
1	To study different stages of meiosis by preparing temporary mount slide.	4	1, 2	CO1	PSO2
2	To study Anther differentiation before meiosis through cross section visualization	4	1, 2	CO1, CO2, CO3	PSO2
3	Structure of anther (young and mature), tapetum (amoeboid and secretory) (Permanent slides).	4	1, 2	CO2, CO3	PSO2
4	Types of ovules: anatropous, orthotropous, circinotropous, amphitropous/ campylotropous.	4	1, 2	CO2, CO3	PSO2
5	To study the arrangement of floral parts through floral diagrams of wild type and homeotic mutants	4	1, 2	CO2, CO3	PSO2
6	Pollination types and seed dispersal mechanisms (including appendages, aril, caruncle) (Photographs and specimens).	4	1, 2	CO3	PSO2
7	Dissection of embryo/endosperm from developing seeds	4	1, 2	CO2	PSO2

8	Calculation of percentage of germinated pollen in a given medium	4	1, 2, 4, 5	CO1, CO2	PSO2
9	To study the general embryology and study early development of Frog, Chick and Human.	4	1, 2	CO4	PSO2
10	Study regeneration of limb in amphibian	4	1, 2	CO4	PSO2
11	To study metamorphosis in frog	4	1, 2	CO4	PSO2
12	To study chick embryology through permanent slides	4	1, 2	CO1, CO4	PSO2
13	To study the development of chick embryo by Candelling	4	1, 2	CO4	PSO2
14	Sex determination in *Drosophila*	4	1, 2	CO2, CO3	PSO2
15	Study of *Drosophila* life cycle in laboratory	4	1, 2	CO4	PSO2
16	To study complete development in maggots and in snail egg	4	1, 2	CO4	PSO2

Reference Books

1	Bhojwani, S.S. & Bhatnagar, S.P. (2011). Embryology of Angiosperms. Vikas Publication House Pvt. Ltd. New Delhi. 5th edition.
2	Lersten, N. R. (2008). Flowering plant embryology: with emphasis on economic species. John Wiley & Sons
3	Brachet, J., & Alexandre, H. (2012). Introduction to molecular embryology. Springer Science & Business Media.

School: School of Science	**Program: B.Sc. Life Science**
Course Code: MG321	**Course Name: Entrepreneurship**

Year	**III**	**Core Subject(Yes/No):**	Yes	**Lecture:**	**3**
Semester	**VI**	**Elective Subject(Yes/No):**		**Tutorial**	**0**
Typology of Course	Lectures	**Foundation Subject(Yes/No):**		**Practical:**	
		Year of Syllabus Revision:		**Total Credit:**	**3**
		Year of Introduction	**2015**	**Prerequisites (If any)**	

Course Description:

Introductory course on Entrepreneurship aims at sensitizing students to the spirit of entrepreneurship. The course includes discussion on the entrepreneurial journeys of various entrepreneurs in diverse fields so as to help students understand different aspects of an entrepreneur as well as entrepreneurial venture. Further it aims at systematically identifying opportunities and developing new business ideas. The course also deals with the issues concerning entrepreneurial ventures at a broad level like entrepreneurial ecosystem in India, marketing of a new venture, sources of finance etc.

Course Objectives:

The objective of the course is to :

- Introduce students to the idea of entrepreneurship and exposing learners to take entrepreneurship as a career choice.
- To help students develop better understanding about the various stages of entrepreneurial process.
- Develop creativity, problem solving and opportunity recognition skills.
- Provide students with first-hand experience of entrepreneurship
- To help them introspect about their own entrepreneurial capabilities

Course Outcome (CO):

Upon completion of the course students are expected to demonstrate knowledge, skill and abilities in the following areas:

CO 1 *: Foresee Entrepreneurship as one of the possible career path for themselves*
CO 2 *: Recognize the innate entrepreneurial potential within themselves*
CO 3 *: Recognize and assess opportunities in their environments*
CO 4 *: Evaluate the feasibility of any innovative idea*
CO 5 *: Conduct Concept Test and Buying Intention Survey*
CO 6 *: Identify appropriate sources of finance for their business*
CO 7 *: Determine appropriate legal form of business for establishing their venture*
CO 8 *: Select and apply for required intellectual property right*
CO 9 : *Prepare Business Model Canvas*
CO 10: *Present Elevator Pitch*

Unit No.	**Topic/Unit**	**Contact Hours**	**BT Level**	**CO**	**PSO**
1	**Introduction to Entrepreneurship**	10	2,3,4	CO1 CO2	PSO3
2	**Creativity and Innovation**	10	4,5,6	CO1	PSO3

				CO2 CO3 CO4 CO5	
3	**Marketing, Financial and Legal aspects of new venture**	12	2,3,4,5	CO1 CO6 CO7 CO8	PSO3
4	**Business Plan and Pitching**	8	2,3,4,5,6	CO1 CO2 CO9 CO10	PSO3

Reference Books

1.	Bansal, R. (2011). *Connect The Dots*. Westland
2.	Bansal, R. (2011). *I have a dream. Westland*
3.	Barringer, B. R., Ireland,R.D. (2015). *Entrepreneurship: Successfully launching new ventures*. Pearson Education India
4.	Bygrave , W. D., & Zacharakis , A. (2011). *Entrepreneurship.* John Wiley & Sons, Inc
5.	Hisrich, R. D., Peters, M. P., & Shepherd, D. A. (2018). *Entrepreneurship*. McGraw Hill Education
6.	Kawasaki, G. (2004). *The art of the start: The time-tested, battle-hardened guide for anyone starting anything*. Penguin.
7.	Kuratko, D. F., & Rao, T. V. (2012). *Entrepreneurship: A South-Asian Perspective*. Cengage Learning
8.	Mauborgne, R., & Kim, W. C. (2005). *Blue Ocean Strategy- How to Create Uncontested Market Space and Make the Competition Irrelevant.* Harvard Business School Publishing Corporation. Boston, Massachusetts.
9.	Harvard Business Publishing Articles – Class readings

School: School of Science			**Program: B.Sc. Life Science**		
Course Code: SE318			**Course Name:** Introduction to Forensic Science		
Year	**III**	**Core Subject(Yes/No):**	-	**Lecture:**	**2**
Semester	**VI**	**Elective Subject(Yes/No):**	-Yes	**Tutorial**	**-**
Typology of Course	Lectures	**Foundation Subject(Yes/No):**	-	**Practical:**	**-**
		Year of Syllabus Revision:	-	**Total Credit:**	**2**
		Year of Introduction	**2016**	**Prerequisites (If any)**	-

Course Description: This course is an applicative course and gives an insight to the working in a forensic laboratory. Through this course, students shall gain exposure to the different techniques and methods used in forensics as well as its several levels of applications in crime detection and analysis.

Course Objectives:

1. Explain the importance of forensic analysis.
2. Understand the application of analytical techniques in forensic analysis.

Course Outcome (CO):

CO1: Understand the historical aspects of forensic science.
CO2: Study the roles and regulations of various disciplines of forensic science.
CO3: Understand the several aspects of investigating the crime site.
CO4: Study the assessment patterns of physical evidence

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	**Introduction** History, Basis of Forensic Sciences. Types of forensic scientists. Role of forensic scientists. Sub-specialities of forensic science-Forensic pathology, Forensic toxicology, forensic psychology, digital forensics and criminology. Science and Technology in criminal investigation.	15	1,2,3	CO1,CO2,	PSO1, PSO3
2	**Forensic investigation** Crime scene investigation, assessing physical evidence, Role of forensic experts in investigation, Firearms, Tool markers, abusive drug and drug evidence, forensic serology, Forensic laboratory tools, Evaluation of blood	15	1,2,3	CO3, CO4	PSO1, PSO3

	strain in patterns: identification and characterization. Identification of biological fluids, Microanalysis and examination of trace evidence, The fingerprint analysis. Forensic Genetics.				

Reference Books

1.	W.J. Welcher (Ed.), Scott's Standard Methods of Chemical Analysis, Vol. III A, 6th Edition (1966), and vol. III B, 5th Edition (1975), Van Nostrand Reinhold Co. London.
2.	Peter Fordham, Non-destructive Testing Techniques, 1st edition (1968), London Business Publications Ltd., London
3.	W. Horwitz, Official Methods of Analysis, 11th Edition (1970), Association of Official Analytical Chemists, Washington DC.
4.	K. Simpson and B. Knight, Forensic Medicine, 9th Edition (1985), Edward Arnold Publishers Ltd. London.

School: School of Science			**Program: B.Sc. Life Science**		
Course Code: SE210			**Course Name: Food and Nutrition II**		
Year	**III**	**Core Subject(Yes/No):**	**Yes**	**Lecture:**	**2**
Semester	**VI**	**Elective Subject(Yes/No):**	**No**	**Tutorial**	**NA**
Typology of Course	Lectures	**Foundation Subject(Yes/No):**	**No**	**Practical:**	**NA**
		Year of Syllabus Revision:		**Total Credit:**	**2**
		Year of Introduction	**2016**	**Prerequisites (If any)**	**NIL**

Course Description: This course emphasizes on importance of nutrition in health. It also focuses on importance of diet in preventing diseases, especially lifestyle disorders. It emphasizes on role of nutrition policies and programmes in boosting health.

Course Objectives:

1. To prepare students for successful career in clinical nutrition and dietetics
2. To help the students understand the importance of food safety
3. To enable students to apply the knowledge gained through the subject to improve their own lifestyle

Course Outcome (CO):

1. To understand the essentials of diet and health
2. To apply the knowledge on management of health

Unit No.	**Topic/Unit**	**Contact Hours**	**BT Level**	**CO**	**PSO**
1	Social, population and environmental influences on nutrition, the food chain, types of nutritional studies; Food Selection and meal Planning- Factors to be considered, Dietary Guidelines Normal Clinical Nutrition- malnutrition, obesity, inflammatory response, enteral and parenteral nutrition. Dietetics & Therapeutic Aspects of Clinical Nutrition	15	1,2	1	PSO3
2	Nutrition Policies & Programmes; Nutrigenetics-personalized nutrition, Nutrient Requirements Based on Genotype; Nutrition in Special Conditions: chronic diseases- diabetes, cardiovascular diseases. Health Promotion & Nutritional Education. Food Safety in Practice.	15	1,2	2	PSO3

Reference Books	
1.	Desrosier, N.W. and Desrosier, J.N. (1997) *The Technology of Food Preservation*, Westport : Connecticut Publishing Company.

2.	Whitney, E., Hamilton, E., and Rolfes, S. (1990) *Understanding Nutrition*, St. Paul, MN: West Publishing Company.
3.	Sunetra Roday, (2012) *Food Science and Nutrition*, Oxford Publishing Company.

School: School of Science			**Program: B.Sc. Life Science**		
Course Code: SE310			**Course Name: Introduction to Pharmacognosy**		
Year	**III**	**Core Subject(Yes/No):**	**No**	**Lecture:**	**2**
Semester	**VI**	**Elective Subject(Yes/No):**	**Yes**	**Tutorial**	**-**
Typology of Course	Lectures	**Foundation Subject(Yes/No):**	**No**	**Practical:**	**-**
		Year of Syllabus Revision:		**Total Credit:**	**2**
		Year of Introduction	**2016**	**Prerequisites (If any)**	**NA**

Course Description:
This course is designed for study of medicinally important plants with their cultivation, collection and adulteration of crude drugs, and the role of these plants in national economy.

Course Objectives:

- Introduction to medicinal compounds and raw materials of natural origin including biosynthesis, chemical structures and qualitative and quantitative analysis.
- Understanding the role of natural products in research and development of drugs as well as in disease prevention and treatment. Acquisition of basic knowledge and skills in quality control of herbal drugs and products.

Course Outcome (CO):
CO1Recognize and define medicinal natural compounds according to their chemical structure and biosynthetic pathway
CO2Associate medicinal compounds with their natural sources
CO3Use basic pharmacognostical terminology in Latin
CO4Understanding the quality control of herbal drugs with their effectiveness and safe use
CO5Introduction to the Indian Pharmacopoeia and its usage in the area of herbal drug analysis

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	• Course Introduction: History, Scope and Development of Pharmacognosy • Classification of crude drugs • Sources of crude drugs: Crude drugs of Plant, Animal and Mineral origin • Different types of plant tissues and their functions • Morphological and Microscopical study: Leaf, root, stem, bark, wood, flower, fruit and seed • Modifications of leaf, root and stem	15	1, 2	CO1 CO2 CO5	PSO1
2	• Study of medicinally important plants belonging to the families with special	15	1, 2	CO3 CO4	PSO1

	reference to: Solanaceae, Umbelliferae, Leguminosae, Liliaceae • Cultivation, collection and adulteration of crude drugs: Methods of cultivation, Factors influencing cultivation of medicinal plants, methods of collection and different types of adulteration • Role of medicinal plants in national economy				

Reference Books	
1.	Text book of Pharmacognosy: T. E. Wallis; CBS publishers, New Delhi.
2.	The Ayurvedic Pharmacopoeia of India: Government of India, Ministry of Health & Family Welfare, 1st edition, Part-I, Vol. III, 2001.
3.	Quality Control Methods for Medicinal Plant Materials: 2002, WHO, Geneva.
4.	Trease and Evan's Pharmacognosy: W. C. Evans, 14th edition, 1997, W. B. Saunders Company, Singapore.
5.	Cultivation of medicinal plants, C. K. Kokate, 4th edition, 2007, Nirali Prakashan, Pune
6.	Botany for Degree Student: A. C. Dutta; Oxford University Press, New Delhi.
7.	Pharmacognosy: C. K. Kokate; Nirali Prakashan, Pune

<table>
<tr><td colspan="3">School: Science</td><td colspan="3">Program: BSc</td></tr>
<tr><td colspan="3">Course Code: SE208</td><td colspan="3">Course Name: Herbal Cosmetics</td></tr>
<tr><td>Year</td><td>III</td><td>Core Subject(Yes/No):</td><td>No</td><td>Lecture:</td><td>2</td></tr>
<tr><td>Semester</td><td>VI</td><td>Elective Subject(Yes/No):</td><td>Yes</td><td>Tutorial</td><td>0</td></tr>
<tr><td rowspan="3">Typology of Course</td><td rowspan="3">Lectures</td><td>Foundation Subject(Yes/No):</td><td>No</td><td>Practical:</td><td>0</td></tr>
<tr><td>Year of Syllabus Revision:</td><td>2020</td><td>Total Credit:</td><td>2</td></tr>
<tr><td>Year of Introduction</td><td>2014</td><td>Prerequisites (If any)</td><td>HSC Science</td></tr>
</table>

Course Description:
students will learn to use scientific method to combine the cosmetic properties of plants with cosmetic making techniques to achieve health benefits and balance in the body. Plants of medicinal value will be introduced and how to process them will be shown. Safe use of herbs to make beauty products will be discussed.

Course Objectives:
The course will enhance knowledge regarding herbal products, their medicinal application, preparations, encourage students to prepare original, unadulterated good quality beauty products at home. Enterprising students may see ways to become entrepreneurs and develop signature products.

Course Outcome (CO):
CO1: illustrate the Fundamental knowledge on cosmetic and cosmeceuticals
CO2: Learn various skin problems and how to overcome through skin preparations
CO3: Learn about the formulation design, formulation, and evaluations of herbal cosmetics
CO4: Understand basics of Perfumery, and Aromatherapy. Moreover, sound knowledge of plants with aromatic compounds and herbal formulation for perfumery.

Unit No.	**Topic/Unit**	**Contact Hours**	**BT Level**	**CO**	**PSO**
1	Unit 1: Creams and Lotions: Cosmetics, definition, Structure of skin, various forms of cosmetics, main ingredients, preservatives, quality control measures, instrumentation for extraction and manufacture. Cosmetic creams: base cream, cleansing creams, Emollient creams, Finishing creams, cold cream, Preparation of creams. Cosmetic emulsions, properties of emulsions, emulsifiers, Creams: Cleansing creams (Cold creams, Quick liquifying creams, liquid cleaners), Emollient creams, finishing creams (Vanishing creams), Special creams (Astringent creams, Bleaching creams, Acne creams, All-purpose creams, Estrogenic creams, Industrial or protective creams) etc. Commercially available ingredients, retinoids, hydroxy acids, antioxidants etc., antimicrobial compounds from plants, Plants improving blood circulation etc.	15	1, 2, 3, 4, 5	CO1, CO2, CO3	PSO1, PSO3, PSO4
2	Unit 2: Perfumery and Aromatherapy: Perfumes, Flower perfumes, leaf perfumes, Fruit perfumes, root perfumes etc. Different perfumes from rose, jasmine, tuberose,	15	1, 2, 3, 4, 5	CO1, CO3, CO4	PSO1, PSO3, PSO4

	sandalwood, kewda, Lavender, peppermint, Neroli, petit grain oils etc. constituent compounds, monoterpenes, methods of extraction, preparation of perfumes. Perfumes for soaps, detergents, incense, candles, household products, creams, powders, aerosols, industrial perfumes. Aromatherapy: Principles and practice.				
Reference Books					
1.	André O. Barel, Handbook of Cosmetic Science and Technology, 3rd Ed., Maibach, University of Calirfornia, San Francisco, CA, 2009				
2.	P. K. Chattopadhyay, Herbal Cosmetics & Ayurvedic Medicines, (EOU), 1999.				
3.	H. Panda, Herbal Cosmetics Handbook, 2004				
4.	NIIR Board, Handbook on Herbal Products, (Medicines, Cosmetics, Toiletries, Perfumes)				

School: SOS			**Program: BSc LS**		
Course Code: SE314			**Course Name: Conservation Biology**		
Year	**III**	**Core Subject(Yes/No):**	No	**Lecture:**	**2**
Semester	**VI**	**Elective Subject(Yes/No):**	Yes	**Tutorial**	
Typology of Course	Lectures	**Foundation Subject(Yes/No):**	No	**Practical:**	
		Year of Syllabus Revision:	-	**Total Credit:**	**2**
		Year of Introduction	**2016**	**Prerequisites (If any)**	

Course Description:

This course introduces ethical and scientific foundation of conservation. It also focuses on overview of biological diversity and species distribution. Moreover, course emphasis the threats to the biodiversity.

Course Objectives:

Gain understanding and knowledge about basic of conservation. To learn and understand the threats to the biodiversity.

Course Outcome (CO):

After completing this course, students will be able to:

CO1. *Aware of the enormous responsibility humans have as global stewards of the land and sea.*

CO2. *Focuses on ethics and scientific principles relevant to conservation, threats to biodiversity, and practical aspects of conservation.*

CO3. *To understand the species distribution*

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	**Unit 1: Ethical and Scientific Foundations of Conservation** Overview of Conservation Biology, The nature and function of biological diversity, Distribution of biodiversity, Earth history and changes in species distributions, Diversity and ecosystem functioning, Conservation Values & Ethics.	15	1,2,3	CO1,CO2, CO3	PSO1, PSO2
2	**Unit 2: Primary Threats to Biodiversity** Habitat Degradation & Loss, Habitat Fragmentation, Overexploitation, Species Invasions Climate Change	15	1,2,3	CO1,, Co2	PSO1, PSO2

Reference Books	
1.	R. B. Primack, *Essentials of Conservation Biology*, 4th Ed.
2.	Martha J. Groom, Gary K. Meffe & C. Ronald Carroll, *Principles of Conservation Biology*, 3rd Ed., Sinauer Associates, Inc., Sunderland, MA, USA, 2006.

NAVRACHANA UNIVERSITY
a UGC recognized University

Curriculum

School:	**SOS**
Program Code:	**163**
Program Name:	**Bachelors of Science (Microbiology)**
Academic Year:	**2021-2022**

GLOSSARY:

Programme Outcomes (POs): POs are statements that describe what the students graduating from any of the educational Programmes of the institution should be able to do on completion.

Programme Specific Outcomes (PSOs): PSOs are statements that describe what the graduates of a specific educational Programme should be able to do on completion.

Course Outcomes (COs): COs are statements that describe what students should be able to do on completion of the course.

NOTE:

Programme Outcomes (POs): Programme Outcomes (POs) are what knowledge, skills and attitudes a graduate should have at the time of graduation. While as at present, no agency has formally defined the POs of General Higher Education in a 3-year degree Programmes in India, POs of all professional Programmes in engineering and other areas are identified at the national level, by the concerned accrediting agency. POs are not specific to a discipline.

Course Outcomes (COs): COs are statements that describe what students should be able to do at the end of a course. They can be 6±2 for courses with 2 to 4 credits, and 8±2 for courses with 5 to 6 credits.

Vision of School: A premier Science School of Excellence in Research and Innovation

Mission of School:

- To focus on developing UG, PG and Doctoral Research
- Faculty Development and Empowerment
- Push for Innovation and Entrepreneurship through Industry and Academia connect
- To focus on social issues and society concerns through various activities at SOS and NUCERI

Programme Outcomes (POs):

PO1:	**Critical Thinking**: Take informed actions after identifying the assumptions that frame our thinking and actions, checking out the degree to which these assumptions are accurate and valid, and looking at our ideas and decisions (intellectual, organizational, and personal) from different perspectives.
PO2:	**Effective Communication**: Speak, read, write and listen clearly in person and through electronic media in English and in one Indian language, and make meaning of the world by connecting people, ideas, books, media and technology.
PO3:	**Social Interaction:** Elicit views of others, mediate disagreements and help reach conclusions in group settings
PO4:	**Effective Citizenship**: Demonstrate empathetic social concern and equity centered national development, and the ability to act with an informed awareness of issues and participate in civic life through volunteering

PO5:	**Ethics:** Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them.
PO6:	**Environment and Sustainability:** Understand the issues of environmental contexts and sustainable development.
PO7:	**Self-directed and Life-long Learning:** Acquire the ability to engage in independent and life-long learning in the broadest context socio-technological changes

Program Specific Outcome (PSO):

PSOs of BSc Microbiology

PSO1:	Understand the nature and basic concepts of cell biology, Microbiology, Molecular biology, Physiology, Biochemistry, Taxonomy and ecology. Also, to understand basic aspects of chemistry. Critically evaluate the concepts of Microbiology courses. Analyse the relationships among animals, plants and microbes.
PSO2:	It aims at the holistic development of the student and empowers them with sufficient overall knowledge and Perform procedures as per laboratory standards in the areas of Microbiology, Biochemistry, Bioinformatics, Molecular biology and Genetics
PSO3:	Understand the applications of Microbiology in Food industry, genetics, Medicine- Immunology, Virology.
PSO4:	To prepare graduates possessing communication skills, management skills and contribute as a member of multidisciplinary team, appreciates and respects diversity of opinion, considerate global, societal, environmental, and ethical issues

Course Structure

L = Lecture	**T = Tutorial**	**P = Practical**	**C = Credit**
number of hours per week	number of hours per week	number of hours per week	Total Credits

Semester	**I**	**II**	**III**	**IV**	**V**	**VI**	**Total**
Credits	**22**	**24**	**23**	**27**	**27**	**26**	**149**

Total Credits	**149**
Minor Specialization Credits	
Total Credits Including Minor	

CURRICULUM AND TEACHING SCHEME

Semester-I													
Teaching Scheme											**Elements of** Employability (Emp)/ Entrepreneurship (Ent)/ Skill Development (SD)	**Relevance to** Local (L)/ National (N)/ Regional(R)/ Global developmental needs (G)	**Relation to** Gender (G)/ Environment and Sustainability (ES)/ Human Values (HV)/ Professional Ethics (PE)
						Theory Course		**Practical Course**		**Total marks**			
Course Code	**Course Name**	**L**	**T**	**P**	**C**	**Internal Examination (%)**	**End semester Examination (%)**	**Internal Examination (%)**	**End semester Examination (%)**				
LS177	Living world and diversity	3	0	0	3	60	40	-NA-	-NA-	100		L, N, R, G	
LS178	Microbial, Plant and Animal Physiology	3	0	0	3	60	40	-NA-	-NA-	100		L, N, R, G	
LS103	Life Science Laboratory I	0	0	4	2	-NA-	-NA-	60	40	100	Emp, SD	L, N, R, G	
LS104	Life Science Laboratory II	0	0	2	1	-NA-	-NA-	60	40	100	Emp, SD	L, N, R, G	
CH104	Inorganic Chemistry	3	0	0	3	60	40	-NA-	-NA-	100		L, N, R, G	
CH105	Chemistry Laboratory II	0	0	2	1	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	
MA110	Foundation Mathematics I	3	0	0	3	60	40	-NA-	-NA-	100		L, N, R, G	
LC119	Communication I	3	0	0	3	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	
MG117	Principles of Management, Accounts	3	0	0	3	60	40	-NA-	-NA-	100		L, N, R, G	
	Total Credits	**18**	**0**	**8**	**22**								

Semester-II													
Teaching Scheme											**Elements of** Employability (Emp)/ Entrepreneurship (Ent)/ Skill Development (SD)	**Relevance to** Local (L)/ National (N)/ Regional(R)/ Global developmental needs (G)	**Relation to** Gender (G)/ Environment and Sustainability (ES)/ Human Values (HV)/ Professional Ethics (PE)
						Theory Course		**Practical Course**		**Total marks**			
Course Code	**Course Name**	**L**	**T**	**P**	**C**	**Internal Examination (%)**	**End semester Examination (%)**	**Internal Examination (%)**	**End semester Examination (%)**				
LS179	Biochemistry-I	3	0	0	3	60	40	-NA-	-NA-	100		L, N, R, G	
LS180	Cytology and Genetics	3	0	0	3	60	40	-NA-	-NA-	100		L, N, R, G	
LS138	Life Science Laboratory III	0	0	4	2	-NA-	-NA-	60	40	100	Emp, SD	L, N, R, G	
LS139	Life Science Laboratory IV	0	0	2	1	-NA-	-NA-	60	40	100	Emp, SD	L, N, R, G	
CH109	Conceptual Organic Chemistry	3	0	0	3	60	40	-NA-	-NA-	100		L, N, R, G	
CH108	Chemistry Laboratory IV	0	0	2	1	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	
HS106	Humanities	2	0	0	2	60	40	-NA-	-NA-	100		L, N, R, G	HV
MA117	Foundation Mathematics II	3	0	0	3	60	40	-NA-	-NA-	100		L, N, R, G	
LC120	Communication II	3	0	0	3	60	40	-NA-	-NA-	100		L, N, R, G	
MG108	Economics and Finance	3	0	0	3	60	40	-NA-	-NA-	100		L, N, R, G	
	Total Credits	**20**	**0**	**8**	**24**								

Semester-III													
Teaching Scheme											**Elements of** Employability (Emp)/ Entrepreneurship (Ent)/ Skill Development (SD)	**Relevance to** Local (L)/ National (N)/ Regional(R)/ Global developmental needs (G)	**Relation to** Gender (G)/ Environment and Sustainability (ES)/ Human Values (HV)/ Professional Ethics (PE)
						Theory Course		**Practical Course**		**Total marks**			
Course Code	**Course Name**	**L**	**T**	**P**	**C**	**Internal Examination (%)**	**End semester Examination (%)**	**Internal Examination (%)**	**End semester Examination (%)**				
LS273	Ethno and Economic Biology	3	0	0	3	60	40	-NA-	-NA-	100		L, N, R, G	
LS276	Microbiology-I	3	0	0	3	60	40	-NA-	-NA-	100		L, N, R, G	
LS275	Biochemistry-II	3	0	0	3	60	40	-NA-	-NA-	100		L, N, R, G	
LS234	Life Science Laboratory V	0	0	6	3	-NA-	-NA-	60	40	100	Emp, SD	L, N, R, G	
LS277	Microbiology Laboratory I	0	0	4	2	-NA-	-NA-	60	40	100	Emp, SD	L, N, R, G	
CH203	Molecules of Life	3	0	0	3	60	40	-NA-	-NA-	100		L, N, R, G	
CH205	Chemistry Laboratory VI	0	0	4	2	-NA-	-NA-	60	40	100	Emp, SD	L, N, R, G	
ID	Interdisciplinary course	2	0	0	2	60	40	-NA-	-NA-	100		L, N, R, G	
HR226	Introduction to HR and MM1	2	0	0	2	60	40	-NA-	-NA-	100		L, N, R, G	
	Total Credits	**16**	**0**	**14**	**23**								

Semester-IV													
Teaching Scheme											**Elements of** Employability (Emp)/ Entrepreneurship (Ent)/ Skill Development (SD)	**Relevance to** Local (L)/ National (N)/ Regional(R)/ Global developmental needs (G)	**Relation to** Gender (G)/ Environment and Sustainability (ES)/ Human Values (HV)/ Professional Ethics (PE)
						Theory Course		**Practical Course**		**Total marks**			
Course Code	**Course Name**	**L**	**T**	**P**	**C**	**Internal Examination (%)**	**End semester Examination (%)**	**Internal Examination (%)**	**End semester Examination (%)**				
LS150	Biophysics, Biostatistics and Biochemical Techniques	3	0	0	3	60	40	-NA-	-NA-	100	Emp	L, N, R, G	
BO211	Microbiology-II	3	0	0	3	60	40	-NA-	-NA-	100	Emp	L, N, R, G	
PAT201	Parasitology, Histopathology and Plant Pathology	3	0	0	3	60	40	-NA-	-NA-	100	Emp	L, N, R, G	
LS153	Life Science Laboratory VII	0	0	6	3	-NA-	-NA-	60	40	100	Emp, SD	L, N, R, G	
BO212	Microbiology Laboratory II	0	0	4	2	-NA-	-NA-	60	40	100	Emp, SD	L, N, R, G	
CH208	Physical Chemistry	3	0	0	3	60	40	-NA-	-NA-	100	Emp	L, N, R, G	
CH105	Chemistry Laboratory VIII	0	0	4	2	-NA-	-NA-	60	40	100	Emp	L, N, R, G	
ES201	Environment Science	3	0	2	4	60	40	-NA-	-NA-	100	Emp	L, N, R, G	
ID	Interdisciplinary course	2	0	0	2	60	40	-NA-	-NA-	100	Emp	L, N, R, G	
HR311	Introduction to HR and Marketing II	2	0	0	2	60	40	-NA-	-NA-	100	Emp	L, N, R, G	
	Total Credits	**20**	**0**	**14**	**27**								

Semester-V													
Teaching Scheme											**Elements of** Employability (Emp)/ Entrepreneur-ship (Ent)/ Skill Development (SD)	**Relevance to** Local (L)/ National (N)/ Regional(R)/ Global developmental needs (G)	**Relation to** Gender (G)/ Environment and Sustainability (ES)/ Human Values (HV)/ Professional Ethics (PE)
						Theory Course		**Practical Course**		**Total marks**			
Course Code	**Course Name**	**L**	**T**	**P**	**C**	**Internal Examination (%)**	**End semester Examination (%)**	**Internal Examination (%)**	**End semester Examination (%)**				
LS303	Biotechnology and Bioinformatics	3	0	0	3	60	40	-NA-	-NA-	100		L, N, R, G	
MI202	Microbial Physiology and Metabolism	3	0	0	3	60	40	-NA-	-NA-	100		L, N, R, G	
LS304	Molecular Biology and Microbial Genetics	3	0	0	3	60	40	-NA-	-NA-	100		L, N, R, G	
MI205	Microbiology Laboratory III	0	0	8	4	-NA-	-NA-	60	40	100	Emp, SD	L, N, R, G	
MI303	Microbiology Laboratory IV	3	0	8	4	-NA-	-NA-	60	40	100	Emp, SD	L, N, R, G	
PS322	Scientific Enquiry and Research Methodology	3	0	0	3	60	40	-NA-	-NA-	100		L, N, R, G	
PS310	Khoj	3	0	0	3	60	40	-NA-	-NA-	100		L, N, R, G	
SE201*	Essential Laboratory Practices	2	0	0	2	60	40	-NA-	-NA-	100		L, N, R, G	
SE202*	Food and Nutrition I	2	0	0	2	60	40	-NA-	-NA-	100		L, N, R, G	
SE302*	Medicinal Chemistry I	2	0	0	2	60	40	-NA-	-NA-	100		L, N, R, G	
	Total Credits	**19**	**0**	**16**	**27**								

***- Any two of the following elective subjects**

Semester-VI

Teaching Scheme											**Elements of** Employability (Emp)/ Entrepreneurship (Ent)/ Skill Development (SD)	**Relevance to** Local (L)/ National (N)/ Regional(R)/ Global developmental needs (G)	**Relation to** Gender (G)/ Environment and Sustainability (ES)/ Human Values (HV)/ Professional Ethics (PE)
						Theory Course		**Practical Course**		**Total marks**			
Course Code	**Course Name**	**L**	**T**	**P**	**C**	**Internal Examination (%)**	**End semester Examination (%)**	**Internal Examination (%)**	**End semester Examination (%)**				
MI301	Medical Microbiology	3	0	0	3	60	40	-NA-	-NA-	100		L, N, R, G	
MI302	Industrial & Food Microbiology	3	0	0	3	60	40	-NA-	-NA-	100		L, N, R, G	
MI305	Biofertilizers and Biopesticides	3	0	0	3	60	40	-NA-	-NA-	100		L, N, R, G	
MI303	Microbiology Laboratory V	0	0	8	4	-NA-	-NA-	60	40	100	Emp, SD	L, N, R, G	
MI304	Microbiology Laboratory VI	0	0	8	4	-NA-	-NA-	60	40	100	Emp, SD	L, N, R, G	
	Project Work	0	0	4	2	-NA-	-NA-	60	40	100	Emp, SD	L, N, R, G	
MG321	Entrepreneurship	3	0	0	3	60	40	-NA-	-NA-	100	Ent	L, N, R, G	PE
*SE210	Foods and Nutrition II	2	0	0	2	60	40	-NA-	-NA-	100		L, N, R, G	
*SE310	Introduction to pharmacognosy	2	0	0	2	60	40	-NA-	-NA-	100		L, N, R, G	
*SE318	Introduction to forensic science	2	0	0	2	60	40	-NA-	-NA-	100		L, N, R, G	
*SE208	Herbal Cosmetics	2	0	0	2	60	40	-NA-	-NA-	100		L, N, R, G	
	Total Credits	**16**	**0**	**20**	**26**								

Articulation Matrix COs and POs Mapping

Semester-I	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
Living world and diversity	✓					✓	✓
Microbial, Plant and Animal Physiology	✓						✓
Life Science Laboratory I	✓					✓	
Life Science Laboratory II	✓						
Inorganic Chemistry	✓						
Chemistry Laboratory II	✓						
Foundation Mathematics I	✓						
Communication I		✓					
Principles of Management, Accounts	✓						
Semester-II	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
Biochemistry-I	✓						✓
Cytology and Genetics	✓						✓
Life Science Laboratory III	✓						
Life Science Laboratory IV	✓						
Conceptual Organic Chemistry	✓						✓
Chemistry Laboratory IV	✓						
Humanities					✓		
Foundation Mathematics II	✓						
Communication II		✓					
Economics and Finance	✓						

Semester-III	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
Ethno and Economic Biology	✓						
Microbiology-I	✓						
Biochemistry-II	✓						
Life Science Laboratory V	✓						
Microbiology Laboratory I	✓						
Molecules of Life	✓						
Chemistry Laboratory VI	✓						
Interdisciplinary course	✓	✓	✓	✓	✓	✓	
Management	✓			✓			
Semester-IV	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
Biophysics, Biostatistics and Biochemical Techniques	✓						✓
Microbiology-II	✓						✓
Parasitology, Histopathology and Plant Pathology	✓						✓
Life Science Laboratory VII	✓						
Microbiology Laboratory II	✓						
Physical Chemistry	✓						
Chemistry Laboratory VIII	✓						
Environment Science	✓					✓	
Interdisciplinary course	✓	✓	✓	✓	✓	✓	
Introduction to HR and Marketing II	✓			✓			

Semester-V	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
Biotechnology and Bioinformatics	✓						✓
Microbial Physiology and Metabolism	✓						✓
Molecular Biology and Microbial Genetics	✓						✓
Microbiology Laboratory III	✓						
Microbiology Laboratory IV	✓						
Scientific Enquiry and Research Methodology							✓
Khoj	✓	✓	✓	✓	✓	✓	✓
Essential Laboratory Practices	✓				✓		
Food and Nutrition	✓						
Introduction to Neuroscience and Cognition	✓						
Introduction to cell/tissue culture	✓						
Semester-VI	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
Medical Microbiology	✓						✓
Industrial & Food Microbiology	✓						✓
Biofertilizers and Biopesticides	✓						
Microbiology Laboratory V	✓						
Microbiology Laboratory VI	✓						
Project Work	✓	✓	✓	✓	✓	✓	✓
Entrepreneurship	✓			✓	✓		

Foods and Nutrition II	✓						
Introduction to pharmacognosy	✓						
Introduction to forensic science	✓						
Herbal Cosmetics	✓						

PSO's - PO's Mapping

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
PSO1	✓			✓		✓	✓
PSO2	✓					✓	✓
PSO3	✓				✓		✓
PSO4		✓	✓	✓	✓	✓	

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Syllabus of Courses

Bloom's Taxonomy Levels (BT Level):
1. Remember 2. Understand 3. Application 4. Analysis 5. Evaluation 6. Creation

SEMESTER 1

<table>
<tr><td colspan="3">School: School of Science</td><td colspan="3">Program: B.Sc. Microbiology</td></tr>
<tr><td colspan="3">Course Code: LS177</td><td colspan="3">Course Name: Living world and diversity</td></tr>
<tr><td>Year</td><td>I</td><td>Core Subject (Yes/No):</td><td>Yes</td><td>Lecture:</td><td>3</td></tr>
<tr><td>Semester</td><td>I</td><td>Elective Subject (Yes/No):</td><td>No</td><td>Tutorial</td><td>0</td></tr>
<tr><td rowspan="3">Typology of Course</td><td rowspan="3">Lectures</td><td>Foundation Subject (Yes/No):</td><td>No</td><td>Practical:</td><td>0</td></tr>
<tr><td>Year of Syllabus Revision:</td><td></td><td>Total Credit:</td><td>3</td></tr>
<tr><td>Year of Introduction</td><td>2021</td><td>Prerequisites (If any)</td><td>No</td></tr>
</table>

Course Description:
The course discusses the concepts of microbial taxonomy, classification of microorganisms based on classical and advanced methods; general characters and classification of non-chordates and chordates and the classification of plants from evolutionary lower plants to higher plants like gymnosperms and angiosperms.

Course Objectives:
The students will be able to understand the different characteristics of microbes, animals and plants.

Course Outcome (CO):
CO1: Gain knowledge about classification and general characteristics of animals
CO2: Understand the classification and general characteristics of plants
CO3: Learn about microbial diversity and classification of microbes
CO4: Learn about the 5-kingdom, 6-kingdom and three domain classification
CO5: Help in identifying organisms based on their different features

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	Whittaker's five-kingdom concept. Three-domain concept of Carl Woese. Characters used in microbial taxonomy (morphological, physiological, ecological, genetics protein content, nucleic acid sequence and base composition)	15	1,2,3	CO3. CO4 CO5	PSO1 PSO2

	Bacteriology: General characters and structure of Eubacteria, Archaeobacteria, Cyanobacteria General comparison. Virology: General structure of Viruses, Detailed structure of animal viruses (pox virus, polio Virus, HIV), Plant virus (TMV) & Bacteriophages. Fungi: Range of thallus organization and reproduction, Important genera of Fungi, Economics Importance of Fungi Algae: General characteristics, classification and economic importance.				
2	Non Chordates: General account of Non chordate body organization; General account of Protozoa, Porifera, Cnidaria, Nematoda, Mollusca, Annelida, Arthropoda and Echinodermata. Chordates: General characters of Chordata, Protochordata, Vertebrata, Pisces, Amphibia, Reptilia and Aves.	15	1,2,3	CO1 CO5	PSO1 PSO2
3	Evolutionary Lower Plants- Algae, Fungi and Lichens: General characters, classification and economic importance, important features and life history Introduction to Archegoniate with emphasis on general characters and adaptation to land habit. Classification, general morphology, anatomy and reproduction of Bryophytes, Pteridophytes, Gymnosperms and Angiosperms.	15	2, 3, 4	CO2 CO5	PSO1 PSO2

Reference Books	
1.	Prescot, M.J., Harley, J.P. and Klein, D.A. Microbiology. 5th Edition WCB Mc Graw Hill, New York, (2002).
2.	Tortora, G.J., Funke, B.R. and Case, C.L. Microbiology: An Introduction. Pearson Education, Singapore, (2004).
3.	Black J.G. Microbiology- Principles and Explorations. John Wiley & Sons Inc. New York, (2002).
4.	Pelczar, MJ Chan ECS and Krieg NR, Microbiology McGraw-Hill.
5.	B. R. Vasishtha, Botany for Degree Students: Vol. – II Fungi, 1962.
6.	B. R. Vasishtha, Botany for Degree Students: Vol. III Bryophyta, 1963.
7.	P. C. Vasishtha, Botany for Degree Students: Vol. IV Pteridophyta, 1971.
8.	Moore, J. (2006). An Introduction to the Invertebrates (2nd ed.). Cambridge: Cambridge University Press. doi:10.1017/CBO9780511754760
9.	Kotpal, R. L. (2010). Modern Text Book of Zoology Vertebrates. New Delhi: Rastogi Publications.
10.	Hickman, C. P., Roberts, L. S., & Larson, A. (1997). Integrated principles of zoology. Boston, Mass: WCB/McGraw-Hill.

School: School of Science			**Program: B.Sc. Microbiology**		
Course Code: LS178			**Course Name: Microbial, Plant and Animal Physiology**		
Year	**I**	**Core Subject (Yes/No):**	**Yes**	**Lecture:**	**3**

Semester	**I**	**Elective Subject (Yes/No):**	**-**	**Tutorial**	**-**
Typology of Course	**Lectures**	**Foundation Subject (Yes/No):**	**-**	**Practical:**	**-**
		Year of Syllabus Revision:	**2021**	**Total Credit:**	**3**
		Year of Introduction	**2021**	**Prerequisites (If any)**	**-**

Course Description:
This course introduces to the physiological systems in Microbes, Plants and Animals. The varied physiological aspects pertaining to the diverse group of living organisms is dealt in the present course. The course helps to get knowledge of different physiological system helping in maintenance of homeostasis. Physiological systems related to Digestion, Respiration, Circulation, Excretion etc. in animal system will be essential part of the course. Besides within microbial world, growth and nutritive required shall be covered. Plant physiological systems will be also considered as part of the course

Course Objectives:
To get insight of the types of transport: active/ passive within cell. Knowledge of cell membrane and cell organelles. Digestive system, circulatory system, respiratory system etc and plant physiological systems will be the main objective of the course.

Course Outcome (CO):
CO1: Growth characteristics of microorganisms
CO2: Nutritional variations in microorganisms
CO3: Physiological responses in animals
CO4: General account of different physiologies
CO5: Physiology of plants such as water relations, transpiration and effect of nutrients and minerals on plant growth and development

Unit No.	**Topic/Unit**	**Contact Hours**	**BT Level**	**CO**	**PSO**
1	**Unit I** Microbial Nutritional types: Requirement of Nutrients for microbes and classification of microorganisms based on carbon, energy and electron sources viz. Photoautotrophs; Photo organotrophs; Chemo-lithotrophs (ammonia, nitrate Sulphur, hydrogen, iron oxidizing bacteria); Chemo-organotrophs. Primary and secondary active transport; Passive and facilitated diffusion. Definitions of growth, measurement of microbial growth, Batch culture, Continuous culture, generation time and specific growth rate, synchronous growth, diauxic growth curve.	15	1,2,3	CO1, CO2,	PSO1

2	**Unit II** Levels of Physiological response- Molecular, Membrane, Organ and Organism Membrane physiology- Functional consequences of molecular composition and arrangement, Transport across cell membrane- Diffusion, active transport, ports- uniports, symports and antiport; Physiology of digestion- Nutritive patterns, feeding patterns: large particle feeding, surface nutrient and absorption; Circulation: Circulating fluids- cytoplasm, hydrolymph, hemolymph, lymph and blood, open and closed systems, respiration and gas exchange; homeostasis: osmotic regulation, excretion and thermoregulation.	15	1,2,3	CO3, CO4	PSO1
3	**Unit III** Physical aspects of water absorption – Diffusion, Imbibition, Osmosis – Exosmosis, Endosmosis, Plasmolysis, Water potential and its components, Mechanism of water absorption by root – active and passive absorption, Movement of water towards xylem by apoplast and symplast pathway, Ascent of sap, Root pressure, Transpiration and types, Mechanism of transpiration and stomatal movement, Significance and factors affecting transpiration. Mineral nutrition, brief account on Micro and macro nutrients, Function and deficiency symptoms of the following mineral nutrients: N, P, K, Mg, B, Fe, Zn, growth movements: Phototropism, Gravitropism and their reaction mechanism. Respiration: Process, types, measurement of respiration, R.Q., substrates, mechanism (Glycolysis, TCA Cycle, HMP shunt and oxidative phosphorylation).	15	1,2,3	CO5	PSO1

Reference Books	
1.	Caldwell, D.R. (1995). Microbial Physiology and Metabolism, Wm. C. Brown Publishers, USA.
2.	Principles of anatomy and physiology, Grabowski, S. R., & Tortora, G. J. (2000). New York, NY: Wiley.
3.	Biology of Animals, C. P. Hickman, L. S. Roberts, and A. Larson, McGraw Hill Company, New York
4.	Animal Physiology, Knut Schmidt-Nielsen, Cambridge University Press, UK
5.	Animal Physiology, R. W. Hill, G. A. Wyse & M. Anderson, Sinauer, New York
6.	F.B. Salisbury & C.W. Ross - (1974) Plant Physiology.
7.	L. Taiz & E. Zeiger – (2002) Plant Physiology

School: School of Science			**Program: B.Sc. Microbiology**		
Course Code: CH104			**Course Name: Inorganic Chemistry**		
Year	**I**	**Core Subject (Yes/No):**	**Yes**	**Lecture:**	**3**
Semester	**I**	**Elective Subject (Yes/No):**		**Tutorial**	**-**
Typology of Course	Lectures	**Foundation Subject (Yes/No):**		**Practical:**	**-**
		Year of Syllabus Revision:	**2021**	**Total Credit:**	**3**
		Year of Introduction	**2014**	**Prerequisites (If any)**	**-**

Course Description:

This course explains the basics of chemical bonding in a molecule. It mainly involves VBT and VSEPR model in detail for the prediction of shapes of molecules and ions containing lone pairs, sigma and pi bonds. It also explains about the Weak Chemical Forces that exist in molecules. In the second part it explains about ionic equilibria concept in solution. It gives an idea about electrolytes and their properties. It also explains the term buffer solution and their application in biochemical process. Further, it explains the term indicator and focuses on the acid-base indicators and their applications in acid-base titrations. The last part of the course deals with the fundamentals of coordination chemistry. It gives an idea about the structure of metal complexes. Nature of ligand based on their splitting of d-orbitals.

Course Objectives:

Gain an understanding of the concept of pH, Buffer solution, and different electrolytes. Further exploring the application of VBT and VESPER theory to understand the structure of molecules. Students will also undergo detailed understanding of different type titrations. Last, they will also undergo a detailed understanding of metal complex formation and their properties.

Course Outcome (CO):

CO1: Acquire knowledge of theories pertaining Chemical bonding.
CO2: Comprehend principles underlying ionic equilibrium.
CO3: Exploring the use of Metal–Ligand Bonding theories in transition Metal complexes.
CO4: Detail understanding of weak forces of interaction.
CO5: Comprehend knowledge on use of different indicators used in acid-base titration.
CO6: Understanding magnetic properties of metal complexes.

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	**Unit-I: Chemical bonding:** Ionic bond: (General characteristics, types of ions, size effects, radius ratio rule and its limitations.), Covalent bond: Valence bond approach, concept of resonance in various organic and inorganic compounds, hybridization and structure, equivalent and non – equivalent hybrid orbitals, Bent's rule and its applications, VSEPR model for predicting the shapes of molecules and ions containing lone pairs, sigma and pi bonds. LCAO method, symmetry and overlap for s – s , s – p and p – p combinations, MO treatment of homonuclear diatomic molecules of 2nd period (B_2, C_2 ,N_2, O_2 ,F_2) and	15	1, 2, 3, 4, 5	CO1 CO2	PSO1 PSO3

	heteronuclear di – atomic molecules (CO, NO) and their ions. Weak Chemical Forces: van der Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interactions, Instantaneous dipole-induced dipole interactions. Repulsive forces, Hydrogen bonding (theories of hydrogen bonding, valence bond treatment).				
2	**Unit-II: Ionic Equilibrium** Strong, moderate and weak electrolytes, degree of ionization, factors affecting the degree of ionization, ionization constant and ionic product of water. Theories of acids and bases. Ionization of weak acids and bases, pH scale, common ion effect; dissociation constants of mono-, di- and triprotic acids (exact treatment). Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions; derivation of Henderson equation and its applications; buffer capacity, buffer range, buffer action and applications of buffers in biochemical processes. Solubility and solubility product of sparingly soluble salts-applications of solubility product principle. Qualitative treatment of acid-base titration curves (calculation of pH at various stages). Theory of acid–base indicators; selection of indicators and their limitations.	15	1, 2, 3, 4, 5	CO1 CO5	PSO1 PSO3
3	**Unit-III: Coordination Chemistry** Werner's theory, IUPAC nomenclature of coordination compounds, isomerism in coordination compounds. Stereochemistry of complexes with 4 and 6 coordination numbers. Chelate effect, polynuclear complexes, Labile and inert complexes. valence bond theory (inner and outer orbital complexes), electroneutrality principle and back bonding. Crystal field theory, measurement of 10 $Dq_{(\text{octahedral (o) and tetrahedral (t)})}$, CFSE in weak and strong fields, pairing energies, factors affecting the magnitude of 10 $Dq_{(o,t)}$. Applications of CFT: Special reference to colour of the metal complexes, Magnetic properties of the metal complexes.	15	1, 2, 3, 4, 5	CO3 CO6	PSO1 PSO3

Reference Books	
1.	J. D. Lee, Concise Inorganic Chemistry, 5th Ed., Blackwell Science, London, 1996.
2.	F. A. Cotton, G. Wilkinson & P. L. Guas, Basic Inorganic Chemistry, 3rd Ed., John Wiley, 1994.
3.	B. Douglas, D. McDaniel & J. Alexander, Concepts and Models of Inorganic Chemistry, 3rd Ed., John Wiley, 1994.
4.	B. R. Puri, L. R. Sharma & K. C. Kalia, Principles of Inorganic Chemistry, Shoban Lal Nagin Chand and Co., 1996.
5.	J. E. Huheey, E. A. Kieter& R. L. Keiter, Inorganic Chemistry, 4th Ed., Harper Collins, New York, 1993.
6.	D. F. Shriver & P. W. Atkins, Inorganic Chemistry, 3rd Ed., W. H. Freeman and Co, London, 1999.
7.	T. Moeller, Inorganic Chemistry: A Modern Introduction, Wiley, New York, 1990.

<table>
<tr><td colspan="3">School: School of Business and Law</td><td colspan="3">Program: B.Sc. Microbiology</td></tr>
<tr><td colspan="3">Course Code: MG117</td><td colspan="3">Course Name: Principles of Management and Accounts</td></tr>
<tr><td>Year</td><td>I</td><td>Core Subject (Yes/No):</td><td>Yes</td><td>Lecture:</td><td>3</td></tr>
<tr><td>Semester</td><td>I</td><td>Elective Subject (Yes/No):</td><td>No</td><td>Tutorial</td><td></td></tr>
<tr><td rowspan="3">Typology of Course</td><td rowspan="3">Lectures</td><td>Foundation Subject (Yes/No):</td><td>Yes</td><td>Practical:</td><td></td></tr>
<tr><td>Year of Syllabus Revision:</td><td>2021</td><td>Total Credit:</td><td>3</td></tr>
<tr><td>Year of Introduction</td><td>2009</td><td>Prerequisites (If any)</td><td>-</td></tr>
</table>

Course Description:
The course outline has been designed to serve the purpose of understanding basics of management and accounting

Course Objectives:
The overall all objective of this course is to educate students about the management as an activity and have a holistic approach to the concept. Accountancy basics are the requirement of the generation.

Course Outcome (CO):
CO1: Become an efficient learner of management
CO2: Develop and understand methods of management.
CO3: Gain knowledge managing finance through Accounts

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	Unit 1- Management Basics, Management theories, Process of management, Managers qualities	11	1,2	CO1	PSO1
2	Unit 2- Evolution of Management, Functions - Planning Planning process, Decicion making, PRINCIPLES OF ORGANISATIONS, COORDINATION AND CONTROLLING, Directing	11	1,2,3	CO1, CO2	PSO1, PSO2
3	Unit 3- Accounting Basics, Rules of accounting, Principles Accounting process, Journal, Journal enteries, Ledger, Trial Balance	11	2, 3, 4	CO1, CO3	PSO1, PSO2
4	Unit 4- Financial Statements, Books of accounts, Profit and loss statement, Balance sheet, Analysis	12	1, 2, 3	CO3	PSO1, PSO2, PSO4

<table>
<tr><td colspan="2">Reference Books</td></tr>
<tr><td>1.</td><td>Principles of Management Book by Dan Voich and Daniel A. Wren</td></tr>
<tr><td>2.</td><td>ICAI ONLINE PDF</td></tr>
</table>

<table>
<tr><td colspan="3">School: School of Science</td><td colspan="3">Program: B.Sc. Microbiology</td></tr>
<tr><td colspan="3">Course Code: LC117</td><td colspan="3">Course Name: Communication</td></tr>
<tr><td>Year</td><td>I</td><td>Core Subject (Yes/No):</td><td></td><td>Lecture:</td><td>2</td></tr>
<tr><td>Semester</td><td>I</td><td>Elective Subject (Yes/No):</td><td></td><td>Tutorial</td><td>-</td></tr>
<tr><td rowspan="3">Typology of Course</td><td rowspan="3">Lectures</td><td>Foundation Subject (Yes/No):</td><td>Yes</td><td>Practical:</td><td>-</td></tr>
<tr><td>Year of Syllabus Revision:</td><td></td><td>Total Credit:</td><td>2</td></tr>
<tr><td>Year of Introduction</td><td>2020-2021</td><td>Prerequisites (If any)</td><td>Knowledge of basic grammar components and vocabulary</td></tr>
</table>

Course Description:

This Communication course is conceptualized as a course aimed at enhancing English language as a tool of learning and English language as a tool of communication in a professional context. It offers a framework for English language proficiency required of a student in academic work in general as well as in discipline specific perspective. As a tool of learning, the four skills of language and learning: listening, speaking, reading and writing are practiced. The practice of communication in the professional context deals with understanding the mechanics of language. The focus is on building the language skills required in discipline specific areas. It is a workshop based course providing hands-on experience to learners. This course focuses largely on training the students in writing and speaking proficiency, usage of English language in academic context as well as preparing them for the outside world of work.

Course Objectives:

This course will enable students to:

- Develop their overall listening, speaking, reading and writing skills,
- Develop knowledge of vocabulary and grammar,
- Read and comprehend texts of varying length at basic/low intermediate level.
- Understand and use effective writing skills to express ideas/give information.
- Develop students' general capacity to a level that enables them to use English for their academic and professional requirements.

Course Outcome (CO):

CO1: Explain the prerequisites of effective communication
CO2: Identify people’s communication styles and needs
CO3: Summarize a passage of text in their own words highlighting the embedded ideas, facts, supportive arguments
CO4: Describe the need for Emotional Intelligence in professional settings.
CO5: Make effective presentations with appropriate verbal and non-verbal communication.
CO6: Explain the importance of information acquisition, processing and dissemination.
CO7: Justify the importance of Knowing and upholding the policies, laws and regulations relevant to professional practice regardless of personal views.

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	Comprehension Paragraphs writing including all grammar Paraphrasing and notetaking Revision of all Communication skills – LSRW with activities Communication skills - Precis / Abstract writing Letter Writing – formal, informal. Digital Literacy, Use of social media Report Writing	10	1,2,3,4,5	CO1 CO2 CO3 CO4 CO5 CO6 CO7	PSO1 PSO3
2	Professional skills - A Resume writing, Interview and Group Discussion	5	1,2,3,4,5	CO1 CO2 CO4	PSO3
3	**Professional skills B –** Presentation, Oral presentation • Preparation • Using the report as guideline • Formulating the central message • Arranging the ideas, facts and supportive arguments • Making a positive impact (appearance, gestures, eye contact, body language, style of speaking) • Effective use of visual aids y (types of visual aid equipment, using the equipment correctly) • Maximizing delivery (fielding questions, managing answers, handling difficult situations, short talk guidelines, impromptu sessions) • Practical Session: Delivery of a two-minute presentation (each delegate delivers a presentation on a particular aspect of the technical report)	10	1,2,3,4,5	CO1 CO2 CO3 CO4 CO5 CO6	PSO2 PSO3
4	SOCIAL SKILLS Leadership and Management skills	5	1,2,3,4,5	CO1 CO2 CO4 CO7	PSO3

Reference Books:	
1.	John Seely; Oxford Guide to Effective Writing and Speaking; Oxford University Press; 2009 Ed.
2.	L. Gartside; Modern Business Correspondence; The English Language Book Society and Macdonald and Evans Ltd.
3.	Lester and Beason; The McGraw Hill Handbook of English Grammar and Usage; Tata McGraw Hill Education Private Limited; 2010 Ed.
4.	Ellet, William; The case Study Handbook; Harvard Business Review Press
5.	Bovee, Thill and Chaturvedi; Business Communication Today; Pearson Education; 2009 9TH ed.
6.	Scot Ober; Contemporary Business Communication; Biztantra Publications; 2009 5th ed.
7.	Inch. E.S. & Warnick Barbara; Critical Thinking and Communication; Perason;2011 ed.
8.	Herrmann Robert Ned; The Whole Business Brain; McGraw-Hill, 1998.

9.	Clemen, T Robert; Making Hard Decisions ; Duxbury Press, 1996

School: School of Sciences			**Program: B.Sc. Microbiology**		
Course Code: MA110			**Course Name: Foundation in Mathematics**		
Year	**I**	**Core Subject (Yes/No):**	**No**	**Lecture:**	**3**
Semester	**I**	**Elective Subject (Yes/No):**	**No**	**Tutorial**	**0**
Typology of Course	**Lectures**	**Foundation Subject (Yes/No):**	**Yes**	**Practical:**	**0**
		Year of Syllabus Revision:	**-**	**Total Credit:**	**3**
		Year of Introduction	**2014**	**Prerequisites (If any)**	**None**

Course Description: The study contains introduction to functions of several variables, Differentiation of multivariate functions, concepts of limits and continuity and their application in Life science. It also gives the introductory data computation, computational methods involved in the calculations of simple and compound interest, profit-loss, discount, tax, variations(direct and inverse) etc.

Course Objectives:
The objective of the course is to:

- Introduce the concept of functions of single and multiple variables
- Teach the concept of differentiability and it's applications to biological/chemical sciences
- Teach the arithmetical methods involved in the calculations of simple and compound interest, profit and loss, discount, taxes, direct and inverse variations etc.

Course Outcome (CO):
CO1: Understand the concept of functions of single and multiple variables
CO2: Internalize definitions of Limits, Continuity and Differentiability
CO3: Differentiate functions of single and multiple variables
CO4: Apply concepts of percentage, profit loss, discount and taxes to real life problems
CO5: Understand direct and inverse variations and solve problems
CO6: Understand growth in terms of simple and compound interest
CO7: Solve time and work problem

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	Functions of two variables, Domain and range of functions of two variables	6	1,2,3	CO1	PSO1
2	Limits and Continuity functions of two variables.	5	1,2,3,4	CO2	PSO1
3	Differentiability, Chain rule, Implicit differentiation	10	1,2,3,5	CO3	PSO1
4	Taylor's theorem for functions of two variables.	6	1,4,5	CO3	PSO1

5	Slightly advanced problems involving applications on percentages, profit & loss, overhead expenses, Discount, tax, Difference between simple and compound interest, Arriving at the formula for compound interest through patterns and using it for simple problems	10	1,3,4,5	CO4, CO5, CO6	PSO1
6	Direct variation, Inverse variation, Time & work problems	8	1,3,4,5	CO6, CO7	PSO1

Reference Books	
1.	Apostol T.M., 1967, Calculus, Vol. II, IInd Edition, John Willey, New York
2.	Narayan Shanti and Mittal P.K., 1979, A Course of Mathematical Analysis, 12th Edition. S. Chand and Co
3.	Spiegel M.R., Advanced Calculus, Schaum Series
4.	Widder D.V., 1944, Advanced Calculus, IInd Edition, Prentice Hall of India, New Delhi.
5.	James T. Shea, 1991.Basic Essentials of Mathematics, Book 2: Percent, Measurement & Formulas, Equations, Ratio & Proportion, sold by Amazon.com
6.	Silvio Belli, Stephen R. Wassell, Kim Williams.,2007. On ratio and proportion: the common properties of quantity Nexus, architecture and mathematics. Kim Williams Books, 2002

School: School of Science			**Program: B.Sc. Microbiology**		
Course Code: LS103			**Course Name: Life Science Laboratory – I**		
Year	**I**	**Core Subject (Yes/No):**	**Yes**	**Lecture:**	**0**
Semester	**I**	**Elective Subject (Yes/No):**	**No**	**Tutorial**	**0**
Typology of Course	**Laboratory**	**Foundation Subject (Yes/No):**	**No**	**Practical:**	**4**
		Year of Syllabus Revision:		**Total Credit:**	**2**
		Year of Introduction	**2021**	**Prerequisites (If any)**	**No**

Course Description:
The course illustrates the understanding of classification of various life forms including animals, plants and microbes. Along with this, the subject also teaches the diversification of living forms, both past and present, and the relationships among living things through time which forms a part of systematics.

Course Outcome (CO):
CO1: Understand the classification of animals
CO2: Understand the classification of microbes
CO3: Understand the economic importance of animals
CO4: Understand the basics of dissection of animals
CO5: Understand the classification of plants

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO

1	Classification of Bacteria	6	1,2,3	CO2 CO4	PSO1 PSO2
2	Classification of animals: Invertebrates	6	1,2,3	CO1 CO2	PSO1 PSO2
3	Classification of animals: Vertebrates	6	2, 3, 4	CO1	PSO1 PSO2
4	General body organization of animals	6	1,2,3	CO1	PSO1 PSO2
5	Classification of Protists	6	1,2,3	CO2	PSO1 PSO2
6	Classification of Fungi	6	1,2,3	CO2	PSO1 PSO2
7	Study of Locomotory organ of animals	6	1,2,3	CO1, CO4	PSO1 PSO2
8	Mounting of earthworm: Setae, nephridia and spermatheca	6	1,2,3	CO1, CO4	PSO1 PSO2
9	Mounting of fish scales and gill racker	6	1,2,3	CO1, CO4	PSO1 PSO2
10	Mounting of prawn appendages	6	1,2,3	CO1, CO4	PSO1 PSO2

Reference Books	
1.	Moore J.- An introduction to the invertebrates- CUP
2.	R.L.Kotpal- Modern Text Book of Zoology Vertebrates- Rastogi Publications
3.	E. A. Bessey, Morphology and Taxonomy of Fungi
4.	Prescott, L.M J.P. Harley and C.A. Klein 1995. Microbiology 2nd edition Wm, C. Brown publishers.
5.	Michael J. Pelczar, Jr. E.C.S. Chan, Moel : Microbiology Mc Graw Hill Book R. Krieg, 1986 Company
6.	Stainer R.Y. Ingraham J.L. Wheolis H.H and Painter P.R. 1986 The Microbial world, 5th edition. Eagle Works Cliffs N.J. Prentica Hall

School: School of Science			**Program: B.Sc. Microbiology**		
Course Code: LS104			**Course Name: Life Science Laboratory II**		
Year	**I**	**Core Subject (Yes/No):**	**Yes**	**Lecture:**	**-**
Semester	**I**	**Elective Subject (Yes/No):**	**No**	**Tutorial**	**NA**
Typology of Course	**Laboratory**	**Foundation Subject (Yes/No):**	**No**	**Practical:**	**NA**
		Year of Syllabus Revision:	**2021**	**Total Credit:**	**2**
		Year of Introduction	**2016**	**Prerequisites (If any)**	**NIL**

Course Description:
The basic concepts of microbial, animal and plant physiology are addressed in this course.

Course Objectives: After completing this course, students will be able to:

- Calculate the species diversity
- Check the effects of physical parameters on microbial growth
- Demonstrate transpiration and plamolysis

Course Outcome (CO):
CO1: To learn the technique of microbiology
CO2: To study physiological changes in plant tissues.
CO3: To Measure the osmosis and tonicity of red blood cell

Unit No.		Contact Hours	BT Level	CO	PSO
1	Calculation of species diversity using “Shannon-Wiener” ecological index	15	1,2	CO1	PSO3
2	To determine the effect of pH on bacterial growth	15	1,2	CO2, CO3	PSO3
3	To determine the temperature of pH on bacterial growth	15	1,2	CO1, CO2, CO3	PSO3
4	Effect of osmotic pressure (salt concentration) on bacterial growth	15	1,2	CO1, CO2, CO3	PSO3
5	Measuring osmosis and tonicity of red blood cells	15	1,2	CO1, CO2	PSO3
6	Study of transpiration in leaves	15	1,2	CO1, CO3	PSO3
7	Study of plasmolysis	15	1,2	CO1, CO2, CO3	PSO3
Reference Books					
1	Esau, K. (1953). Plant anatomy (Vol. 75, No. 5, p. 407). LWW.				
2	Waller, D. M. (1988). Plant morphology and reproduction. Plant reproductive ecology: patterns and strategies, 203-227.				

School: School of Science			**Program: B.Sc . Microbiology**		
Course Code: CH105			**Course Name: Chemistry laboratory-II**		
Year	**I**	**Core Subject (Yes/No):**	No	**Lecture:**	**0**
Semester	**I**	**Elective Subject (Yes/No):**		**Tutorial**	**0**
Mode of Transaction	**Laboratory**	**Foundation Subject (Yes/No):**		**Practical:**	**4**
		Year of Syllabus Revision:		**Total Credit:**	**2**
		Year of Introduction	**2014**	**Prerequisites (If any)**	

Course Description:
student understanding of important concepts in Quantitative chemistry using volumetric analysis through hands-on experiments. In the chemistry laboratory, students will examine, test, and establish for themselves the chemical principles studied in class and from textbooks; will collect experimental data; and will use their reasoning to draw logical conclusions about the meaning of these date.

Course Outcome (CO):

CO1: To understand the fundamentals of volumetric titrations specifically Acidimetry – Alkalimetry titrations.

CO2: Describe the knowledge of the fundamentals of Redox Titrations, complexometric titrations in volumetric analysis.

CO3: Comprehended the titration related to Argentometry titrations, Iodometry and Iodimetry titration using volumetric analysis.

CO4: Record observations and write laboratory reports according to disciplinary standards.

No.	**Experiment**	**Contact Hours**	**BT Level**	**CO**	**PSO**
	Volumetric Titrations				
1	Acid-base Titration	2	1, 2, 3, 4, 5, 6	CO1, CO4	PSO1, PSO3
2	Redox Titration	2	1, 2, 3, 4, 5, 6	CO2, CO4	PSO1, PSO3
3	Redox Titration using External Indicator	2	1, 2, 3, 4, 5, 6	CO2, CO4	PSO1, PSO3
4	Redox titration using internal indicator	2	1, 2, 3, 4, 5, 6	CO2, CO4	PSO1, PSO3
5	Complexometric titration	2	1, 2, 3, 4, 5, 6	CO1, CO2, CO4	PSO1, PSO3
6	Argentometry titration	2	1, 2, 3, 4, 5, 6	CO2, CO3, CO4	PSO1, PSO3
7	Iodometry Titration	2	1, 2, 3, 4, 5, 6	CO2, CO3, CO4	PSO1, PSO3
8	Iodimetry Titration	2	1, 2, 3, 4, 5, 6	CO2, CO3, CO4	PSO1, PSO3

Reference Books	
1.	O. P. Pandey, D. N. Bajpai, S. Giri, Practical Chemistry, Revised Edition.
2.	R. C. Shah, Inorganic Analysis Part I Qualitative Analysis, Baroda Book Depot, Vadodara, 2001.

SEMESTER 2

School: School of Science			**Program: B.Sc. Microbiology**		
Course Code: LS179			**Course Name: Biochemistry -I**		
Year	I	**Core Subject (Yes/No):**	Yes	**Lecture:**	3
Semester	II	**Elective Subject (Yes/No):**	-	**Tutorial**	-
Typology of Course	Lectures	**Foundation Subject (Yes/No):**	-	**Practical:**	-
		Year of Syllabus Revision:		**Total Credit:**	3
		Year of Introduction	**2021**	**Prerequisites (If any)**	-

Course Description:
This course introduces with the types of biomolecules, with significance of water for life and buffer and its role in biological system. It also focuses on basic introduction and classification of carbohydrates like cellulose, chitin, agar, pectin, proteoglycans, blood group polysaccharides, glycogen and starch, bacterial cell wall polysaccharides. And, biological significance of fats and fatty acids like glycerophospholipids, sphingomyelins, glycolipids-cerebrosides, gangliosides. Moreover, it gives an introduction and classification of amino acids, stating the biological significance of fibrous proteins.

Course Objectives:
Student Should be able to classify biomolecules and have detail understanding of the basic and complex biomolecule structure. Biomolecules sources and their function in human body will be one of the objectives of course

Course Outcome (CO):
CO1: Learn the elements present in biomolecules and the difference monomers and polymers.
CO2: Explain the role of water in the synthesis and breakdown of polymers.
CO3: List the four major complex biomolecules found in living cells, three of which are found on food labels and the basis for grouping of biomolecules into those four groups.
CO4: For each group of biomolecules learn the names of its generic monomer (simple unit) and polymer (complex structure) and their function.

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	Unit-I: Basics of biological chemicals & Biomolecules: Introduction to biomolecules, Types of bonds in molecules of life and chemical foundation. Acid – Base chemistry. Study of structural properties of water, significance of water for life and buffer and its role in biological system. Carbohydrates: Introduction to carbohydrates, Occurrence and Classification of Carbohydrates, and Physiological properties of Carbohydrates. Occurrence and biological importance of carbohydrates like Cellulose, Chitin, agar, pectin, proteoglycans, blood group polysaccharides, glycogen and starch, bacterial cell wall polysaccharides-Glycoprotein etc. Fatty acids: Introduction, classification,	15	1,2,3	CO1, CO2, CO3, CO4	PSO1, PSO2

	nomenclature, structure and properties of saturated and unsaturated fatty acids. Examples of essential fatty acids and their nomenclature, physical, chemical and biological properties and significance. Biological significance of Fats like Glycerophospholipids, sphingomyelins, glycolipids-cerebrosides, gangliosides.				
2	Unit- II: Proteins and Nucleic acid: Introduction and classification of amino acids. Physical and chemical properties of amino acids. Study of Essential amino acids. Protein structure: primary, secondary, tertiary and quaternary structure of proteins. Denaturation and renaturation of proteins. Behaviour of proteins in solutions. Biological significance of fibrous proteins (keratins, collagen and elastin), globular proteins (hemoglobin, myoglobin), lipoproteins, metalloproteins, glycoproteins and nucleoproteins. Composition of RNA and DNA, generalized structural plan of nucleic acids, nomenclature and major features of DNA double helix. Properties and types of DNA and RNA. Size of DNA and packaging in Eukaryotic and Prokaryotic cells	15	1,2,3	CO3, CO4	PSO1, PSO2
3	Unit- III: Basics of Bio-catalysts – The Enzyme: Introduction, concept. Classification, lock and key model, induced fit model, active site, enzyme specificity and types. Enzyme kinetics, factors affecting the velocity of enzyme action. Enzyme concentration, temperature, pH, substrate concentration. Enzyme inhibition, reversible and irreversible, competitive, non-competitive and uncompetitive inhibition, allosteric enzymes. Isoenzymes, Zymogen form of enzyme and its activation. Applications of various enzymes. AB Enzymes.	15	2, 3, 4	CO4	PSO1, PSO2

Reference Books	
1.	Lehninger Principles of Biochemistry by David L. Nelson, Michael M. Cox, 6th edition
2.	Biochemistry, 4th Edition Donald Voet, Judith G. Voet
3.	Harper's Biochemistry (30th edition) by Peter A Mayes and Victor W Rodwell
4.	Cell Biology, P.K. Gupta, 1998.
5.	Genetics, P.K. Gupta, , 1998.
6.	P.S. Verma & V.K. Agarwal, Cell biology, molecular biology, genetics and evolution, 1968.

School: School of Science			**Program: B.Sc. Microbiology**		
Course Code: LS180			**Course Name: Cytology and Genetics**		
Year	**I**	**Core Subject (Yes/No):**	**Yes**	**Lecture:**	**3**
Semester	**II**	**Elective Subject (Yes/No):**	**-**	**Tutorial**	**-**

Typology of Course	**Lectures**	**Foundation Subject (Yes/No):**	**-**	**Practical:**	**-**
		Year of Syllabus Revision:		**Total Credit:**	**3**
		Year of Introduction	**2021**	**Prerequisites (If any)**	**-**

Course Description:
The course starts with an introduction to cellular biology focusing on various types of cells, comparative study prokaryotic and eukaryotic cells along with the understanding of simple and complex tissues specially in plants. It also focuses on various cell organelles- membrane bound and non-membrane bound, found in living cells, their detailed structure and function and basics of protein trafficking. The course helps to get knowledge of genetics and Mendalian inheritance, concept of alleles and cytogenetics overview of chromosomes and various abnormalities and mutations.

Course Objectives:
Types of cells- prokaryotic and eukaryotic and their structure, cell organelles- ribosomes, endoplasmic reticulum, golgi bodies, mitochondria and others, cell cycle and its regulation will be covered in this course. Moreover, concepts of genetics such as Mendelian genetics, chromosome structure, chromosomal abnormalities are the key course objectives of this course.

Course Outcome (CO):
CO1: Types of cells found in the living world
CO2: Cell organelles, their structure, and functions
CO3: Cytological structures
CO4: Cell cycle- mitosis and meiosis
CO5: Mendelian genetics and cytogenetics
CO6: Chromosomal abnormalities, diseases and mutations

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	**Unit I** Cytology - I: A brief introduction to Cell Biology, History, and concept of Cell Theory. Various types of cells and comparative study Prokaryotic (archaea and eubacteria) and eukaryotic cell (animal and plant cells). Simple tissues: Living (collenchyma and parenchyma) and dead (sclerenchyma) cell types Complex Tissues: Xylem and Phloem elements structure and function. Cell wall: Layers, function, formation of cell wall Intercellular communications: Plasmodesmata, pits - structure, types and functions. An introduction to Cell Organelles: cell wall, cell membrane, nucleus, endoplasmic reticulum, Golgi apparatus, vacuoles, lysosomes, mitochondria, plastids, and chloroplasts. Protein trafficking: Targeting proteins to ER, smooth ER and lipid synthesis. Export of proteins and lipids from ER. Protein import and mitochondrial assembly.	15	1,2,3	CO1, CO2,	PSO1
2	**Unit II**	15	1,2,3	CO3, CO4	PSO1

	Cytology-II: Non-membrane bound organelles: Ribosomes, centrioles, basal bodies, Cytoskeleton–Microtubules: structure and function. Structure of cilia and flagella. Microfilaments. Introduction to cell cycle and cell division: Mitosis, Meiosis I and Meiosis II. Cell death and cell renewal: Cell cycle regulation, Restriction point, and checkpoints. Apoptosis and necrosis - brief outline. Salient features of a transformed cell/cancer cell.				
3	**Unit III** Genetics: Introduction to genetics and Mendalian inheritance, Gene interactions: allelic and nonallelic, modified dihybrid ratios, Modified Mendalian ratios: allelic and nonallelic interactions- complementary genes, epistasis, additive, inhibitory, lethal genes, pleiotropy, polygenic inheritance, cytoplasmic inheritance. Cytogenetics: Chromosome morphology, karyotype and idiogram, Special types of chromosomes. Giant chromosome (Polytene chromosome, lampbrush chromosome). Chromosomal abnormality: numerical disorder; structural abnormalities. e.g. Down syndrome; Turner syndrome; Wolf-Hirschhorn syndrome. Genetic mutations.	15	1,2,3	CO5, CO6	PSO1

Reference Books	
1.	The Cell: A Molecular Approach (7th Edition) by Geoffrey M. Cooper, Robert E. Hausman
2.	Essential Cell Biology (4th Edition) Bruce Alberts, Dennis Bray, Karen Hopkin, Alexander D.Johnson, Julian Lewis, Martin Raff, Keith Roberts, and Peter Walter.
3.	Cell Biology, Genetics, Molecular Biology (1st Edition) P.S.Verma, 2004
4.	Cell and Molecular Biology (8th edition) by E. M. F. De Robertis and Eduardo de Robertis
5.	Cell Biology, P.K. Gupta, 1998.
6.	Genetics, P.K. Gupta, , 1998.
7.	Cytology, Genetics and Molecular Genetics by B.N. Pandey
8.	Lewin's Genes XII (12th edition) by Jones & Bartlett
9.	E.J. Gardner, Principles of genetics, 1968.
10.	G.B. Wilson & J.H. Morrison, Cytology, 1968.

<table>
<tr><td colspan="3">School: School of Science</td><td colspan="3">Program: B.Sc. Microbiology</td></tr>
<tr><td colspan="3">Course Code: MG108</td><td colspan="3">Course Name: Economics and Finance</td></tr>
<tr><td>Year</td><td>I</td><td>Core Subject (Yes/No):</td><td>Yes</td><td>Lecture:</td><td>3</td></tr>
<tr><td>Semester</td><td>II</td><td>Elective Subject (Yes/No):</td><td>No</td><td>Tutorial</td><td>-</td></tr>
<tr><td rowspan="2">Typology of Course</td><td rowspan="2">Lectures</td><td>Foundation Subject (Yes/No):</td><td>Yes</td><td>Practical:</td><td>-</td></tr>
<tr><td>Year of Syllabus Revision:</td><td>2021</td><td>Total Credit:</td><td>3</td></tr>
</table>

		Year of Introduction	**2009**	**Prerequisites (If any)**	

Course Description:
The course outline has been designed to serve the purpose of understanding basics of management and accounting

Course Objectives:
The overall all objective of this course is to educate students about the management as an activity and have a holistic approach to the concept. Accountancy basics are the requirement of the generation.

Course Outcome (CO):
CO1: Efficiency in concept of Micro and Macro economics
CO2: Develop and understand methods of Financial management.
CO3: Identify sources and application of Finance

Unit No.	**Topic/Unit**	**Contact Hours**	**BT Level**	**CO**	**PSO**
1	Unit 1- Economics: Basics, Concept of scarcity, Opportunity Costs, Relation with other disciplines, Microeconomics –Demand, Supply, Diminishing utility	11	1,2	CO1	PSO1
2	Unit 2- Economics: Macro Economics, National Income, Unemployment, GDP	11	1,2,3	CO1,CO2	PSO1, PSO2
3	Unit 3- Finance: Basic concepts, Relation with other disciplines	11	2, 3, 4	CO2,CO3	PSO1, PSO2
4	Unit 4- Finance: Sources of Finance, Long, Medium, Short Term, Application of finance	12	1, 2, 3	CO2,CO3	PSO1, PSO2, PSO3, PSO4

Reference Books:

1.	Economics for Beginners
2.	Financial Management by Prasanna Chandra

School: School of Science	**Program: B.Sc. Microbiology**
Course Code: MA117	**Course Name: Foundation Mathematics-II**

Year	**I**	**Core Subject (Yes/No):**	**No**	**Lecture:**	**3**
Semester	**II**	**Elective Subject (Yes/No):**	**No**	**Tutorial**	**0**
Typology of Course	**Lectures**	**Foundation Subject (Yes/No):**	**Yes**	**Practical:**	**0**
		Year of Syllabus Revision:		**Total Credit:**	**3**
		Year of Introduction	**2014**	**Prerequisites (If any)**	

Course Description:
The study contains Introduction of Integration and its application in Life science. It also gives the introductory statistics.

Course Objectives:

- Develop understanding of fundamentals of Integral Calculus
- Understand the importance of Calculus
- Understand and apply different statistical methods for data analysis

Course Outcome (CO):

CO1: Able to understand the fundamentals of Integral Calculus
CO2: Able to calculate integration for different types of functions
CO3: Able to calculate Area, volume for 2D, 3D figures
CO4: Able to apply different statistical methods for data analysis

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	Unit 1Simple Integrations Introduction to Integration Formulas in Integration Simple sums related to Integration	15	1	CO1, CO2	PSO1
2	Unit 2 Area and Volume Finding areas and surface areas for two dimensional figures Finding Volume for three dimensional figures	10	2	CO3	PSO2
3	Unit 3 Introduction to Statistics Bar Graph, Histogram, Box plot, Scatter plot, Mean, Median, Mode, Range, Variance, Standard deviation, Skewness, Kurtosis	20	3, 4	CO4	PSO3 PSO4

Reference Books	
1.	Spiegel M.R., Advanced Calculus, Schaum Series.
2.	Hogg R. V. & Craig A. T. 1988) : Introduction to Mathematical Statistics, Mcmillan.
3.	Mood A. M & Graybill F. A & Boes D. G (1974) : Introduction to theory of Statistics, Mcgraw Hill.

School: School of Science			**Program: B.Sc. Microbiology**		
Course Code: LC 120			**Course Name: Communication II**		
Year	**I**	**Core Subject (Yes/No):**	**Yes**	**Lecture:**	**3**
Semester	**II**	**Elective Subject (Yes/No):**		**Tutorial**	**-**
Typology of Course	**Lectures**	**Foundation Subject (Yes/No):**		**Practical:**	**-**
		Year of Syllabus Revision:	**2021**	**Total Credit:**	**03**
		Year of Introduction	**2018**	**Prerequisites (If any)**	**Knowledge of basic grammar components and vocabulary.**

Course Description:
This Communication course is conceptualized as a course aimed at enhancing English language as a tool of learning and English language as a tool of communication in a professional context. It offers a framework for English language proficiency required of a student in academic work in general as well as in discipline specific areas. As a tool of learning, the four skills of language and learning: listening, speaking, reading and writing are practiced. The focus is on building language skills required in discipline specific areas.

The practice of communication in the professional context deals with understanding hierarchy, tone and appropriate vocabulary.

This Course focuses largely on training the students in writing and speaking proficiency, usage of English language in academic context as well as preparing them for the world of work.

Course Objectives:
This course will enable students to:

- Develop their overall listening, speaking, reading and writing skills,
- Develop knowledge of vocabulary and grammar,
- Read and comprehend texts of varying length at basic/low intermediate level.
- Understand and use effective writing skills to express ideas/give information.
- Develop students' general capacity to a level that enables them to use English for their academic and professional requirements.

Course Outcome (CO):
CO1: Describe the Communication cycle, types of communication, barriers and ways to address these.
CO2: Read and analyze texts and evaluate ideas therein
CO3: Express oneself clearly while communicating with others (reports, letters, ...)
CO4: Participate constructively in class discussions
CO5: Illustrate communication and techno skills while making presentations
CO6: Refer to authentic sources of information and cite the same ethically.

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	**Communication Skills –** – Comprehension (including all grammar components) – Essay writing – Precis writing / Abstract writing – Report Writing (Compiling the report & Report structure) – Importance of Digital Literacy; Use of social media – Capstone Paper and presentation	15	1,2,3,4, 5,6	CO1 CO2 CO3 CO4 CO5 CO6	PSO1 PSO5
2	**Professional Skills - A** – Letter Writing – Resume writing, – Interview – Group Discussion skills.	5	1,2,3,4, 5	CO3 CO4 CO6	PSO1 PSO5
3	**Professional Skills - B** – Designing the KWL Chart - Formulating the central message – Arranging the ideas, facts & supportive arguments – Making a positive impact (appearance, gestures, eye contact, body language, style of	10	1,2, 3, 4,5	CO4 CO5 CO6	PSO1 PSO5

	speaking) – Effective use of visual aids (types of visual aid equipment, using the equipment correctly) – Maximizing delivery (fielding questions, managing answers, handling difficult situations, short talk guidelines, impromptu sessions) – Practical Session: Delivery of a two-minute presentation (each student delivers a presentation on the KWL Chart) **Professional Ethics** – Understanding academic integrity – Plagiarism rules				
4	**Social Skills** – Leadership and Management skills	5	1,2,3,4, 5	CO4 CO5 CO6	PSO1 PSO5
5	**Critical thinking skills** – Significance of Critical thinking skills – Concept map designing – Fishbone Diagram	10	1,2,3,4, 5,6	CO2 CO3 CO4 CO5	

Reference Books:	
1.	John Seely; Oxford Guide to Effective Writing and Speaking; Oxford University Press; 2009 Ed.
2.	L. Gartside; Modern Business Correspondence; The English Language Book Society and Macdonald and Evans Ltd.
3.	Lester and Beason; The McGraw Hill Handbook of English Grammar and Usage; Tata McGraw Hill Education Private Limited; 2010 Ed.
4.	Ellet, William; The case Study Handbook; Harvard Business Review Press
5.	Bovee, Thill and Chaturvedi; Business Communication Today; Pearson Education; 2009 9TH ed.
6.	Scot Ober; Contemporary Business Communication; Biztantra Publications; 2009 5th ed.
7.	Inch. E.S. & Warnick Barbara; Critical Thinking and Communication; Perason;2011 ed.
8.	Herrmann Robert Ned; The Whole Business Brain; McGraw-Hill, 1998
9.	Clemen, T Robert; Making Hard Decisions; Duxbury Press, 1996

School: School of Science			**Program: B.Sc. Microbiology**		
Course Code: HS106			**Course Name: Humanities**		
Year	**I**	**Core Subject (Yes/No):**	**Yes**	**Lecture:**	**2**
Semester	**II**	**Elective Subject (Yes/No):**		**Tutorial**	**NA**
Typology of Course	**Lectures**	**Foundation Subject (Yes/No):**		**Practical:**	**NA**
		Year of Syllabus Revision:	**2020**	**Total Credit:**	**2**

		Year of Introduction	**2019**	**Prerequisites (If any)**	**NA**

Course Description:
The Course on Humanities entails the study of the human world and society from a critical perspective. The Humanities Course provides a broad understanding of the world in which we live, and how people can participate as active and informed citizens with the skills needed for the 21st century. The course focuses on the relationship between education, technology and society. The course also makes students aware about the theories and approaches to learning in view of 21st century requirements. The Course highlights the need to develop an understanding of ethical considerations and the implications of decisions that are made for individuals, society, the economy and the environment.

Course Objectives:
- To enable students to understand the impact of education on the Individual and society.
- To enable students to understand the interdependence between education and society.
- To make students aware about the theories and approaches to learning in view of 21st century requirements.
- To enable students to identify the impact of technology on their life and society.
- To enable students to develop the skill of ethical reasoning and/or ethical decision making.

Course Outcome (CO):
CO1: Describe the necessity of education and its impact on society
CO2: Explain various theories of learning and their implications
CO3: Relate the theories of learning with the present societal contexts (eg Make in India/Digital India/ Skill India)
CO4: Justify the need for EQ to achieve career and professional goals
CO5: Explain the inter-dependence between education and technology in shaping society.
CO6: Explain the importance of ethical decision making and academic integrity.

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	- Necessity of Education for human life, Impact of Education on society. - Necessity of education in Human life - UNESCO 4 Pillars of Education - Impact of education on society - Make in India/Digital India/ Skill India. - Necessity: Individual vs. citizen. (Russel - Ability to read & write, Decent livelihood, Better communication, Use of technology, Secure transactions, Serve society, Knowledge Propagation, Social harmony)	8	2,3,4,5	CO1 CO3	PSO3
2	- Knowledge of the different types of education - Formal, Informal & Non formal education; Liberal, Professional, Vocational & Technical education - Emotional Intelligence: Models of Emotional Intelligence. - Domains of Learning: Cognitive, Effective & Psychomotor - Approaches to Learning: Behaviorism; Constructivism. - Theories of Learning: Multiple Intelligence; Information processing theory.	10	2,3,4,5	CO2 CO4	PSO3

3	- Impact of technology on education and society (Technology and Social Change; Technological Determinism; Technology and Inequality; Technology & Human Well-being; Technology and Environmental Change,..)	6	2,3,4,5	CO5	PSO3
4	– Ethical and value implications of education and technology on individual and society; – Professional ethics, Plagiarism. – Professional ethics (Durkheim), Positive & Negative Thinking, Assertiveness, Assertive rights	6	2,3,4	CO6	PSO3

Suggested Reading	
1.	Bucchi, Massimiano (2004) Science in society: An introduction to social studies of science. London & NY: Routledge Taylor & Francis group.
2.	Durkheim, Emile (1957/2003) Professional ethics and civic morals. (Tr.) Cornelia Brookfield (Prefaced by) Bryan S. Turner. London & NY: Routledge (2nd Edition)
3.	Matthew H. Olson, Julio J. Ramirez (2020), An Introduction to Theories of Learning, London & NY: Routledge Taylor & Francis group, (10th Edition)
4.	Rethinking education: Towards a global common good? by UNESCO publishing.
5.	Richard Paul Janaro & Thelma C. Altshuler (2011). The Art of Being Human: Humanities as a Technique for Living Person. Pearson Publication.
6	Rohan Dsouza. Environment, Technology and Development. Orient Blackswan, 2012.
7	Russel, Bertrand (1932/2010) Education and social order. London & NY: Routledge Classics
8	R.V.G. Menon. Technology and Society. Pearson, 2011

<table>
<tr><td colspan="3">School: School of Science</td><td colspan="3">Program: B.Sc. Microbiology</td></tr>
<tr><td colspan="3">Course Code: LS138</td><td colspan="3">Course Name: Life Science Laboratory III</td></tr>
<tr><td>Year</td><td>II</td><td>Core Subject (Yes/No):</td><td>Yes</td><td>Lecture:</td><td></td></tr>
<tr><td>Semester</td><td>III</td><td>Elective Subject (Yes/No):</td><td>-</td><td>Tutorial</td><td></td></tr>
<tr><td rowspan="3">Mode of Transaction</td><td rowspan="3">Laboratory</td><td>Foundation Subject (Yes/No):</td><td>-</td><td>Practical:</td><td>6</td></tr>
<tr><td>Year of Syllabus Revision:</td><td></td><td>Total Credit:</td><td>3</td></tr>
<tr><td>Year of Introduction</td><td>2020</td><td>Prerequisites (If any)</td><td></td></tr>
<tr><td colspan="6">Course Description:
The course is designed to introduce laboratory fundamentals of human anatomy and physiology. Clinical physiology concepts and experiments such as blood and urine analysis are included in detail. The course also includes basic qualitative estimations of carbohydrates, proteins and lipids and their significance in context to human physiology.</td></tr>
</table>

Course Outcome (CO):
CO1: Gain understanding of anatomy and physiology of humans
CO2: Understand concepts and mechanisms associated with various physiological systems
CO3: Understand the relationship between anatomical structure, functions and their clinical observations.

No.	Experiment	Contact Hours	BT Level	CO	PSO
1	Understand and solve basic problems of normality, molarities, % solution preparation	12	1,2,3,5	CO1	PSO2, PSO3
2	Qualitative analysis of Carbohydrates: a) Test for carbohydrates: Molisch's test b) Test for reducing sugar: Fehling's Test, Barfoed's Test, Seliwanoff's Test, Bial's Test c) Action of Alkali on Sugars d) To perform Inversion of Sucrose e) Test for Polysaccharide: Iodine Test f) Test for aldose and ketose: Osazone Test	12	1,2,4,5	CO1	PSO2, PSO3
3	Qualitative analysis of Amino acids and Proteins: a) Test for amino acids and proteins : Solubility test, Ninhydrine test, Biuret test, Precipitation test b) Specific Reactions for Individual Amino Acids: Xanthoproteic test, Millon's Test, Sakaguchi Test, Nitroprusside Test, Hopkin's Cole Test, Folin test	12	1,2,3,5	CO1	PSO2, PSO3
4	Qualitative analysis of Lipids: a) Test for solubility of lipids in polar & non-polar solvents : Solubility test b) Translucent Spot Test c) Emulsification Test d) Free fatty acid test e) Sudan red IV test f) Saponification test- Soap preparation g) Test for Glycerol :Dichromate Test Test for Cholesterol : Salkowski test to detect the presence of unsaturated fatty acids	12	1, 2, 3	CO1	PSO2, PSO3

Reference Books

1.	The Science of Laboratory Diagnosis 2nd Edition by John Crocker (Editor), David Burnett (Editor)
2.	Advanced Practical Zoology by Dr. P.S.Verma, 2012

School: School of Science			**Program: B.Sc. Microbiology**		
Course Code: LS139			**Course Name: Life Science Laboratory IV**		
Year	**I**	**Core Subject (Yes/No):**	**Yes**	**Lecture:**	**-**
Semester	**II**	**Elective Subject (Yes/No):**	**-**	**Tutorial**	**-**
Typology of Course	**Practical**	**Foundation Subject (Yes/No):**	**-**	**Practical:**	**4**
		Year of Syllabus Revision:		**Total Credit:**	**2**
		Year of Introduction	**2021**	**Prerequisites (If any)**	**-**

Course Description:
This course introduces the study of cell, cell organelles and cell division. Students will gain the knowledge regarding how to differentiate blood cells by preparation blood smear and performing cell count techniques. They will learn the interaction of biotic and abiotic components practically. They will

gain the knowledge regarding plants and animal distribution throughout the world, India as well as in Gujarat.

Course Objectives:
Students will be able to correlate various abnormalities in the human body with the blood practical. Various physiochemical parameters will also help the students to learn about the abnormalities in the human system.

Course Outcome (CO):
CO1: Gain understanding the cell components and cytology
CO2: To analyze genetic disorders
CO3: To gain an understanding of animal and plant distribution internationally, nationally and regionally.
CO4: Understand the abnormalities in the blood cells due to various physiological effects

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	To study General laboratory instruments and compound microscope handling technique	6	1,2,3	CO1	PSO1
2	To prepare temporary mount slide of onion peel as a study model of plant cell	6	2,3,4	CO2, CO4	PSO1 PSO2
3	To prepare temporary mount slide of cheek cells (Human buccal cavity epithelial cells) as a study model of animal cell	6	2,3,4	CO2 CO4	PSO1 PSO2
4	To study mitotic stages of cell division through observing permanent slides under compound microscope	6	2,3,4,5	CO2 CO4	PSO1 PSO2
5	To prepare temporary mount slide for mitotic stages study in Onion root tip cells (in Meristematic tissue)	6	2,3,4	CO2 CO4	PSO1 PSO2
6	To study meiotic stages of cell division through observing permanent slides under compound microscope	6	1,2,3	CO3 CO4	PSO1 PSO2
7	To study pipette handling, Pipette calibration and solution preparation	6	1,2,3	CO1	PSO1
8	To observe and study plasmolysis process in Tredescetia and onion leaves with using different solutions	6	1,2,3	CO1 CO4	PSO1 PSO2
9	To prepare blood smear on slide of own blood	6	1,2,3	CO1 CO4	PSO1 PSO2
10	To observe and study white blood cells by performing differential staining through leishman's stain in blood cells smear of own blood	6	1,2,3	CO1 CO2 CO4	PSO1 PSO2

Reference Books	
1.	Cell biology Practical Manual by by Dr. Renu Gupta (Author), Dr. Seema Makhija (Author), Dr. Ravi Toteja (Author) – 2018
2.	Basic Histopathology. A Colour Atlas and Text. Paul Wheater, George Burkitt, Alan Stevens and James Lowe. ELBS with Churchill Livingstone 4th edition, 2002
3.	Ecology Lab Manual , Book by Darrell S. Vodopich , 2009

School: School of Science			**Program: B.Sc. Microbiology**		
Course Code: CH108			**Course Name: Chemistry Laboratory-IV**		
Year	**I**	**Core Subject (Yes/No):**	Yes	**Lecture:**	**0**
Semester	**II**	**Elective Subject (Yes/No):**	No	**Tutorial**	**0**
Mode of Transaction	**Laboratory**	**Foundation Subject (Yes/No):**	No	**Practical:**	**4**
		Year of Syllabus Revision:	**2018**	**Total Credit:**	**2**
		Year of Introduction	**2014**	**Prerequisites (If any)**	

Course Description:

An essential element of experimental organic chemistry is the identification of unknown organic compounds from the given mixture. This course covers the following topics: separation and purification of organic molecules; synthesis using diverse techniques; and functional group identification using organic methods.

Course Outcome (CO):

CO1: Students will explore the concept of Inorganic qualitative analysis for the identification of cations and anions.

CO2: Students will explore the experiments with qualitative analysis of inorganic salt by following the test in a sequential manner and will gain knowledge to identify acid and basic radicals from the mixture.

No.	Experiment	Contact Hours	BT Level	CO	PSO
	Inorganic Spotting (Salt Analysis)				
1	NH4Cl	2	1, 2, 3, 4, 5	CO1, CO2	PSO1, PSO2, PSO3
2	CuSO4	2	1, 2, 3, 4, 5	CO1, CO2	PSO1, PSO2, PSO3
3	KCl	2	1, 2, 3, 4, 5	CO1, CO2	PSO1, PSO2, PSO3
4	CdCl2	2	1, 2, 3, 4, 5	CO1, CO2	PSO1, PSO2, PSO3
5	MnCl2	2	1, 2, 3, 4, 5	CO1, CO2	PSO1, PSO2, PSO3
6	MgCO3	2	1, 2, 3, 4, 5	CO1, CO2	PSO1, PSO2, PSO3
7	NaBr	2	1, 2, 3, 4, 5	CO1, CO2	PSO1, PSO2, PSO3
8	Pb (NO3)2	2	1, 2, 3, 4, 5	CO1, CO2	PSO1, PSO2, PSO3
9	Na3PO4	2	1, 2, 3, 4, 5	CO1, CO2	PSO1, PSO2, PSO3
10	CaCl2	2	1, 2, 3, 4, 5	CO1, CO2	PSO1, PSO2, PSO3
11	Sr (NO3)2	2	1, 2, 3, 4, 5	CO1, CO2	PSO1, PSO2, PSO3

12	BaCl2	2	1, 2, 3, 4, 5	CO1, CO2	PSO1, PSO2, PSO3
13	FeSO4	2	1, 2, 3, 4, 5	CO1, CO2	PSO1, PSO2, PSO3

Reference Books	
1.	G. Svehla, Vogel’s Qualitative Inorganic Analysis, 6th Ed., Orient Longman, 1989
2.	R. C. Shah, Inorganic Analysis Part I Qualitative Analysis, Baroda Book Depot, Vadodara, 2001.

SEMESTER 3

School: School of Science			**Program: B.Sc. Microbiology**		
Course Code: LS273			**Course Name: Ethno and Economic Biology**		
Year	**II**	**Core Subject (Yes/No):**	**Yes**	**Lecture:**	**3**
Semester	**III**	**Elective Subject (Yes/No):**	**No**	**Tutorial**	**0**
Typology of Course	**Lectures**	**Foundation Subject (Yes/No):**	**No**	**Practical:**	**0**
		Year of Syllabus Revision:		**Total Credit:**	**3**
		Year of Introduction	**2021**	**Prerequisites (If any)**	**No**

Course Description:
Ethnobiology is the study of the interaction between plants, animals and people. It deals with the scientific study of the way living things are treated or used by different human cultures and the dynamic relationships between people, biota, and environments. Ethology explains the science of animal behavior under natural conditions and viewing behavior as an evolutionarily adaptive trait. Economic biology deals with the application of botanical and zoological knowledge for the benefit of mankind

Course Objectives:
The course will enable to comprehend the animal behavior as well as understand the importance of Ethno Biology and Economic Biology

Course Outcome (CO):
CO1: Explore the way living things are treated or used by different human cultures
CO2: Understand the ethology /system and social organization of animal
CO3: Explore into the world of economic benefits procured from animals like poultry bird, honeybees, cattle –Dairy industry etc.
CO4: Describe how the use of plants as medicines contribute to human well-being and survival

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	Ethnobotany: Folk medicines of ethnobotany, ethnic communities. Application of natural products to certain diseases- Jaundice, cardiac, infertility, diabetics, Blood pressure and skin diseases.	20	1,2,3,6	CO1 CO4	PSO1 PSO2

	Medico-ethnobotanical sources in India; Significance of the following plants in ethno botanical practices (along with their habitat and morphology) a) Azadiractha indica b) Ocimum sanctum c) Vitex negundo. d) Gloriosa superba e) Tribulus terrestris f) Pongamia pinnata g) Cassia auriculata h) Indigofera tinctoria i) Tinospora cordifolia. Ethnobotany as a tool to protect interests of ethnic groups. Sharing of wealth concept with few examples from India. Biopiracy, Intellectual Property Rights and Traditional Knowledge				
2	Ethology: History and overview of ethology, Behavioral Patterns, Hormones and behavior, biological rhythms, Orientation behavior, social organization of Lion, Deer, Monkey and Honeybees.	10	1,2,3	CO2 CO3	PSO1 PSO2
3	Economic Zoology: Basic concepts in dairy science: Semen collection & preservation; artificial insemination; multiple ovulation and embryo transfer, Poultry science: Maintenance and management Economic Entomology: Apiculture, Lac culture & Sericulture, Study of aquaculture profile of freshwater carps and fish farm layout. Economic Botany: Origin of cultivated plants, Vavilov's centers of origin. Botanical name, family, part used, morphology and uses of the following: Cereals: Wheat; Legumes: Gram, soybean; Spices: Clove, black pepper; Beverages: Tea; Oils and Fats: Groundnut; Fibre yielding plants: Cotton.	15	1,2, 3, 4	CO1 CO3	PSO1 PSO2 PSO3

Reference Books

1.	Daniel, M. (2009) Taxonomy: Evolution at Work, Narosa Publishers, New Delhi
2.	Heywood, V.H. & Moore D.M. (1984). Current concepts in Plant Taxonomy
3.	Kochhar, S.L. (2011). Economic Botany in the Tropics, MacMillan Publishers India Ltd., New Delhi. 4th edition.
4.	Trivedi P C, 2006. Medicinal Plants: Ethnobotanical Approach, Agrobios, India.
5.	Animal Behavior, by Michael D. Breed (Author), Janice Moore, Academic Press
6.	Economic Zoology, Jaiswal V, Phi Learning Pvt.
7.	Animal Behaviour (Ethology), V.K. Agarwal, S Chand.
8.	Systematics and Economic Zoology.
9.	Mechanism of Animal Behaviour, Peter Marler and J. Hamilton; John Wiley & Sons, USA

School: School of Science			**Program: B.Sc. Microbiology**		
Course Code: LS276			**Course Name: Microbiology I**		
Year	**II**	**Core Subject (Yes/No):**	**Yes**	**Lecture:**	**3**
Semester	**III**	**Elective Subject (Yes/No):**	**-**	**Tutorial**	**-**

Typology of Course	**Lectures**	**Foundation Subject (Yes/No):**	-	**Practical:**	-
		Year of Syllabus Revision:		**Total Credit:**	3
		Year of Introduction	2021	**Prerequisites (If any)**	-

Course Description:
The course deals with the basics of microbiology- history, introduction to various microbes such as bacteria, fungi and viruses, their classification, morphology, and anatomy. It also includes the concept of sterilization and staining techniques commonly used in microbiology.

Course Objectives:
To get an introduction to the various types of microorganisms- bacteria, viruses and their classification. The course also gives an understanding of the various diseases caused by microorganisms. Sterilization and disinfection are also the main objective of the course.

Course Outcome (CO):
CO1: History and basics of microbiology
CO2: General characteristics of microbes- bacteria, fungi and viruses and their classification
CO3: Classification of microbes
CO4: Common microbial diseases and their etiology
CO5: Concept and types of sterilization and sterile techniques

Unit No.	**Topic/Unit**	**Contact Hours**	**BT Level**	**CO**	**PSO**
1	**Unit I** Overview of history of Microbiology and Virology: Biogenesis and abiogenesis Contributions of Redi, Spallanzani, Needham, Pasteur, Tyndal, Joseph Lister, Koch [Germ Theory], Edward Jenner and Flemming [Penicillin], Scope of Microbiology. General characteristics of viruses, differences between bacteria and viruses. Classification of viruses Physical and chemical Structures of different Viruses on the basis of capsid symmetry - enveloped (Herpes virus), helical (TMV) and icosahedral (Polyoma viruses), Capsids, complex (Bacteriophage, and Virion size, enveloped (Herpes), helical (TMV) and icosahedral (Polyoma), Capsids.	15	1,2,3	CO1, CO2,	PSO1
2	**Unit II** Classification of Microbes: Systems of classification, Numerical taxonomy, Identifying characters for classification, General properties and principles of classification of microorganisms Systematics of bacteria, Nutritional types [Definition and examples]. Classification on the basis of oxygen requirement.) Microbes in Extreme Environment – Nature, special features of the thermophilic, methanogenic and halophilic Archaea; photosynthetic bacteria, Cyanobacteria some Archaea who live in extreme conditions like cold, and space.	15	1,2,3	CO3, CO4	PSO1

	List of common bacterial, fungal and viral diseases of human beings [Name of the disease, causative pathogen, parts affected]				
3	**Unit III** Concept of Sterilization and staining techniques- Definition of sterilization, dry and moist heat, pasteurization, tyndallization; radiation, ultrasonication, filtration. Physical and Chemical methods of sterilization; disinfection sanitization, antisepsis sterilant and fumigation. Determination of phenol coefficient of disinfectant. Definition of auxochrome, chromophores, dyes, Classification of stains, Theories of staining, Mechanism of gram staining, acid fast staining, negative staining, capsule staining, flagella staining, endospore staining.	15	1,2,3	CO5	PSO1

Reference Books	
1.	Prescott, L.M J.P. Harley and C.A. Klein 1995. Microbiology 2nd edition Wm, C. Brown publishers.
2.	Michael J. Pelczar, Jr. E.C.S. Chan, Moel: Microbiology Mc Graw Hill Book R. Krieg, 1986 company
3.	Stainer R.Y. Ingraham J.L. Wheolis H.H and Painter P.R. 1986 The Microbial world, 5th edition. Eagle Works Cliffs N.J. Prentica Hall

School: School of Science			**Program: B.Sc. Microbiology**		
Course Code: LS275			**Course Name: Biochemistry -II**		
Year	**II**	**Core Subject (Yes/No):**	Yes	**Lecture:**	3
Semester	**III**	**Elective Subject (Yes/No) :**	-	**Tutorial**	0
Typology of Course	Lectures	**Foundation Subject (Yes/No):**	-	**Practical:**	0
		Year of Syllabus Revision:	-	**Total Credit:**	3
		Year of Introduction	2021	**Prerequisites (If any)**	LS179

Course Description:
The course introduces the fundamentals of biochemistry like the introduction and concept of biocatalysts, enzyme kinetics, isoenzymes and its applications. Additionally, it gives an idea on the energy generating mechanisms in different organisms, and an overview on the intermediary metabolism. It also includes an in-depth understanding on the biochemistry of photosynthesis and plant secondary metabolites.

Course Objectives:
The course objectives include, detail understanding on enzymes, enzyme kinetics and its application. Also, course objective includes intermediary metabolism and photosynthetic process understanding in detail.

Course Outcome (CO):
After completing this course, students will be able to:

CO1: Introduced to fundamentals of biochemistry
CO2: Able to understand the different types of biomolecules and their important physiological roles in a living system
CO3: Able to understand biochemistry of photosynthesis
CO4: Studying various secondary metabolites in plants and their functions

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	Unit I Basics of Bio-catalysts – The Enzyme: Introduction, concept. Classification, lock and key model, induced fit model, active site, enzyme specificity and types. Enzyme kinetics, factors affecting the velocity of enzyme action. Enzyme concentration, temperature, pH, substrate concentration. Enzyme inhibition, reversible and irreversible, competitive, non-competitive and uncompetitive inhibition, allosteric enzymes. Isoenzymes, Zymogen form of enzyme and its activation. Applications of various enzymes Energy generating mechanisms in organisms: Energy generation-based organism classification (e.g., Autotroph's heterotrophs), aerobic and an-aerobic energy generations (e.g., Fermentation), catabolism, anabolism, ATP as energy currency, reducing power of the cell.	15	1,2,3	CO1, CO2	PSO1
2	Unit II Intermediary metabolism: Overview of Glucose metabolism: Glycolysis, Gluconeogenesis and pentose phosphate pathway. Glycogenesis and glycogenolysis. Fatty acid oxidation. Citric acid cycle, reactions of citric acid cycle, anaplerotic reactions, amphibolic role, regulation of citric acid cycle, glyoxylate pathway, coordinated regulation of glyoxylate and citric acid pathways, biosynthesis and degradation of glycogen, sucrose, starch and cellulose. Overview of amino acids and nucleic acids: Biosynthesis of amino acids, Catabolism of amino acids. Precursor functions of amino acids Biosynthesis of purine and pyrimidine nucleotides. De novo synthesis of purines and pyrimidines. Degradation of purine and pyrimidine nucleotides. Integration of metabolism. Amino acid biosynthesis in plants; GS/GOGAT cycle; transamination; peptide bond and polypeptide chain; protein targeting; protein degradation.	15	1,2,3	CO2	PSO1
3	Unit III Photosynthesis: Photosynthesis: Process, significance, structure and composition of the photosynthetic apparatus, PS I & II composition & functions, pathways of carbon fixation C3, C4/CAM, Pseudo cyclic, photorespiration - significance, distribution of reactions in space and time including mechanism, factors affecting photosynthesis. Transport of organic substances: Transport of photosynthate; source-sink relationship; the	15	1,2,3	CO3, CO4	PSO1

	mechanism of translocation in phloem; assimilate partitioning. Special features of secondary plant metabolism, terpenes (classification, biosynthesis), lignin, tannins, pigments, phytochrome, waxes, alkaloids, biosynthesis of nicotine, functions of alkaloids, cell wall components. Toxins of plant origin – mycotoxins, phytohemagglutinin, lathyrogens, nitriles, protease inhibitors, protein toxins.				

Reference Books	
1.	Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York).
2.	Textbook of Biochemistry with Clinical Correlations (2011) 7th ed., Devlin, T.M., John Wiley & Sons, Inc. (New Jersey).
3.	Biochemistry (2012) 7th ed., Berg, J.M., Tymoczko, J.L. and Stryer L., W.H. Freeman and Company (New York).
4.	Fundamentals of Enzymology (1999) 3rd ed., Nicholas C.P. and Lewis S., Oxford University Press Inc. (New York), ISBN:0 19 850229 X.
5.	Biochemistry And Molecular Biology of Plants by Buchanan, w and Jones.
6.	Plant Biochemistry: An Introduction (Pb) Paperback – 2016, by Dharmapalan B
7.	P.S. Verma & P.K. Agarwal, Plant Physiology, 1977.

School: School of Science			**Program: B.Sc. Microbiology**		
Course Code: MG117			**Course Name: Principles of Management and Accounting**		
Year	**II**	**Core Subject (Yes/No):**	**Yes**	**Lecture:**	**3**
Semester	**III**	**Elective Subject (Yes/No):**	**No**	**Tutorial**	
Typology of Course	**Lectures**	**Foundation Subject (Yes/No):**	**No**	**Practical:**	
		Year of Syllabus Revision:	**2021**	**Total Credit:**	**3**
		Year of Introduction	**2009**	**Prerequisites (If any)**	

Course Description:
The course outline has been designed to serve the purpose of understanding basics of management and accounting

Course Objectives:
The overall all objective of this course is to educate students about the management as an activity and have a holistic approach to the concept. Accountancy basics are the requirement of the generation.

Course Outcome (CO):
CO1: Become an efficient learner of management
CO2: Develop and understand methods of management.
CO3: Gain knowledge managing finance through Accounts

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	Unit 1- Management Basics, Management theories, Process of management, Managers qualities	11	1,2	CO1	PSO1
2	Unit 2- Evolution of Management, Functions - Planning Planning process, Decicion making, PRINCIPLES OF ORGANISATIONS, COORDINATION AND CONTROLLING, Directing	11	1,2,3	CO1, CO2	PSO1, PSO2
3	Unit 3- Accounting Basics, Rules of accounting, Principles Accounting process, Journal, Journal enteries, Ledger, Trial Balance	11	2, 3, 4	CO1,CO3	PSO1, PSO2
4	Unit 4- Financial Statements, Books of accounts, Profit and loss statement, Balance sheet, Analysis	12	1, 2, 3	CO3	PSO1, PSO2, PSO4
Reference Books					
1.	Principles of Management Book by Dan Voich and Daniel A. Wren				
2.	ICAI ONLINE PDF				

School: School of Science			**Program: B.Sc. Microbiology**		
Course Code: CH203			**Course Name: Molecules of Life**		
Year	**II**	**Core Subject (Yes/No):**	**Yes**	**Lecture:**	**3**
Semester	**III**	**Elective Subject (Yes/No):**	**No**	**Tutorial**	**0**
Typology of Course	Lectures	**Foundation Subject (Yes/No):**	**No**	**Practical:**	**0**
		Year of Syllabus Revision:	**2020**	**Total Credit:**	**3**
		Year of Introduction	**2014**	**Prerequisites (If any)**	**High School Chemistry**

Course Description:

This course deals with the chemistry of carbohydrates, amino acids, enzymes, nucleic acid. In the first unit classification of carbohydrates with example and applications along with linkage between different monosaccharides are included. Second unit deals with the detail study of amino acid and peptide linkages, mechanism of enzyme action, drug action-receptor theory, binding role of –OH group, -NH_2 group, double bond and aromatic ring. Third unit deals with Nucleic acids and lipids and their biological applications. Unit four describes the importance of bio-inorganic system and its application in day-to-day life.

Course Objectives:

- The course is intended to meet the needs of students wishing to gain appreciation of how the biochemistry of important molecules emerge from its structure.
- The later part of the course ideals with the role of metal ion in biological systems

Course Outcome (CO):

CO1: Gain insight in to the role of some essential macromolecules their chemical properties and organization in to higher order functional structures like enzymes, CO2: Structure and Function of Biomolecules like Peptides, carbohydrates, Lipids and Nucleotides CO3: Fundamentals of metal ions in Biology CO4: The chemistry of metals ions in many critical biological processes like respiration, muscle contraction etc.

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	**Carbohydrates** Classification of carbohydrates, reducing and non-reducing sugars, General Properties of Glucose and Fructose, their open chain structure. Epimers, mutarotation and anomers. Cyclic structure of glucose. Haworth projections. Cyclic structure of fructose. Linkage between monosaccharides, structure of disaccharides (sucrose, maltose, lactose) and polysaccharides (only structures of starch and cellulose).	15	1,2,3,4,5	CO1 CO2	PSO1
2	**Nucleic Acids and Lipids** Nucleic acids: Components of Nucleic acids: Adenine, Guanine, Thymine, Cytosine and Uracil (Structures only), Nucleosides and nucleotides (nomenclature), Structure of polynucleotides; Structure of DNA (Watson-Crick model) and RNA(types of RNA). Lipids: Introduction to lipids, classification, Hydrogenation, Saponification, Iodine number. Biological importance of triglycerides, phospholipids, glycolipids and steroids (cholesterol).	15	1,2,3,4,5	CO2	PSO1
3	**Bioinorganic Chemistry** Metal ions present in biological systems. Classification of elements as essential, non-essential, trace and toxic. Bioinorganic chemistry of toxic metals-lead, cadmium, mercury and arsenic. Detoxification using chelating agent. Role of iron in human system with reference to Hemoglobin. Role of globin in Hemoglobin. Role of alkali and alkaline earth metals (sodium, potassium, calcium and magnesium) in biological system (Sodium – Potassium pump).	15	1,2, 3, 4	CO3 CO4	PSO1 PSO2 PSO4 PSO7 PSO8

Reference Books	
1.	Organic chemistry, 12 Edition, Solomons, T. W. Graham, author. | Fryhle, Craig B. | Snyder, S. A. (Scott A.), John -Wiley, 2016.
2.	U. Satyanarayana, Biochemistry, 2nd Edition, Books and Allied (P) Ltd., Kolkata, 2002.
3.	Biological Inorganic chemistry: A New Introduction to Molecular Structure and Function, Third Edition, Elsevier-Academic press, 2019

School: School of Science			**Program: B.Sc. Microbiology**		
Course Code: LS234			**Course Name: Life Science Laboratory V**		
Year	**II**	**Core Subject (Yes/No):**	**Yes**	**Lecture:**	

Semester	**III**	**Elective Subject (Yes/No):**	-	**Tutorial**	
Mode of Transaction	**Laboratory**	**Foundation Subject (Yes/No):**	-	**Practical:**	**6**
		Year of Syllabus Revision:		**Total Credit:**	**3**
		Year of Introduction	**2020**	**Prerequisites (If any)**	

Course Description:

Students will gain knowledge regarding action mechanism of enzyme during the laboratory hours through performing colorimetric assays. Students can compare different parameters on enzyme activity. Furthermore, they will observe the different beahviours of organisms like paramecium when exposed to varying stimuli.

Course Outcome (CO):

At the end of the course, students will:

CO1: Understand action mechanism of different enzymes via colorimetric assay

CO2: Understand activity of enzymes and factors affecting on enzyme activity

CO3: Gain knowledge on the various behaviours of organisms when exposed to different stimuli

CO4: Understand the basics of economic biology

No.	**Experiment**	**Contact Hours**	**BT Level**	**CO**	**PSO**
1	To prepare solutions and buffers.		1,2,3,5	CO1	PSO2, PSO3
2	Enzymology: • To determine the effect of different temperatures on the activity of salivary content, amylase on starch • To determine the effect of different pH on the activity of salivary content, amylase on starch • To estimate the amount of carbohydrate present in the given sample by using Anthrone method • To plot standard curve of maltose 6. To analyze the effect of substrate concentration on the activity of enzyme • To analyze the effect of Enzyme concentration on the activity of enzyme • To analyze the effect of substrate concentration on catalase enzyme activity • To perform and study various protein precipitation methods in laboratory (Acid precipitation, salting precipitation, alcohol precipitation)	CO1, CO2	1,2,4,5	CO1	PSO2, PSO3
3	Ethology • Effect of darkness on fish color • Respiratory behavior in fish • Territorial behavior in fish • Stickleback fish behavior	CO3	1,2,3,5	CO1	PSO2, PSO3
4	Economic Biology • Basics of Apiculture, Sericulture, Lac culture and Pisciculture • Determination of adulteration in spices. Zoogeography realms and its fauna • Biogeography zones of India and its fauna	CO4	1, 2, 3	CO1	PSO2, PSO3

Reference Books	
1.	Cell Biology: A Laboratory Handbook, Volumes 1, 2, 3; Edited by Julio E. Celis, Academic Press; San Diego, New York, Boston, London, Sydney, Tokyo, Toronto, 1994; 1714 pp. ISBN 0-12-164714-5
2.	Fundamentals of Enzymology (1999) 3rd ed., Nicholas C.P. and Lewis S., Oxford University Press Inc. (New York), ISBN:0 19 850229 X.
3	Ethology practical by Vilmos Altbäcker, Márta Gácsi, András Kosztolányi, Ákos Pogány, Gabriella Lakatos, and Péter Pongrácz. Eötvös Loránd University, 2013. 4. Ecology Lab Manual, Book by Darrell S. Vodopich, 2009.

School: School of Science			**Program: B.Sc. Microbiology**		
Course Code: LS277			**Course Name: Microbiology Laboratory I**		
Year	**II**	**Core Subject (Yes/No):**	**Yes**	**Lecture:**	
Semester	**III**	**Elective Subject (Yes/No):**	**-**	**Tutorial**	
Mode of Transaction	**Labortory**	**Foundation Subject (Yes/No):**	**-**	**Practical:**	**4**
		Year of Syllabus Revision:		**Total Credit:**	**2**
		Year of Introduction	**2020**	**Prerequisites (if any)**	**-**

Course Description:
This course will cover basic microbiology techniques and their applications. It also deals with handling of microbial cultures and maintenance of aseptic conditions.

Course Outcome (CO):
CO1: Gain expertise in maintenance of microbial culture using proper sterile techniques and optimum conditions of growth
CO2: To identify and comprehend experimental knowhow of various techniques involved in handling of microbial culture

No.	**Experiment**	**Contact Hours**	**BT Level**	**CO**	**PSO**
1	To study basic microbiology tools	2	1,2,3,5	CO1	PSO2, PSO3
2	To study the methods of sterilization	2	1,2,4,5	CO1, CO2	PSO2, PSO3
3	Demonstration of pH measurement of culture media.	2	1,2,3,5	CO1, CO2	PSO2, PSO3
4	To prepare the culture media-Solid, Broth, Agar slants	2	1, 2, 3	CO1, CO2	PSO2, PSO3
5	To check the quality of culture media	2	1,2,3,5	CO1, CO2	PSO2, PSO3
6	To prepare petri dishes	2	1,2,3,5	CO1, CO2	PSO2, PSO3
7	To obtain pure culture of bacteria using streak plate method	2	1,2,3,5	CO1, CO2	PSO2, PSO3

8	To obtain pure culture of bacteria using pour plate method	2	1,2,3,5	CO1, CO2	PSO2, PSO3
9	To obtain pure culture of bacteria using spread plate method	2	1,2,3,5	CO1, CO2	PSO2, PSO3
10	Demonstration of Viable plate count method by serial dilution.	2	2,3	CO1, CO2	PSO2, PSO3
Reference Books					
1.	Practical Microbiology by Dr. R.C. Dubey and Dr. D.K. Maheshwari, S Chand publication.				
2.	Basic Practical Microbiology manual compiled by John Grainger, Chairman of MISAC Janet Hurst, Deputy Executive Secretary of SGM Dariel Burdass, SGM Educational Projects Administrator				

School: School of Science			**Program: B.Sc. Microbiology**		
Course Code: CH 205			**Course Name: Chemistry Laboratory-VI**		
Year	**II**	**Core Subject (Yes/No):**	Yes	**Lecture:**	**0**
Semester	**III**	**Elective Subject (Yes/No):**	No	**Tutorial**	**0**
Mode of Transaction	**Laboratory**	**Foundation Subject (Yes/No):**	No	**Practical:**	**4**
		Year of Syllabus Revision:		**Total Credit:**	**2**
		Year of Introduction	**2014**	**Prerequisites (If any)**	**-**

Course Description:

It includes determination of organic compounds having different nature such as acid, base and neutral organic compound and includes analysis of water samples as well as quantitative analysis of using redox, complexometric and precipitation titration

Course Outcome (CO):

CO1: Detail idea about different functional group and identification method of different functional group as well as other identifications methods
CO2: Gain knowledge of organic qualitative analysis
CO3: Identify given unknown organic compound

No.	Experiment	Contact Hours	BT Level	CO	PSO
1	Organic spotting (Benzoic acid)	2	1,2,3,4,5	CO1, CO2, CO3	PSO2
2	Organic spotting (Urea)	2	1,2,3,4,5	CO1, CO2, CO3	PSO2
3	Organic spotting (Beta – naphthol)	2	1,2,3,4,5	CO1, CO2, CO3	PSO2
4	Organic spotting(Napthalene)	2	1,2,3,4,5	CO1, CO2, CO3	PSO2
5	Organic spotting (Salicylic Acid)	2	1,2,3,4,5	CO1, CO2, CO3	PSO2
6	Organic spotting (Thiourea)	2	1,2,3,4,5	CO1, CO2, CO3	PSO2
7	Organic spotting (Bromo Benzene)	2	1,2,3,4,5	CO1, CO2, CO3	PSO2
8	Organic spotting (Para nitro aniline)	2	1,2,3,4,5	CO1, CO2, CO3	PSO2
9	Organic spotting (Aniline)	2	1,2,3,4,5	CO1, CO2, CO3	PSO2
10	Organic spotting (m- nitro Aniline)	2	1,2,3,4,5	CO1, CO2, CO3	PSO2

11	Organic spotting (p- nitro Aniline)	2	1,2,3,4,5	CO1, CO2, CO3	PSO2
12	Organic spotting (Sulfanilic acid)	2	1,2,3,4,5	CO1, CO2, CO3	PSO2
13	Organic spotting (Acetalide)	2	1,2,3,4,5	CO1, CO2, CO3	PSO2
14	Organic spotting (Ethyl Acetate)	2	1,2,3,4,5	CO1, CO2, CO3	PSO2
15	Organic spotting (Benzaldehyde)	2	1,2,3,4,5	CO1, CO2, CO3	PSO2

Reference Books	
1.	J. Mendham, R. C. Denney, J. B. Barnes & M. J. K. Thomas, Vogel’s Textbook of Quantitative Chemical Analysis, 6th Ed., Pearson Education, New Delhi, 2003.
2.	R. C. Shah, Organic Qualitative Analysis, 5 th Ed., Baroda Book Depot, Vadodara, 1996

SEMESTER 4

School: School of Science			**Program: B.Sc. Microbiology**		
Course Code: BO211			**Course Name: Microbiology-II**		
Year	**II**	**Core Subject (Yes/No):**	Yes	**Lecture:**	**3**
Semester	**IV**	**Elective Subject (Yes/No):**	-	**Tutorial**	**-**
Typology of Course	**Lectures**	**Foundation Subject (Yes/No):**	-	**Practical:**	**-**
		Year of Syllabus Revision:	-	**Total Credit:**	**3**
		Year of Introduction	**2019**	**Prerequisites (If any)**	**Basics of Microbiology**

Course Description:
Course deals with various aspects of microbial life, their pattern of growth and reproduction. Nutritional requirements are critical for the growth of microbes. Control of microorganisms by different methods is depicted. Various antimicrobials like antibacterials, antivirals and antifungals used in clinical practical are discussed along with their modes of action. The course introduces environmental microbiology which includes soil, air and water microbiology and its management.

Course Objectives:

- Gain understanding of basics of microbial growth and reproduction.
- Understand modes of action of antimicrobials, antibiotics, antifungals and antivirals.
- Learn about environmental microbiology, wastewater management, air and soil microbiology

Course Outcome (CO):
CO1: Gain the knowledge of the microbial growth patterns, doubling time etc. in normal and stress conditions.
CO2: To understand various cultivation methods of microbes.
CO3: Understand the types and mechanisms of antimicrobial and antiviral agents.
CO4: Understand the distribution, types of soil and peculiar features of soil microbes.
CO5: Understand the distribution, types of soil and peculiar features of water microbes.

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	**Microbial Growth and Reproduction** Cultivation of microbes- Bacteria fungi, virus. Culture technique - media preparation. Types ofmedia. Isolation of pure culture - preservation of cultures. Cultivation of bacteria- Types of growth media (natural, synthetic, complex, enriched, selective definition with example), pure culture methods (streak plate, spread plate, pour plate, stabculture, slant culture). Anaerobic (thioglycolate, anaerobic chamber, Robertson's media,microaerophilic), liquid shake culture of aerobic bacteria. Microbial growth- Growth curve measurement of microbial growth- Measurement of cell number, measurement of cell mass. Factors affecting growth.	15	1,2,3,4	CO1, CO2,	PSO1

2	**Antimicrobial agents** Control of microbial growth by Antiseptics. Antimicrobial drugs and Antibiotics – Antimicrobial resistance. Antifungal, Antivirals, Antimicrobials used in clinical practical Antibacterial agents: Five modes of action with one example each: Inhibitor of nucleic acidsynthesis; Inhibitor of cell wall synthesis; Inhibitor of cell membrane function; Inhibitor of proteinsynthesis; Inhibitor of metabolism. Antifungal agents: Mechanism of action of Amphotericin B, Griseofulvin. Antiviral agents: Mechanism of action of Amantadine, Acyclovir, Azidothymidine	15	1,2,3,4	CO3	PSO1
3	**Environmental Microbiology** Soil microbiology: Types of soil- Microflora of soil. Biogeochemical cycles – carbon, nitrogen, phosphorus, Sulphur and iron. Organic matter decomposition - Composting & Vermicomposting. Biopesticide (Bacterial, Viral & Fungal). Air microbiology- Sources of microorganisms in air – Assessment of air quality. Water microbiology- Microbial assessment of water quality – Water purification. Waste treatment –Solid and liquid waste treatment. General outline of water treatment process: septic tank,sedimentation, Activated sludge and trickling filter process. Microbial interaction between microorganisms, plants and animals – Rhizosphere, phyllosphere. Rumen microbiology.	15	1,2,3,4	CO4, CO5	PSO1

Reference Books	
1.	Microbiology by Lansing M. Prescott and John P. Harley and Donald Klein; Ed. 6th; McGraw-Hill Science, 2004.
2.	Color ATLAS and textbook of diagnostic microbiology by Elmer W Koneman and Stephen D Allen and William M Janda and Paul C Schreckenberger and Washington C Winn; Ed. 6th; Lippincott Williams & Wilkins, 2005.
3.	Medical microbiology: a guide to microbial infections: pathogenesis, immunity, laboratory diagnosis and control by David Greenwood and Richard C. B. Slack and John F. Peuthere, ed. 17thEd. Churchill Livingstone; 2007.
4.	Environmental Microbiology (3rd ed.) by Pepper Charles Gerba and Terry Gentry, Academic Press, 2014.
5.	Environmental Microbiology (2nd ed.) by Ralph Mitchell and Ji-Dong Gu, Wiley-Blackwell, 2009 6. 2008
6.	Textbook of Environmental Microbiology by Pradipta K. Mohapatra, Paperback,

<table>
<tr><td colspan="3">School: School of Science</td><td colspan="3">Program: BSC –Life Science</td></tr>
<tr><td colspan="3">Course Code: PAT201</td><td colspan="3">Course Name:
Parasitology, Histopathology and Plant Pathology</td></tr>
<tr><td>Year</td><td>II</td><td>Core Subject(Yes/No):</td><td>Yes</td><td>Lecture:</td><td>3</td></tr>
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Semester	**IV**	**Elective Subject(Yes/No):**	-	**Tutorial**	-
Typology of Course	**Lectures**	**Foundation Subject(Yes/No):**	-	**Practical:**	-
		Year of Syllabus Revision:	-	**Total Credit:**	**3**
		Year of Introduction	**2021**	**Prerequisites (If any)**	-

Course Description:

This course examines diseases in relation to the healthy body and the pathophysiological processes that occur when disease is present. It also includes the defensive, compensating and adaptive responses to the presence of disease by various body systems. The uses of techniques like microscopy and histology are also included in the course in order to understand its uses in detection of diseases.

Course Objectives:

- To study the pathophysiological processes of various disease.
- To understand the defensive, compensating and adaptive responses to the presence of disease
- To study the uses of techniques like microscopy and histology for diagnosis of diseases.

Course Outcome (CO):

CO1 Gain understanding of host-parasite interactions

CO2 Understand the pathophysiology of the protozoan parasites.

CO3 Understand the mechanism of several diseases and current remedial or preventive measures.

CO4 Understand usage of histochemistry and microscopy in detection and study of pathological conditions.

CO5 To study the plant pathogenesis and its molecular mechanistic approach.

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	Introduction to parasitic protozoans, Classification of protozoa and definition of key concepts –Entamoeba Histolytica and other Amoebae inhabiting the alimentary canal, Giardia Lamblia, Trichomonas vaginalis and other important flagellates, Plasmodium falciparum other Plasmodia species, Toxoplasma gondii and Trypanosoma species, Schistosomiasis, Leishmaniasis, Emerging protozoan diseases, Diagnostic Methods applied in parasitology.	15	1,2,3,4	CO1, CO2,	PSO1
2	Histochemistry, histological techniques – theory and practice, Function and components of the compound light microscope, Ultrastructure of different tissues, Routine stains, and staining processes in pathology, Fixation of tissues, Embedding, and cutting, Frozen and cryostat sectioning of fresh tissues; Immunohistochemistry.	15	1,2,3,4	CO3, CO4	PSO1
3	General Account of Plant Pathogens: Historical developments, general account of diseases caused by plant pathogens. Pathogen attack and defense mechanisms: Plant-microbe interactions, Physical, physiological, biochemical and molecular aspects. Plant disease epidemiology: Transmission and spread of plant	15	1,2,3,4	CO5	PSO1

	pathogens; disease cycles Major Plant Diseases: Differentiation between bacterial, viral and fungal diseases using morphological symptoms.				

Reference Books	
1.	Microbiology by Prescott; 9th edition
2.	Parasitology, Protozoology & Helminthology by K.D Chatterjee
3.	Textbook of Microbiology by Ananthanarayan and Paniker; 7th edition
4.	Medical Microbiology by Jawetz, Melnick, & Adelberg; 27th Edition
5.	Human Histology by Stevens and Lowe's; 4th edition
6.	Veterinary Histology by Jennings and Premanand

School: School of Science			**Program: B.Sc. Microbiology**		
Course Code: LS150			**Course Name: Biophysics, Biostatistics & Biochemical techniques**		
Year	**II**	**Core Subject (Yes/No):**	**Yes**	**Lecture:**	**3**
Semester	**IV**	**Elective Subject (Yes/No):**	**No**	**Tutorial**	**-**
Typology of Course	**Lectures**	**Foundation Subject (Yes/No):**	**No**	**Practical:**	**-**
		Year of Syllabus Revision:		**Total Credit:**	**3**
		Year of Introduction	2021	**Prerequisites (If any)**	**NA**

Course Description:

The course basically introduces with the methods of analysis, both physical and chemical and to statistically analyse the data. Additionally, it also comprehends the principles and application of different instruments used in laboratories.

Course Objectives:

After completing this course student will be able to:

- be introduced to methods of analysis, both physical and chemical and to statistically analyse the data
- comprehend the principles and application of different instruments used in laboratories

Course Outcome (CO):

CO1: Explain models of biological systems and models dealing with statistical mechanics and transport phenomena

CO2: Solve qualitative and quantitative problems, using appropriate statistical mechanics and computing techniques

CO3: Recognize the importance of data collection and its role in determining scope of inference

CO4: Choose and apply appropriate statistical methods for analyzing variables

CO5: Recognize potential laboratory safety concerns and address them using appropriate techniques

CO6: Apply modern instrumentation theory and practice to biochemical problems

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO

1	Biophysics: Physics of biomembrane; Role of Thermodynamics in biophysics, Biomechanics. Membrane biophysics: Lipid polymorphism, lipid-protein interaction, lipid raft structure and function, membrane proteins, transport of nutrients across the membrane and regulation of transport through transport proteins. Principles of Microscopy - Structure, operations and applications of various advanced microscopes. General Principles and operation of various laboratory equipment - Spectrophotometer, pH meter, Magnetic stirrer, Shakers. Types of PCRs.	15	1, 2, 3, 4	CO1, CO2	PSO1
2	Biostatistics: What is statistics? Biostatistics – Definition, History and Scope. Sampling, Sampling methods, Population, data collection and presentation of data. Measures of Central tendency: Mean, Median, Mode. Measures of Dispersion: Standard deviation (SD), Standard error mean (SEM), Introduction to testing of hypothesis: Null hypothesis, t-test, chi-test, statistical inference, analysis of variance, correlation, regression techniques, and non-parametric statistical methods. Application of Biostatistics: In medicine, Biotechnology, Environmental biology, Genetics.	15	1, 2, 3, 4, 5	CO3, CO4	PSO1
3	Biochemical techniques: Basics of solution concentration (Molarity, Normality, Molality), saturated solutions. Concept of a buffer, Henderson-Hasselbach equation, Working principles and instrumentation of UV-visible and fluorescence spectroscopy. Working principles of Centrifugation techniques (Density gradient method, cell fractionation). Purification and characterization of a molecule or protein from a complex mixture (native or heterologously expressed) involving the chromatographic techniques: (Paper chromatography, thin layer chromatography, gas chromatography, Ion exchange chromatography, Gel filtration chromatography, Affinity chromatography, High Performance Liquid Chromatography (HPLC). Electrophoresis: SDS-Polyacrylamide gel electrophoresis (SDS-PAGE); Agarose gel electrophoresis.	15	1, 2, 3, 4, 5	CO5, CO6	PSO1

Reference Books	
1.	E.S. Lenhoff, Tools of Biology.
2.	G.W. Snedcor & W.G. Cochran, Statistical methods.
3.	M. Daniel, Basic Biophysics for Biologists, 1989.
4.	M.A. Pallniswamy, Basic statistics for biologist.
5.	P. N. Arora & P. K. Mohan, Biostatistics.
6.	Wilson & Walker, Principles and Techniques of Biochemistry and Molecular Biology, 1975.
7.	Zar, Biostatistical Analysis, 2006.

<table>
<tr><td colspan="3">School: School of Science</td><td colspan="3">Program: B.Sc. Microbiology</td></tr>
<tr><td colspan="3">Course Code: ES201</td><td colspan="3">Course Name: Environmental Studies</td></tr>
<tr><td>Year</td><td>II</td><td>Core Subject (Yes/No):</td><td>Yes</td><td>Lecture:</td><td>3</td></tr>
<tr><td>Semester</td><td>IV</td><td>Elective Subject (Yes/No):</td><td>No</td><td>Tutorial</td><td>-</td></tr>
<tr><td rowspan="3">Typology of Course</td><td rowspan="3">Lectures and Practical</td><td>Foundation Subject (Yes/No):</td><td>No</td><td>Practical:</td><td>1</td></tr>
<tr><td>Year of Syllabus Revision:</td><td></td><td>Total Credit:</td><td>4</td></tr>
<tr><td>Year of Introduction</td><td>2021</td><td>Prerequisites (If any)</td><td>NA</td></tr>
</table>

Course Description:
Through interdisciplinary academic courses and co-curricular activities, the students shall become passionate stewards of the environment, scholars in sustainability and environmental management, and experts in environmental studies. The students will gain an in-depth knowledge of the different components of Environment. They will be able to recognize the components of Environment and different components of Environment. Field studies are as essential as class work and form an irreplaceable synergistic tool in the entire learning process.

Course Objectives:

- Students will be sensitized towards Environment and its concepts.
- Students will develop an understanding of environment and its types.
- To help the students develop their abilities to engage in discussions.
- To develop the logical and analytical reasoning capabilities.

Course Outcome (CO):
CO1: Gaining in-depth knowledge on natural processes that sustain life and govern economy
CO2: Recognize the physical, chemical, and biological components of the earth's systems and show how they function
CO3: Developing critical thinking for shaping strategies (scientific, social, economic and legal) for environmental protection and conservation of biodiversity, social equity and sustainable development
CO4: Understand core concepts and methods from ecological and physical sciences and their application in environmental problem-solving
CO5: Adopting sustainability as a practice in life, society and industry
CO6: Acquiring values and attitudes towards understanding complex environmental economic-social challenges, and participating actively in solving current environmental problems and preventing the future ones
CO7: Predicting the consequences of human actions on the web of life, global economy and quality of human life

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	Multidisciplinary nature of environmental studies (Definition, scope and importance) Need for public awareness. Renewable and non-renewable resources: Natural resources and associated problems. a) Forest resources: Use and over-exploitation, deforestation. Timber extraction, mining, dams and their effects on forest and tribal people. b) Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems. c) Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources. d) Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity. e) Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. f) Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification. Role of an individual in conservation of natural resources. Equitable use of resoureces for sustainable lifestyles.	15	1, 2	CO1 CO2	PSO1
2	**Ecosystems** Concept of an ecosystem. Structure and function of an ecosystem. Producers, consumers and decomposers. Energy flow in the ecosystem. Ecological succession. Food chains, food webs and ecological pyramids. Introduction, types, characteristic features, structure and function of the following ecosystem: a. Forest ecosystem, b. Grassland ecosystem, c. Desert ecosystem, d. Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries).	10	1, 2	CO2 CO3	PSO1
3	**Biodiversity and its conservation** Introduction - Definition: genetic, species and ecosystem diversity. Biogeographical classification of India. Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values. Biodiversity at global, National and local levels. India as a mega-diversity nation. Hot-sports of biodiversity. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts. Endangered and endemic species of India. Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.	10	1, 2, 5	CO3	PSO1
4	**Environmental Pollution** Definition. Cause, effects and control measures of: a. Air pollution, b. Water pollution, c. Soil pollution, d. Marine pollution, e. Noise pollution, f. Thermal pollution, g. Nuclear hazards, Solid waste Management: Causes, effects and control measures of urban and industrial wastes. Role of an individual in prevention of pollution. Pollution case studies.	10	1, 2, 4	CO6 CO7	PSO1

	Disaster management: floods, earthquake, cyclone and landslides.				
5	**Field work (on working Saturdays)** • Visit to a local area to document environmental assets: river/forest/grassland/hill/mountain • Visit to a local polluted site-Urban/Rural/Industrial/Agricultural • Floristic studies (Study of common trees, herbs, climbers, shrubs, etc.) • Faunal studies (Study of common insects, birds, butterflies, etc.) • Study of simple ecosystems- pond, river, hill slopes, etc.	30	2, 3, 4, 6	CO3 CO4 CO5	PSO1

Reference Books	
1.	Agarwal, K.C. 2001 Environmental Biology, Nidi Publ. Ltd. Bikaner.
2.	Bharucha Erach, The Biodiversity of India, Mapin Publishing Pvt. Ltd., Ahmedabad – 380 013, India.
3.	Miller T.G. Jr. Environmental Science, Wadsworth Publishing Co.
4.	Odum, E.P. 1971. Fundamentals of Ecology. W.B. Saunders Co. USA.
5.	Heywood, V.H & Waston, R.T. 1995. Global Biodiversity Assessment. Cambridge Univ.
6.	Townsend C., Harper J, and Michael Begon, Essentials of Ecology, Blackwell Science.
7.	Wanger K.D., 1998 Environmental Management. W.B. Saunders Co. Philadelphia.

School: SOS			**Program: B.Sc. Microbiology**		
Course Code: CH 208			**Course Name: Physical Chemistry**		
Year	**II**	**Core Subject (Yes/No):**	**Yes**	**Lecture:**	**3**
Semester	**IV**	**Elective Subject (Yes/No):**		**Tutorial**	**0**
Typology of Course	**Lectures**	**Foundation Subject (Yes/No):**		**Practical:**	**0**
		Year of Syllabus Revision:		**Total Credit:**	**3**
		Year of Introduction	**2014**	**Prerequisites (If any)**	**High school chemistry**

Course Description:

This course describes the basics of physical chemistry and covers thermodynamics, electrochemistry, chemical kinetics, phase equilibrium and photochemistry. Unit I deal with all the three laws of thermodynamics including thermo-chemistry. In second unit, basics of chemical and ionic equilibrium is discussed. In addition, Le Chatelier's principle, pH scale, buffer solutions are dealt with. In electrochemistry, mainly the definition of different terminologies used followed by Kohlrausch law of independent migration are discussed. Basics of chemical kinetics and the detailed study of zero order and first order kinetics with problems are discussed in the unit. Course shall also describe different spectroscopic techniques, specifically, the UV-Visible and IR spectroscopy.

Course Objectives:

- To gain understanding of Thermodynamics and equilibrium with examples relevant to biological systems.
- Gain understanding of kinetic systems and reaction rate
- Develop preliminary understanding of different spectroscopic techniques.

Course Outcome (CO):

CO1: Appreciation of Chemical Thermodynamics and its application to relevant systems
CO2: Application of Thermodynamics to equilibrium systems and redox systems
CO3: Basic idea of Reaction rate
CO4: Spectroscopic techniques and its principle.

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	**Unit I- Thermodynamics** State of a system, state variables, intensive and extensive variables, concept of heat and work, thermodynamic equilibrium, First Law of thermodynamics. Calculation of work (w), heat (q), changes in internal energy (ΔU) and enthalpy (ΔH) for expansion or compression of an ideal gas under isothermal conditions for both reversible and irreversible processes. Calculations of w, q, ΔU and ΔH for processes involving changes in physical states. Thermochemistry, enthalpy of combustion, enthalpy of neutralization and Integral enthalpies of solution. Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data. Statements of Second Law of thermodynamics, concept of entropy, Gibbs energy and Helmholtz energy, criteria of spontaneity. Gibbs–Helmholtz equation. Statement of Third Law of thermodynamics. Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Qualitative treatment of Le Chatelier's principle. Relationships between Kp, Kc and Kx. Strong and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water, pH scale. Ionization of weak acids and bases, common ion effect, Salt hydrolysis and simple calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions, buffer capacity and buffer range. Solubility and solubility product of sparingly soluble salts – applications of solubility product principle.	15	1,2,3,4,5	CO1 CO2	PSO1
2	**Unit II-Electrochemistry**: Metallic and electrolytic conductance, conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. Kohlrausch law of independent migration B. Sc. Chemistry (Subsidiary) Academic year: 2019-2022 School of Science Navrachana University Vadodara Page 14 of 15 of ions. Applications of conductance measurements: determination of degree of ionization of weak electrolyte, Reversible and irreversible cells. Concept of EMF of a cell, measurement of EMF of a cell. Nernst equation and its importance. Types of electrodes, standard electrode potential, electrochemical series. Thermodynamics of a reversible cell. Calculation of equilibrium constant	10	1,2,3,4,5	CO2	PSO1
3	Unit III –Chemical Kinetics: The concept of reaction rates. Effect of temperature, pressure, catalyst and other factors on reaction	10	1,2,3,4,5	CO3	PSO1

	rates. Order and molecularity of a reaction. Derivation of integrated rate equations for zero and first order reactions. Half–life of a reaction. General methods for determination of order of a reaction. Concept of activation energy and its calculation from Arrhenius equation.				
4	Unit 1V-Photochemistry: Laws of photochemistry. Fluorescence and phosphorescence. Quantum efficiency and reasons for high and low quantum yields. Primary and secondary processes in photochemical reactions. Photochemical and thermal reactions. Spectroscopy: Spectroscopy and its importance in chemistry. Electromagnetic radiation and its interaction with matter. Types of spectroscopy. Beer-Lambert's Law, Limitations of Beer-Lambert Law. UV-Visible Spectroscopy. Theory, Instrumentation and applications. InfraRed Spectroscopy (vibrational spectroscopy): Theory, Instrumentation and applications.	10	1,2,3,4,5	CO4	PSO1

Reference Books	
1.	B. R. Puri& L. R. Sharma, Principles of physical chemistry, Shoban Lal Nagin Chand and Co. 33rd Ed., 1992.
2.	S. H. Maron& J. B. Lando, Fundamentals of physical chemistry, Macmillan limited, New York, 1966.
3.	Gilbert. W. Castellan, Physical chemistry, 3rd Ed., Narosa publishing house, 1985.
4.	K. K. Rohatgi Mukherjee, Fundamentals of photochemistry, Revised Ed., Wiley Eastern Ltd., 1996
5.	S. H. Maron& J. B. Lando, Fundamentals of Physical Chemistry, Macmillan limited, New York, 1966.

School: School of Science			**Program: B.Sc. Microbiology**		
Course Code: LS153			**Course Name: Life Science Laboratory VII**		
Year	**II**	**Core Subject (Yes/No):**	**Yes**	**Lecture:**	
Semester	**IV**	**Elective Subject (Yes/No):**	**-**	**Tutorial**	
Mode of Transaction	**Laboratory**	**Foundation Subject (Yes/No):**	**-**	**Practical:**	**6**
		Year of Syllabus Revision:		**Total Credit:**	**3**
		Year of Introduction	**2020**	**Prerequisites (If any)**	

Course Description:
Students will gain the knowledge regarding the working of various lab instruments like centrifuge, pH meter, autoclave etc. Also the students will be exposed to hand on working of various biochemical techniques like chromatography, gel electrophoresis and colorimetric assays. They will also be solving basic problems of bioinformatics along with understanding and application of various types of graphs used in data presentation.

Course Outcome (CO):
At the end of the course, students will:
CO1: The principles and application of different instruments used in laboratories
CO2: Gain hands on the biochemical techniques

CO3: Solve basic problems of biostatistics
CO4: Understand the basics of histological slide observations and preparations, uses of different stains

No.	Experiment	Contact Hours	BT Level	CO	PSO
1	**Biochemical techniques**: 1. To study the working principle of weighing balance, autoclave, light microscope, centrifuge, hot air oven, visible spectrophotometer, magnetic starrier and vortex. 2. Preparation of buffer 3. Paper chromatography and Thin layer chromatography 4. Agarose gel Electrophoresis	8	1,2,3,5	CO1, CO2	PSO2, PSO3
2	**Biostatistics**: 5. To solve the problems regarding mean, median, mode, standard deviation and standard error. 6. Sampling methods and its analysis 7. To study the types of graphs for data analysis	8	1,2,4,5	CO3	PSO2, PSO3
3	**Histology**: 8. Basics of Slide Preparation 9. Basics of different stains used in fixation: Hematoxylin And Eosin (HE Stain), Leishman Staining, Giemsa Staining, Nissl Stain, Wright's stain 10. Study of permanent slides of different types of Epithelial cells, Muscle tissue, Nerve cells 11. Study of permanent slides of different body organs 12. Fixation of tissues, Embedding and cutting, Frozen and cryostat sectioning of fresh tissues, Immunohistochemistry	8	1,2,3,5	CO4	PSO2, PSO3
4	**Parasitology**: 13. Study of different stages of infection of Liver flukes, Fasciola hepatica, Taenia solium 14. Diagnostic Methods applied in parasitology	8	1,2,3,5	CO4	PSO2, PSO3
5	**Plant Pathology**: 15. Isolation of plant pathogens from different resources 16. Economic important plant diseases	8	1,2,4,5	CO4	PSO2, PSO3

Reference Books

1.	Biochemistry, U.Satyanarayana, Books and Allied Publication.,2011
2.	Biochemical methods by Sadasivam and A.Manickam, New Age International Pvt.Publication.,2010
3	Textbook of Biochemistry with Clinical Correlations (2011) 7thed., Devlin, T.M., John Wiley & Sons, Inc. (New Jersey)
4	Biochemistry (2012) 7thed., Berg, J.M., Tymoczko, J.L. and Stryer L., W.H. Freeman and Company (New York)
5	Fundamentals of Enzymology (1999) 3rded., Nicholas C.P. and Lewis S., Oxford University Press Inc. (New York), ISBN:0 19 850229 X.

School: School of Science			**Program: B.Sc. Microbiology**		
Course Code: BO212			**Course Name: Microbiology Laboratory II**		
Year	**II**	**Core Subject (Yes/No):**	**Yes**	**Lecture:**	**-**
Semester	**IV**	**Elective Subject (Yes/No):**	**-**	**Tutorial**	**-**
Mode of Transaction	**Laboratory**	**Foundation Subject (Yes/No):**	**-**	**Practical:**	**4**
		Year of Syllabus Revision:	**-**	**Total Credit:**	**2**

		Year of Introduction	2020	Prerequisites (If any)	-

Course Description:
This course will cover basic microbiology techniques and their applications. It also deals with handling of microbial cultures and maintenance of aseptic conditions.

Course Outcome (CO):
CO1: Recognize the extent of metabolic diversity present in microbial world
CO2: Identify various physiological groups of bacteria with their special metabolic features.
CO3: Understand growth pattern of microbes in different growth conditions.
CO4: Study biochemical mechanisms to identify the microbes.
CO5: Understand antimicrobial activity of microbes.

No.	Experiment	Contact Hours	BT Level	CO	PSO
1	To determine the bacterial growth curve by turbidimetry method.	4	2, 3, 4, 5	CO1	PSO2
2	To determine the effect of pH on bacterial growth	4	2, 3, 4, 5	CO2, CO3	PSO2
3	To determine the effect of temperature on bacterial growth	4	2, 3, 4, 5	CO2, CO3	PSO2
4	To estimate the bacterial population, count by turbidimetry method.		2, 3, 4, 5	CO2, CO3	PSO2
5	Effect of osmotic pressure (Salt concentration) on bacterial growth.	4	2, 3, 4, 5	CO2, CO3	PSO2
6	Germicidal effect of UV light on growth of bacteria.	4	2, 3, 4, 5	CO2, CO3	PSO2
7	Effect of heavy metals on growth of bacteria.	4	2, 3, 4, 5	CO2, CO3	PSO2
8	Demonstration of sugar fermentation by bacteria.	4	2, 3, 4, 5	CO4	PSO2
9	To check the starch hydrolysis by bacteria. To check the gelatin hydrolysis by bacteria.	4	2, 3, 4, 5	CO4	PSO2
10	IMViC test	4	2, 3, 4, 5	CO4	PSO2
11	To study the presence of catalase enzyme in bacterial species.	4	2, 3, 4, 5	CO4	PSO2
12	To study the presence of coagulase enzyme in bacterial species.	4	2, 3, 4, 5	CO4	PSO2
13	To perform anti-microbial susceptibility by Kirby-Bauer method.	4	2, 3, 4, 5	CO5	PSO2
14	Motility test of bacterial species.	4	2, 3, 4, 5	CO1, CO5	PSO2

Reference Books	
1.	Practical Microbiology by Dr. R.C. Dubey and Dr. D.K. Maheshwari, S Chand publication.

School: School of Science			**Program: B.Sc. Microbiology**		
Course Code: CH210			**Course Name: Chemistry Laboratory-VIII**		
Year	**II**	**Core Subject (Yes/No):**	Yes	**Lecture:**	**0**
Semester	**IV**	**Elective Subject (Yes/No):**	No	**Tutorial**	**0**
Mode of Transaction	Laboratory	**Foundation Subject (Yes/No):**	No	**Practical:**	**4**
		Year of Syllabus Revision:		**Total Credit:**	**2**
		Year of Introduction	2014	**Prerequisites (If any)**	

Course Description:

Basic concepts of Physical chemistry and determination of physical properties of a liquid.
Understand the basic concepts of reaction kinetics and determination of rate constant of a chemical reaction, analyse water sample, Physical Chemistry experiments based on surface tension, viscosity and chemical kinetics. Chromatographic experiments based on TLC

Course Outcome (CO):

CO1: Understand the basic concepts of Physical chemistry and determination of physical properties of a liquid.
CO2: Understand the basic concepts of reaction kinetics and determination of rate constant of a chemical reaction
CO3: Analyse water sample as well as quantitative analysis using complexometric titrations
CO4: Physical Chemistry experiments based on surface tension, viscosity and chemical kinetics. Chromatographic experiments based on TLC.
CO5: Volumetric analysis based on complexometric titration, Iodometry

No.	Experiment	Contact Hours	BT Level	CO	PSO
1	Preparations of TLC plates	2	1,2,3,4,5	CO4	PSO2
2	TLC to separate an unknown mixture and also to calculate the Rf values	2	1,2,3,4,5	CO4	PSO2
3	To determine the viscosity of given liquid	2	1,2,3,4,5	CO4	POS2
4	To determine the surface tension of given liquid	2	1,2,3,4,5	CO4	PSO2
5	Determination of λmax and concentration of given potassium permanganate solution using visible spectrometry	2	1,2,3,4,5	CO1	PSO2
6	Inversion of cane sugar by polarimeter	2	1,2,3,4,5	CO3	PSO2
7	Estimation of glucose	2	1,2,3,4,5	CO5	PSO2
8	Chemical kinetics	2	1,2,3,4,5	CO5	PSO2
9	Complexometric titration	2	1,2,3,4,5	CO5	PSO2
10	Iodometric titration	2	1,2,3,4,5	CO5	PSO2

Reference Books	
1.	R. C. Shah, Inorganic Quantitative Analysis, 5th Ed., Baroda Book Depot, Vadodara, 1996
2.	J. Mendham, R. C. Denney, J. B. Barnes & M. J. K. Thomas, Vogel's Textbook of Quantitative Chemical Analysis, 6th Ed., Pearson Education, New Delhi, 2003

3.	A. M. Halpern & G. C. McBane, Experimental Physical Chemistry, 3rd Ed., W.H. Freeman & Co., New York, 2003
4	B. D. Khosla, V. C. Garg & A. Gulati, Senior Practical Physical Chemistry, R. Chand & Co., New Delhi, 2011
5	C. W. Garland, J. W. Nibler, & D. P. Shoemaker, Experiments in Physical Chemistry, 8th Ed., McGraw – Hill, New York, 2003
6	V.D. Athawale and P. Mathur, Experimental Physical Chemistry, 1st Edition, New Age International Publications, New Delhi 2001

SEMESTER 5

School: School of Science			**Program: B.Sc. Microbiology**		
Course Code: LS303			**Course Name: Biotechnology and Bioinformatics**		
Year	**III**	**Core Subject (Yes/No):**	**Yes**	**Lecture:**	**3**
Semester	**V**	**Elective Subject (Yes/No):**	**No**	**Tutorial**	**NA**
Typology of Course	**Lectures**	**Foundation Subject (Yes/No):**	**No**	**Practical:**	**NA**
		Year of Syllabus Revision:	**2021**	**Total Credit:**	**3**
		Year of Introduction	**2016**	**Prerequisites (If any)**	**NIL**

Course Description:
Through this course, students apply their knowledge of biochemistry courses to biotechnology, which also refers to genetic engineering. Students will learn about the research and advances pertaining to DNA cloning and modification are addressed, and students will learn the agricultural, medical, industrial and other applications of biotechnology research. This course also includes in depth knowledge of use of bioinformatics studies in research and development.

Course Objectives:

- To prepare students for successful career in industry and research institutes.
- To develop the ability of applying the bioengineering techniques in research and academia.
- To enable students to work in a team with multidisciplinary approach.
- To provide students with fundamental strength in analyzing, designing and solving industry related problems.

Course Outcome (CO):
CO1: Identify the advent of modern biotechnology from ancient biotechnology
CO2: Understand the type of vectors and the type of cloning methods
CO3: Describe different type of GMOs
CO4: To be able to understand the analytical techniques in Biotechnology
CO5: Apply various applications of biotechnology in research and development
CO6: Learn the basics of bioinformatics and its tools for understanding clinical and biological data

Unit No.	**Topic/Unit**	**Contact Hours**	**BT Level**	**CO**	**PSO**
1	Introduction to Biotechnology, definition and scope, Historical perspectives, and importance, Commercial potential, Biotechnology in India and Global trends. Recombinant DNA technology: Restriction - modification system, restriction enzymes, types, nomenclature, properties and examples (EcoRI, BamHI, SmaI) Cloning	15	1,2	CO1, CO2, CO3	PSO2

	Vectors, Prokaryotic cloning and expression vectors-Bacteriophage-λ vectors replacement & insertional vectors cosmid, phagemid. BAC, Eukaryotic cloning and expression vectors-yeast vectors-YEP, YIP, YCP, SV-40, retroviral vector, MAC; plasmid-based vectors- co-integrate & binary vectors. Introduction into eukaryotic expression system, Applications of Recombinant DNA technology - Genetically modified organism (GMOs). Recombinant vaccines. Applications in agriculture, medicine and industry. Gene therapy, DNA fingerprinting, Single Cell Protein (SCP).				
2	Techniques: Polymerase chain reaction (PCR): Principle and applications, primer-design, brief overview of various PCR techniques: inverse-, multiplex-, hotstart-, touchdown, nested PCR; RT-PCR, Construction of genomic and cDNA libraries, Screening & Selection of Recombinants, immunochemical methods of screening, nucleic acid hybridization (Colony and Plaque hybridisation), gene probes, southern, northern and western blot, Sequencing of DNA Sanger sequencing, Maxam Gilbert method, next generation sequencing.	15	1,2	CO4, CO5	PSO2
3	Bioinformatics: Significance of Bioinformatics in Biological Science- Biological Databases (Accession codes & identifications) Examples of Biological. Database (A) Nucleotide sequence Databases (B) Protein sequence databases (EMBL, Gene Bank). Primary Nucleotide sequence, databases, protein sequences, databases), Genetic DataBases, sequence similarity and gene identification, Construction of phylogenetic trees, Computational tools for genome analysis. Biotechnology and Society - Public perception, Biopesticides, Biofuels and Biological Control, Medical Biotechnology, Patenting and IPR issues, Ethical and Biosafety issues.	15	1,2,5	CO6	PSO2

Reference Books

1.	Textbook of Biotechnology by Lydell Norris, 2016
2.	Textbook of Biotechnology by R.C.Dubey, 2014.
3.	Advanced Biotechnology by R.C.Dubey, 2014.
4.	Essentials of Bioinformatics by Jin Xiong
5.	Bioinformatics Basics by Hooman Rashidi, Lukas K. Buehler
6.	Introduction to Bioinformatics: A Theoretical and Practical Approach by Stephen A. Krawetz, David D. Womble

<table>
<tr><td colspan="3">School: School of Science</td><td colspan="3">Program: B.Sc. Microbiology</td></tr>
<tr><td colspan="3">Course Code: MI202</td><td colspan="3">Course Name: Microbial Physiology & Metabolism</td></tr>
<tr><td>Year</td><td>III</td><td>Core Subject (Yes/No):</td><td>Yes</td><td>Lecture:</td><td>3</td></tr>
<tr><td>Semester</td><td>V</td><td>Elective Subject (Yes/No):</td><td>-</td><td>Tutorial</td><td>-</td></tr>
<tr><td rowspan="3">Typology of Course</td><td rowspan="3">Lectures</td><td>Foundation Subject (Yes/No):</td><td>-</td><td>Practical:</td><td>-</td></tr>
<tr><td>Year of Syllabus Revision:</td><td>-</td><td>Total Credit:</td><td>3</td></tr>
<tr><td>Year of Introduction</td><td>2020</td><td>Prerequisites (If any)</td><td>Basics of microbiology</td></tr>
</table>

Course Description:
The course provides information on nutritional classification of microbes and subsequent growth and development. It also deals with responses of microbes in different environmental conditions.

Course Objectives:

- To study the characteristic features of extremophiles
- To understand the mechanisms of energy generation and nutrient uptake.
- To differentiating concepts microbial respiration.

Course Outcome (CO):
CO1: Characteristics of microbes which enable them to grow under unusual environmental conditions of temperature, oxygen, different solute concentration and water activity.
CO2: Mechanisms of energy generation and nutrient uptake
CO3: Aerobic and Anaerobic respiration in microbes.
CO4: Differentiating concepts of aerobic and anaerobic respiration and how these are manifested in the form of different metabolic pathways in microorganisms
CO5: Characteristic features extremophiles.

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	Microbial growth in response to environment- Temperature (psychrophiles, mesophiles, thermophiles, extremophiles, thermodurics, psychrotrophs), pH (acidophiles, alkaliphiles), solute and water activity (halophiles, xerophiles, osmophilic), Oxygen (aerobic, anaerobic, microaerophilic, facultative aerobe, facultative anaerobe), barophilic. Synchronous growth, diauxic growth curve. Measurement of cell numbers, cell mass and metabolic activity. Nutrient uptake and Transport Passive and facilitated diffusion, Primary and secondary active transport, concept of uniport, symport and antiport Group translocation Iron uptake	15	1,2,3	CO1, CO2,	PSO1

2	Chemoheterotrophic Metabolism - Aerobic Respiration. Concept of aerobic respiration, anaerobic respiration and fermentation Sugar degradation pathways i.e. EMP, ED, Pentose phosphate pathway, TCA cycle Electron transport chain: components of respiratory chain, comparison of mitochondrial and bacterial ETC, electron transport phosphorylation, uncouplers and inhibitors. Anaerobic respiration and fermentation. Anaerobic respiration with special reference to dissimilatory nitrate reduction (Denitrification; nitrate/nitrite and nitrate/ammonia respiration; fermentative nitrate reduction). Fermentation- Alcohol fermentation and Pasteur effect; Lactate fermentation	15	1,2,3	CO2, CO3, CO4	PSO1
3	Chemolithotrophic and Phototrophic Metabolism. Introduction to aerobic and anaerobic chemolithotrophy with an example each.Hydrogenoxidation (definition and reaction) and methanogenesis (definition and reaction) Introduction to phototrophic metabolism - groups of phototrophic microorganisms, anoxygenic vs. oxygenic photosynthesis with reference to photosynthesis in green bacteria, purple bacteriaand cyanobacteria	15	1,2,3	CO5	PSO1

Reference Books	
1.	Madigan MT, and Martinko JM (2014). Brock Biology of Microorganisms. 14th edition.Prentice Hall International Inc.
2.	Gottschalk G. (1986). Bacterial Metabolism. 2nd edition. Springer Verlag 6. StanierRY,Ingrahm JI,
3.	Wheelis ML and Painter PR. (1987). General Microbiology. 5th edition, McMillan Press. 7.Willey JM,
4.	Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGrawHill Higher Education.
5.	Moat AG and Foster JW. (2002). Microbial Physiology. John Wiley and Sons
6.	Bacterial Physiology and Metabolism (2008). Byung Hong Kim and Technology Geoffrey

School: School of Science			**Program: B.Sc. Microbiology**		
Course Code: LS304			**Course Name: Molecular Biology and Microbial Genetics**		
Year	**III**	**Core Subject (Yes/No):**	**Yes**	**Lecture:**	**3**
Semester	**V**	**Elective Subject (Yes/No):**	**-**	**Tutorial**	**-**
Typology of Course	**Lectures**	**Foundation Subject (Yes/No):**	**-**	**Practical:**	**-**

		Year of Syllabus Revision:		**Total Credit:**	**3**
		Year of Introduction	**2021**	**Prerequisites (If any)**	**-**

Course Description:
The course deals with the molecular mechanisms that occur in microbes such as DNA replication, transcription and translation, the understanding of operons and molecular basis of recombination. It also encompasses the gene transfer mechanisms such as transformation, transduction and conjugation and mechanisms behind them.

Course Objectives:
To get insight of the types of transport: active/ passive within cell. Knowledge of cell membrane and cell organelles. Digestive system, circulatory system, respiratory system etc and plant physiological systems will be the main objective of the course.

Course Outcome (CO):
CO1: Genome organization, DNA replication
CO2: Molecular mechanisms like transcription and translation
CO3: Regulation of gene expression
CO4: Cancer biology
CO5: Mechanisms by which genetic material is transferred among the microorganisms namely transformation, transduction and conjugation

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	**Unit I:** Molecular Biology- I DNA Replication in pro- and eukaryotes - Gene concept, mechanisms of DNA replication, inhibitors of DNA replication. Transfer of genetic information in pro- and eukaryotes: Transcription- Structure and Types of RNA, role of polymerase, initiation, elongation and termination of transcription, posttranscriptional modifications and inhibitors; splicing mechanisms. Translation- Code- features and deciphering of genetic code, inhibitors of protein synthesis.	15	1,2,3	CO1, CO2,	PSO1
2	**Unit II:** Molecular Biology II Regulation of gene expression - Prokaryotes inducible and repressible systems, positive and negative controls, Molecular basis of recombination - Holliday model, role of rec genes in genetic recombination. Oncogenes and cancer - Types of cancers- sarcomas, carcinomas, leukemias and lymphomas. Oncogenes and Tumor Suppressor Genes.	15	1,2,3	CO3, CO4	PSO1
3	**Unit III** Gene transfer mechanisms- Bacterial transformation (detection of transformation, development of competence, mechanism of transformation, transfection); conjugation-effective contact and pilli in conjugation, F-factor, the conjugal transfer process; high frequency recombination (Hfr) strains; the order of chromosome transfer; formation of F prime (F'); transduction – generalized transduction; abortive transduction; specialized transduction. Sexduction, Bacteriophages – lytic phages (T4, T7), lysogenic phages (phage λ, ΦX 174).	15	1,2,3	CO5	PSO1

Reference Books	
1.	Microbial genetics by Freifelder
2.	Gene Cloning by T A Brown
3.	Principles of gene manipulation by Old and Primerose
4.	Genes IX Lewin
5.	Molecular Biology of the Gene: Watson et al

School: School of Science	**Program: B.Sc. Microbiology**
Course Code: PS322	**Course Name: Scientific Enquiry and Research Methodology**

Year	**III**	**Core Subject (Yes/No):**	**Yes**	**Lecture:**	**3**
Semester	**V**	**Elective Subject (Yes/No):**		**Tutorial**	**-**
Typology of Course	**Lectures**	**Foundation Subject (Yes/No):**		**Practical:**	**-**
		Year of Syllabus Revision:		**Total Credit:**	**3**
		Year of Introduction	**2021**	**Prerequisites (If any)**	

Course Description:
This course is designed to orient students to Research Methodology and develop a research aptitude in them. Topics included are an understanding of basic research methodology - problem identification; importance of literature review; types of research designs; tool and techniques of data collection; techniques of data analysis; reporting of findings; scientific and research writing. Section on review of different types of researches provides the understanding to carry out the research work independently. Once equipped with this knowledge, students would have the requisite knowledge and understanding to conduct research in an area of their choosing

Course Objectives:
At the end of this course, students should be able to:

- Read, interpret and critically evaluate 'research'.
- Explain and apply research terminologies; describe the research process and the principal activities, skills and ethics associated with the research process.
- Identify and explain the difference between quantitative, qualitative & mixed methods research.
- Explain components of a research study and justify the theory as well as the methodological decisions, including sampling, measurement and analysis.
- Critically review a research study including an abstract, introduction, literature review, objectives of the study, research design and ethical considerations.

Course Outcome (CO):
CO1: Explain key research concepts and issues
CO2: Explain the difference between quantitative, qualitative & mixed methods research.
CO3: Relate the type of Study with methodology to be adopted – research design, tools / techniques of data collection and analysis.
CO4: Evaluate critically a research study and its various components
CO5: Read, comprehend, and explain research articles in their academic discipline
CO6: Explain the ethical issues that need to be addressed in the conducting of research

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	Definition of research and its importance; Steps in the process of research Identifying a research problem; Discussion on importance, feasibility… Quantitative & Qualitative research characteristics	8	1,2,3,4,5	CO1 CO2 CO4	PSO1
2	Reviewing related literature Understanding Concepts, Variables. Understanding Research questions Understanding Hypothesis, types of hypothesis; Framing of Objectives.	8	2,3,4,5	CO1 CO3 CO4	PSO1 PSO3
3	Research design – Experimental, Correlational Research design – Survey, Field study Research design – Mixed method Research design - Action research	9	2, 3, 4,5	CO2 CO3 CO4	PSO1 PSO3
4	Understanding Population, Sample, Sampling techniques Tools and techniques of data collection Designing tools with Reliability, Validity, Objectivity, Sensitivity Understanding Normal Probability curve; Implications.	10	2,3,4,5	CO1 CO3	PSO1 PSO2 PSO3
5	Data Analysis - Qualitative Research. Data Analysis – Quantitative Research (Central Tendency – calculating Mean, Median, Mode)	4	1,2,3,4,5	CO1 CO3	PSO1 PSO2 PSO3
6	Critically review a research proposal - including an abstract, introduction, literature review, objectives of the study, research design and ethical considerations. Ethical issues in conducting research Skills needed to design and conduct research	6	2,3,4,5	CO4 CO5 CO6	PSO1 PSO3 PSO6

Reference Books:

1.	Anthony, M., Graziano, A.M. and Raulin, M.L., 2009. Research Methods: A Process of Inquiry, Allyn and Bacon.
2.	Best J.W., and Kahn J.V., (2003) Research in education Ninth edition, New Delhi: Prentice Hall of India
3.	Cresswell J.W. (2011) Educational Research New Delhi: PHI learning Pvt. Ltd.
4.	Day, R.A., 1992.How to Write and Publish a Scientific Paper, Cambridge University Press.
5.	Fink, A., 2009. Conducting Research Literature Reviews: From the Internet to Paper. Sage Publications.
6.	Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers.
7.	Kothari C.R., (2008), Research Methodology- Methods and Techniques, Wiley and Eastern Ltd., New Delhi,
8.	Koul Lokesh., (2009) Methodology of educational research fourth edition., New Delhi: Vikas publishing
9.	Leedy, P.D. and Ormrod, J.E., 2004 Practical Research: Planning and Design, Prentice Hall.
10.	Marshall Stephen D, Nick Green (2010) Your Ph.D companion New Delhi: Viva books

11.	Mc Burney H. Donald., (2001) “Research Methodology “fifth edition., Australia: Thomson - Wadsworth
12.	Pandya Shefali., (2010) Educational Research New Delhi: APH Publishing corporation
13.	Panneerselvam R., (2010) Research Methodology New Delhi: Anmol Publication
14.	Satarkar, S.V., 2000. Intellectual property rights and Copy right. Ess Ess Publications.
15.	Sharma R. N., (2008) Statistical techniques in educational research Delhi: Surjeet publication

School: School of Science			**Program: B.Sc. Microbiology**		
Course Code: SE201			**Course Name: Essential Laboratory Practices**		
Year	**III**	**Core Subject (Yes/No):**	**-**	**Lecture:**	**3**
Semester	**V**	**Elective Subject (Yes/No):**	**Yes**	**Tutorial**	**-**
Typology of Course	**Lectures**	**Foundation Subject (Yes/No):**		**Practical:**	**-**
		Year of Syllabus Revision:		**Total Credit:**	**3**
		Year of Introduction	**2021**	**Prerequisites (If any)**	Basic knowledge about lab apparatus handling and SOPs which students have learned in their previous year laboratory sessions.

Course Description:
This Essential Laboratory Practice course provides an essential grounding in the way all types of non-clinical health and environmental safety studies should be planned, performed, monitored, recorded, archived and reported.

Course Objectives:
At the end of this course:

- To provide students with good laboratory practice
- To prepare student for Quality control training
- To prepare students for Clinical Studies

Course Outcome (CO):
CO1: Understand the role of Essential Laboratory Practices in the Biotechnology industry
CO2: Understand the regulatory aspects of laboratories
CO3: Understand the importance of quality control
CO4: Learn about Food and Drug Regulations
CO5: Learn about In-vitro and In Vivo techniques principle and application

Unit No.	Topic/Unit	Contact Hours	BT level	CO
1	**Unit I** In vivo studies, In vitro studies, regulatory affairs, drug development, preclinical studies, clinical studies	15	1,2,3,5	CO1, CO5,
2	**Unit II**	15	1,2,3,4	CO1,

	Quality System Regulations (QSR), Good Clinical Practice (GCP), Good Laboratory Practices (GLP), Good Manufacturing Practice (GMP), FDA inspections			CO2, CO3, CO4

Reference Books:	
1.	Weinberg, S. (Ed.). (2003). Good laboratory practice regulations. Marcel Dekker.
2.	Seiler, J. P. (2006). Good Laboratory Practice: The why and the how. Springer Science & Business Media.
3.	McPherson, R. A., & Pincus, M. R. (2017). Henry's Clinical Diagnosis and Management by Laboratory Methods E-Book. Elsevier Health Sciences.
4.	Ezzelle, J., Rodriguez-Chavez, I. R., Darden, J. M., Stirewalt, M., Kunwar, N., Hitchcock, R., ... & D'souza, M. P. (2008). Guidelines on good clinical laboratory practice: bridging operations between research and clinical research laboratories. Journal of pharmaceutical and biomedical analysis, 46(1), 18-29.

<table>
<tr><td colspan="3">School: School of Science</td><td colspan="3">Program: B.Sc. Microbiology</td></tr>
<tr><td colspan="3">Course Code: SE202</td><td colspan="3">Course Name: Food and Nutrition</td></tr>
<tr><td>Year</td><td>III</td><td>Core Subject (Yes/No):</td><td>-</td><td>Lecture:</td><td>2</td></tr>
<tr><td>Semester</td><td>V</td><td>Elective Subject (Yes/No):</td><td>Yes</td><td>Tutorial</td><td></td></tr>
<tr><td rowspan="3">Typology of Course</td><td rowspan="3">Lectures</td><td>Foundation Subject (Yes/No):</td><td>-</td><td>Practical:</td><td></td></tr>
<tr><td>Year of Syllabus Revision:</td><td></td><td>Total Credit:</td><td>2</td></tr>
<tr><td>Year of Introduction</td><td>2016</td><td>Prerequisites (If any)</td><td></td></tr>
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Course Description:

Nutrition refers to the science which deals with the role of nutrients and other substances in health, growth, physiology and disease of an individual. A proper diet, is determined by the proper proportions, requisite quantities, availability, method of cooking and palatability of the food.

Course Objectives:

- To prepare students for successful career in industry and research institutes.
- To enable students to work in a team with multidisciplinary approach.
- To provide students with fundamental strength in analysing, designing and solving health related problems.

Course Outcome (CO):

CO1: Identify nutrition and health problems associated with diet

CO2: Importance of eating patterns and dietary needs both for people of different ages and for different groups within society

CO3: Understand the basis for different methods of cooking

Unit No.	**Topic/Unit**	**Contact Hours**	**BT Level**	**CO**	**PSO**
1	An understanding of the terms used in nutrition and the concept of diet and nutrition Balanced diet, My plate,	15	1,2	CO1	PSO3

	Nutrition and dietetics. Nutritive value of foods - The sources and functions of: proteins, carbohydrates, fats, vitamins, Mineral elements, water, Sources and uses of food energy, Sources and functions of dietary fibre. Dietary guidelines - Factors affecting food requirements, Planning and serving of family meals. Meals for all ages and occupations. Special needs of pregnant and lactating women, convalescents, Vegetarians, Use of herbs, spices and garnishes. Composition and value of the main foods in the diet - Milk, meat, fish, cheese, eggs, margarine and Butter, Cereals, fruits and vegetables.				
2	Cooking of food Transfer of heat by conduction, convection and radiation. Principles involved in the different methods of cooking – boiling, stewing, grilling, baking, roasting, frying, steaming, pressure cooking, Preparation and cooking of food to preserve nutritional value and flavour. Traditional methods of cooking. Economical use of food, equipment, fuel and labour. Food spoilage, and hygiene in the handling and storage of food, Food preservation.	15	1,2	CO2, CO3	PSO3
Reference Books					
1	N.W. Desrosier & J. N. Desrosier, The Technology of Food Preservation, Westport: Connecticut, Publishing Company, 1997. 2. Deaton, A., & Drèze, J. (2009).				
2	Food and nutrition in India: facts and interpretations. Economic and political weekly, 42-65. 3. Duyff, R. L. (2012).				
3	American dietetic association complete food and nutrition guide. Houghton Mifflin Harcourt. 4. Curry, K. R. (2000).				
4	Multicultural competence in dietetics and nutrition. Journal of the Academy of Nutrition and Dietetics, 100(10), 1142.				
5	E. Whitney, E. Hamiliton & S. Rolfes, Understanding Nutrition, St. Paul, MN: West Publishing Company, 1990. 6. Mahan, L. K. (2004).				
6	Krause's food, nutrition, & diet therapy (Vol. 11). S. Escott-Stump (Ed.). Philadelphia: Saunders.				

School: School of Science			**Program: B.Sc. Microbiology**		
Course Code: MI205			**Course Name: Microbiology Laboratory III**		
Year	**III**	**Core Subject (Yes/No):**	**Yes**	**Lecture:**	
Semester	**V**	**Elective Subject (Yes/No):**	**-**	**Tutorial**	
Mode of Transaction	**Laboratory**	**Foundation Subject (Yes/No):**	**-**	**Practical:**	**8**
		Year of Syllabus Revision:		**Total Credit:**	**4**
		Year of Introduction	**2020**	**Prerequisites (If any)**	**-**

Course Description:

This course will cover the biotechnology and molecular biological techniques like Nucleic acid and protein isolation and characterization. Students will learn some basic biological databases and their applications. This course will also cover the experiments related to endocrine glands like histology study, 3D visualization through online software and live demonstration of animal dissection (Fish model).

Course Outcome (CO):

CO1: Techniques used in RNA, DNA and protein analysis
CO2: Basic biological databases
CO3: Histology and function of endocrine glands

No.	Experiment	Contact Hours	BT Level	CO	PSO
1	To study Principle, SOPs, and Applications of Laboratory Instruments.	4	1,2,3,5	CO1	PSO2, PSO3
2	To study Buffer Preparation (TE, TAE, TBE)	4	1,2,4,5	CO1	PSO2, PSO3
3	To isolate genomic DNA from E. coli bacteria	4	1,2,3,5	CO1, CO2	PSO2, PSO3
4	To check the quality and do quantification of Genomic DNA isolated from E. coli bacteria.	4	1, 2, 3	CO1, CO2	PSO2, PSO3
5	To isolate RNA from E. coli bacteria by TriZol Method.	4	1,2,3,5	CO1, CO2	PSO2, PSO3
6	To check the quality and do quantification of RNA isolated from E. coli bacteria.	4	1,2,3,5	CO1, CO2	PSO2, PSO3
7	To perform Plasmid isolation from E. coli bacteria by the Alkaline Lysis method (Miniprep).	4	1,2,3,5	CO1, CO2	PSO2, PSO3
8	To study the Gel electrophoretic Technique	4	1,2,3,5	CO1, CO2	PSO2, PSO3
9	Perform Agarose gel electrophoresis for isolated DNA and RNA from E. coli bacteria.	4	1,2,3,5	CO1, CO2	PSO2, PSO3
10	To study Gel Visualization and Analysis through Trans illuminator and Gel Doc system.	4	2,3	CO1, CO2	PSO2, PSO3
11	To study the Basic Biological Database through online websites	4	1,2,3,5	CO1, CO2	PSO2, PSO3
12	To perform Bacterial transformation of the Host cell (Blue-white Screening)	4	1,2,3,5	CO1, CO2	PSO2, PSO3
13	To perform Plaque formation Assay	4	1,2,3,5	CO1, CO2	PSO2, PSO3
14	Demonstration of Endpoint PCR and Reverse transcriptase PCR	4	1,2,3,5	CO1, CO2	PSO2, PSO3

Reference Books

1.	Practical Microbiology by Dr. R.C. Dubey and Dr. D.K. Maheshwari, S Chand publication.
2.	Basic Practical Microbiology manual compiled by John Grainger, Chairman of MISAC Janet Hurst, Deputy Executive Secretary of SGM Dariel Burdass, SGM Educational Projects Administrator

School: School of Science			**Program: B.Sc. Microbiology**		
Course Code: MI303			**Course Name: Microbiology Laboratory – IV**		
Year	**III**	**Core Subject (Yes/No):**	**Yes**	**Lecture:**	**-**
Semester	**V**	**Elective Subject (Yes/No):**	**-**	**Tutorial**	**-**
Mode of Transaction	**Laboratory**	**Foundation Subject (Yes/No):**	**-**	**Practical:**	**8**
		Year of Syllabus Revision:	**-**	**Total Credit:**	**4**
		Year of Introduction	**2020**	**Prerequisites (If any)**	**Basics of microbiology**

Course Description:

This course will cover introduction to microbial metabolism and classification of bacteria on the basis of growth supporting environmental factors such as oxygen, temperature, pH, osmotic pressure, salt and hydrostatic pressure.

Course Outcome (CO):

CO1: Recognize the extent of metabolic diversity present in microbial world
CO2: Identify various physiological groups of bacteria with their special metabolic features.
CO3: Understand growth pattern of microbes in different growth conditions.
CO4: Study biochemical mechanisms to identify the microbes.
CO5: Understand antimicrobial activity of microbes.

No.	Experiment	Contact Hours	BT Level	CO	PSO
1	To determine the bacterial growth curve by turbidimetry method.	4	2, 3, 4, 5	CO1	PSO2
2	To determine the effect of pH on bacterial growth	4	2, 3, 4, 5	CO2, CO3	PSO2
3	To determine the effect of temperature on bacterial growth	4	2, 3, 4, 5	CO2, CO3	PSO2
4	To estimate the bacterial population, count by turbidimetry method.		2, 3, 4, 5	CO2, CO3	PSO2
5	Effect of osmotic pressure (Salt concentration) on bacterial growth.	4	2, 3, 4, 5	CO2, CO3	PSO2
6	Germicidal effect of UV light on growth of bacteria.	4	2, 3, 4, 5	CO2, CO3	PSO2
7	Effect of heavy metals on growth of bacteria.	4	2, 3, 4, 5	CO2, CO3	PSO2
8	Demonstration of sugar fermentation by bacteria.	4	2, 3, 4, 5	CO4	PSO2

9	To check the starch hydrolysis by bacteria. To check the gelatin hydrolysis by bacteria.	4	2, 3, 4, 5	CO4	PSO2
10	IMViC test	4	2, 3, 4, 5	CO4	PSO2
11	To study the presence of catalase enzyme in bacterial species.	4	2, 3, 4, 5	CO4	PSO2
12	To study the presence of coagulase enzyme in bacterial species.	4	2, 3, 4, 5	CO4	PSO2
13	To perform anti-microbial susceptibility by Kirby-Bauer method.	4	2, 3, 4, 5	CO5	PSO2
14	Motility test of bacterial species.	4	2, 3, 4, 5	CO1, CO5	PSO2

Reference Books	
1.	Practical Microbiology by Dr. R.C. Dubey and Dr. D.K. Maheshwari, S Chand publication.

SEMESTER 6

School: School of Science			**Program: B.Sc. Microbiology**		
Course Code: MI301			**Course Name: Medical Microbiology**		
Year	**III**	**Core Subject (Yes/No):**	**Yes**	**Lecture:**	**3**
Semester	**VI**	**Elective Subject (Yes/No):**	**-**	**Tutorial**	**-**
Typology of Course	Lectures	**Foundation Subject (Yes/No):**	**-**	**Practical:**	**-**
		Year of Syllabus Revision:	**2021**	**Total Credit:**	**3**
		Year of Introduction	**2019**	**Prerequisites (If any)**	**-**

Course Description:
This course aims to provide knowledge of medical microbiology which includes microorganisms, diagnosis, disease causation, and treatment of pathogens to advanced practical training and major significance to public health. It focuses on molecular mechanisms and current updates regarding same.

Course Objectives:
To get an introduction in the fundamental concept of basic medical microbiology. The course also gives an understanding on the various types of bacterial, fungal, viral and parasitic diseases, their mode of action, etiology, prevention and cure.

Course Outcome (CO):
CO1: Introduction to bacteriology, reproduction and growth of bacteria
CO2: Bacterial diseases caused in humans and its pathogenesis
CO3: Concept of parasitology, Epidemiology and Immunology of parasitic infections
CO4: Common parasitic diseases
CO5: Common viral diseases in humans and genetics of animal viruses.

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	**Unit I:** Bacteriology Introduction, Taxonomy, nomenclature and identification of bacteria, Reproduction and growth, Organization and ultrastructure of micro-organisms and various antibiotics, Antimicrobial used in clinical practical, Normal human flora, Pathogenesis and virulence factors of bacteria, Human diseases caused by bacteria in the following: Respiratory tract infections, Urinary tract infections, Genital tract infections, Gastrointestinal tract infections, Blood stream and CNS infections. Epidemiology of bacterial diseases.	15	1,2,3	CO1, CO2,	PSO1
2	**Unit II:** Parasitology Classification of parasitic protozoa. Cellular organization of parasitic protozoa. Epidemiology of parasitic infections. Immunology and immunopathology of parasitic infections, Control of parasites and parasitic infections. Common parasitic disease: Trypanosomiasis, Leishmaniosis, Malaria, Opportunistic parasitic infections, Helminths.	15	1,2,3	CO3, CO4	PSO1

	Medical Mycology: Classification, Cryptococcosis, Candidiasis, Blastomycosis, Histoplasmosis, Coccidiomycosis, Phycomycosis.				
3	**Unit III:** Clinical Virology The structure, components and classification of viruses. Viral multiplication cycle, effect of virus infection on the host cell, cytopathic effects, inhibition of host cell cytopathic effects, inhibition of host macromolecular biosynthesis, changes in regulation of gene expression. Genetics of animal viruses. History, epidemiology, diagnosis, clinical features, treatment and prevention of small pox, herpes, adenoviruses, arboviruses, picornaviruses, myxoviruses.	15	1,2,3	CO5	PSO1

Reference Books	
1.	Microbiology by Lansing M. Prescott and John P. Harley and Donald Klein; Ed. 6th;McGraw- Hill Science, 2004.
2.	Color ATLAS and textbook of diagnostic microbiology by Elmer W Koneman and Stephen D Allen and William M Janda and Paul C Schreckenberger and Washington C Winn; Ed. 6th; Lippincott Williams & Wilkins, 2005.
3.	Medical microbiology: a guide to microbial infections: pathogenesis, immunity, laboratory diagnosis and control by David Greenwood and Richard C. B. Slack and John F.Peuthere, ed. 17th Ed. Churchill Livingstone; 2007.
4.	Essentials of diagnostic microbiology by Lisa Anne Shimeld and Anne T. Rodgers; Delmar Publishers, 1999.
5.	Medical Microbiology by Geo. Brooks and Karen C. Carroll and Janet Butel and Stephen Morse; Ed. 24th; McGraw-Hill Medical, 2007.
6.	Topley and Wilson's Microbiology and Microbial Infections by Leslie Collier and Albert Balows and Max Sussman; Ed. 9th; 6-Volume Set; A Hodder Arnold Publication, 2000.

School: School of Science			**Program: B.Sc. Microbiology**		
Course Code: MI302			**Course Name: Industrial and Food Microbiology**		
Year	**III**	**Core Subject (Yes/No):**	**Yes**	**Lecture:**	**3**
Semester	**VI**	**Elective Subject (Yes/No):**	**-**	**Tutorial**	**-**
Typology of Course	**Lectures**	**Foundation Subject (Yes/No):**	**-**	**Practical:**	**-**
		Year of Syllabus Revision:		**Total Credit:**	**3**
		Year of Introduction	**2021**	**Prerequisites (If any)**	**-**

Course Description:
Subject introduces various concepts of industrial microbiology like fermentation, bioreactor, control of fermentation process, important microbial strains and its culture, and down-stream processing. It includes the product process of various microbial products as well as spoilage and preservation of food. Fermented food and food borne diseases are essential part of the curriculum.

Course Objectives:
To understand importance of microbes in industrial production of commercially valuable chemicals and biomolecules. To acquire fundamentals of industrial growth optimization and scale-up requirements of various microbial strains. To learn about possible health hazards associated with pathogenic food microbes and regulatory stature to maintain food quality in packaged foods.

Course Outcome (CO):
CO1: Development of an understanding about industrial application of microbes
CO2: Understanding role of industrial growth optimization of microbes
CO3: Learning about key factors playing role in industrial microbial product development
CO4: Learning about the synthesis of various industrial products by microbes
CO5: Role of bacteria in maintaining health; probiotics
CO6: Role of bacteria in food spoilage
CO7: Health hazard of microbes contaminating foods and related regulatory parameters

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	Introduction to industrial microbiology: brief history and developments in industrial microbiology. Fermentation processes: Solid-state and liquid-state (stationary and submerged) fermentations; Batch, fed batch and continuous fermentations. Bioreactors/fermenters: Components of a typical bioreactor, types of bioreactors Laboratory, pilot-scale and production fermenters; constantly stirred tank fermenter, tower fermenter, fixed bed and fluidized bed bioreactors and air-lift fermenter. Measurement and control of fermentation parameters: pH, temperature, dissolved oxygen, foaming and aeration. Isolation of industrially important microbial strains: Primary and secondary screening, strain development, preservation and maintenance of industrial strains. Media and ingredients for industrial fermentations: Crude and synthetic media; molasses, corn-steep liquor, sulphite waste liquor, whey and yeast extract.Down-stream Processing: Filtration, centrifugation, cell disruption, solvent extraction, precipitation and ultrafiltration, lyophilization, spray drying.	15	1,2,3	CO1, CO2,	PSO1
2	Microbial production of industrial products (micro-organisms involved, media, fermentation conditions, downstream processing and uses): Citric acid, ethanol, penicillin, glutamic acid, riboflavin, enzymes (amylase, cellulase, protease, lipase, glucoseisomerase, glucose oxidase), wine,beer, bioinsecticides (Bt) and Steroid transformations.Enzyme immobilization: Methods of immobilization, advantages and applications of immobilization, large scale applications of immobilized enzymes (glucose isomerase and penicillin acylase).Foods as	15	1,2,3	CO3, CO4	PSO1

	asubstrate for microorganisms: Intrinsic and extrinsic factors that affect growth and survival of microbes in foods, natural flora and source of contamination of foods in general.Microbial spoilage of various foods: Principles, Spoilage of vegetables, fruits, meat, eggs, milk and butter, bread, canned foods.Principles and methods of food preservation: Principles, physical methods of food preservation: temperature (low, high, canning, drying), irradiation, hydrostatic pressure, high voltage pulse, microwave processing and aseptic packaging, chemical methods of food preservation: salt, sugar, organic acids, SO2, nitrite and nitrates, ethylene oxide, antibiotics and bacteriocins.				
3	Fermented foods: Dairy starter cultures, fermented dairy products: yogurt, acidophilus milk, kumiss, kefir, dahi and cheese, other fermented foods: dosa, sauerkraut, soy sauce and tampeh and probiotics. Food borne diseases (causative agents, foods involved, symptoms and preventive measures): Food intoxications: Staphylococcus aureus, Clostridium botulinum and mycotoxins; Food infections: Bacillus cereus, Vibrio parahaemolyticus, Escherichia coli, Salmonellosis, Shigellosis, Yersinia enterocolitica, Listeria monocytogenes and Campylobacter jejuni.Food sanitation and control: HACCP, Indices of food sanitary quality and sanitizers.Water Potability: Treatment and safety of drinking (potable) water, methods to detect portability over water samples: (a) standard qualitative procedure: presumptive test/MPN test, confirmed and completed tests for faecal coliforms (b) Membrane filter technique and (c) Presence/absence tests.	15	1,2,3	CO5, CO6, CO7	PSO1

Reference Books	
1.	Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited
2.	Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial3.Microbiology 5th edition. Panima Publishing Co. New Delhi.
3.	tanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2ndedition, Elsevier Science Ltd
4.	Frazier WC and Westhoff DC. (2003). Food Microbiology. 18thedition. Tata McGraw HillPublishing Company Ltd, New Delhi, India.
5.	Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th edition.Pearson Education.

<table>
<tr><td colspan="3">School: School of Science</td><td colspan="3">Program: B.Sc. Microbiology</td></tr>
<tr><td colspan="3">Course Code: MI305</td><td colspan="3">Course Name:
Biofertilizers & Biopesticides</td></tr>
<tr><td>Year</td><td>III</td><td>Core Subject (Yes/No):</td><td>Yes</td><td>Lecture:</td><td>3</td></tr>
<tr><td>Semester</td><td>VI</td><td>Elective Subject (Yes/No):</td><td>-</td><td>Tutorial</td><td>-</td></tr>
<tr><td rowspan="3">Mode of Transaction</td><td rowspan="3">Theory</td><td>Foundation Subject (Yes/No):</td><td>-</td><td>Practical:</td><td>-</td></tr>
<tr><td>Year of Syllabus Revision:</td><td>-</td><td>Total Credit:</td><td>3</td></tr>
<tr><td>Year of Introduction</td><td>2020</td><td>Prerequisites (If any)</td><td>-</td></tr>
</table>

Course Description:

This course will impart knowledge on the fundamental aspects of agricultural microbiology and introduce them to its applications. The relationship between microbes and plants as well as the role of microbes in enhancing the productivity of crops by enriching soil fertility will be highlighted. There is a tremendous scope of microbiology in agriculture which will be explained to the students. The mode of action of biopesticides and biofertilizers and its practical applications will be discussed.

Course Outcome (CO):

CO1: Acquire knowledge on scope and importance of biopesticides
CO2: Demonstrate mass production and application technology of biopesticides
CO3: Comprehend the types of biofertilizers and their characteristics features
CO4: Explain the mechanism and mass production of biofertilizers

No.	Experiment	Contact Hours	BT Level	CO	PSO
1	Unit I: Biofertilizers - Introduction, status and scope. Structure and characteristic features of bacterial biofertilizers- Azospirillum, Azotobacter, Bacillus, Pseudomonas, Rhizobium and Frankia; Cynobacterial biofertilizers- Anabaena, Nostoc, Hapalosiphon and fungal biofertilizers- AM mycorrhiza and ectomycorhiza. Nitrogen fixation -Free living and symbiotic nitrogen fixation. Mechanism of phosphate solubilization and phosphate mobilization, Potassium solubilisation	15	2, 3, 4, 5	CO1, CO2	PSO1
2	Unit II: Production technology: Strain selection, sterilization, growth and fermentation, mass productionof carrier based and liquid biofertiizers. FCO specifications and quality control of biofertilizers. Application technology for seeds, seedlings, tubers, sets etc. Bio fertilizers - Storage, shelf life, quality control and marketing. Factors influencing the efficacy of bio fertilizers. Importance of Trichogramma, Cryptolaemus, Chrysoperla, NPV and entomo fungal pathogens. Establishing insectary for host insects and natural	15	2, 3, 4, 5	CO2, CO3	PSO1

	enemies, Mass production of Verticillium/ Beauveria/ Metarhzium/ Nomuraea/ Paecilomyces/ Hirsutellathompsoni/ Trichoderma/ Pseudomonas/ Bacillus/ Potash Mobilizers/ Sulphur oxidizers/ organic matter decomposers.				
3	Unit III: History, concept, Importance, scope and potential of biopesticide. Classification of biopesticides viz. pathogen, botanical pesticides, and biorationales. Mass production technology of biopesticides. Virulence, pathogenicity and symptoms of entomopathogenic pathogens and nematodes. Methods of application of biopesticides. Methods of quality control and Techniques of biopesticides. Impediments and limitation inproduction and use of biopesticide	15	2, 3, 4, 5	CO3, CO4	PSO1

Reference Books	
1.	Kannaiyan, S. (2003). Biotechnology of Biofertilizers, CHIPS, Texas.
2.	Mahendra K. Rai (2005). Hand book of Microbial biofertilizers, The Haworth Press, Inc.NewYork.
3	Reddy, S.M. et. al. (2002). Bioinoculants for sustainable agriculture and forestry, ScientificPublishers.
4	Subba Rao N.S (1995) Soil microorganisms and plant growth, Oxford and IBH publishingco. Pvt.Ltd. NewDelhi.
5	Saleem F and Shakoori AR (2012) Development of Bioinsecticide, Lap Lambert AcademicPublishing GmbH KG
6	Aggarwal SK (2005) Advanced Environmental Biotechnology, APH publication.

School: School of Science			**Program: B.Sc. Microbiology**		
Course Code: MG231			**Course Name: Entrepreneurship**		
Year	**III**	**Core Subject (Yes/No):**	**Yes**	**Lecture:**	**3**
Semester	**VI**	**Elective Subject (Yes/No):**	**No**	**Tutorial**	
Typology of Course	**Lectures**	**Foundation Subject (Yes/No):**		**Practical:**	
		Year of Syllabus Revision:		**Total Credit:**	**3**
		Year of Introduction	**2015**	**Prerequisites (If any)**	
Course Description: Introductory course on Entrepreneurship aims at sensitizing students to the spirit of entrepreneurship. The course includes discussion on the entrepreneurial journeys of various entrepreneurs in diverse fields so as to help students understand different aspects of an entrepreneur					

as well as entrepreneurial venture. Further it aims at systematically identifying opportunities and developing new business ideas. The course also deals with the issues concerning entrepreneurial ventures at a broad level like entrepreneurial ecosystem in India, marketing of a new venture, sources of finance etc.

Course Objectives:

The objective of the course is to :

- Introduce students to the idea of entrepreneurship and exposing learners to take entrepreneurship as a career choice.
- To help students develop better understanding about the various stages of entrepreneurial process.
- Develop creativity, problem solving and opportunity recognition skills.
- Provide students with first-hand experience of entrepreneurship
- To help them introspect about their own entrepreneurial capabilities

Course Outcome (CO):

Upon completion of the course students are expected to demonstrate knowledge, skill and abilities in the following areas:

CO 1 : Foresee Entrepreneurship as one of the possible career path for themselves
CO 2 : Recognize the innate entrepreneurial potential within themselves
CO 3 : Recognize and assess opportunities in their environments
CO 4 : Evaluate the feasibility of any innovative idea
CO 5 : Conduct Concept Test and Buying Intention Survey
CO 6 : Identify appropriate sources of finance for their business
CO 7 : Determine appropriate legal form of business for establishing their venture
CO 8 : Select and apply for required intellectual property right
CO 9 : Prepare Business Model Canvas
CO 10: Present Elevator Pitch

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	Introduction to Entrepreneurship	10	2,3,4	CO1, CO2	PSO3
2	Creativity and Innovation	10	4,5,6	CO1, CO2, CO3, CO4, CO5	PSO3
3	Marketing, Financial and Legal aspects of new venture	12	2,3,4,5	CO1, CO6, CO7, CO8	PSO3
4	Business Plan and Pitching	8	2,3,4,5,6	CO1, CO2, CO9, CO10	PSO3

Reference Books

1.	Bansal, R. (2011). Connect The Dots. Westland
2.	Bansal, R. (2011). I have a dream. Westland
3.	Barringer, B. R., Ireland,R.D. (2015). Entrepreneurship: Successfully launching new ventures. Pearson Education India
4.	Bygrave , W. D., & Zacharakis , A. (2011). Entrepreneurship. John Wiley & Sons, Inc
5.	Hisrich, R. D., Peters, M. P., & Shepherd, D. A. (2018). Entrepreneurship. McGraw Hill Education
6.	Kawasaki, G. (2004). The art of the start: The time-tested, battle-hardened guide for anyone starting anything. Penguin.

7.	Kuratko, D. F., & Rao, T. V. (2012). Entrepreneurship: A South-Asian Perspective. Cengage Learning
8.	Mauborgne, R., & Kim, W. C. (2005). Blue Ocean Strategy- How to Create Uncontested Market Space and Make the Competition Irrelevant. Harvard Business School Publishing Corporation. Boston, Massachusetts.
9.	Harvard Business Publishing Articles – Class readings

School: School of Science			**Program: BSC –Life Science**		
Course Code: SE318			**Course Name: Introduction to Forensic Science**		
Year	**III**	**Core Subject (Yes/No):**	**-**	**Lecture:**	**2**
Semester	**VI**	**Elective Subject (Yes/No):**	**Yes**	**Tutorial**	**-**
Typology of Course	**Lectures**	**Foundation Subject (Yes/No):**	**-**	**Practical:**	**-**
		Year of Syllabus Revision:	**-**	**Total Credit:**	**2**
		Year of Introduction	**2016**	**Prerequisites (If any)**	**-**

Course Description:

This course is an applicative course and gives an insight to the working in a forensic laboratory. Through this course students shall gain exposure to the different techniques and methods used in forensics as well as its several levels of applications in crime detection and analysis.

Course Objectives:

- Explain the importance of forensic analysis.
- Understand the application of analytical techniques in forensic analysis.

Course Outcome (CO):

CO1: Understand the historical aspects of forensic science.
CO2: Study the roles and regulations of various disciplines of forensic science.
CO3: Understand the several aspects of investigating the crime site.
CO4: Study the assessment patterns of physical evidence

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	**Introduction** History, Basis of Forensic Sciences. Types of forensic scientists. Role of forensic scientists. Sub-specialities of forensic science-Forensic pathology, Forensic toxicology, forensic psychology, digital forensics and criminology. Science and Technology in criminal investigation.	15	1,2,3	CO1, CO2	PSO1, PSO3
2	**Forensic investigation**	15	1,2,3	CO3, CO4	PSO1, PSO3

	Crime scene investigation, assessing physical evidence, Role of forensic experts in investigation, Firearms, Tool markers, abusive drug and drug evidence, forensic serology, Forensic laboratory tools, Evaluation of blood strain in patterns: identification and characterization. Identification of biological fluids, Microanalysis and examination of trace evidence, The fingerprint analysis. Forensic Genetics.				

Reference Books	
1.	W.J. Welcher (Ed.), Scott's Standard Methods of Chemical Analysis, Vol. III A, 6th Edition (1966), and vol. III B, 5th Edition (1975), Van Nostrand Reinhold Co. London.
2.	Peter Fordham, Non-destructive Testing Techniques, 1st edition (1968), London Business Publications Ltd., London
3.	W. Horwitz, Official Methods of Analysis, 11th Edition (1970), Association of Official Analytical Chemists, Washington DC.
4.	K. Simpson and B. Knight, Forensic Medicine, 9th Edition (1985), Edward Arnold Publishers Ltd.London.

School: School of Science			**Program: B.Sc. Microbiology**		
Course Code: SE210			**Course Name: Food and Nutrition II**		
Year	**III**	**Core Subject (Yes/No):**	No	**Lecture:**	2
Semester	**VI**	**Elective Subject (Yes/No):**	Yes	**Tutorial**	NA
Typology of Course	**Lectures**	**Foundation Subject (Yes/No):**	No	**Practical:**	NA
		Year of Syllabus Revision:		**Total Credit:**	2
		Year of Introduction	**2016**	**Prerequisites (If any)**	**NIL**

Course Description:

This course emphasizes on importance of nutrition in health. It also focuses on importance of diet in preventing diseases, especially lifestyle disorders. It emphasizes on role of nutrition policies and programmes in boosting health.

Course Objectives:

- To prepare students for successful career in clinical nutrition and dietetics
- To help the students understand the importance of food safety
- To enable students to apply the knowledge gained through the subject to improve their own lifestyle

Course Outcome (CO):

CO1: To understand the essentials of diet and health
CO2: To apply the knowledge on management of health

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO

1	Social, population and environmental influences on nutrition, the food chain, types of nutritional studies; Food Selection and meal Planning- Factors to be considered, Dietary Guidelines Normal Clinical Nutrition- malnutrition, obesity, inflammatory response, enteral and parenteral nutrition. Dietetics & Therapeutic Aspects of Clinical Nutrition	15	1,2	1	PSO3
2	Nutrition Policies & Programmes; Nutrigenetics- personalized nutrition, Nutrient Requirements Based on Genotype; Nutrition in Special Conditions: chronic diseases- diabetes, cardiovascular diseases. Health Promotion & Nutritional Education. Food Safety in Practice.	15	1,2	2	PSO3
Reference Books					
1.	Desrosier, N.W. and Desrosier, J.N. (1997) The Technology of Food Preservation, Westport : Connecticut Publishing Company.				
2.	Whitney, E., Hamilton, E., and Rolfes, S. (1990) Understanding Nutrition, St. Paul, MN: West Publishing Company.				
3.	Sunetra Roday, (2012) Food Science and Nutrition, Oxford Publishing Company.				

School: School of Science			**Program: B.Sc. Microbiology**		
Course Code: SE310			**Course Name: Introduction to Pharmacognosy**		
Year	**III**	**Core Subject (Yes/No):**	No	**Lecture:**	**2**
Semester	**VI**	**Elective Subject (Yes/No):**	Yes	**Tutorial**	**-**
Typology of Course	**Lectures**	**Foundation Subject (Yes/No):**	No	**Practical:**	**-**
		Year of Syllabus Revision:		**Total Credit:**	**2**
		Year of Introduction	**2016**	**Prerequisites (If any)**	**NA**

Course Description:
This course is designed for study of medicinally important plants with their cultivation, collection and adulteration of crude drugs, and the role of these plants in national economy.

Course Objectives:

- Introduction to medicinal compounds and raw materials of natural origin including biosynthesis, chemical structures and qualitative and quantitative analysis. Understanding the role of natural products in research and development of drugs as well as in disease prevention and treatment. Acquisition of basic knowledge and skills in quality control of herbal drugs and products.

Course Outcome (CO):

CO1: Recognize and define medicinal natural compounds according to their chemical structure and biosynthetic pathway

CO2: Associate medicinal compounds with their natural sources

CO3: Use basic pharmacognostical terminology in Latin

CO4: Understanding the quality control of herbal drugs with their effectiveness and safe use
CO5: Introduction to the Indian Pharmacopoeia and its usage in the area of herbal drug analysis

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	• Course Introduction: History, Scope and Development of Pharmacognosy • Classification of crude drugs • Sources of crude drugs: Crude drugs of Plant, Animal and Mineral origin • Different types of plant tissues and their functions • Morphological and Microscopical study: Leaf, root, stem, bark, wood, flower, fruit and seed • Modifications of leaf, root and stem	15	1, 2	CO1 CO2 CO5	PSO1
2	• Study of medicinally important plants belonging to the families with special reference to: Solanaceae, Umbelliferae, Leguminosae, Liliaceae • Cultivation, collection and adulteration of crude drugs: Methods of cultivation, Factors influencing cultivation of medicinal plants, methods of collection and different types of adulteration • Role of medicinal plants in national economy	15	1, 2	CO3 CO4	PSO1

Reference Books	
1.	Text book of Pharmacognosy: T. E. Wallis; CBS publishers, New Delhi.
2.	The Ayurvedic Pharmacopoeia of India: Government of India, Ministry of Health & Family Welfare, 1st edition, Part-I, Vol. III, 2001.
3.	Quality Control Methods for Medicinal Plant Materials: 2002, WHO, Geneva.
4.	Trease and Evan's Pharmacognosy: W. C. Evans, 14th edition, 1997, W. B. Saunders Company, Singapore.
5.	Cultivation of medicinal plants, C. K. Kokate, 4th edition, 2007, Nirali Prakashan, Pune
6.	Botany for Degree Student: A. C. Dutta; Oxford University Press, New Delhi.
7.	Pharmacognosy: C. K. Kokate; Nirali Prakashan, Pune

School: Science			**Program: B.Sc. Microbiology**		
Course Code: SE208			**Course Name: Herbal Cosmetics**		
Year	**III**	**Core Subject (Yes/No):**	**No**	**Lecture:**	**2**
Semester	**VI**	**Elective Subject (Yes/No):**	**Yes**	**Tutorial**	**0**
Typology of Course	**Lectures**	**Foundation Subject (Yes/No):**	**No**	**Practical:**	**0**
		Year of Syllabus Revision:		**Total Credit:**	**2**
		Year of Introduction	**2014**	**Prerequisites (If any)**	**HSC Science**
Course Description:					

Students will learn to use scientific method to combine the cosmetic properties of plants with cosmetic making techniques to achieve health benefits and balance in the body. Plants of medicinal value will be introduced and how to process them will be shown. Safe use of herbs to make beauty products will be discussed.

Course Objectives:

The course will enhance knowledge regarding herbal products, their medicinal application, preparations, encourage students to prepare original, unadulterated good quality beauty products at home. Enterprising students may see ways to become entrepreneurs and develop signature products.

Course Outcome (CO):

CO1: Illustrate the Fundamental knowledge on cosmetic and cosmeceuticals
CO2: Learn various skin problems and how to overcome through skin preparations
CO3: Learn about the formulation design, formulation, and evaluations of herbal cosmetics
CO4: Understand basics of Perfumery, and Aromatherapy. Moreover, sound knowledge of plants with aromatic compounds and herbal formulation for perfumery.

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	Unit 1: Creams and Lotions: Cosmetics, definition, Structure of skin, various forms of cosmetics, main ingredients, preservatives, quality control measures, instrumentation for extraction and manufacture. Cosmetic creams: base cream, cleansing creams, Emollient creams, Finishing creams, cold cream, Preparation of creams. Cosmetic emulsions, properties of emulsions, emulsifiers, Creams: Cleansing creams (Cold creams, Quick liquifying creams, liquid cleaners), Emollient creams, finishing creams (Vanishing creams), Special creams (Astringent creams, Bleaching creams, Acne creams, All-purpose creams, Estrogenic creams, Industrial or protective creams) etc. Commercially available ingredients, retinoids, hydroxy acids, antioxidants etc., antimicrobial compounds from plants, Plants improving blood circulation etc.	15	1, 2, 3, 4, 5	CO1, CO2, CO3	PSO1, PSO3, PSO4
2	Unit 2: Perfumery and Aromatherapy: Perfumes, Flower perfumes, leaf perfumes, Fruit perfumes, root perfumes etc. Different perfumes from rose, jasmine, tuberose, sandalwood, kewda, Lavender, peppermint, Neroli, petit grain oils etc. constituent compounds, monoterpenes, methods of extraction, preparation of perfumes. Perfumes for soaps, detergents, incense, candles, household products, creams, powders, aerosols, industrial perfumes. Aromatherapy: Principles and practice.	15	1, 2, 3, 4, 5	CO1, CO3, CO4	PSO1, PSO3, PSO4

Reference Books	
1.	André O. Barel, Handbook of Cosmetic Science and Technology, 3rd Ed., Maibach, University of Calirfornia, San Francisco, CA, 2009
2.	P. K. Chattopadhyay, Herbal Cosmetics & Ayurvedic Medicines, (EOU), 1999.
3.	H. Panda, Herbal Cosmetics Handbook, 2004
4.	NIIR Board, Handbook on Herbal Products, (Medicines, Cosmetics, Toiletries, Perfumes)

<table>
<tr><td colspan="3">School: School of Science</td><td colspan="3">Program: B.Sc. Microbiology</td></tr>
<tr><td colspan="3">Course Code: MI304</td><td colspan="3">Course Name:
Microbiology Laboratory VI</td></tr>
<tr><td>Year</td><td>III</td><td>Core Subject (Yes/No):</td><td>Yes</td><td>Lecture:</td><td>-</td></tr>
<tr><td>Semester</td><td>VI</td><td>Elective Subject (Yes/No):</td><td>-</td><td>Tutorial</td><td>-</td></tr>
<tr><td rowspan="3">Mode of Transaction</td><td rowspan="3">Laboratory</td><td>Foundation Subject (Yes/No):</td><td>-</td><td>Practical:</td><td>8</td></tr>
<tr><td>Year of Syllabus Revision:</td><td>-</td><td>Total Credit:</td><td>4</td></tr>
<tr><td>Year of Introduction</td><td>2020</td><td>Prerequisites (If any)</td><td>-</td></tr>
</table>

Course Description:

This course deals with the pilot setup for production of secondary metabolites, its analysis and application.

Course Outcome (CO):

CO1: Fermentation process by bacteria and types and design of fermenters.
CO2: Identification of the microbes those are tolerant to extreme conditions.
CO3: Detection of antibiotic producers.
CO4: Identification, characterization of microbes of the food products.
CO5: Detection of amylase and protease producers.

No.	Experiment	Contact Hours	BT Level	CO	PSO
1	Fermenter design and requirements of microbial system	4	2, 3, 4, 5	CO1	PSO2
2	Demonstration of wine production using grape juice	4	2, 3, 4, 5	CO1	PSO2
3	Isolation of Amylase producers from the environment	4	2, 3, 4, 5	CO5	PSO2
4	Production and assaying of microbial proteases		2, 3, 4, 5	CO5	PSO2
5	Isolation of Antibiotic Producing Microbes from Soil	4	2, 3, 4, 5	CO3	PSO2
6	Isolation of psychrophiles from milk samples	4	2, 3, 4, 5	CO2	PSO2
7	Quantitative analysis of milk by standard plate count method	4	2, 3, 4, 5	CO4	PSO2
8	Enzymatic test of milk using methylene blue reductase test	4	2, 3, 4, 5	CO4	PSO2
9	Detection of bacteria in spoiled tinned food	4	2, 3, 4, 5	CO4	PSO2
10	Microbiological analysis of food products	4	2, 3, 4, 5	CO4	PSO2
11	Demonstration of microbiological production of curd	4	2, 3, 4, 5	CO4	PSO2
12	Detection of molds on food products	4	2, 3, 4, 5	CO4	PSO2
13	Isolation of salt tolerant microorganisms from food samples	4	2, 3, 4, 5	CO2	PSO2
14	Isolation of Sugar tolerant microorganisms from food samples	4	2, 3, 4, 5	CO2	PSO2

Reference Books	
1.	Practical Manual on Food and Industrial Microbiology by Anil Kumar Puniya and Shilpa Vij, Dairy Microbiology Division, National Dairy Research Institute, Karnal, Haryana
2.	Practical Microbiology by Dr. R.C. Dubey and Dr. D.K. Mahesh Wari, S Chand publication.

School: School of Science			**Program: B.Sc. Microbiology**		
Course Code: MI303			**Course Name:** **Microbiology Laboratory V**		
Year	**III**	**Core Subject (Yes/No):**	**Yes**	**Lecture:**	**-**
Semester	**VI**	**Elective Subject (Yes/No):**	**-**	**Tutorial**	**-**
Mode of Transaction	**Laboratory**	**Foundation Subject (Yes/No):**	**-**	**Practical:**	**8**
		Year of Syllabus Revision:	**-**	**Total Credit:**	**4**
		Year of Introduction	**2020**	**Prerequisites (If any)**	**-**

Course Description:
This course deals with the pilot setup for production of secondary metabolites, its analysis and application.

Course Outcome (CO):
CO1: Fermentation process by bacteria and types and design of fermenters.
CO2: Identification of the microbes those are tolerant to extreme conditions.
CO3: Detection of antibiotic producers.
CO4: Identification, characterization of microbes of the food products.
CO5: Detection of amylase and protease producers.

No.	Experiment	Contact Hours	BT Level	CO	PSO
1	Fermenter design and requirements of microbial system	4	2, 3, 4, 5	CO1	PSO2
2	Demonstration of wine production using grape juice	4	2, 3, 4, 5	CO1	PSO2
3	Isolation of Amylase producers from the environment	4	2, 3, 4, 5	CO5	PSO2
4	Production and assaying of microbial proteases		2, 3, 4, 5	CO5	PSO2
5	Isolation of Antibiotic Producing Microbes from Soil	4	2, 3, 4, 5	CO3	PSO2
6	Isolation of psychrophiles from milk samples	4	2, 3, 4, 5	CO2	PSO2
7	Quantitative analysis of milk by standard plate count method	4	2, 3, 4, 5	CO4	PSO2
8	Enzymatic test of milk using methylene blue reductase test	4	2, 3, 4, 5	CO4	PSO2
9	Detection of bacteria in spoiled tinned food	4	2, 3, 4, 5	CO4	PSO2
10	Microbiological analysis of food products	4	2, 3, 4, 5	CO4	PSO2
11	Demonstration of microbiological production of curd	4	2, 3, 4, 5	CO4	PSO2

12	Detection of molds on food products	4	2, 3, 4, 5	CO4	PSO2
13	Isolation of salt tolerant microorganisms from food samples	4	2, 3, 4, 5	CO2	PSO2
14	Isolation of Sugar tolerant microorganisms from food samples	4	2, 3, 4, 5	CO2	PSO2

Reference Books	
1.	Practical Manual on Food and Industrial Microbiology by Anil Kumar Puniya and Shilpa Vij, Dairy Microbiology Division, National Dairy Research Institute, Karnal, Haryana
2.	Practical Microbiology by Dr. R.C. Dubey and Dr. D.K. Mahesh Wari, S Chand publication.

NAVRACHANA UNIVERSITY
a UGC recognized University

Curriculum

School:	School of Science
Program Code:	163
Program Name:	BSc Chemistry
Academic Year:	2021-24

GLOSSARY:

Programme Outcomes (POs): POs are statements that describe what the students graduating from any of the educational Programmes of the institution should be able to do on completion.

Programme Specific Outcomes (PSOs): PSOs are statements that describe what the graduates of a specific educational Programme should be able to do on completion.

Course Outcomes (COs): COs are statements that describe what students should be able to do on completion of the course.

NOTE:

Programme Outcomes (POs): Programme Outcomes (POs) are what knowledge, skills and attitudes a graduate should have at the time of graduation. While as at present, no agency has formally defined the POs of General Higher Education in a 3-year degree Programmes in India, POs of all professional Programmes in engineering and other areas are identified at the national level, by the concerned accrediting agency. POs are not specific to a discipline.

Course Outcomes (COs): COs are statements that describe what students should be able to do at the end of a course. They can be 6±2 for courses with 2 to 4 credits, and 8±2 for courses with 5 to 6 credits.

Vision of School:
A premier Science School of Excellence in Research and Innovation

Mission of School:

- To focus on developing Undergraduate, Post-graduate and Doctoral Research
- Faculty Development and Empowerment
- Push for Innovation and Entrepreneurship through Industry and Academia connect
- To focus on social issues and society concerns through various activities at SOS and NUCERI

Programme Outcomes (POs):

PO1:	**Critical Thinking**: Take informed actions after identifying the assumptions that frame our thinking and actions, checking out the degree to which these assumptions are accurate and valid, and looking at our ideas and decisions (intellectual, organizational, and personal) from different perspectives.
PO2:	**Effective Communication**: Speak, read, write and listen clearly in person and through electronic media in English and in one Indian language, and make meaning of the world by connecting people, ideas, books, media and technology.
PO3:	**Social Interaction**: Elicit views of others, mediate disagreements and help reach conclusions in group settings.
PO4:	**Effective Citizenship**: Demonstrate empathetic social concern and equity centred national development, and the ability to act with an informed awareness of issues and participate in civic life through volunteering.
PO5:	**Ethics**: Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them.
PO6:	**Environment and Sustainability**: Understand the issues of environmental contexts and sustainable development.
PO7:	**Self-directed and Life-long Learning**: Acquire the ability to engage in independent and life-long learning in the broadest context socio-technological changes

Program Specific Outcome (PSO): CHEMISTRY

PSO1:	Understand the nature and basic concepts of physics, life sciences, mathematical sciences and their significance with respect to understanding fundamentals and applications of chemical sciences. Students will also acquire fundamental understanding of basic concepts of humanities, communication skills, critical thinking, accounts, intellectual property rights and principles of management.
PSO2:	Apply appropriate techniques for the qualitative and quantitative analysis of chemicals in laboratories and in industries. Acquires the ability to synthesize, separate and characterize compounds using laboratory and instrumentation techniques.
PSO3:	Students will have a firm foundation in the fundamentals and application of current chemical and scientific theories including those in Analytical, Inorganic, Organic, Physical, environmental, polymer and biochemistry.
PSO4:	Develops analytical skills and problem-solving skills requiring application of chemical sciences principles.
PSO5:	Students will appreciate the central role of chemistry in our society and use this as a basis for ethical behavior in issues facing chemists including an understanding of safe handling of chemicals, environmental issues and key issues facing our society in energy, health and medicine. Also, students will be able to explain why chemistry is an integral activity for addressing social, economic, and environmental problems.
PSO6	Students will also acquire basic understanding of research methodology and acquire research skills through research projects.

Course Structure

L = Lecture	**T = Tutorial**	**P = Practical**	**C = Credit**
number of hours per week	number of hours per week	number of hours per week	Total Credits

Semester	**I**	**II**	**III**	**IV**	**V**	**VI**	**Total**
Credits	22	24	23	27	27	26	149

Total Credits	**149**
Minor Specialization Credits	
Total Credits Including Minor	

CURRICULUM AND TEACHING SCHEME

Semester-I													
Teaching Scheme											**Elements of** Employability (Emp)/ Entrepreneurship (Ent)/ Skill Development (SD)	**Relevance to** Local (L)/ National (N)/ Regional(R)/ Global developmental needs (G)	**Relation to** Gender (G)/ Environment and Sustainability (ES)/ Human Values (HV)/ Professional Ethics (PE)
						Theory Course		**Practical Course**		**Total marks**			
Course Code	***Course Name***	**L**	**T**	**P**	**C**	**Internal Examination (%)**	**End semester Examination (%)**	**Internal Examination (%)**	**End semester Examination (%)**				
CH138	Inorganic Chemistry-I	3	0	0	3	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	
CH103	Chemistry Laboratory-I	0	0	2	2	-NA-	-NA-	60	40	100	Emp, SD	L, N, R, G	
BO103	Evolutionary Biology and Plant Kingdom	3	0	0	3	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	
BO104	Botany Laboratory II	0	0	1	1	-NA-	-NA-	60	40	100	Emp, SD	L, N, R, G	
ZO103	Classification of Animals I	3	0	0	3	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	
ZO104	Zoology Laboratory II	0	0	1	1	-NA-	-NA-	60	40	100	Emp, SD	L, N, R, G	
MA110	Foundation course in Mathematics I	3	0	0	3	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	
MG117	Principles of Management, Accounts	3	0	0	3	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	PE
LC 119	Communication I	3	0	0	3	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	PE
	Total Credits	**18**	**0**	**4**	**22**								
SEMESTER II													
CH139	States of Matter	3	0	0	3	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	
CH106	Chemistry Laboratory III	0	0	2	2	-NA-	-NA-	60	40	100	Emp, SD	L, N, R, G	

ZO107	Evolutionary Biology & Biotic Interactions	3	0	0	3	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	
ZO108	Zoology Laboratory IV	0	0	1	1	-NA-	-NA-	60	40	100	Emp, SD	L, N, R, G	
BO108	Angiosperm Morphology & Classification	3	0	0	3	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	
BO107	Botany Laboratory IV	0	0	1	1	-NA-	-NA-	60	40	100	Emp, SD	L, N, R, G	
MA117	Foundation course in Mathematics II	3	0	0	3	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	
MG108	Economics & Finance	3	0	0	3	-NA-	-NA-	60	40	100	Emp, SD	L, N, R, G	PE
HS106	Humanities	2	0	0	2	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	HV
LC120	Communication II	3	0	0	3	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	PE
	Total Credits	**20**	**0**	**4**	**24**								
SEMESTER III													
CH255	Organic Chemistry I	**3**	**0**	**0**	**3**	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	
CH 256	Inorganic Chemistry-II	**3**	**0**	**0**	**3**	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	
CH204	Chemistry Laboratory V	**0**	**0**	**3**	**3**	-NA-	-NA-	60	40	100	Emp, SD	L, N, R, G	
BO204	Plant Structural Biology & Physiology	**3**	**0**	**0**	**3**	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	
BO205	Botany Laboratory VI	**0**	**0**	**2**	**2**	-NA-	-NA-	60	40	100	Emp, SD	L, N, R, G	
ZO201	Ecology & Zoogeography	**3**	**0**	**0**	**3**	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	ES
ZO203	Zoology Laboratory VI	**0**	**0**	**2**	**2**	-NA-	-NA-	60	40	100	Emp, SD	L, N, R, G	
HR226	HR & Marketing I	**2**	**0**	**0**	**2**	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	PE
ID	University ID	**2**	**0**	**0**	**2**	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	PE, HV, ES
	Total Credits	**16**	**0**	**7**	**23**								
SEMESTER IV													
CH257	Organic Chemistry II	**3**	**0**	**0**	**3**	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	
CH258	Thermodynamics and Chemical Equilibrium	**3**	**0**	**0**	**3**	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	
CH209	Chemistry Laboratory VII	**0**	**0**	**3**	**3**	-NA-	-NA-	60	40	100	Emp, SD	L, N, R, G	
BO208	Plant Ecology, Genetics & Applied Botany	**3**	**0**	**0**	**3**	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	ES
BO210	Botany Laboratory VIII	**0**	**0**	**2**	**2**	-NA-	-NA-	60	40	100	Emp, SD	L, N, R, G	
ZO209	Comparative Anatomy & Physiology	**3**	**0**	**0**	**3**	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	
ZO211	Zoology Laboratory VIII	**0**	**0**	**2**	**2**	-NA-	-NA-	60	40	100	Emp, SD	L, N, R, G	

HR311	Introduction to HR & Marketing II	**2**	**0**	**0**	**2**	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	PE
ES201	Environmental Studies	**4**	**0**	**0**	**4**	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	PE, ES
ID	University ID	**2**	**0**	**0**	**2**	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	PE, HV, ES
	Total Credits	**20**	**0**	**7**	**27**								
SEMESTER V													
CH311	Organic Chemistry III	**3**	**0**	**0**	**3**	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	
CH302	Physical Chemistry II	**3**	**0**	**0**	**3**	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	
CH303	Spectroscopy & Separation Techniques	**3**	**0**	**0**	**3**	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	
CH304	Chemistry Laboratory IX	**0**	**0**	**4**	**4**	-NA-	-NA-	60	40	100	Emp, SD	L, N, R, G	
CH305	Chemistry Laboratory X	**0**	**0**	**4**	**4**	-NA-	-NA-	60	40	100	Emp, SD	L, N, R, G	
PS310	KHOJ	**3**	**0**	**0**	**3**	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	ES, HV, PE
PS322	Scientific Enquiry and research Methodology	**3**	**0**	**0**	**3**	-NA-	-NA-	-NA-	-NA-	100	Emp, SD	L, N, R, G	HV, ES, PE
Elective Courses (any two)													
SE201	Essential Laboratory Practices	**2**	**0**	**0**	**2**	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	
SE202	Food and Nutrition	**2**	**0**	**0**	**2**	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	
SE204	Intellectual Property Rights and Patents Law	**2**	**0**	**0**	**2**	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	
SE213	Introduction to Neuroscience and Cognition	**2**	**0**	**0**	**2**	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	
SE302	Medicinal Chemistry-I	**2**	**0**	**0**	**2**	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	
SE305	Introduction to cell /tissue culture	**2**	**0**	**0**	**2**	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	
SE307	Number Theory	**2**	**0**	**0**	**2**	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	
	Total Credits	**19**	**0**	**8**	**27**								
SEMESTER VI													
CH312	Inorganic Chemistry-III	**3**	**0**	**0**	**3**	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	
CH313	Electrochemistry and Photochemistry	**3**	**0**	**0**	**3**	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	
CH314	Organic Chemistry-IV	**3**	**0**	**0**	**3**	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	
CH309	Chemistry Laboratory-XI	**0**	**0**	**8**	**4**	-NA-	-NA-	60	40	100	Emp, SD	L, N, R, G	
CH310	Chemistry Laboratory-XII	**0**	**0**	**8**	**4**	-NA-	-NA-	60	40	100	Emp, SD	L, N, R, G	

MG321	Entrepreneurship	**3**	**0**	**0**	**3**	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	ES, HV, PE
	Project Work	**0**	**0**	**2**	**2**	-NA-	-NA-	-NA-	-NA-	100	Emp, SD	L, N, R, G	HV, ES, PE
Elective Courses (any two)													
SE208	Herbal Cosmetics	**2**	**0**	**0**	**2**	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	
SE210	Food and Nutrition-II	**2**	**0**	**0**	**2**	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	
SE218	Introduction to Polymer Science	**2**	**0**	**0**	**2**	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	
SE310	Introduction to Pharmacognosy	**2**	**0**	**0**	**2**	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	
SE311	Introduction to Paint Technology	**2**	**0**	**0**	**2**	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	
SE312	Medicinal Chemistry-II	**2**	**0**	**0**	**2**	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	
SE313	Green Chemistry	**2**	**0**	**0**	**2**	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	ES
SE314	Conservation Biology	**2**	**0**	**0**	**2**	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	ES
SE316	Bioinformatics	**2**	**0**	**0**	**2**	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	
SE319	Fuzzy Logic	**2**	**0**	**0**	**2**	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	
SE318	Introduction to forensic Science	**2**	**0**	**0**	**2**	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	
CH264	Industrial Hazards, Hygiene and Safety	**2**	**0**	**0**	**2**	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	ES, HV, PE
	Total Credits	**16**	**0**	**18**	**26**								

Core Elective Subjects (For example)

Course code	**Course Name**

Articulation Matrix COs and POs Mapping							
Semester-I	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
Inorganic Chemistry-I	√					√	√
Chemistry Laboratory-I	√					√	√
Evolutionary Biology and Plant Kingdom	√						
Botany Laboratory II	√						
Classification of Animals I	√						
Zoology Laboratory II	√						
Foundation course in Mathematics I	√						
Principles of Management, Accounts	√	√					
Communication I	√	√	√	√			
Semester-II	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
States of Matter	√						√
Chemistry Laboratory III	√						√
Evolutionary Biology & Biotic Interactions	√						
Zoology Laboratory IV	√						
Angiosperm Morphology & Classification	√						
Botany Laboratory IV	√						
Foundation course in Mathematics II	√						
Economics & Finance	√	√					
Humanities	√	√	√	√			
Communication II	√	√	√	√			√
Semester-III	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
Organic Chemistry I	√						√

Inorganic Chemistry-II	√						√
Chemistry Laboratory V	√						√
Plant Structural Biology & Physiology	√						
Botany Laboratory VI	√						
Ecology & Zoogeography	√		√			√	
Zoology Laboratory VI	√						
HR & Marketing I	√	√	√				
University ID	√	√	√	√		√	
Semester-IV	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
Organic Chemistry II	√						√
Physical Chemistry I	√						√
Chemistry Laboratory VII	√						√
Plant Ecology, Genetics & Applied Botany	√					√	
Botany Laboratory VIII	√						
Comparative Anatomy & Physiology	√						
Zoology Laboratory VIII	√						
Introduction to HR & Marketing II	√	√	√				
Environmental Studies	√		√	√		√	√
University ID	√	√	√	√		√	
Semester-V	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
Organic Chemistry III	√						√
Physical Chemistry II	√						√
Spectroscopy & Separation Techniques	√						√
Chemistry Laboratory IX	√						√

Chemistry Laboratory X	√						√
Essential Laboratory Practices	√					√	√
Food and Nutrition	√						√
Intellectual Property Rights and Patents Law	√					√	√
Introduction to Neuroscience and Cognition	√						
Medicinal Chemistry-I	√						√
Introduction to cell /tissue culture	√						
Number Theory	√						
KHOJ	√		√	√	√	√	√
Scientific Enquiry and research Methodology	√		√	√	√	√	√
Semester-VI	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
Inorganic Chemistry-III	√						√
Electrochemistry and Photochemistry	√						√
Organic Chemistry-IV	√						√
Chemistry Laboratory-XI	√						√
Chemistry Laboratory-XII	√						√
Herbal Cosmetics	√			√			√
Food and Nutrition-II	√			√			
Introduction to Polymer Science	√						
Introduction to Pharmacognosy	√			√			
Introduction to Paint Technology	√						√
Medicinal Chemistry-II	√			√			√
Green Chemistry	√			√		√	√
Conservation Biology	√			√		√	
Bioinformatics	√						

Fuzzy Logic	√						
Introduction to forensic Science	√						√
Entrepreneurship	√	√		√	√		√
Project Work	√	√		√	√		√
Industrial Hazards, Hygiene, and Safety	√	√		√	√		√

PSO's - PO's Mapping

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
PSO1	√	√		√	√		√
PSO2	√					√	√
PSO3	√					√	√
PSO4	√	√		√	√	√	√
PSO5		√		√	√	√	√
PSO6	√	√	√		√	√	√

Syllabus of Courses

Bloom's Taxonomy Levels (BT Level):

1. Remember 2. Understand 3. Application 4. Analysis 5. Evaluation 6. Creation

SEMESTER I

School: Science			**Program: B.Sc. (Chemistry)**		
Course Code: CH 138			**Course Name:** Inorganic Chemistry-I		
Year	**I**	**Core Subject (Yes/No):**	**Core**	**Lecture:**	**3**
Semester	**I**	**Elective Subject(Yes/No):**	**No**	**Tutorial**	**0**
Typology of Course	Lectures	**Foundation Subject(Yes/No):**	**No**	**Practical:**	**0**
		Year of Syllabus Revision:	**2019**	**Total Credit:**	**3**
		Year of Introduction	**2014**	**Prerequisites (If any)**	**12th Science**

Course Description:

In the first unit, the basics of quantum mechanics are discussed. It mainly deals with Schrödinger wave equation and its interpretation, shapes of orbitals – s, p, d orbitals etc. In the second unit the details of periodic properties are discussed and in addition, the comparative study of each block is discussed. The second unit deals with the concept of chemical bonding, hybridization and the factors affecting the same are elaborately discussed. The detailed study of Valence Shell Electron Pair Repulsion (VSEPR) theory and Valence Bond Theory (VBT) are also involved in the last section. The third unit deals with nuclear chemistry, it will give an idea about the fundamental particles of a nucleus, isotopes, natural abundance, stability of the nucleus, n/p ratio, mass defect and nuclear binding energy etc.

Course Objectives:

The course will provide you with the necessary skills to understand the theoretical basis of structure and bonding as well as the physical and chemical properties of inorganic compounds.

Course Outcome (CO):

CO1 Explain the importance of quantum chemistry in developing the model of the atom.

CO2 Understand the origin of Schrodinger wave equation and its application in calculating the energy and wave functions of various atomic and molecular systems.

CO3 Acquire competency to predict the patterns in the properties exhibited by the elements.

CO4 Understand the concept of chemical bonding and hybridization.

CO5 Understand the fundamentals of nuclear chemistry and their application in today's life.

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	**Unit-I: Atomic Structure and Quantum Mechanics:** Atomic Structure: Dual nature of radiation and matter, de Broglie's principle, Heisenberg's Uncertainty principle, Schrödinger wave equation and its interpretation, origin of quantum numbers and symbols for orbitals, shapes of orbitals – s, p, d. Radial and angular probabilities.	15	1,2,3,4,5	CO1 CO2	PSO1 PSO3 PSO4
2	**Unit-II: Chemical Bonding and Molecular Structure:** Ionic Bonding: Energy consideration in ionic bonding, Lattice Energy, and Solvation Energy and their importance in the context of Stability and Solubility of ionic compounds. Fajan's rule, Bond moment, dipole moment and percentage ionic character. Hydrogen Bonding.Covalent Bonding: Valence Shell Electron Pair Repulsion (VSEPR) theory and shapes of simple covalent molecules like H2O, NH3, BF3, CH4, PCI5, SF6, IF7.Valence Bond Theory (VBT) – assumptions, linear combination of atomic orbitals and properties of hybrid	15	1,2,3,4,5	CO2 CO3 CO4	PSO1 PSO3 PSO4

	orbitals. hybridization involving s, p and d orbitals (dsp2 , sp3d, dsp3 , d2 sp3 , sp3d 2 , sp3d 3) and shapes of simple molecules like SF6, IF5, PCl5, IF7. Molecular Orbital Theory (MOT) – Formation of bonding and antibonding molecular orbitals and bond order. Graphical representation of orbital energies (MO diagram). Bonding in homodiatomic molecules/ions like N2, F2, B2, C2, O2, O2- , O2+ with MO diagrams, relation between bond order and bond lengths, magnetic properties. Bonding in hetero – diatomic molecules/ions like CO, NO, NO+ and HX.				
3	**Unit-III: Nuclear Chemistry:** Fundamental particles of nucleus, isotopes, natural abundance, stability of nucleus, n/p ratio, mass defect and nuclear binding energy, Einstein's mass energy relationship. Natural radioactivity and disintegration rate, half-life, average life, artificial transmutation and radioactivity. Radioactive series. Nuclear reactions, nuclear fission, nuclear fusion, thermonuclear radiation. Applications of radioactivity in chemistry and industry.	15	1,2,3,4,5	CO5	PSO1 PSO3 PSO4

Reference Books	
1.	J. D. Lee, Concise Inorganic Chemistry, 5th Ed., Blackwell Science, London, 1996.
2.	F. A. Cotton, G. Wilkinson & P. L. Guas, Basic Inorganic Chemistry, 3rd Ed., John Wiley, 1994.
3.	B. R. Puri, L. R. Sharma & K. C. Kalia, Principles of Inorganic Chemistry, Shoban Lal Nagin Chand and Co., 1996.
4.	J. E. Huheey, E. A. Kieter& R. L. Keiter, Inorganic Chemistry, 4th Ed., Harper Collins, New York, 1993.
5.	D. F. Shriver & P. W. Atkins, Inorganic Chemistry, 3rd Ed., W. H. Freeman and Co, London, 1999.

School: School of science	**Program: B.Sc chemistry**
Course Code: CH 103	**Course Name:** Chemistry Laboratory-I

Year	**I**	**Core Subject (Yes/No):**	**Yes**	**Lecture:**	**0**
Semester	**I**	**Elective Subject (Yes/No):**	**NO**	**Tutorial**	**0**
Mode of Transaction	Laboratory	**Foundation Subject (Yes/No):**	**No**	**Practical:**	**4**
		Year of Syllabus Revision:	**2018**	**Total Credit:**	**2**
		Year of Introduction	**2014**	**Prerequisites (If any)**	**12th Science**

Course Description:

This laboratory course deals with Handson training of two distinct aspects of chemistry, (i) Titrimetric analysis and (ii) Organic qualitative analysis. Titrimetric analysis_section is dealing with quantitative chemical analysis, carried out to determine the concentration of a substance in given solution. Organic qualitative analysis includes the characterization and elucidation of unknown organic compounds.

Course Outcome (CO):

CO1 To understand the fundamentals of volumetric titrations specifically Acidimetry – Alkalimetry titrations

CO2 Describe the knowledge of the fundamentals of Redox Titrations, complexometric titrations in volumetric analysis for various analysis including water samples)

CO3 comprehended the Handson training related to Organic qualitative analysis.

CO4 Record observations and write laboratory reports according to disciplinary standards.

No.	Experiment	Contact Hours	BT Level	CO	PSO
1	Benzoic acid	2	1, 2, 3, 4, 5, 6	CO3, CO4	PSO1, PSO2
2	Cinnamic acid	2	1, 2, 3, 4, 5, 6	CO3, CO4	PSO1, PSO2
3	Phenol	2	1, 2, 3, 4, 5, 6	CO3, CO4	PSO1, PSO2
4	Benzaldehyde	2	1, 2, 3, 4, 5, 6	CO3, CO4	PSO1, PSO2
5	Cinnamaldehyde	2	1, 2, 3, 4, 5, 6	CO3, CO4	PSO1, PSO2
6	Benzophenone	2	1, 2, 3, 4, 5, 6	CO3, CO4	PSO1, PSO2
7	Acetone	2	1, 2, 3, 4, 5, 6	CO3, CO4	PSO1, PSO2
8	Acetophenone	2	1, 2, 3, 4, 5, 6	CO3, CO4	PSO1, PSO2
9	Acetanilide	2	1, 2, 3, 4, 5, 6	CO3, CO4	PSO1, PSO2
10	Methyl alcohol	2	1, 2, 3, 4, 5, 6	CO3, CO4	PSO1, PSO2
11	Aniline	2	1, 2, 3, 4, 5, 6	CO3, CO4	PSO1, PSO2
12	Nitrobenzene	2	1, 2, 3, 4, 5, 6	CO3, CO4	PSO1, PSO2
13	Acetamide	2	1,2,3,4,5	CO3, CO4	PSO1, PSO2

14	Benzamide	2	1, 2, 3, 4, 5, 6	CO3, CO4	PSO1, PSO2
15	Bromo benzene	2	1, 2, 3, 4, 5, 6	CO3, CO4	PSO1, PSO2
16	Sulphanilic acid	2	1, 2, 3, 4, 5, 6	CO3, CO4	PSO1, PSO2
17	Thiourea	2	1, 2, 3, 4, 5, 6	CO3, CO4	PSO1, PSO2
18	chlorobenzene	2	1, 2, 3, 4, 5, 6	CO3, CO4	PSO1, PSO2
19	Redox titration	2	1, 2, 3, 4, 5, 6	CO2, CO4	PSO1, PSO2
20	*Acidimetry-Alkalimetry titrations*	2	1, 2, 3, 4, 5, 6	CO1, CO4	PSO1, PSO2
21	Complexometric titration	2	1, 2, 3, 4, 5, 6	CO2, CO4	PSO1, PSO2

Reference Books	
1.	R. C. Shah, *Organic Analysis Part I Qualitative Analysis*, Baroda Book Depot, Vadodara, 2001
2.	A. I. Vogel, *Fundamentals of Quantitative Analysis*, 5th Ed., Addison Wesley longman., 1989.

School: School of Science			**Program: BSc – Chemistry**		
Course Code: BO103			**Course Name:** Evolutionary Biology and Plant Kingdom		
Year	**I**	**Core Subject(Yes/No):**	No	**Lecture:**	**3**
Semester	**I**	**Elective Subject(Yes/No):**	No	**Tutorial**	0
Typology of Course	Lectures	**Foundation Subject(Yes/No):**	Yes	**Practical:**	0
		Year of Syllabus Revision:	NA	**Total Credit:**	**3**
		Year of Introduction	**2014**	**Prerequisites (If any)**	12th Science

Course Description:

This course offers an evolutionary survey of the origin and diversification of land plants through geological time. The course will start with the green algae and on how plants may have transitioned from aquatic to the land environment. Land plants that will be discussed include bryophytes, lycophytes, pteridophytes, gymnosperms and angiosperms with emphasis on representative fossil and living taxa. Lectures will emphasize on life histories, anatomical and morphological adaptations, ecology and climate change, extinction, phylogenetics, economic importance, and conservation strategies of representative taxa.

Course Objectives:

- To introduce principles of evolution and population genetics.
- To understand the diversity of evolutionary lower plants and their success on the earth
- To gain a knowledge of morphology and anatomy different plant groups

Course Outcome (CO):

CO1: Gain basic understanding about principles of evolution and population genetics.
CO2: Learn morphology and anatomy of lower plant groups
CO3: Understand importance of the lower plant groups
CO4: Learn morphology and anatomy of higher plant groups
CO5: Understand importance of the higher plant groups

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	Account of origin of life, changes in atmosphere, theory of special creation. Chemical evolution: Primordial molecules, formation of biomolecules, sequential steps in chemical evolution, experimental evidence for chemical evolution: Miller's, Fox and Urey's experiments. Evidence for evolution: Fossilization, domestication, classification, comparative studies in Anatomy, Embryology, Physiology, Biochemistry, Genetics. Theories of evolution: Lamarck, Darwin, Mutation and Neo-Lamarckism, Neo-Darwinism and it's present understanding. Synthetic theory of evolution: Steps involved, chromosomal variation and Natural selection of organisms, environmental modifications.	15	1,2	CO1	PSO1
2	A general account on structure of Viruses and modes of reproduction A general account on structure of Bacteria. Gram Positive and Gram-Negative Bacteria. A general account of algae with emphasis on the significant characters and importance of the algae. Study of vegetative and reproductive structure of major algal groups. An account on the general characters of fungi and the basic criteria used in fungal taxonomy. Study of vegetative and reproductive structures of various groups of fungi. A General account on Lichens and their economic importance.	15	1,2	CO2, CO3	PSO1

3	An introduction to the Archegoniate with emphasis on general characters and adaptation to land habit. Concept of apogamy and apospory; experimental studies in Bryophytes and Pteridophytes. Characteristic features and classification of Bryophytes and Pteridophytes. Study of vegetative and reproductive structures of major types. Diversity, Distribution and important characters of Gymnosperms. Morphology of Vegetative and reproductive structures in different groups. Reproductive Mechanisms	15	1,2	CO4, CO5	PSO1

Reference Books	
1.	C.J. Alexopoulos, *Introductory Mycology* , 1968.
2	E.A. Bessey, *Morphology and Taxonomy of Fungi* , 1968.
3	H.C. Dubey, *An Introduction to Fungi* , 2005.
4	S.C. Gangulee, K. S. Das, C. D. Dutta & A. K. Kar, *College Botany* , Vol. – I, 1968.
5	N. S. Parihar, *Bryophyta*, 1956.
6	N. S. Parihar, *Pteridophyta*, 1955.
7	G. M. Smith, *Cryptogamic Botany* , Vol. – I & II, 1972.
8	B. R. Vasishtha, *Botany for Degree Students: Vol. – II Fungi*, 1962.
9	B. R. Vasishtha, *Botany for Degree Students: Vol. III Bryophyta* , 1963.
10	P. C. Vasishtha, *Botany for Degree Students: Vol.IV Pteridophyta* , 1971.

School: School of Science	**Program: BSc – Chemistry**
Course Code: BO104	**Course Name:** Botany Laboratory II

Year	**I**	**Core Subject(Yes/No):**	**No**	**Lecture:**	**0**
Semester	**I**	**Elective Subject(Yes/No):**	**No**	**Tutorial**	**0**
Typology of Course	Laboratory	**Foundation Subject(Yes/No):**	**Yes**	**Practical:**	**2**
		Year of Syllabus Revision:	**NA**	**Total Credit:**	**1**
		Year of Introduction	**2014**	**Prerequisites (If any)**	12th Science

Course Description:

Classification of Bacteria in general and Staining of Gram Positive and Gram-Negative Bacteria. Study of viruses and bacteria using electron micrographs (photographs). Study of Lichens through available type specimen or slides. Study of Algae through available type specimen or slides. Study of Fungi through available type specimens. Morphology (vegetative and reproductive structures) and anatomy of the Gymnosperms: Pinus and Gnetum.

Course Objectives:

- To gain basic understanding about living micro and macro-organisms.
- To know the Characteristic and the evolution in the plant kingdom
- To understand the Origin and journey of the plant from primitive to advanced.

Course Outcome (CO):

CO1: Understand morphology and anatomy of Bacteria
CO2: Understand morphology and anatomy of Fungi
CO3: Understand morphology and anatomy of Algae
CO4: Understand morphology and anatomy of Bryophytes
CO5: Understand morphology and anatomy of Pteridophytes

Unit No.	**Topic/Unit**	**Contact Hours**	**BT Level**	**CO**	**PSO**
3	Study of Gram Positive and Gram Negative Bacteria	2	1,2,3	CO1	PSO1
4	Study of mold fungi: Mucor	2	1,2,3	CO2	PSO1
3	Study of mushroom fungi: Agaricus	2	1,2,3	CO2	PSO1
4	Study of cyanobacteria: Nostoc	2	1,2,3	CO3	PSO1
5	Study of cyanobacteria: Rivularia	2	1,2,3	CO3	PSO1
6	Study of green algae: Volvox	2	1,2,3	CO3	PSO1
7	Study of brown algae: Sargassum	2	1,2,3	CO3	PSO1
8	Study of bryophyte: Riccia	2	1,2,3	CO4	PSO1
9	Study of bryophyte: Funaria	2	1,2,3	CO5	PSO1
10	Study of pteridophyte: Nephrolepis	2	1,2,3	CO5	PSO1

Reference Books	
1.	Practical Botany by Dr. Ashok Bendre -2010

School: School of Science				**Program: BSc – Chemistry**	
Course Code: ZO103				**Course Name: Classification of Animals-I**	
Year	**I**	**Core Subject (Yes/No):**	**No**	**Lecture:**	**3**
Semester	**I**	**Elective Subject (Yes/No):**	**No**	**Tutorial**	**0**
Typology of Course	**Lectures**	**Foundation Subject (Yes/No):**	**Yes**	**Practical:**	0
		Year of Syllabus Revision:	**NA**	**Total Credit:**	**3**
		Year of Introduction	**2014**	**Prerequisites (If any)**	12th Science

Course Description:
This course includes systematic classification system of animals. It has two units which gives in-depth understanding of general account of various phylum. Course provides characteristic features of different phylum based on which zoological classification is being done.

Course Objectives:
To introduce basics of zoological classification system of non-chordates and chordates.
To learn general characteristic features of various phylum.
To understand body organisation and physiology of organisms.

Course Outcome (CO):
CO1: Understanding of non-chordate classification.
CO2: Learn about general features of protozoa, porifera, cnidarian, nematode, Mollusca, annelida, arthropoda and Echinodermata.
CO3: Studying classification system of chordates.
CO4: Learning general characters of protochordata, pisces, amphibia, reptilian and aves.
CO5: Understanding about various accounts of mammals.

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	**Unit 1:** Non Chordates – I: General account of Non chordate body organization, Protozoa: General characters and classification. General account of Porifera: Cell types, canal system, skeleton, reproduction. General account of Cnidarian body organization, Coral reefs and their significance, Polymorphism in Cnidaria, Triploblastic body organization: types and formation of coelom. Nematoda general account. General account of different classes of Mollusca, torsion. General account of Annelida and Metamerism, General account of Arthropoda. General account of Echinodermata.	22	1,2	CO1, CO2,	PSO1
2	**Unit 2:** Chordates – I: Chordata: General characters. Protochordata: General characters. Vertebrata: General characters. Pisces: General characters. Amphibia: General characters. Reptilia: General characters. Aves: General characters. General account of Flightless Birds and their distribution, Migration in birds, Flight adaptations in birds. Mammalia: General characters. General account on Aquatic mammals. Placenta in mammals.	23	1,2	CO3, CO4, CO5	PSO1

Reference Books	
1.	A Manual of Zoology Vol. I&II, Ekambarnath Ayyar and Ananthakrishnan Viswanthan Pvt. Ltd. Madras.
2.	Chordate Zoology Jordan, E. L. and Verma, P.S, S. Chand & Co. New Delhi.

3.	Handbook of Indian Birds, S. Ali, BNHS-Oxford Press, Mumbai.
4.	Handbook of Indian Reptiles & Amphibians, J. C. Daniel, BNHS-Oxford Press, Mumbai.
5.	Hickman, C. P. Integrated principals of Zoology.
6.	Invertebrate Form & Function, E. J. W. Barrington, PHI, New Delhi.
7.	Invertebrate Zoology Jordan, E. L. and Verma, P.S, S. Chand & Co. New Delhi.
8.	Invertebrate Zoology, Dhami, P. S. and Dhami, J. K. S. Chand and Company..

School: School of Science			**Program: B.Sc. Chemistry**		
Course Code: ZO104			**Course Name: Zoology Laboratory-II**		
Year	**I**	**Core Subject(Yes/No):**	**No**	**Lecture:**	**0**
Semester	**I**	**Elective Subject(Yes/No):**	**No**	**Tutorial**	**0**
Mode of Transaction	**Laboratory**	**Foundation Subject(Yes/No):**	**Yes**	**Practical:**	**2**
		Year of Syllabus Revision:	NA	**Total Credit:**	**1**
		Year of Introduction	**2014**	**Prerequisites (If any)**	**12th Science**

Course Description:
This course introduces the general body organization and classification of animals. The habitat and the unique characteristics of each phylum would be discussed with examples which will help the students to classify and identify the animals. The process of making permanent slides (mounting) will also be taught to the students.

Course Outcome (CO):
CO1: To understand the basics of classification and the characteristics of invertebrates.
CO2: To understand each phyla of invertebrates with the help of an example.
CO3: To learn how to make permanent slides.

No.	Experiment	Contact Hours	BT Level	CO	PSO
1	Basics of classification and the characteristics of Invertebrates	2	1,2	CO1	PSO2
2	Phylum: Porifera and Coelenterata	2	1,2	CO1, CO2	PSO2
3	Phylum: Platyhelminthes and Aschelminthes	2	1,2	CO1, CO2	PSO2
4	Phylum: Annelida and Arthropoda	2	1,2	CO1, CO2	PSO2
5	Phylum: Mollusca and Echinodermata	2	1,2	CO1, CO2	PSO2
6	Permanent mounting of slides	2	1,2,3	CO3	PSO2

Reference Books

1	Invertebrate Zoology – Jordan and Verma
2	Practical Zoology Invertebrates - Verma

School: School of Science	**Program: B.SC (Chemistry)**
Course Code: MA110	**Course Name: Foundation in Mathematics**

Year	**I**	**Core Subject(Yes/No):**	**No**	**Lecture:**	**3**
Semester	**I**	**Elective Subject(Yes/No):**	**No**	**Tutorial**	**0**
Typology of Course	Lectures	**Foundation Subject(Yes/No):**	**Yes**	**Practical:**	**0**
		Year of Syllabus Revision:	**NA**	**Total Credit:**	**3**
		Year of Introduction	**2018**	**Prerequisites (If any)**	**12th Science**

Course Description:
The study contains introduction to functions of several variables, Differentiation of multivariate functions, concepts of limits and continuity and their application in Life science. It also gives the introductory data computation, computational methods involved in the calculations of simple and compound interest, profit-loss, discount, tax, variations(direct and inverse) etc.

Course Objectives:

- Introduce the concept of functions of single and multiple variables
- Teach the concept of differentiability and it's applications to biological/chemical sciences
- Teach the arithmetical methods involved in the calculations of simple and compound interest, profit and loss, discount, taxes, direct and inverse variations etc.

Course Outcome (CO):

CO1	Understand the concept of functions of single and multiple variables
CO2	Internalize definitions of Limits, Continuity and Differentiability
CO3	Differentiate functions of single and multiple variables
CO4	Apply concepts of percentage, profit loss, discount and taxes to real life problems
CO5	Understand direct and inverse variations and solve problems
CO6	Understand growth in terms of simple and compound interest
CO7	Solve time and work problem

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	Functions of two variables, Domain and range of functions of two variables	6	1,2,3	CO1	PSO1
2	Limits and Continuity functions of two variables.	5	1,2,3,4	CO2	PSO1
3	Differentiability, Chain rule, Implicit differentiation	10	1,2,3,5	CO3	PSO1
4	Taylor's theorem for functions of two variables.	6	1,4,5	CO3	PSO1
5	Slightly advanced problems involving applications on percentages, profit & loss, overhead expenses, Discount, tax, Difference between simple and compound interest, Arriving at the formula for compound interest through patterns and using it for simple problems	10	1,3,4,5	CO4, CO5, CO6	PSO1
6	Direct variation, Inverse variation, Time & work problems	8	1,3,4,5	CO6, CO7	PSO1

Reference Books

1.	Apostol T.M., 1967, *Calculus,* Vol. II, IInd Edition, John Willey, New York
2.	Narayan Shanti and Mittal P.K., 1979, *A Course of Mathematical Analysis*, 12th Edition. S. Chand and Co
3.	Spiegel M.R., *Advanced Calculus,* Schaum Series
4.	Widder D.V., 1944, *Advanced Calculus,* IInd Edition, Prentice Hall of India, New Delhi.
5.	James T. Shea, 1991.*Basic Essentials of Mathematics, Book 2: Percent, Measurement & Formulas, Equations, Ratio & Proportion*, sold by Amazon.com
6.	Silvio Belli, Stephen R. Wassell, Kim Williams.,2007. *On ratio and proportion: the common properties of quantity Nexus, architecture and mathematics*. Kim Williams Books, 2002

School: School of Sciences	**Program: Data Science**
Course Code:LC119	**Course Name: Communication I**

Year	**I**	**Core Subject(Yes/No):**	**No**	**Lecture:**	**02**
Semester	**I**	**Elective Subject(Yes/No):**	**No**	**Tutorial**	**0**
Typology of Course	Lectures	**Foundation Subject(Yes/No):**	**Yes**	**Practical:**	**0**
		Year of Syllabus Revision:	**NA**	**Total Credit:**	**02**
		Year of Introduction	**2018**	**Prerequisites (If any)**	**Knowledge of basic grammar components and vocabulary.**

Course Description:

This Communication course is conceptualized as a course aimed at enhancing English language as a tool of learning and English language as a tool of communication in a professional context. It offers a framework for English language proficiency required of a student in academic work in general as well as in discipline specific perspective. As a tool of learning, the four skills of language and learning: listening, speaking, reading, and writing are practiced. The practice of communication in the professional context deals with understanding the mechanics of language. The focus is on building the language skills required in discipline specific areas. It is a workshop-based course providing hands-on experience to learners. This course focuses largely on training the students in writing and speaking proficiency, usage of English language in academic context as well as preparing them for the outside world of work.

Course Objectives:

- Develop their overall listening, speaking, reading and writing skills,
- Develop knowledge of vocabulary and grammar,
- Read and comprehend texts of varying length at basic/low intermediate level.
- Understand and use effective writing skills to express ideas/give information.
- Develop students' general capacity to a level that enables them to use English for their academic and professional requirements.

Course Outcome (CO):

CO1 Explain the prerequisites of effective communication

CO2 Identify people’s communication styles and needs

CO3 Summarize a passage of text in their own words highlighting the embedded ideas, facts, supportive arguments

CO4 Describe the need for Emotional Intelligence in professional settings.

CO5 Make effective presentations with appropriate verbal and non-verbal communication.

CO6 Explain the importance of information acquisition, processing and dissemination.

CO7 Justify the importance of Knowing and upholding the policies, laws and regulations relevant to professional practice regardless of personal views.

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	Comprehension Paragraphs writing including all grammar Paraphrasing and notetaking Revision of all Communication skills – LSRW with activities Communication skills - Precis / Abstract writing Letter Writing – formal, informal. Digital Literacy, Use of social media Report Writing		1 2 3 4 5	CO1 CO2 CO3 CO4 CO5 CO6 CO7	PSO1 PSO3
2	Professional skills - A Resume writing,		1,2,3,4,5	CO1 CO2	PSO3

	Interview and Group Discussion			CO4	
3	**Professional skills B –** Presentation, Oral presentation • Preparation • Using the report as guideline • Formulating the central message • Arranging the ideas, facts and supportive arguments • Making a positive impact (appearance, gestures, eye contact, body language, style of speaking) • Effective use of visual aids y (types of visual aid equipment, using the equipment correctly) • Maximizing delivery (fielding questions, managing answers, handling difficult situations, short talk guidelines, impromptu sessions) • Practical Session: Delivery of a two-minute presentation (each delegate delivers a presentation on a particular aspect of the technical report)		1,2, 3, 4,5	CO1 CO2 CO3 CO4 CO5 CO6	PSO2 PSO3
4	SOCIAL SKILLS Leadership and Management skills		1, 2, 3,4	CO1 CO2 CO4 CO7	PSO3

Reference Books	
1.	John Seely; **Oxford Guide to Effective Writing and Speaking**; Oxford University Press; 2009 Ed
2.	L. Gartside; **Modern Business Correspondence**; The English Language Book Society and Macdonald and Evans Ltd.
3.	Lester and Beason; **The McGraw Hill Handbook of English Grammar and Usage**; Tata McGraw Hill Education Private Limited; 2010 Ed
4.	Ellet, William; **The case Study Handbook**; Harvard Business Review Press
5.	Bovee, Thill and Chaturvedi; **Business Communication Today;** Pearson Education; 2009 9TH ed
6	Scot Ober; **Contemporary Business Communication**; Biztantra Publications; 2009 5th ed.
7	Inch. E.S. & Warnick Barbara; **Critical Thinking and Communication**; Perason;2011 ed.
8	Herrmann Robert Ned; **The Whole Business Brain**; McGraw-Hill, 1998.
9	Clemen, T Robert; **Making Hard Decisions**; Duxbury Press, 1996

School: School of Science	**Program: BSc Chemistry**
Course Code: MG117	**Course Name:** Principles of Management and Accounting

Year	**I**	**Core Subject(Yes/No):**	**No**	**Lecture:**	**3**
Semester	**I**	**Elective Subject(Yes/No):**	**No**	**Tutorial**	**0**
Typology of Course	Lectures and Tutorials	**Foundation Subject(Yes/No):**	**Yes**	**Practical:**	**0**
		Year of Syllabus Revision:	**NA**	**Total Credit:**	**3**
		Year of Introduction	**2014**	**Prerequisites (If any)**	**12th Science**

Course Description:
The course outline has been designed to serve the purpose of understanding basics of management and accounting

Course Objectives:
The overall all objective of this course is to educate students about the management as an activity and have a holistic approach to the concept. Accountancy basics are the requirement of the generation.

Course Outcome (CO):
CO1 Become an efficient learner of management
CO2 Develop and understand methods of management.
CO3 Gain knowledge managing finance through Accounts

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	Unit 1- Management Basics, Management theories, Process of management, Managers qualities	11	1,2	CO1	PSO1
2	Unit 2- Evolution of Management, Functions - Planning Planning process, Decicion making, PRINCIPLES OF ORGANISATIONS, COORDINATION AND CONTROLLING, Directing	11	1,2,3	CO1, CO2	PSO1, PSO2
3	Unit 3- Accounting Basics, Rules of accounting, Principles Accounting process, Journal, Journal enteries, Ledger, Trial Balance	11	2, 3, 4	CO1,CO3	PSO1, PSO2
4	Unit 4- Financial Statements, Books of accounts, Profit and loss statement, Balance sheet, Analysis	12	1, 2, 3	CO3	PSO1, PSO2, PSO4
Reference materials					
	Principles of Management Book by Dan Voich and Daniel A. Wren				
	ICAI ONLINE PDF				

SEMESTER II

School: Science			**Program: B.Sc. (Chemistry)**		
Course Code: CH 139			**Course Name:** States of Matter		
Year	**I**	**Core Subject(Yes/No):**	**Core**	**Lecture:**	**3**
Semester	**II**	**Elective Subject(Yes/No):**	**No**	**Tutorial**	**0**
Typology of Course	Lectures	**Foundation Subject(Yes/No):**	**No**	**Practical:**	**0**
		Year of Syllabus Revision:	**2020**	**Total Credit:**	**3**
		Year of Introduction	**2014**	**Prerequisites (If any)**	**12th Science**

Course Description:
This course illustrates different states of matter such as gaseous, liquid, solid states etc. Gaseous state includes the fundamentals as well as Maxwell distribution of molecular velocity, deviation from ideal behaviour, critical phenomenon, Joule Thompson effect and Inversion Temperature etc. Surface tension and Viscosity Effect of temperature on surface tension and coefficient of viscosity of a liquid are included in the second unit. The last unit is mainly based on the solid-state chemistry and a little description of other states and their applications therein.

Course Objectives:
Students can Illustrate how a scientific model can be constructed based on the experimental observations of the behaviour of gases and to explain the properties in terms of microscopic organization. explain the properties liquid state using intermolecular forces and to differentiate the colloidal state from true solutions in terms of size of the particles and to relate this attribute with their properties with the number of particles to the colligative properties. Explain different structures of solid based on solid states' chemistry.

Course Outcome (CO):

CO1 Ability to understand the weak forces of interaction amongst gaseous molecules.

CO2 Explore the different theories to understand the gaseous molecule's chemistry.

CO3 Ability to use a variety of theories to understand important properties of liquid state.

CO4 Grasp the concepts of Solid-state chemistry and their applications in exploring morphology of solid materials.

CO5 Ability to understand the Colloidal and emulsion state of materials.

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	**Unit-I: Gaseous State:** Derivation of Kinetic gas equation, deduction of simple problems on – root mean square velocity, most probable velocity, collision frequency, collision diameter, mean free path heat capacity of gases, Maxwell distribution of molecular velocity (Derivation not required). Deviation from ideal behaviour, Van der Waals equation, critical phenomenon, Law of corresponding states, Reduced Equation of states, Joule Thompson effect and Inversion Temperature, Methods of Liquefaction of gases – Faraday's, Linde's, and Claude's method.	15	1,2,3,4,5	CO1 CO2	PSO1 PSO2 PSO3 PSO4
2	**Unit-II Liquid State:** Qualitative treatment of the structure of liquids, Definition and determination of Surface tension and Viscosity Effect of temperature on surface tension and coefficient of viscosity of a liquid (qualitative treatment) Parachor – determination and application	5	1,2,3,4,5	CO3	PSO1 PSO2 PSO3 PSO4
3	**Unit-III Solid State:** Symmetry elements, unit cells, crystal systems. Laws of crystallography-Law of constancy of interfacial angles. Law of rational indices. Miller indices X-Ray diffraction by crystals. Bragg's law. Structure of NaCl, KCl and CsCl (qualitative treatment only). Defects in crystals	10	1,2,3,4,5	CO4	PSO1 PSO2 PSO3 PSO4

4	**Unit-IV Colloids and Liquid crystals:** Colloidal State, Classification of colloids, Preparation and purification of sols, Stability of sols, Schulze-Hardy rule, Gold Number. Emulsions, gel and foam. Association colloids, Surfactants, Micelle formation and critical micelle concentration, Action of soap. Applications. Mesomorphic state: Difference between liquid crystal, liquid and solid. Classification and structure of nematic, smectic and cholesteric phases. Non-conventional liquid crystals. Applications.	15	1,2,3,4,5	CO5	PSO1 PSO2 PSO3 PSO4

Reference Books	
1.	B. R. Puri& L. R. Sharma, Principles of Physical Chemistry, Shoban Lal Nagin Chand and Co. 33rd Ed., 1992
2.	Arther Adamson, A Textbook of Physical chemistry, 2nd Ed., Academic Press, New York, 1979
3.	ArunBahl, B. S. Bahl& G. D. Tuli, Essentials of Physical Chemistry, S. Chand and Sons, New Delhi, 2010.
4.	S. H. Maron& J. F. Prutton, Principles of Physical Chemistry, 4th Ed., Oxford and IBH, New Delhi, 1972.
5.	P.W. Atkins, Physical chemistry, Oxford University Press, 1978.

School: School of Science		**Program: B.Sc. Chemistry**			
Course Code: CH 106		**Course Name: Chemistry Laboratory-IV**			
Year	**I**	**Core Subject(Yes/No):**	**Yes**	**Lecture:**	**0**
Semester	**II**	**Elective Subject(Yes/No):**	**No**	**Tutorial**	**0**
Mode of Transaction	Laboratory	**Foundation Subject(Yes/No):**	**No**	**Practical:**	**2**
		Year of Syllabus Revision:	2018	**Total Credit:**	**1**
		Year of Introduction	2014	**Prerequisites (If any)**	**12th Science**

Course Description:
Semi-micro qualitative analysis of Inorganic compounds containing single salt.

Course Outcome (CO):
CO1 Identify unknown radicals in a given inorganic salt
CO2 understand the basic concepts associated with separation and identification of radicals

No.	Experiment	Contact Hours	BT Level	CO	PSO
1	CdCl2	2	1,2,3,4,5	CO1, CO2	PSO2, PSO3
2	KCl	2	1,2,3,4,5	CO1, CO2	PSO2, PSO3
3	CuSO4	2	1,2,3,4,5	CO1, CO2	PSO2, PSO3
4	NH4Cl	2	1,2,3,4,5	CO1, CO2	PSO2, PSO3
5	MnCl2	2	1,2,3,4,5	CO1, CO2	PSO2, PSO3
6	FeSO4	2	1,2,3,4,5	CO1, CO2	PSO2, PSO3
7	BaCl2	2	1,2,3,4,5	CO1, CO2	PSO2, PSO3
8	Sr (NO3)2	2	1,2,3,4,5	CO1, CO2	PSO2, PSO3
9	CaCl2	2	1,2,3,4,5	CO1, CO2	PSO2, PSO3
10	Na3PO4	2	1,2,3,4,5	CO1, CO2	PSO2, PSO3
11	Pb (NO3)2	2	1,2,3,4,5	CO1, CO2	PSO2, PSO3
12	NaBr	2	1,2,3,4,5	CO1, CO2	PSO2, PSO3
13	MgCO3	2	1,2,3,4,5	CO1, CO2	PSO2, PSO3

Reference Books	
1.	R. C. Shah, Ino*rganic Analysis Part I Qualitative Analysis*, Baroda Book Depot, Vadodara, 2001
2.	J. Mendham, R. C. Denney, J. B. Barnes & M. J. K. Thomas, Vogel's Textbook of Quantitative Chemical Analysis, 6th Ed., Pearson Education, New Delhi, 2003.

School: School of Science	**Program: BSc Chemistry**
Course Code: ZO107	**Course Name: Evolutionary Biology and Biotic interactions**

Year	**I**	**Core Subject(Yes/No):**	**No**	**Lecture:**	**3**
Semester	**II**	**Elective Subject(Yes/No):**	**No**	**Tutorial**	**0**
Typology of Course	Lectures and Tutorials	**Foundation Subject(Yes/No):**	**Yes**	**Practical:**	**0**
		Year of Syllabus Revision:	**NA**	**Total Credit:**	**3**
		Year of Introduction	**2014**	**Prerequisites (If any)**	**12th Science**

Course Description:
This Course describes the basics of evolution, formation of earth and origin of life; basic theories of evolution and basic processes of interaction between abiotic and biotic factors and adaptation in organisms.

Course Objectives:
This course will examine principles of biological evolution. Topics include evolutionary genetics, adaptation and natural selection, the fossil record, speciation and macroevolution.

Course Outcome (CO):
CO1: Understand the concept of evolution
CO2: Gain knowledge about the contributions of great evolutionary biologist.
CO3: Understand the basic life processes.
CO4: Understanding the concept of adaptation by various organisms to survive in extreme conditions.
CO5: Explain concept of plant and animal interactions among themselves and with others.

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	**Unit 1: Origin of life on earth:** Physical Evolution and Chemical Evolution, Organic Evolution and Origin of Metabolism - Anaerobism to Aerobism, Origins of Darwinian Evolutionary Theory, Pre-Darwinian Ideas and Neo-Darwinism, Theory of Natural Selection, Modeling of Molecular Evolution and Carbon Dating Technique	15	1, 2, 4	CO1 CO2 CO3	PSO1 PSO5
2	**Unit 2: Evolution:** Microevolution: Genetic Variation and change within Species, Macroevolution: Major Evolutionary Events – Speciation & Extinction, Tetrapod Evolution from Fishes, Significance of Dipnoans & Coelocanths, Evolution of Reptiles and their success as true land vertebrates, Evolution of Birds and Mammals – need for Homeothermism, Hominid Evolution	15	1, 2, 3, 4, 5, 6	CO3 CO4	PSO1 PSO5
3	**Unit 3: Biotic Interactions:** Morphophysiological Adaptations for life in water: Hydrophytes, Halophytes, Planktons and Nektons, Pelagic and Benthic forms, Inter-tidal forms, Oceanic forms and Deep Sea animals Morphophysiological Adaptations for Terrestrial Life: Mesophytes, Epiphytes, Cursorial, Fussorial, Scansorial and Volant Adaptations, Aerial Adaptations. Adaptations under extreme conditions: Life in Polar Regions, Life in Desert. Colouration and Mimicry, Bioluminiscence, Chemiluminiscence and Electric Organs, Echolocation, Plant – Plant Associations: Mutualism, Competition and Parasitism, Plant – Animal Associations: Herbivory, Pollination, Seed dispersion, Pests and Parasitism, Animal – Animal Associations: Mutualism, Commensalism, Ammensalism, Parasitism, Competition and Predation.	15	1, 2, 4	CO3 CO4 CO5	PSO1 PSO3 PSO4 PSO5

Reference Books	
1.	Reece, Jane B., Taylor, Martha R.,Simon, Eric J., Dickey, Jean L., Hogan, Kelly.(2016). Campbell Biology: Concepts & connections. 4th ed., Essex, Pearson Education Ltd
2.	Verma, P.S., Agarwal, V.V.K., (2008). Cell biology, genetics, molecular biology, evolution and ecology, New Delhi, S.Chand.
3.	Cox, Michael M., Nelson, David L., (2008). Principles of biochemistry. 5th ed., New York: W. H. Freeman and Company.
4.	Satyanarayana, U, Chakrapani, U., (2013). Biochemistry- with clinical concept & case studies, 4th. ed., Elsevier India Pvt. Ltd.
5.	Ferrier, Denise R., (2014). Lippincott`s illustrated reviews: Biochemistry. 6th ed., New Delhi: Wolters kluwer pvt. Ltd.
6.	Prasanthrajan, M. Mahendran,P.P. A text book on ecology & environmental science. Udaipur: Agrotech Publishing Academy.
7.	Rajagopalan, R. Basics of environmental studies. New York: Oxford University Press.

School: School of Science	**Program: BSc Chemistry**
Course Code: ZO108	**Course Name: Zoology Laboratory III**

Year	**II**	**Core Subject (Yes/No):**	**No**	**Lecture:**	**0**
Semester	**II**	**Elective Subject (Yes/No):**	**No**	**Tutorial**	**0**
Typology of Course	Laboratory	**Foundation Subject (Yes/No):**	**Yes**	**Practical:**	**2**
		Year of Syllabus Revision:	**NA**	**Total Credit:**	**1**
		Year of Introduction	**2014**	**Prerequisites (If any)**	**12th Science**

Course Description:

Students will gain the knowledge regarding biotic and abiotic interaction practically during field visit. Basic soil and water parameter will be going to be evaluated for different samples. Students will gain the knowledge of fossilization by observing fossil in lab and also learn evolution and geological time scale by charts and models.

Course Objectives:

The students will be able to relate the role of abiotic factors with the living of wild animals and their importance in completing the life cycle.

Course Outcome (CO):

CO1: Understand Biotic and abiotic interaction

CO2: Learn Soil and water analysis

CO3: Understand Fossilization, Evolution and Geological time scale

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	To study Biotic and Abiotic factors	10	1,2,3	CO1	PSO1
2	To determine CaCO3 in soil contain	4	2,3,4	CO2, CO3	PSO1
3	To determine Soil pH.	4	2,3,4	CO2	
4	To determine water holding capacity of different types of soil.	4	2,3,4,5	CO2	PSO1
5	To study Soil structure.	4	2,3,4	CO2 CO3	PSO1
6	To study Geological time scale	4	1,2,3	CO3	PSO1

Reference Books

1.	Ecology Lab Manual , Book by Darrell S. Vodopich , 2009
2.	Ecology and environmental parameters, S.K. Maitri, 2006

School: School of Science	**Program: BSc Chemistry**
Course Code: BO108	**Course Name:** Angiosperm Morphology and Classification

Year	**I**	**Core Subject(Yes/No):**	No	**Lecture:**	**3**
Semester	**II**	**Elective Subject(Yes/No):**	No	**Tutorial**	0
Typology of Course	Lectures	**Foundation Subject(Yes/No):**	Yes	**Practical:**	0
		Year of Syllabus Revision:	NA	**Total Credit:**	**3**
		Year of Introduction	**2014**	**Prerequisites (If any)**	12th Science

Course Description:

This course helps to develop a recognition and appreciation for the role of plant structure in modification and adaptation of form involved in the evolution of the land plants. This course combines study of reproductive development and morphological characters. Plants are examined by major groups as a means of understanding the diversity of vascular plants.

Course Objectives:

- To gain a knowledge of morphology of angiosperms
- To be trained to identify and classify plants

Course Outcome (CO):

CO1: Learn about basic morphology of vegetative parts of plants
CO2: Understand special adaptation acquired by vegetative parts of plants
CO3: Learn about basic morphology of reproductive parts of plants
CO4: Understand special adaptation acquired by reproductive parts of plants
CO5: Gain knowledge about plant classification

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	Root: Different regions and general functions, types of root systems. Stem: Various parts, normal functions (Different types of buds, vegetative and reproductive, branching of stem and forms of stem. Leaf: Structure, duration and normal functions. Simple and compound leaves and morphological variation in parts of leaves. Seed: Definition, structure and types.	15	1,2	CO1, CO2	PSO1
2	Bracts, peduncle and inflorescence: Basic types and functions. Flower: Structure of a typical flower, definition and examples of different types of flowers. Introduction to the floral whorls and their significance. Diversity of forms in different floral whorls. Fruits: Definitions of true, false and parthenocarpic fruits. Major types of fruits.	15	1,2	CO3, CO4	PSO1
3	Angiosperms: Unique features of angiosperms and diversity; identification, nomenclature and classification (Bentham & Hooker's system); primitive and advanced features; the international code of botanical nomenclature. Angiosperm Families: Major angiosperm families. Detailed account of Brassicaceae, Malvaceae, Rutaceae, Fabaceae, Asteraceae, Solanaceae, Lamiaceae, Euphorbiaceae and Liliaceae.	15	1,2	CO5	PSO1

Reference Books	
1.	M. Daniel, Taxonomy – Evolution at work , 2009.

School: School of Science	**Program: BSc – Chemistry**
Course Code:BO107	**Course Name:** Botany Laboratory IV

Year	**I**	**Core Subject(Yes/No):**	**No**	**Lecture:**	0
Semester	**II**	**Elective Subject(Yes/No):**	**No**	**Tutorial**	0
Typology of Course	Laboratory	**Foundation Subject(Yes/No):**	**Yes**	**Practical:**	**2**
		Year of Syllabus Revision:	**NA**	**Total Credit:**	**1**
		Year of Introduction	**2014**	**Prerequisites (If any)**	12th Science

Course Description:

This course deals with Taxonomy, adaptation and association of plants. Students will gain the knowledge regarding different morpho-physiological adaptations for life in different habitats with relevant examples. They will learn the different ways plants associate with each other and with their surroundings practically. They will gain the knowledge regarding the locally available plants and their adaptive features.

Course Objectives:

- To be able to analyze different structural and physiological adaptations.
- To know how plants associate with each other and cope up with the environment.
- To understand the concept of evolution, natural selection and mutation and how these helped in the formation of new species.
- To be able to perform basic taxonomic practices like preparation and preservation of Herbarium Sheet

Course Outcome (CO):

CO1: Understand different types of roots
CO2: Understand different types of stem
CO3: Understand different characters of leaves
CO4: Understand various kinds of buds, parts of the flower and types of inflorescences
CO5: Understand various types of fruits, seed types
CO6: Understand the classification, distinguishing characters, diagnostic characters, LS flower, T.S Ovary, floral formula

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
5	To study different types of root	2	1,2,3	CO1	PSO1
6	To study different types of stem	2	1,2,3	CO2	PSO1
3	To study different characters of leaves	2	1,2,3	CO3	PSO1
4	To study various kinds of buds, parts of the flower and types of inflorescences	2	1,2,3	CO4	PSO1
5	To study types of fruits, seed types	2	1,2,3	CO5	PSO1
6	To study the classification, distinguishing characters, diagnostic characters, LS flower, T.S Ovary, floral formula and any 5 economically important plants each of families mentioned in the theory.	2	1,2,3	CO6	PSO1
7	Field visit to study morphological characters of the plants	2	1,2,3	CO1 – CO6	PSO1

Reference Books	
1.	Practical Botany by Dr. Ashok Bendre -2010

School: Science	**Program:** BSc Chemistry
Course Code: MA117	**Course Name:** Foundation Course for Mathematics-II

Year	**I**	**Core Subject(Yes/No):**	**No**	**Lecture:**	**3**
Semester	**II**	**Elective Subject(Yes/No):**	**No**	**Tutorial**	**0**
Typology of Course	Lectures and Tutorials	**Foundation Subject(Yes/No):**	**Yes**	**Practical:**	**0**
		Year of Syllabus Revision:	**NA**	**Total Credit:**	**3**
		Year of Introduction	**2014**	**Prerequisites (If any)**	**12th Science**

Course Description:
The study contains Introduction of Integration and its application in Life science. Its also gives the introductory statistics.

Course Objectives:
1. Develop understanding of fundamentals of Integral Calculus
2. Understand the importance of Calculus
3. Understand and apply different statistical methods for data analysis

Course Outcome (CO):

CO1	Able to understand the fundamentals of Integral Calculus
CO2	Able to calculate integration for different types of functions
CO3	Able to calculate Area, volume for 2D, 3D figures
CO4	Able to apply different statistical methods for data analysis

Unit No.	**Topic/Unit**	**Contact Hours**	**BT Level**	**CO**	**PSO**
1	Simple Integrations Introduction to Integration Formulas in Integration Simple sums related to Integration	15	1	CO1, CO2	PSO1
2	Area and Volume Finding areas and surface areas for two dimensional figures Finding Volume for three dimensional figures	10	2	CO3	PSO1
3	Introduction to Statistics Bar Graph, Histogram, Box plot, Scatter plot, Mean, Median, Mode, Range, Variance, Standard deviation, Skewness, Kurtosis	20	3, 4	CO4	PSO1 PSO2

Reference Books	
1.	Spiegel M.R., Advanced Calculus, Schaum Series.
2.	Hogg R. V. & Craig A. T. 1988) : Introduction to Mathematical Statistics, Mcmillan.
3.	Mood A. M & Graybill F. A & Boes D. G (1974) : Introduction to theory of Statistics, Mcgraw Hill.

School: School of Science		**Program: Bachelor of Science**			
Course Code: HS 106		**Course Name: Humanities**			
Year	**I**	**Core Subject(Yes/No):**	**No**	**Lecture:**	**2**
Semester	**II**	**Elective Subject(Yes/No):**	**No**	**Tutorial**	**0**
Typology of Course	Lectures	**Foundation Subject(Yes/No):**	**Yes**	**Practical:**	**0**
		Year of Syllabus Revision:	**2020, 2021**	**Total Credit:**	**2**
		Year of Introduction	**2019**	**Prerequisites (If any)**	**12th Science**

Course Description:

The Course on Humanities entails the study of the human world and society from a critical perspective. The Humanities Course provides a broad understanding of the world in which we live, and how people can participate as active and informed citizens with the skills needed for the 21st century. The course focuses on the relationship between education, technology and society. The course also makes students aware about the theories and approaches to learning in view of 21st century requirements. The Course highlights the need to develop an understanding of ethical considerations and the implications of decisions that are made for individuals, society, the economy and the environment.

Course Objectives:

1. To enable students to understand the impact of education on the Individual and society.
2. To enable students to understand the interdependence between education and society.
3. To make students aware about the theories and approaches to learning in view of 21st century requirements.
4. To enable students to identify the impact of technology on their life and society.
5. To enable students to develop the skill of ethical reasoning and/or ethical decision making.

Course Outcome (CO):

CO1: Describe the necessity of education and its impact on society
CO2: Explain various theories of learning and their implications
CO3: Relate the theories of learning with the present societal contexts (eg Make in India/Digital India/ Skill India)
CO4: Justify the need for EQ to achieve career and professional goals
CO5: Explain the inter-dependence between education and technology in shaping society.
CO6: Explain the importance of ethical decision making and academic integrity.

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	Necessity of Education for human life, Impact of Education on society. Necessity of education in Human life - UNESCO 4 Pillars of Education Impact of education on society - Make in India/Digital India/ Skill India. Necessity: Individual vs. citizen. (Russel - Ability to read & write, Decent livelihood, Better communication, Use of technology, Secure transactions, Serve society, Knowledge Propagation, Social harmony)	8	2,3,4,5	CO1 CO3	PSO3
2	Knowledge of the different types of education - Formal, Informal & Non formal education; Liberal, Professional, Vocational & Technical education Emotional Intelligence: Models of Emotional Intelligence. Domains of Learning: Cognitive, Effective & Psychomotor Approaches to Learning: Behaviorism; Constructivism. Theories of Learning: Multiple Intelligence; Information processing theory.	10	2,3,4,5	CO2 CO4	PSO3

3	Impact of technology on education and society (Technology and Social Change; Technological Determinism; Technology and Inequality; Technology & Human Well-being; Technology and Environmental Change)	6	2,3,4,5	CO5	PSO3
4	Ethical and value implications of education and technology on individual and society. Professional ethics, Plagiarism. Professional ethics (Durkheim), Positive & Negative Thinking, Assertiveness, Assertive rights	6	2,3,4	CO6	PSO3

Suggested Reading	
1.	Bucchi, Massimiano (2004) *Science in society: An introduction to social studies of science.* London & NY: Routledge Taylor & Francis group.
2.	Durkheim, Emile (1957/2003) *Professional ethics and civic morals*. (Tr.) Cornelia Brookfield (Prefaced by) Bryan S. Turner. London & NY: Routledge (2nd Edition)
3.	Matthew H. Olson, Julio J. Ramirez (2020), *An Introduction to Theories of Learning,* London & NY: Routledge Taylor & Francis group, (10th Edition)
4.	Rethinking education: Towards a global common good? by UNESCO publishing.
5.	Richard Paul Janaro & Thelma C. Altshuler (2011). The Art of Being Human: Humanities as a Technique for Living Person. Pearson Publication.
6	Rohan Dsouza. Environment, Technology and Development. Orient Blackswan, 2012.
7	Russel, Bertrand (1932/2010) *Education and social order.* London & NY: Routledge Classics
8	R.V.G. Menon. Technology and Society. Pearson, 2011

School: School of Science	**Program: B.Sc. Chemistry**
Course Code: LC 120	**Course Name: Communication II**

Year	**I**	**Core Subject(Yes/No):**	**No**	**Lecture:**	**03**
Semester	**II**	**Elective Subject(Yes/No):**	**No**	**Tutorial**	**00**
Typology of Course	Lectures	**Foundation Subject(Yes/No):**	**YES**	**Practical:**	**00**
		Year of Syllabus Revision:	**2020**	**Total Credit:**	**03**
		Year of Introduction	**2019**	**Prerequisites (If any)**	**Knowledge of basic grammar components and vocabulary.**

Course Description:
This Communication course is conceptualized as a course aimed at enhancing English language as a tool of learning and English language as a tool of communication in a professional context. It offers a framework for English language proficiency required of a student in academic work in general as well as in discipline specific areas. As a tool of learning, the four skills of language and learning: listening, speaking, reading and writing are practiced. The focus is on building language skills required in discipline specific areas.
The practice of communication in the professional context deals with understanding hierarchy, tone and appropriate vocabulary. This Course focuses largely on training the students in writing and speaking proficiency, usage of English language in academic context as well as preparing them for the world of work.

Course Objectives:
This course will enable students to …..
Develop their overall listening, speaking, reading and writing skills,
Develop knowledge of vocabulary and grammar,
Read and comprehend texts of varying length at basic/low intermediate level.
Understand and use effective writing skills to express ideas/give information.
Develop students' general capacity to a level that enables them to use English for their academic and professional requirements.

Course Outcome (CO):
CO1: Describe the Communication cycle, types of communication, barriers and ways to address these.
CO2: Read and analyze texts and evaluate ideas therein
CO3: Express oneself clearly while communicating with others (reports, letters, …)
CO4: Participate constructively in class discussions
CO5: Illustrate communication and techno skills while making presentations
CO6: Refer to authentic sources of information and cite the same ethically.

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	**Communication Skills –** Comprehension (including all grammar components) Essay writing Precis writing / Abstract writing Report Writing (Compiling the report & Report structure) Importance of Digital Literacy; Use of social media Capstone Paper and presentation	15	1,2,3,4,5,6	CO1 CO2 CO3 CO4 CO5 CO6	PSO1 PSO5
2	**Professional Skills - A** Letter Writing Resume writing, Interview	5	1,2,3,4,5	CO3 CO4 CO6	PSO1 PSO5

	Group Discussion skills.				
3	**Professional Skills - B** Designing the KWL Chart - Formulating the central message Arranging the ideas, facts & supportive arguments Making a positive impact (appearance, gestures, eye contact, body language, style of speaking) Effective use of visual aids (types of visual aid equipment, using the equipment correctly) Maximizing delivery (fielding questions, managing answers, handling difficult situations, short talk guidelines, impromptu sessions) Practical Session: Delivery of a two-minute presentation (each student delivers a presentation on the KWL Chart) **Professional Ethics** Understanding academic integrity Plagiarism rules	10	1,2, 3, 4,5	CO4 CO5 CO6	PSO1 PSO5
4	**Social Skills** Leadership and Management skills	5	1,2,3,4,5	CO4 CO5 CO6	PSO1 PSO5
5	**Critical thinking skills** Significance of Critical thinking skills Concept map designing Fishbone Diagram	10	1,2,3,4,5,6	CO2 CO3 CO4 CO5	

Additional Reading material:

1.	John Seely; **Oxford Guide to Effective Writing and Speaking**; Oxford University Press; 2009 Ed.
2.	L. Gartside; **Modern Business Correspondence**; The English Language Book Society and Macdonald and Evans Ltd.
3.	Lester and Beason; **The McGraw Hill Handbook of English Grammar and Usage**; Tata McGraw Hill Education Private Limited; 2010 Ed.
4.	Ellet, William; **The case Study Handbook**; Harvard Business Review Press
5.	Bovee, Thill and Chaturvedi; **Business Communication Today;** Pearson Education; 2009 9TH ed.
6.	Scot Ober; **Contemporary Business Communication**; Biztantra Publications; 2009 5th ed.
7.	Inch. E.S. & Warnick Barbara; **Critical Thinking and Communication**; Perason;2011 ed.
8.	Herrmann Robert Ned; **The Whole Business Brain**; McGraw-Hill, 1998
9.	Clemen, T Robert; **Making Hard Decisions**; Duxbury Press, 1996

School: School of Science			**Program: BSc Chemistry**		
Course Code: MG108			**Course Name: Economics and Finance**		
Year	**II**	**Core Subject(Yes/No):**	**No**	**Lecture:**	**2**
Semester	**II**	**Elective Subject(Yes/No):**	**No**	**Tutorial**	**0**
Typology of Course	Lectures and Tutorials	**Foundation Subject(Yes/No):**	**Yes**	**Practical:**	**0**
		Year of Syllabus Revision:	**2021**	**Total Credit:**	**2**
		Year of Introduction	**2009**	**Prerequisites (If any)**	**12th Science**

Course Description:
The course outline has been designed to serve the purpose of understanding basics of management and accounting

Course Objectives:
The overall all objective of this course is to educate students about the management as an activity and have a holistic approach to the concept. Accountancy basics are the requirement of the generation.

Course Outcome (CO):
CO1 Efficiency in concept of Micro and Macro economics
CO2 Develop and understand methods of financial management.
CO3 Identify sources and application of Finance

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	Unit 1- Economics: Basics, Concept of scarcity, Opportunity Costs, Relation with other disciplines, Microeconomics –Demand, Supply, Diminishing utility	9	1,2	CO1	PSO1
2	Unit 2- Economics: Macro Economics, National Income, Unemployment, GDP	8	1,2,3	CO1, CO2	PSO1, PSO2
3	Unit 3- Finance: Basic concepts, Relation with other disciplines	6	2, 3, 4	CO2, CO3	PSO1, PSO2
4	Unit 4- Finance: Sources of Finance, Long, Medium, Short Term, Application of finance	8	1, 2, 3	CO2, CO3	PSO1, PSO2, PSO3, PSO4

Reference Books	
1	Economics for Beginners
2	Financial Management by Prasanna Chandra

SEMESTER III

School: Science			**Program: BSc Chemistry**		
Course Code: CH 255			**Course Name: Organic Chemistry I**		
Year	**II**	**Core Subject(Yes/No):**	**Yes**	**Lecture:**	**3**
Semester	**III**	**Elective Subject(Yes/No):**	**No**	**Tutorial**	**0**
Typology of Course	Lectures and Tutorials	**Foundation Subject(Yes/No):**	**No**	**Practical:**	**0**
		Year of Syllabus Revision:	**2019**	**Total Credit:**	**3**
		Year of Introduction	**2014**	**Prerequisites (If any)**	**12th science**

Course Description:
This course deals with the basic properties of organic compounds, their nomenclature and the method of naming organic compounds learn various methods of preparation of hydrocarbons. It includes the reaction as well as mechanisms so that the concept will be better understood. It is broadly divided into two distinct parts. The first part involves the chemistry of aliphatic alkane, alkene, and alkynes. For example, Wurtz reaction, Corey – House method, petroleum refining, Dieckmann's ring closure, substitution, and ring-opening reactions. Baeyer's strain theory and theory of strain less rings etc. The last part is based on the chemistry of aromatic systems. It involves Hückel's rule of aromaticity, electrophilic substitution reactions and oxidation chemistry.

Course Objectives:
The students can be able to demonstrate an understanding of basic principles of organic chemistry and how they relate to everyday experiences

Course Outcome (CO):
CO1 understands the basic properties of nomenclature, organic compounds
CO2 comprehends the knowledge of nomenclature, synthesis, and applications of alkanes and cycloalkanes
CO3 comprehend the knowledge of nomenclature, synthesis, and applications of alkenes, Alkyne, and dienes
CO4 understands the knowledge of nomenclature, synthesis, and applications of Benzene, and arenes

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	Unit 1: Alkanes and Cycloalkanes: Hybridization of organic molecules. Preparation of alkanes: Wurtz reaction, reduction or hydrogenation of alkenes, Corey – House method, petroleum refining. Reactions: Halogenation, Mechanism of free radical halogenation. Cycloalkanes: Preparation using Wurtz reaction, Dieckmann's ring closure and reduction of aromatic hydrocarbons. Reactions: Mechanism of substitution and ring-opening reactions. Baeyer's strain theory and theory of strain less rings	15	1, 2, 3, 4, 5	CO1, CO2	PSO1, PSO3, PSO4
2	Unit 2: Alkenes, Alkynes and Dienes: Alkenes: General methods of preparation, dehydrogenation, dehydrohalogenation, dehydration, Hoffmann and Saytzeff's rules, cis and trans eliminations. Reactions: Mechanism of electrophilic and free radical addition – the addition of hydrogen, halogen, hydrogen halide (Markovnikov's rule), hydrogen bromide (peroxide effect), sulphuric acid, water, hydroboration, Ozonolysis, dihydroxylation with KMnO4, allylic bromination by NBS. Mechanism of hydroboration-oxidation and oxymercuration-demercuration. Oxidative cleavage of alkenes. Dienes: Stability of dienes (conjugated, isolated and cumulative dienes) 1,2- and 1,4-addition reactions in conjugated dienes, Diels-Alder reaction. Alkynes: Preparation, Mechanism of dehydrohalogenation and dehydrogenation. Reactions: Acidity of alkynes, formation of acetylides, Mechanism of addition of water, hydrogen halides and halogens, oxidation, ozonolysis and hydroboration/oxidation, oxidative cleavage of alkynes.	15	1, 2, 3, 4, 5	CO1, CO3	PSO1, PSO3, PSO4

3	Unit 3: Benzene and Arenes: Benzene: Kekulé structure, stability of benzene, resonance Aromaticity: Hückel's rule, aromaticity in benzene and other cyclic systems with examples of aromatic, non-aromatic and antiaromatic systems of cyclic hydrocarbons (C3 to C8) Electrophilic substitution reactions: halogenation, nitration, sulphonation, Friedel–Crafts alkylation and acylation. Oxidation reactions: With oxygen and ozone, mercuration. Oxidation and halogenation (ring vs side chain) of alkylbenzenes. Disubstitution reactions of aromatic compounds, orientation and reactivity. Polynuclear aromatic hydrocarbons: Preparation and properties of naphthalene, anthracene and phenanthrene. Synthetic uses.	15	1, 2, 3, 4, 5	CO1, CO4	PSO1, PSO3, PSO4

Reference Books	
1.	R. T. Morrison, R. N. Boyd and S. K. Bhattacharjee, Organic Chemistry, 7th Ed., Pearson New Delhi, 2012.
2.	M. K. Jain and S. C. Sharma, Modern Organic Chemistry, Vishal Publishing Co., New Delhi, 2018
3.	J. Clayden, N. Greeves, S. Warren, P. Wothers, Organic Chemistry, 1st Ed., Oxford University Press, New York, 2001
4.	B. Y. Paula, Organic Chemistry, 3rd Ed., Pearson Education, Inc. (Singapore), New Delhi, reprint, 2002.
5.	T. W. Graham Solomons, Organic Chemistry, 6th Ed., John Wiley and sons, 1996
6.	Jerry March, Advanced Organic Chemistry, 4th Ed., John Wiley and Sons, New York, 1992.
7.	S. H. Pine, Organic Chemistry, 5th Ed., McGraw Hill International Edition, Chemistry Series, New York, 1987
8.	Francis A. Carey, Organic Chemistry, 3rd Ed., Tata – McGraw Hill Publications, New Delhi, 1999.

School: Science	**Program: B.Sc. (Chemistry)**
Course Code: CH 256	**Course Name: Inorganic Chemistry II**

Year	**II**	**Core Subject(Yes/No):**	**Yes**	**Lecture:**	**3**
Semester	**III**	**Elective Subject(Yes/No):**	**No**	**Tutorial**	**0**
Typology of Course	Lectures	**Foundation Subject(Yes/No):**	**No**	**Practical:**	**0**
		Year of Syllabus Revision:	**2020**	**Total Credit:**	**3**
		Year of Introduction	**2014**	**Prerequisites (If any)**	**12th Science**

Course Description:
The first part of the course explains characteristic properties of s, p, d and f block elements including noble gas family and their compounds particularly keeping the focus on the recent discoveries. It also gives information of similarity and difference in behaviour among each and every block of the periodic table. In addition, in d- block it includes the difference between 3d and other transition elements. Besides that, it covers their wide applications in day today life. The second part covers basic terminologies of coordination compounds, capability and limitations valence bond theory and crystal field theory in details.

Course Objectives:

The objective of this course is to develop abilities of students to understand elements presents into periodic table in detail and understand the coordination chemistry of complex molecules.

Course Outcome (CO)

CO1 Explain the structure and properties of the compounds of p – block elements including noble gas family particularly keeping focus on the recent discoveries.

CO2 Understand the characteristic properties of transition elements and explain the properties in terms of oxidation states exhibited by the elements.

CO3 They will be able to explain the properties of d-block elements and application of these complexes in various industries.

CO4 Ability to give the IUPAC name to coordination compounds. Further they will be able to explain the nature of ligand based on splitting of d-orbital.

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	**Unit 1: s and p block elements:** Characteristic and distinctive properties of s and p block elements. Chemistry of s Block elements: Hydrogen. Hydrides – Classification and Chemistry. Heavy water – manufacture and properties. Alkali Metals: Li, Na, K, Rb and Cs – occurrence, comparative study of elements, oxides, halides, hydroxides and carbonates. Exceptional property of Lithium. Alkaline Earth Metals: Be, Mg, Ca, Sr and Ba – occurrence and comparative study of the elements, oxides, hydroxides, halides, sulphates and carbonates. Exceptional property of Beryllium. p-Block elements: Comparative study of the p – Block elements – Groups 13 – 18 with special reference to electronic configuration, structure of elements and trends in atomic and ionic radii, ionization potential, electron affinity, electronegativity and oxidation states. Inert pair effect. Occurrence, extraction and important uses of p-Block elements.	15	1,2,3,4,5	CO1 CO2	PSO1 PSO2 PSO3 PSO4
2	**Unit 2: d-Block Elements Chemistry of Transition elements:** Characteristics properties of d – block elements. Electronic configuration. Comparative account of atomic and ionic radii, density, M.P., B.P., metallic character, reactivity of metals, ionization energies. Difference between the properties of the elements of first and the other two transition Series. Application of coordination compounds in analysis and industry. Lanthanides and Actinides: Abundance, occurrence and extraction of lanthanides and actinides. Separation of lanthanides. Metallurgy of thorium and uranium.	15	1,2,3,4,5	CO3 CO4	PSO1 PSO2 PSO3 PSO4

	Preparation of transuranium elements. Electronic configuration, oxidation states, atomic & ionic radii. Lanthanide contraction and its consequences.				
3	**Unit 3: Coordination Compounds Coordination compounds:** Introduction to basic terminologies (primary and secondary coordination spheres, ligands and their types, Coordination number and coordination geometry, chelation, sequestering agents), Effective Atomic Number (EAN) and 18 electron rules. Bonding in complexes with coordination number 4 & 6 in terms of VBT, high and low spin complexes. Capability and limitations of VBT. Electrostatic concept of complex formation: Crystal field theory (CFT), energyof the d or the d orbitals in spherical, octahedral, tetrahedral, tetragonal and square planar fields. Extrinsic and intrinsic distortion in octahedral geometry, Weak field and strong field complexes. Spectrochemical series, agnetism and geometry of complexes on the basis of CFT. Factors affecting the crystal field splitting. Geometry preferred by various transition metal ions in strong and weak fields. Limitations of crystal field theory (qualitative approach).	15	1,2,3,4,5	CO1 CO3 CO4	PSO1 PSO2 PSO3 PSO4

Reference Books	
1.	D. F. Shriver and P. W. Atkins, Inorganic Chemistry, 3rd Edn. (1999), ELBS, London.
2.	F. A. Cotton and G. Wilkinson, Advanced Inorganic Chemistry, 6th Edn. (1999), John Wiley & Sons, New York.
3.	D.N. Sathyanarayana, Electronic Absorption Spectroscopy and Related Techniques (2001), Universities Press (India) Ltd., Hyderabad.
4.	J. D. Lee, Concise Inorganic Chemistry, 5th Ed., Blackwell Science, London, 1996.
5.	B. R. Puri, L. R. Sharma &, K. C. Kalia, Principles of Inorganic Chemistry, Shoban Lal Nagin Chand and Co., Delhi, 1996.

School: School of Science			**Program: B.Sc. Chemistry**		
Course Code: CH 204			**Course Name: Chemistry Laboratory-V**		
Year	**II**	**Core Subject (Yes/No):**	**Yes**	**Lecture:**	**0**
Semester	**III**	**Elective Subject (Yes/No):**	**NO**	**Tutorial**	**0**
Mode of Transaction	Laboratory	**Foundation Subject (Yes/No):**	**NO**	**Practical:**	**6**
		Year of Syllabus Revision:	**2018**	**Total Credit:**	**3**
		Year of Introduction	**2014**	**Prerequisites (If any)**	**12th science**

Course Description:
It includes determination of organic compounds having different nature such as acid, base and neutral organic compound and also includes analysis of water samples as well as quantitative analysis of using redox, complexometric and precipitation titration

Course Outcome (CO):
CO1 gain knowledge on organic qualitative analysis
CO2 To understand the fundamentals of volumetric titrations specifically Acidimetry – Alkalimetry titrations.
CO3 Describe the knowledge of the fundamentals of Redox Titrations, complexometric titrations, Precipitation titration in volumetric analysis.
CO4 comprehended the titration related to Argentometry titrations, Iodometry and Iodimetry titration using volumetric analysis.
CO5 Record observations and write laboratory reports according to disciplinary standards.

No.	Experiment	Contact Hours	BT Level	CO	PSO
1	Organic spotting (Benzoic acid)	3	1, 2, 3, 4, 5, 6	CO1, CO5	PSO1, PSO2, PSO3, PSO4
2	Organic spotting (Urea)	3	1, 2, 3, 4, 5, 6	CO1, CO5	PSO1, PSO2, PSO3, PSO4
3	Organic spotting (Beta – naphthol)	3	1, 2, 3, 4, 5, 6	CO1, CO5	PSO1, PSO2, PSO3, PSO4
4	Organic spotting (Naphthalene)	3	1, 2, 3, 4, 5, 6	CO1, CO5	PSO1, PSO2, PSO3, PSO4
5	Organic spotting (Salicylic Acid)	3	1, 2, 3, 4, 5, 6	CO1, CO5	PSO1, PSO2, PSO3, PSO4
6	Organic spotting (Thiourea)	3	1, 2, 3, 4, 5, 6	CO1, CO5	PSO1, PSO2, PSO3, PSO4
7	Organic spotting (Bromo Benzene)	3	1, 2, 3, 4, 5, 6	CO1, CO5	PSO1, PSO2, PSO3, PSO4

8	Organic spotting (Pera nitro aniline)	3	1, 2 3, 4, 5, 6	CO1, CO5	PSO1, PSO2, PSO3, PSO4
9	Organic spotting (Aniline)	3	1, 2, 3, 4, 5, 6	CO1, CO5	PSO1, PSO2, PSO3, PSO4
10	Organic spotting (m- nitro Aniline)	3	1, 2, 3, 4, 5, 6	CO1, CO5	PSO1, PSO2, PSO3, PSO4
11	Organic spotting (p- nitro Aniline)	3	1, 2, 3, 4, 5, 6	CO1, CO5	PSO1, PSO2, PSO3, PSO4
12	Organic spotting(Sulfanilic acid)	3	1, 2, 3, 4, 5, 6	CO1, CO5	PSO1, PSO2, PSO3, PSO4
13	Organic spotting (Acetanilide)	3	1, 2, 3, 4, 5, 6	CO1, CO5	PSO1, PSO2, PSO3, PSO4
14	Organic spotting (Ethyl Acetate)	3	1, 2, 3, 4, 5, 6	CO1, CO5	PSO1, PSO2, PSO3, PSO4
15	Organic spotting (Benzaldehyde)	3	1, 2, 3, 4, 5, 6	CO1, CO5	PSO1, PSO2, PSO3, PSO4
16	Iodometry titration	3	1, 2, 3, 4, 5, 6	CO1, CO2, CO3, CO4, CO5	PSO1, PSO2, PSO3, PSO4
17	Iodimetry titration	3	1, 2, 3, 4, 5, 6	CO1, CO2, CO3, CO4, CO5	PSO1, PSO2, PSO3, PSO4
18	Hardness of water	3	1, 2, 3, 4, 5, 6	CO1, CO2, CO3, CO4, CO5	PSO1, PSO2, PSO3, PSO4
19	Estimation of chloride	3	1, 2, 3, 4, 5, 6	CO1, CO2, CO3, CO4, CO5	PSO1, PSO2, PSO3, PSO4

Reference Books	
1.	J. Mendham, R. C. Denney, J. B. Barnes & M. J. K. Thomas, Vogel's Textbook of Quantitative Chemical Analysis, 6th Ed., Pearson Education, New Delhi, 2003.
2.	R. C. Shah, Organic Qualitative Analysis, 5 th Ed., Baroda Book Depot, Vadodara, 1996

School: School of Science			**Program: BSc – Chemistry**		
Course Code: BO204			**Course Name:** Plant structural biology and Physiology		
Year	**II**	**Core Subject(Yes/No):**	**No**	**Lecture:**	**3**
Semester	**III**	**Elective Subject(Yes/No):**	**No**	**Tutorial**	0
Typology of Course	Lectures	**Foundation Subject(Yes/No):**	**Yes**	**Practical:**	0
		Year of Syllabus Revision:	**NA**	**Total Credit:**	**3**
		Year of Introduction	**2014**	**Prerequisites (If any)**	12th Science

Course Description:

The students will be introduced to classical and modern concepts in green plants. The course will emphasize the importance of photosynthesis, gas exchange, water, and environment responses. The fundamental physiological processes of plants will be studied in depth. This course will also provide an introduction to the classification, relationships, structure, and function of plants. Paleobotany will be introduced and how the seed plants survived on land will be studied.

Course Objectives:

- To understand anatomy and physiology of plants
- To gain a knowledge about paleontology

Course Outcome (CO):

CO1: Gain basic understanding about anatomy of plants.
CO2: Learn morphology and anatomy of gymnosperms
CO3: Understand paleontology with special reference to gymnosperms
CO4: Gained knowledge about metabolic cycles in plants.
CO5: Understand plant physiology

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
7	Plant structural Biology Meristems and its types – shoot and root apical meristems, lateral meristems; structure and function. Tissue System: Epidermal – general organization, trichomes, stomata types, vascular tissues, xylem and phloem. Normal secondary growth, Secondary anomaly: Boerhavia, Salvadora and Bignonia. Embryology: microsporogenesis, megasporogenesis, fertilisation and embryogenesis.	15	1,2	CO1	PSO1
8	General characters, Classification , life cycle of Zamia, Biota, and Ephedra Paleobotany Introduction, process of fertilization, fossil types with examples- cast, compression, impression and Petrification.	15	1,2	CO2, CO3	PSO1
3	Water relation in plants; Diffusion, imbibition, osmosis, absorption of water, ascent of sap, mechanism Transpiration: Types, mechanism, factors and guttation. Mineral nutrition Growth hormones and its role. Enzymes: general account, structure and function Photosynthesis: Mechanism, Role of light, carbon fixation in C3 and C4 plants, factors affecting photosynthesis, photorespiration, structure of chloroplast as related to photosynthetic functions, Translocation of food- mechanisms. Respiration: Structure of mitochondria in relation to respiration, mechanisms, Glycolysis, Kreb's cycle, factors affecting rate, RQ. Fat metabolism	15	1,2	CO4, CO5	PSO1

Reference Books	
1.	A. Fahn, Plant Anatomy, 1964.

2	B. Johri & Biswas, Gymnosperms, 1974.
3	F.B. Salisbury & C.W. Ross, Plant Physiology, 1982.
4	L. Taiz & E. Zeiger, Plant Physiology, 2002.
5	Noggle & Fritz, Plant Physiology, 1982.
6	P.C. Vashishta, Gymnosperms, 1976.
7	P.J. Chandurkar, Plant Anatomy, 1966.
8	P.J. Kramer, Water relations in plants.
9	P.S. Verma & P.K. Agarwal, Plant Physiology, 1977.
10	R.M. Devlin, Plant Physiology, 1974.
11	S.N. Pandey & B.K. Sinha, Plant Physiology, 1972

School: School of Science			**Program: BSc Chemistry**		
Course Code:BO205			**Course Name:** Plant anatomy and morphology		
Year	**I**	**Core Subject(Yes/No):**	**No**	**Lecture:**	**02**
Semester	**I**	**Elective Subject(Yes/No):**	**No**	**Tutorial**	**0**
Typology of Course	Laboratory	**Foundation Subject(Yes/No):**	**Yes**	**Practical:**	**0**
		Year of Syllabus Revision:	**NA**	**Total Credit:**	**2**
		Year of Introduction	**2016**	**Prerequisites (If any)**	**12th Science**

Course Description:
This course covers the study of morphology, anatomy, reproduction and developmental changes there in through typological study should create a knowledge base in understanding plant diversity, economic values, taxonomy of lower group of plants.

Course Objectives:
Basic plant anatomy, taxonomy, and determination of phytochemicals

Course Outcome (CO):
CO1 To understand the identification of different plants.
CO2 To study anatomy of different plants of plant kingdom.
CO3 To understand the various adaptations of plants

Unit No.	**Topic/Unit**	**Contact Hours**	**BT Level**	**CO**	**PSO**
1	Plant anatomy	15	1,2	CO1	PSO3
2	Adaptations of plants	15	1,2	CO2,3	PSO3
Reference Books					
1	Esau, K. (1953). *Plant anatomy* (Vol. 75, No. 5, p. 407). LWW.				
2	Waller, D. M. (1988). Plant morphology and reproduction. *Plant reproductive ecology: patterns and strategies*, 203-227.				

School: School of Science	**Program: BSc – Chemistry**
Course Code: ZO201	**Course Name:** Ecology and Zoogeography

Year	**II**	**Core Subject(Yes/No):**	No	**Lecture:**	**3**
Semester	**III**	**Elective Subject(Yes/No):**	No	**Tutorial**	0
Typology of Course	Lectures	**Foundation Subject(Yes/No):**	Yes	**Practical:**	0
		Year of Syllabus Revision:	NA	**Total Credit:**	**3**
		Year of Introduction	**2014**	**Prerequisites (If any)**	12th Science

Course Description:

This course deals with the understanding of Ecology, Principles and pattern of Animal Distribution, Role of Barriers in distribution, Continental Drift Theory, Major Zoogeographic Realms in the world & their faunal peculiarities and to understand the various environmental issues.

Course Objectives:

- To understand the basic concept of ecosystem
- To learn about biomes and animal distribution

Course Outcome (CO):

CO1: To acquire basic knowledge about ecology.
CO2: Gain understanding about nutrient cycling and energy flow
CO3: Understand about succession
CO4: Gain understanding about biomes around world
CO5: Understand about zoogeography and animal distribution

Unit No.	**Topic/Unit**	**Contact Hours**	**BT Level**	**CO**	**PSO**
1	Ecosystem, Biotic and Abiotic components and Energetics and Biogeochemical cycles, Organization at community level.	15	1,2	CO1, CO2	PSO1
2	Aquatic Biome: Freshwaters, Intertidal Zones, Marine & Wetlands, Terrestrial Biomes: Tropical, Temperate & Boreal Forests, Savannah & Temperate Grasslands, Arid Scrubs & Deserts, Tundra & Mountains, Ecological Succession, Man & Nature: Agro-biomes & Urban Biomes	15	1,2	CO3, CO4	PSO1
3	Principles and pattern of Animal Distribution, Role of Barriers in distribution, Continental Drift Theory, Major Zoogeographic Realms in the world & their faunal peculiarities.	15	1,2	CO5	PSO1

Reference Books	
1.	Environmental Risk Assessment: Quantitative Measures, Anthropogenic Influences, Human Impact, Ian Lerche, Walter Glaesser.

School: School of Science		**Program: B.Sc. Chemistry**			
Course Code: ZO203		**Course Name: Zoology Laboratory VI - Minor**			
Year	**II**	**Core Subject(Yes/No):**	No	**Lecture:**	**0**
Semester	**III**	**Elective Subject(Yes/No):**	No	**Tutorial**	**0**
Mode of Transaction	**Laboratory**	**Foundation Subject(Yes/No):**	Yes	**Practical:**	**4**
		Year of Syllabus Revision:	NA	**Total Credit:**	**2**
		Year of Introduction	**2017**	**Prerequisites (If any)**	12th Science

Course Description:

The course deals with the laboratory practices involved in different soil and water analysis as well as study of various ecosystems. It also comprises the study of zoogeographical realms of the world along with their peculiar fauna. The course also enlightens the bio-geographical zones of India and the various National Parks, Wildlife Sanctuaries and Bio-reserve areas.

Course Outcome (CO):

CO1: To understand the basics of ecology and environment

CO2: To understand the different zoogeographical realms of the world and biogeographic region of India with the help of a map.

CO3: To understand the soil and water analysis

CO4: To study the national parks, sanctuaries, and bio-reserve areas of India with the help of a map

CO5: To understand the working of pH meter

No.	**Experiment**	**Contact Hours**	**BT Level**	**CO**	**PSO**
1	To study the types of ecosystems	2	1,2	CO1	PSO2, PSO3
2	To determine the acidity of the given water sample	2	1,2,3,4,5	CO1, CO3	PSO2, PSO3
3	To determine the alkalinity of the given water sample	2	1,2,3,4,5	CO1, CO3	PSO2, PSO3
4	To study the Zoogeographical realms of the world	2	1,2	CO1, CO2	PSO2, PSO3
5	To study of National Parks, Sanctuaries & Bio-reserve areas (Mapping)	2	1,2	CO1, CO4	PSO2, PSO3
6	To study the bio-geographical zones of India	2	1,2	CO1, CO2	PSO2, PSO3
7	To determine the hardness of the given water sample	2	1,2,3,4,5	CO1, CO3	PSO2, PSO3
8	To determine the BOD of the given water sample	2	1,2,3,4,5	CO1, CO3	PSO2, PSO3
9	To determine the inorganic constituents of soil	2	1,2,3,4,5	CO1, CO3	PSO2, PSO3
10	To study the working of a pH meter	2	1,2,3	CO5	PSO2, PSO3

Reference Books

1	Comprehensive laboratory manual in biology class
2	Environmental Science – Y.K. Singh
3	Cell Biology, Genetics, Molecular Biology, Evolution and Ecology - Verma & Agarwal

School: Science			**Program: BSc Chemistry**		
Course Code: HR226			**Course Name: Introduction HR**		
Year	**II**	**Core Subject(Yes/No):**	**No**	**Lecture:**	**2**
Semester	**III**	**Elective Subject(Yes/No):**	**No**	**Tutorial**	**0**
Typology of Course	Lectures	**Foundation Subject(Yes/No):**	**Yes**	**Practical:**	**0**
		Year of Syllabus Revision:	**NA**	**Total Credit:**	**2**
		Year of Introduction	**2019**	**Prerequisites (If any)**	**12th science**

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	Unit 1: Introduction to Business: · Manufacturing and service sectors; Small and medium enterprises · Forms of Business Organisation: Sole Proprietorship, Joint Hindu Family Firm, Partnership firm, Joint Stock Company, Cooperative society; Limited Liability Partnership; · Public Enterprises. International Business. Multinational Corporations · Technological innovations and skill development. · Social responsibility and ethics. Emerging opportunities in business; Franchising, Outsourcing	15	1, 2, 3, 4		
2	Unit 2: Introduction to HR: · Role of HRM: Nature – Scope – Objective – Importance of HRM · Job Analysis: Meaning – Uses of Job Analysis – Process of Job Analysis – Concept of Job Description & Job Specification. · Human Resource Planning: Meaning HR Planning – Objectives of HRP – Importance – process of HRP · Recruitment & Selection: Sources & Methods of Recruitment - Meaning & process of selection · The Process of Management: Planning; Decision-making · Delegation and Decentalisation of Authority · Leadership: Concept and Styles · Motivation: Concept and Importance; Maslow Need Hierarchy Theory; Herzberg Two Factors Theory. Communication: Process and Barriers; Control: Concept and Process	15	1, 2, 3, 4		

Reference Books	
1	Human Resource Management by V. S. P. Rao (Author), Excel Books
2	Gary Dessler, Human Resource Management, 11/e, Pearson Education, 2008
3	Kotler& Armstrong, Principles of Marketing, Pearson Education/PHI, New Delhi.
4	Philip Kotler, Keller, Koshy&Jha, Marketing Management, Pearson Education, New Delhi.
5	Ramaswamy&Namkumari, A Text Book of Marketing Management, Macmillan.
6	H. J. Bernardin, Human Resource Management: An Experiential Approach, TMH, 2007

SEMESTER IV

School: School of Science			**Program: BSc**		
Course Code: CH257			**Course Name: Organic Chemistry-II**		
Year	**II**	**Core Subject (Yes/No):**	**Yes**	**Lecture:**	**3**
Semester	**IV**	**Elective Subject (Yes/No):**	**No**	**Tutorial**	**0**
Typology of Course	Lectures	**Foundation Subject (Yes/No):**	**No**	**Practical:**	**0**
		Year of Syllabus Revision:	2018	**Total Credit:**	**3**
		Year of Introduction	**2014**	**Prerequisites (If any)**	***See below**

Prerequisites (If any): Students should have cleared the previous year examination; in particular, course entitled *Organic Chemistry-I* (CH255) and *Chemistry Laboratory – V* (CH204). Students should have basic concept of organic compounds (alkane, alkene, alkyne, aromatic compounds, etc.)

Course Description:
First unit describe the stereochemistry of different organic molecules. Representation of different projection and the interconversion of one form to another are included in the unit. It also includes the difference between enantiomer and diastereomer, *meso*-isomer and racemic mixtures, cis-trans and *E-Z* etc. It also describes how to separate the racemic mixture using different techniques. Second unit deals with the chemistry of alkyl and aryl halides. It includes substitution S_N1, S_N2 and S_Ni and S_NAr and elimination E1 and E2 reactions and their mechanisms. The last unit deals with chemistry of alcohols, phenol, ether and epoxides with the examples of a few well-known name reactions such as Victor Meyer test and iodoform test, Riemer–Tiemann reaction, Kolbe reaction, Fries and Claisen rearrangements.

Course Objectives:
The objective of this course is to develop abilities of student to understand the concept of stereoisomers and organic reaction mechanism and to critically interpret the diverse options regarding possible futures for the organic synthesis with different functional groups.

Course Outcome (CO):
Upon completion of the course students are expected to demonstrate knowledge, skill and abilities in the following areas:

CO1	Understand the stereochemistry of optically active compounds (chiral & achiral molecules).
CO2	Recognizing and drawing structural isomers (constitutional isomers), stereoisomers including enantiomers and diastereomers, racemic mixture, and meso compounds.
CO3	Identifying the stereocenters in a molecule and assign the configuration as R or S.
CO4	Understanding the relationship between enantiomers and their specific rotations.
CO5	learn the chemistry of functional groups of organic compounds such as Alkyl & Aryl Halides, Alcohols, Ethers, Phenol & Epoxides
CO6	learn the preparation of organic compounds of halide and oxygen based functional groups
CO7	Gain mechanistic understanding of selected organic reactions

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	**Stereochemistry** Isomerism in organic molecules- Structural and Stereoisomerism. Molecular representations: Newman, Sawhorse, Wedge & Dash, Fischer projections and their interconversions. Conformations and Conformational analysis: Ethane, *n*-butane, ethane derivatives, cyclohexane, monosubstituted and disubstituted cyclohexane and their relative stabilities. Geometrical isomerism in unsaturated and cyclic systems: cis–trans and, syn-anti isomerism, E/Z notations. Geometrical isomerism in dienes – Isolated and conjugated systems, determination of configurations. Chirality and optical isomerism: Configurational	17	1.2.3.4	CO1 CO2 CO3 CO4	PSO2 PSO3 PSO4

	isomers. Molecules with one or two chiral centers – constitutionally symmetrical and unsymmetrical molecules; Enantiomers and Diastereomers. Optical activity in absence of chiral center-with illustrative examples (Allenes and Biphenyls). *Meso* compounds, racemic modifications and methods of their resolution; stereochemical nomenclature: erythro/threo, D/L and R/S nomenclature in acyclic systems. Measurement of optical activity: specific rotation.				
2	**Alkyl Halides and Aryl Halides** *Alkyl halides*: Preparation, physical properties, nucleophilic substitution reactions – S_N1, S_N2 and S_Ni mechanism with stereochemical aspects, factors affecting nucleophilic substitution, elimination vs substitution, nucleophilicity vs basicity. *Aryl halides*: Preparation, physical properties and nucleophilic aromatic substitution: S_NAr, elimination-addition mechanism. Relative reactivity of alkyl, allyl, benzyl, vinyl and aryl halides towards nucleophilic substitution reactions. Organometallic compounds of Mg and Li: synthetic uses.	15	1,2,3,4,5	CO4 CO5 CO6	PSO2 PSO3 PSO4 PSO5
3	**Alcohols, Phenol, Ether and Epoxides** *Alcohols*: Preparation, relative reactivity of primary, secondary and tertiary alcohols. Reactions of alcohols: With hydrogen halides, phosphorus halides, thionyl chloride and ammonia. Oxidation of alcohols: Dehydrogenation and dehydration, Lucas reagent test, Victor Meyer test and Iodoform test. *Glycols*: Preparation and reactions: Oxidation, Pinacol– Pinacolone rearrangement. *Phenols*: Preparation and reactions: Acidity and factors affecting acidity of phenols. Acylation of phenol, ring substitution reactions, Riemer–Tiemann reaction, Kolbe reaction, Fries and Claisen rearrangements. *Ethers and Epoxides*: Preparation and reactions with acid. Acid and base catalyzed ring opening of epoxides.	13	1,2,3,4	CO4 CO5 CO6	PSO2 PSO3 PSO4 PSO5

Reference Books	
1.	Ernest. L. Eliel & Samuel. H. Wilen, *Stereochemistry of Organic Compounds*, John Wiley and Sons, New York, 2004.
2.	D. Nasipuri, *Stereochemistry of Organic Compounds: Principles and Applications,* New Age International Publishers, Third Edition, New Delhi, 2011.
3.	P. S. Kalsi, *Stereochemistry: Conformation and Mechanism*, 2nd Ed., Wiley Eastern Ltd, 1993.
4.	J. Clayden, N. Greeves, S. Warren, P. Wothers, *Organic Chemistry*, 1st Ed., Oxford University Press, New York, 2001.
5.	R. T. Morrison, R. N. Boyd and S. K. Bhattacharjee, *Organic Chemistry*, 7th Ed., Pearson New Delhi, 2012.
6.	T. W. Graham Solomons and Craig B. Fryhle, *Organic Chemistry*, 10th Ed., John Wiley and Sons, 2011.
7.	B. Y. Paula, *Organic Chemistry,* 3rd Ed., Pearson Education, Inc. (Singapore), New Delhi, Reprint, 2002.
8.	Arun Bahl& B. S. Bahl, *A Textbook of Organic Chemistry*, S. Chand and Sons, New Delhi, 2005.
9.	Jerry March, *Advanced Organic Chemistry*, 4th Ed., John Wiley and Sons, New York, 1992.
10.	S. H. Pine, *Organic Chemistry*, 5th Ed., McGraw Hill International Edition, Chemistry Series, New York, 1987.
11.	Francis A. Carey, *Organic Chemistry*, 3rd Ed., Tata – McGraw Hill Publications, New Delhi, 1999.

School: School of Science			**Program: B.Sc. Chemistry**		
Course Code: CH 258			**Course Name: Thermodynamics and Chemical Equilibrium**		
Year	**II**	**Core Subject(Yes/No):**	Yes	**Lecture:**	**3**
Semester	**IV**	**Elective Subject(Yes/No):**	No	**Tutorial**	**0**
Typology of Course	Lectures and Tutorials	**Foundation Subject(Yes/No):**	No	**Practical:**	**0**
		Year of Syllabus Revision:	2019	**Total Credit:**	**3**
		Year of Introduction	2014	**Prerequisites (If any)**	**FY B.Sc. Chemistry**

Course Description:
This course deals with all the four laws of thermodynamics along with thermochemistry and chemical equilibrium. Kirchhoff's law, application of Hess's law, Carnot cycle and heat engine, efficiency of heat engines, entropy and its significance are elaborately explained in thermodynamics. In addition, details of Gibbs-Helmholtz equation and Gibbs-Duhem equation are included in the unit. The last part deals with the details of Gibbs-Duhem equation, Van't Hoff equation and Le Chatelier's principle (qualitative treatment).

Course Objectives:
To be able to use to apply various thermodynamics laws to real system.

Course Outcome (CO):
CO1: understand the basic terms involved in thermodynamics and assess their significance in the study of the thermodynamics.
CO2: To understand and be able to use the first law of thermodynamics for open and closed systems, to set up energy balances for steady- and unsteady-state processes and to solve them for simple and classic cases.
CO3: To understand and be able to use the second law of thermodynamics, to set up entropy balances for steady- and unsteady-state processes and to solve them for simple and limiting cases to establish bounds for solutions to engineering problems.
CO4: To evaluate thermodynamic properties of pure substances with special emphasis on fluids. Be able to use various PVT equations-of-state and heat capacities to evaluate thermodynamic properties (U, H, P, V, T, etc.)
CO5: Comprehend thermochemistry and its significance for a chemical reaction
CO6: Correlate thermodynamics and chemical equilibrium. To apply the laws of thermodynamics and various methods of evaluating state properties to equipment commonly encountered in chemical engineering processes, such as turbines, pumps, engines, and refrigeration units.

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	**Unit 1: First Law and Thermochemistry** Extensive and intensive properties of a system, thermodynamic processes: cyclic, reversible, irreversible processes, isothermal and adiabatic process, Zeroth law of thermodynamics. First law of thermodynamics-statement and equation, relation between Cp and Cv, work of expansion in reversible and irreversible process, adiabatic process, relation between P, V, T.Variation in internal energy and enthalpy with temperature. Thermochemistry- Hess's law, Kirchhoff's law, Bond energy and Bond dissociation energy, calculation from thermochemical data.	16	1,2,3,4,5	CO1, CO2, CO4 CO5	PSO1, PSO3, PSO4, PSO5
2	**Unit 2: Second and Third Law** Second law of thermodynamics, Carnot's theorem, Carnot cycle, efficiency of heat engines, thermodynamic scale of temperature, concept of entropy, entropy change in acyclic, reversible, irreversible processes, calculation of entropy changes of an ideal gas with change in P,V,T, entropy change in physical transformation, entropy of mixing. Helmholtz free energy (A) and Gibb's free energy (G), variation of A and G with P,V,T, criteria for spontaneity and equilibrium, Maxwell's relationship, Gibb's –Helmholtz	17	1,2,3,4,5	CO1, CO3 CO4, CO6	PSO1, PSO3, PSO4, PSO5

	equation. Nernst heat theorem, consequence of the theorem, third law of thermodynamics, and its verification. Determination of absolute entropies of pure substance.				
3	**Unit 3: System of Variable Composition and Chemical Equilibrium** Partial molar quantities-chemical potential, Gibb's – Duhem equation, effect of temperature and pressure on chemical potential, Duhem – Margules equation, concept of activity and activity coefficient, fugacity, derivation of expression of equilibrium constant, temperature pressure and concentration dependence of equilibrium constant –Van't Hoff equation, Le chatelier principle (qualitative treatment).	12	1,2,3,4,5	CO1, CO6	PSO1, PSO3, PSO4, PSO5

Reference Books	
1.	S. H. Maron & J. B. Lando, *Fundamentals of Physical Chemistry*, Macmillan limited, New York, 1966.
2.	B. R. Puri & L. R. Sharma, *Principles of Physical Chemistry*, Shoban Lal Nagin chand and Co. 33rd Ed., 1992.
3.	P.W. Atkins, *Physical Chemistry*, 7th Ed., Oxford University Press, 2001.
4.	S. K. Dogra & S. Dogra, *Physical Chemistry Through Problems*, 4th Ed., New age international, 1996.
5.	Irving M. Klotz & Robert M. Rosenberg, *Chemical Thermodynamics*, John Wiley and sons, Inc., 1994.
6.	J. Rajaram & J. C. Kuriacose, *Thermodynamics*, Shoban Lal Nagin Chand and CO., 1986.
7.	A. Peter & J. Paula, *Physical Chemistry*, 9th Ed., Oxford University Press, 2011.
8.	N. Levine, *Physical Chemistry*, 6th Ed., Tata Mc Graw Hill 2010.

School: School of Science	**Program: B.Sc Chemistry**
Course Code: CH209	**Course Name: Chemistry Laboratory-VII**

Year	**II**	**Core Subject (Yes/No):**	**Yes**	**Lecture:**	**0**
Semester	**IV**	**Elective Subject (Yes/No):**	**No**	**Tutorial**	**0**
Mode of Transaction	Laboratory	**Foundation Subject (Yes/No):**	**No**	**Practical:**	**6**
		Year of Syllabus Revision:	**2018**	**Total Credit:**	**3**
		Year of Introduction	**2014**	**Prerequisites (If any)**	**FY B.Sc. Chemistry**

Course Description:
Semi-micro qualitative analysis of inorganic compounds containing two cations and two anions, including phosphate separation scheme.

Course Outcome (CO):

CO1	Understanding basic principles of Separation
CO2	Separation of Inorganic mixture
CO3	identification of radicals in a given unknown salt mixture
CO4	phosphate separation scheme.

No.	Experiment	Contact Hours	BT Level	CO	PSO
1	$Pb (NO_3)_2 + CuSO_4$	4	1,2,3,4,5	CO1, CO2, CO3,	PSO2
2	$NH_4Br + CoCl_2$	4	1,2,3,4,5	CO1, CO2, CO3,	PSO2
3	$FeSO_4 + Al2(PO_4)_3$	4	1,2,3,4,5	CO1, CO2, CO3, CO4	PSO2
4	$CaCl_2 + KBr$	4	1,2,3,4,5	CO1, CO2, CO3,	PSO2
5	$ZnS + MnSO_4$	4	1,2,3,4,5	CO1, CO2, CO3,	PSO2
6	$Na_2SO_3 +NaNO_2$	4	1,2,3,4,5	CO1, CO2, CO3,	PSO2
7	$Mg_2(Cr_2O_7) + CdCl_2$	4	1,2,3,4,5	CO1, CO2, CO3,	PSO2
8	$BaSO_4 + Ni (NO_3)_2$	4	1,2,3,4,5	CO1, CO2, CO3,	PSO2
9	$SrCO_3 + CdCl_2$	4	1,2,3,4,5	CO1, CO2, CO3,	PSO2

Reference Books

1.	J. Mendham, R. C. Denney, J. B. Barnes & M. J. K. Thomas, Vogel's Textbook of Quantitative Chemical Analysis, 6th Ed., Pearson Education, New Delhi, 2003.
2.	R. C. Shah, Organic Qualitative Analysis, 5 th Ed., Baroda Book Depot, Vadodara, 1996

School: School of Science	**Program: BSc Chemistry**
Course Code: BO208	**Course Name: Plant Ecology, Genetics & Applied Botany**

Year	**II**	**Core Subject(Yes/No):**	**No**	**Lecture:**	**3**
Semester	**IV**	**Elective Subject(Yes/No):**	**No**	**Tutorial**	**0**
Typology of Course	Lectures	**Foundation Subject(Yes/No):**	**Yes**	**Practical:**	**0**
		Year of Syllabus Revision:	**NA**	**Total Credit:**	**3**
		Year of Introduction	**2019**	**Prerequisites (If any)**	**FY BSc Chemistry**

Course Description:

The structure and function of plants are studied in relationship to their fit into the environment. The interaction of plants with each other and with their environment through study of natural and artificial systems, including wetlands, meadows, forests, deserts, disturbed sites, and managed landscapes. Emphasis is placed on the molecular basis of heredity, chromosome structure, patterns of Mendelian and non-Mendelian inheritance, evolution, and biotechnological applications. Foundations of Biostatistical methods will be introduced to the students.

Course Objectives:

- understand environment and its interactions with plants
- understand inheritance, evolutionary processes, biophysical applications, and biostatistics

Course Outcome (CO):

CO1 Apply ecological principles to current conservation issues.
CO2 Discuss interactions between species and the environment that determine community composition and structure.
CO3 Understands the importance of identifying genes, isolating them, determining their function and controlling their expression.
CO4 Analyze the historical evolution of plant breeding, knowing which have been the key scientific and technical advances.
CO5 Choose and apply appropriate statistical methods for analyzing variables.
CO6 Interpret statistical results correctly, effectively, and in context.

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	**Plant ecology:** Definition and scope, Concept and components of environment. Concept and structure of ecosystem, Food chain, food web, Ecological pyramids, Basic ideas about ecosystem functioning, energy flow, organic production, biogeochemical cycles and ecological instruments. Concept and characters of plant community. Ecological classifications of plants, Adaptations in hydrophytes, mesophytes, xerophytes, halophytes and epiphytes. Air, water and land pollution, causes and control measures, Natural resources and their conservation. Problem of depletions of natural vegetation.	15	1, 2	CO1 CO2	PSO1
2	**Genetics:** Genetics and evolution. Structure of nucleus, nucleolus, nuclear membrane and chromosomes, Mendel's aw of inheritance, Linkage and crossing over, Physical basis of hereditary, Mutation and its role in evolution, sex determination, interaction of genes, evolutionary theories, ploidy, chromosomal abnormalities, Cytoplasmic inheritance.	12	1, 2	CO3 CO4	PSO1
3	**Instrumentation and Biostatistics:** Microscopy: Principles of light and electron microscopy, Phase contrast, TEM and SEM, pH meter, spectrophotometer, conductivity meter, turbidity meter and centrifuge. Biostatistics: Introduction, sampling methods in biological experiments and applications. Methods of presentation of data: Tables, graphs, diagrams and	18	2, 3, 4, 5	CO5 CO6	PSO1

	frequency distribution. Measures of central tendency – Mean median and mode for raw and grouped data.				

Reference Books	
1.	D.B. Sotkin & E.A. Keller, *Environmental studies : The earth as a planet*
2.	E.J. Gardner, *Principles of genetics*, 1967
3.	E.P. Odum, *Fundamentals of Ecology*, 1966
4.	E.S. Lenhoff, *Tools of Biology*
5.	J.E. Weaver & F.E. Clements, *Plant ecology*, 1938
6.	K.C. Misra, *Manual of plant ecology*
7.	M.A. Pallniswamy, *Basic statistics for biologist*, 2002
8.	M.W. Strickberger, *Genetics*
9.	P. D. Sharma, *Ecology and Environment*, 1974
10.	P.K. Gupta, *Genetics*, 1998
11.	R.F. Dauvenmire, *Plants & environment*
12.	R.S. Ambasht, *A text book of plant ecology*, 1969
13.	Wilson & Walker, *Principles and Techniques of Biochemistry and Molecular Biology*, 1992

School: School of Science		**Program: BSc Chemistry**			
Course Code: BO210		**Course Name: Botany Laboratory VIII**			
Year	**II**	**Core Subject (Yes/No):**	**No**	**Lecture:**	**2**
Semester	**IV**	**Elective Subject (Yes/No):**	**No**	**Tutorial**	**0**
Typology of Course	Practical	**Foundation Subject (Yes/No):**	**Yes**	**Practical:**	**0**
		Year of Syllabus Revision:	**NA**	**Total Credit:**	**2**
		Year of Introduction	**2019**	**Prerequisites (If any)**	**FY B.Sc. Chemistry**

Course Description:

The structure and function of plants are studied in relationship to their fit into the environment. The interaction of plants with each other and with their environment through study of natural and artificial systems, including wetlands, meadows, forests, deserts, disturbed sites, and managed landscapes. Emphasis is placed on the molecular basis of heredity, chromosome structure, patterns of Mendelian and non-Mendelian inheritance, evolution, and biotechnological applications. Foundations of Biostatistical methods will be introduced to the students.

Course Objectives:

Students will be able to solve the complex statistical problems using various biostatical modelling formulas and graphs.
Students will also be able to correlate the physical adaptations in plants surviving in the extreme of the conditions of the planet earth.

Course Outcome (CO):

CO1.	Understand environment and its interactions with plants
CO2.	Understand inheritance, evolutionary processes, biophysical applications and biostatistics
CO3.	Understand various types of adaptations in plants in extreme conditions
CO4.	Understand the divisional process in plants cells

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	To determine the minimum size of Quadrant by species Area- curve method.	6	1,2,3	CO1	PSO1
2	To study Communities by quadrant method and determine frequency, abundant, density.	6	2,3,4	CO2, CO3	PSO1
3	Graphical representation of Data	6	2,3,4	CO2	
4	To study the phases of Mitosis	6	2,3,4,5	CO2 CO4	PSO1
5	To study the phases of Meiosis	6	2,3,4	CO2 CO4	PSO1
6	To construct punnet structure and calculate probability (Monohybrid)	6	1,2,3	CO3	PSO1
7	To study and construct punnet square (Dihybrid)	6	1,2,3	CO1 CO2	
8	To study submerged Hydrophytes	6	1,2,3	CO1	
9	To study Free-floating hydrophytes	6	1,2,3	CO1	
10	To study Xerophytes	6	1,2,3	CO1	

Reference Books

1.	R.S. Ambasht, A text book of plant ecology, 1969
2.	E.J. Gardner, Principles of genetics, 1967

School: School of Science			**Program: BSc Chemistry**		
Course Code: ZO209			**Course Name: Comparative Anatomy & Physiology**		
Year	**II**	**Core Subject (Yes/No):**	No	**Lecture:**	**3**
Semester	**IV**	**Elective Subject (Yes/No):**	No	**Tutorial**	0
Typology of Course	**Lectures**	**Foundation Subject (Yes/No):**	Yes	**Practical:**	0
		Year of Syllabus Revision:	**NA**	**Total Credit:**	**3**
		Year of Introduction	**2014**	**Prerequisites (If any)**	FY BSc Chemistry

Course Description:

This course focuses on the basic processes of Dentition and Digestive System of lower to higher group of animals, comparative account of Respiratory System, Circulatory System, Excretory System, Modes of Reproduction and Reproductive System, Nervous System and Coordination in animals.

Course Objectives:

To learn about the evolutionary aspect of life development.
To gain understanding of comparative anatomy and physiology of organisms.
To understand comparative organ/system development among different phylum.

Course Outcome (CO):

CO1: Understanding of basics and comparison of integumentary, skeleton and muscular system in different phyla.
CO2: Learning of relative locomotion and digestive system.
CO3: Understanding comparative mechanics of respiratory and circulatory system.
CO4: Understanding comparative functioning of immune and nervous system.
CO5: Learning comparative functional anatomy and physiology of excretory System and osmoregulation.
CO6: Understanding comparative functional anatomy and physiology of reproductive system and chemical regulation.

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	**Unit-I:** Comparative functional Anatomy and Physiology – I: Integumentary System, Skeletal and muscular System and Modes of Locomotion, Dentition and Digestive System.	15	1,2	CO1, CO2,	PSO1
2	**Unit-II:** Comparative functional Anatomy and Physiology – II: Respiratory System, Circulatory and Immune Systems and Thermoregulation, Nervous System.	15	1,2	CO3, CO4	PSO1
3	**Unit- III:**Comparative functional Anatomy and Physiology – III: Excretory System and Osmoregulation, Modes of Reproduction and Reproductive System and Chemical Coordination.	15	1,2	CO5, CO6	PSO1

Reference Books	
1.	Vertebrates: Comparative Anatomy. Kenneth V Kardong.
2.	Comparative Anatomy of the Vertebrates. George Kent, Robert Carr.
3.	Dr Ian Kay- Introduction to Animal Physiology-Garland Science (1998).
4.	David J. Randall, Warren W. Burggren, Kathleen French, Roger Eckert-Eckert. Animal Physiology- Mechanisms and Adaptations (Fourth Edition). W.H. Freeman & Company (1997).

School: School of Science	**Program: BSc Chemistry**
Course Code: ZO211	**Course Name: Zoology Laboratory VIII**

Year	**II**	**Core Subject (Yes/No):**	**No**	**Lecture:**	**0**
Semester	**IV**	**Elective Subject (Yes/No):**	**No**	**Tutorial**	**0**
Typology of Course	Practical	**Foundation Subject (Yes/No):**	**Yes**	**Practical:**	**4**
		Year of Syllabus Revision:	**2018**	**Total Credit:**	**2**
		Year of Introduction	**2014**	**Prerequisites (If any)**	**FY BSc Chemistry**

Course Description:
The course is designed to introduce laboratory fundamentals of human anatomy and physiology. Clinical physiology concepts and experiments such as blood and urine analysis are included in detail. The course also includes basic qualitative estimations of carbohydrates, proteins and lipids and their significance in context to human physiology.

Course Objectives:
Students will be able to correlate various abnormalities in the human body with the blood practical. Various physiochemical parameters will also help the students to learn about the abnormalities in the human system.

Course Outcome (CO):
CO1: Gain understanding of anatomy and physiology of humans
CO2: Understand concepts and mechanisms associated with various physiological systems
CO3: Understand the relationship between anatomical structure, functions and their clinical observations
CO4: Understand the abnormalities in the blood cells due to various physiological effects

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	**Blood practical** To study effect of osmosis on RBCs	5	1,2,3	CO1	PSO1
2	Study of Haemin crystals	5	2,3,4	CO2, CO3	PSO1
3	WBC counting by haemocytometer	5	2,3,4	CO2	PSO1
4	Differential staining of WBC	5	2,3,4,5	CO2	PSO1
5	Clotting time of blood	5	2,3,4	CO2 CO3	PSO1
6	Bleeding time of blood	5	1,2,3	CO3	PSO1
7	**Comparative anatomy and physiology of various body systems** Digestive system	5	1,2,3	CO1 CO2	PSO1
8	Nervous system	5	1,2,3	CO1 CO2	PSO1
9	Respiratory system	5	1,2,3	CO1 CO2	PSO1
10	Circulatory system	5	1,2,3	CO1 CO2	PSO1
11	Excretory system	5	1,2,3	CO1 CO2	PSO1
12	**Physiological chemistry** Detection of carbohydrates	5	2,3,4	CO1 CO4	PSO1
13	Detection of lipids	5	2,3,4	CO1 CO4	PSO1
14	Detection of proteins	5	2,3,4	CO1 CO4	PSO1

Reference Books	
1.	Clinical Haematology by Wintrobe
2.	The Science of Laboratory Diagnosis 2nd Edition by John Crocker (Editor), David Burnett (Editor)

School: School of Science	**Program: BSc Chemistry**
Course Code: ES201	**Course Name: Environmental Studies**

Year	**II**	**Core Subject(Yes/No):**	**No**	**Lecture:**	**3**
Semester	**IV**	**Elective Subject(Yes/No):**	**No**	**Tutorial**	**0**
Typology of Course	Lectures	**Foundation Subject(Yes/No):**	**Yes**	**Practical:**	**1**
		Year of Syllabus Revision:	**NA**	**Total Credit:**	**4**
		Year of Introduction	**2019**	**Prerequisites (If any)**	**FY B.Sc. Chemistry**

Course Description:

Through interdisciplinary academic courses and co-curricular activities, the students shall become passionate stewards of the environment, scholars in sustainability and environmental management, and experts in environmental studies. The students will gain an in-depth knowledge of the different components of Environment. They will be able to recognize the components of Environment and different components of Environment. Field studies are as essential as class work and form an irreplaceable synergistic tool in the entire learning process.

Course Objectives:

- Students will be sensitized towards Environment and its concepts.
- Students will develop an understanding of environment and its types.
- To help the students develop their abilities to engage in discussions.
- To develop the logical and analytical reasoning capabilities.

Course Outcome (CO):

CO1 Gaining in-depth knowledge on natural processes that sustain life and govern economy

CO2 Recognize the physical, chemical, and biological components of the earth’s systems and show how they function

CO3 Developing critical thinking for shaping strategies (scientific, social, economic and legal) for environmental protection and conservation of biodiversity, social equity and sustainable development

CO4 Understand core concepts and methods from ecological and physical sciences and their application in environmental problem-solving

CO5 Adopting sustainability as a practice in life, society and industry

CO6 Acquiring values and attitudes towards understanding complex environmental economic-social challenges, and participating actively in solving current environmental problems and preventing the future ones

CO7 Predicting the consequences of human actions on the web of life, global economy and quality of human life

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	Multidisciplinary nature of environmental studies (Definition, scope and importance) Need for public awareness. Renewable and non-renewable resources: Natural resources and associated problems. a) Forest resources: Use and over-exploitation, deforestation. Timber extraction, mining, dams and their effects on forest and tribal people. b) Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems. c) Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources. d) Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity. e) Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. f) Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification. Role of an individual in	15	1, 2	CO1 CO2	PSO1

	conservation of natural resources. Equitable use of resources for sustainable lifestyles.				
2	**Ecosystems** Concept of an ecosystem. Structure and function of an ecosystem. Producers, consumers and decomposers. Energy flow in the ecosystem. Ecological succession. Food chains, food webs and ecological pyramids. Introduction, types, characteristic features, structure and function of the following ecosystem: a. Forest ecosystem, b. Grassland ecosystem, c. Desert ecosystem, d. Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries).	10	1, 2	CO2 CO3	PSO1
3	**Biodiversity and its conservation** Introduction - Definition: genetic, species and ecosystem diversity. Biogeographical classification of India. Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values. Biodiversity at global, National, and local levels. India as a mega-diversity nation. Hot sports of biodiversity. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts. Endangered and endemic species of India. Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.	10	1, 2, 5	CO3	PSO1
4	**Environmental Pollution** Definition. Cause, effects and control measures of a. Air pollution, b. Water pollution, c. Soil pollution, d. Marine pollution, e. Noise pollution, f. Thermal pollution, g. nuclear hazards, Solid waste Management: Causes, effects and control measures of urban and industrial wastes. Role of an individual in prevention of pollution. Pollution case studies. Disaster management: floods, earthquake, cyclone, and landslides.	10	1, 2, 4	CO6 CO7	PSO1
5	**Field work (on working Saturdays)** • Visit to a local area to document environmental assets: river/forest/grassland/hill/mountain • Visit to a local polluted site- Urban/Rural/Industrial/Agricultural • Floristic studies (Study of common trees, herbs, climbers, shrubs, etc.) • Faunal studies (Study of common insects, birds, butterflies, etc.) • Study of simple ecosystems- pond, river, hill slopes, etc.	30	2, 3, 4, 6	CO3 CO4 CO5	PSO1

Reference Books	
1.	Agarwal, K.C. 2001 Environmental Biology, Nidi Publ. Ltd. Bikaner.
2.	Bharucha Erach, The Biodiversity of India, Mapin Publishing Pvt. Ltd., Ahmedabad – 380 013, India.
3.	Miller T.G. Jr. Environmental Science, Wadsworth Publishing Co.
4.	Odum, E.P. 1971. Fundamentals of Ecology. W.B. Saunders Co. USA.
5.	Heywood, V.H & Waston, R.T. 1995. Global Biodiversity Assessment. Cambridge Univ.
6.	Townsend C., Harper J, and Michael Begon, Essentials of Ecology, Blackwell Science.
7.	Wanger K.D., 1998 Environmental Management. W.B. Saunders Co. Philadelphia.

SEMESTER V

School: School of Science			**Program: BSc Chemistry**		
Course Code: CH311			**Course Name: Organic Chemistry-III**		
Year	**III**	**Core Subject (Yes/No):**	Yes	**Lecture:**	**3**
Semester	**V**	**Elective Subject (Yes/No):**	No	**Tutorial**	**0**
Typology of Course	Lectures	**Foundation Subject (Yes/No):**	No	**Practical:**	**0**
		Year of Syllabus Revision:	2018	**Total Credit:**	**3**
		Year of Introduction	**2014**	**Prerequisites (If any)**	***See below**

Prerequisites (If any): Students should have basic concept of stereochemistry and properties of organic compounds with different functional groups.

Course Description:
This course is designed to provide a fundamental overview of organic chemistry to students interested in pursuing a career in the Chemistry. This course is an introduction to organic chemistry, focusing primarily on the basic principles to understand the structure and reactivity of organic molecules. Emphasis is on aldehydes, ketones, carboxylic acids, nitro compounds, amines and heterocyclic compounds. The course also introduces the chemistry of Pericyclic Reactions. Also, this course is helpful to students to understand better about these compounds while performing practical experiments.

Course Objectives:
The objective of this course is to develop abilities of student to understand the organic reaction mechanism and to critically interpret the diverse options regarding possible futures for the organic synthesis with different functional groups.

Course Outcome (CO):
Upon completion of the course students are expected to demonstrate knowledge, skill and abilities in the following areas:

CO1 A range of organic reactions with Aldehydes, Ketones, Carboxylic Acids, Nitro Compounds, Amines, pericyclic reactions.
CO2 open-ended problems related to different organic compounds with functional group (mentioned above) and produce tangible outcomes.
CO3 Preparing to design a reaction mechanism through to completion, encompassing the organic concept.
CO4 Gain mechanistic understanding of selected organic transformations and variety of name reaction in organic chemistry
CO5 Basic concept of pericyclic reactions

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	**Aldehydes, Ketones and Carboxylic Acids** *Aldehydes and Ketones*: Structure and Nomenclature, preparation of aldehydes: oxidation of primary alcohols and methylbenzenes, reduction of acid chlorides, Reimer-Tiemann reaction, preparation of ketones: oxidation of secondary alcohols, Friedel–Crafts acylation, use of lithium dialkylcuprates. Reactions: nucleophilic addition reactions (addition of CN^-, ammonia and its derivatives, alcohol, Grignard reagents), oxidation, reduction, Cannizzaro reaction, haloform reaction, Beckmann Rearrangement. nucleophilic addition of carbanion (Mechanisms of Aldol, Claisen Schmidt and Benzoin condensations, Perkin's reaction, Knoevenagel reaction), Wittig reaction, Beckmann and Benzil – Benzilic acid rearrangements. Oxidation (including Baeyer Villiger oxidation) and Reduction. □,□-Unsaturated carbonyl compounds (nucleophilic and electrophilic addition in brief), Michael addition. *Carboxylic acids*: Introduction, acidity of carboxylic acid, Preparation of carboxylic acids: oxidation of primary alcohols and alkylbenzenes, carbonation of Grignard reagents, hydrolysis of nitriles.	27	1,2,3,4	CO1 CO2 C03 C04	PSO2 PSO3 PSO4 PSO5

	Reactions of carboxylic acids: Hell-Volhard-Zelinsky reaction, ring substitution in aromatic acids, reduction. *Functional derivative of carboxylic acids*: introduction, nucleophilic acyl substitution (alkyl *vs*. acyl), preparation and reactions of acid chlorides, esters and amides, mechanism of esterification and decarboxylation. Preparation and reactions of dicarboxylic acids, conversion to anhydrides and imides. Reformatsky reaction~~.~~				
2	**Amines and aromatic nitro compounds** Introduction, physical properties, stereochemistry of nitrogen, Aliphatic and aromatic amines preparation: reduction of nitro compounds, ammonolysis of halides, reductive amination, reduction of nitriles and amides, rearrangement reactions (Lossen, Curtius, Schmidt and Hofmann), Gabriel phthalimide synthesis. Reactions: salt formation, alkylation, conversion to amide, ring substitution in aromatic amines, Hofmann elimination, Cope elimination. Structure and basicity of amines: Effects of substituents on basicity of aromatic amines. Separation of 1°, 2° and 3° amines (Hofmann method and Hinsberg method). Diazonium salts: Preparation and reactions (replacement of nitrogen, coupling and reduction)	12	1,2,3,4,5	CO1 CO2 C03 C04	PSO2 PSO3 PSO4 PSO5
3	**Pericyclic Reactions** *Pericyclic Reactions*: Molecular orbitals of ethylene and 1,3-butadiene, and 1,3,5- hexatriene, cycloaddition reactions ([2+2] and [4+2] (Diels-Alder reaction)), electrocyclic reactions, Woodward-Hoffmann rules for electrocyclic reactions, Claisen rearrangement as a sigmatropic reaction, *Photochemical reactions*: Norrish type-I and type-II reactions of carbonyl compounds.	6	1,2,3,4	CO4 CO5	PSO3 PSO4 PSO5

Reference Books	
1.	R. T. Morrison, R. N. Boyd and S. K. Bhattacharjee, *Organic Chemistry*, 7th Ed., Pearson New Delhi, 2012.
2.	M. K. Jain and S. C. Sharma, *Modern Organic Chemistry*, Vishal Publishing Co., New Delhi, 2018.
3.	J. Clayden, N. Greeves, S. Warren, P. Wothers, *Organic Chemistry*, 1st Ed., Oxford University Press, New York, 2001.
4.	T. W. Graham Solomons and Craig B. Fryhle, *Organic Chemistry*, 10th Ed., John Wiley and Sons, 2011.
5.	B. Y. Paula, *Organic Chemistry*, 3rd Ed., Pearson Education, Inc. (Singapore), New Delhi, Reprint, 2002.
6.	ArunBahl& B. S. Bahl, *A Textbook of Organic Chemistry*, S. Chand and Sons, New Delhi, 2005.
7.	Jerry March, *Advanced Organic Chemistry*, 4th Ed., John Wiley and Sons, New York, 1992.
8.	S. H. Pine, *Organic Chemistry*, 5th Ed., McGraw Hill International Edition, Chemistry Series, New York, 1987.

<table>
<tr><td colspan="3">School: School of Science</td><td colspan="3">Program: B.Sc. Chemistry</td></tr>
<tr><td colspan="3">Course Code: CH 302</td><td colspan="3">Course Name: Phase Equilibria, Chemical Kinetics and Catalysis</td></tr>
<tr><td>Year</td><td>III</td><td>Core Subject(Yes/No):</td><td>Yes</td><td>Lecture:</td><td>3</td></tr>
<tr><td>Semester</td><td>V</td><td>Elective Subject(Yes/No):</td><td>No</td><td>Tutorial</td><td>0</td></tr>
<tr><td rowspan="3">Typology of Course</td><td rowspan="3">Lectures and Tutorials</td><td>Foundation Subject(Yes/No):</td><td>No</td><td>Practical:</td><td>0</td></tr>
<tr><td>Year of Syllabus Revision:</td><td>2018</td><td>Total Credit:</td><td>3</td></tr>
<tr><td>Year of Introduction</td><td>2014</td><td>Prerequisites (If any)</td><td>SY B.Sc. Chemistry</td></tr>
</table>

Course Description:
This course deals with phase equilibria of variable systems and chemical kinetics. In the first part, the definitions along with some examples of different terms involved in phase equilibria are discussed. Phase diagram of one component (water, sulphur, carbon dioxide) and two component systems involving eutectic, congruent and incongruent melting points and solid solutions are involved in the chapter. In the latter part, basics of chemical kinetics and the detailed study of zero order, first order and second order kinetics with problems are discussed. In addition, kinetics of complex reactions and theory of catalysis with applications are involved therein.

Course Objectives:
Will acquire basic understanding regarding phase transitions and be able to construct and interpret phase diagrams. Student will be able to learn the fundamentals of chemical reactions, rates of reactions, factors affecting rate of reactions. Will be able to distinguish between order and molecularity of a reaction. Students will comprehend different types of adsorption, applications of adsorption and significance of adsorption for the process of catalysis.

Course Outcome (CO):
CO1 Acquire comprehensive knowledge about phase equilibrium. Able to construct phase diagram, interpret phase diagram and understand phase transitions.
CO2 Utilization of phase diagrams for industrial applications
CO3 understand the rates of reactions and correlation between rate of a reaction and rate constant, factors affecting rates of reactions, mechanism of reaction
CO4 comprehend different types of reactions, theories of reaction rates, effect of catalyst on reaction rates, classification of catalysts and theories of catalysis
CO5 understanding different types of adsorption and their significance with respect to different industrial applications and catalysis.

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	**Unit 1: Phase Equilibria** Concept of phases, components and degrees of freedom, Gibbs Phase Rule; phase diagram for one component systems (water, sulphur, carbon dioxide), with applications. Phase diagrams for two component systems involving eutectic, congruent and incongruent melting points and solid solutions. Solid solutions. Hume-Rothery rules for alloy/solid solution formation. Ideal/non – ideal liquids, Raoult's Law, Henry's Law, Steam Distillation. Fractional distillation. Azeotropes, breaking of azeotrope, partial miscibility of liquids, lower and upper critical solution temperature, Immiscible liquid pairs.	16	1,2,3,4,5	CO1 CO2	PSO1 PSO3 PSO4
2	**Unit 2: Chemical Kinetics** Order and molecularity of a reaction. Differential and integrated form of rate expressions up to second order reactions. Experimental methods of the determination of the order of a reaction, kinetics of complex reactions	16	1,2,3,4,5	CO2	PSO1 PSO3 PSO4

	(integrated rate expressions upto first order): Examples of (i) Opposing reactions (ii) parallel reactions and (iii) consecutive reactions and their differential rate equations (steady – state approximation in reaction mechanisms) (iv) chain reactions. Temperature dependence of reaction rates; Arrhenius equation; activation energy. Collision theory and transition state				
3	**Unit 3: Adsorption and Catalysis** Adsorption: Physisorption and Chemisorption and factors affecting adsorption, Freundlich and Langmuir Adsorption Isotherms. BET isotherm (No derivation). Applications. Catalysis: Catalyst, inhibitor, autocatalysis. Homogeneous and heterogeneous catalysis, General characteristics of catalytic reactions. Theories of catalysis. Applications of catalysts in industries. Turn over number. Enzyme catalysis. Applications of catalysts in industries.	13	1,2,3,4,5	CO3	PSO1 PSO3 PSO4 PSO5

Reference Books	
1.	S. H. Maron& J. B. Lando, *Fundamentals of Physical Chemistry*, Macmillan limited, New York, 1966.
2.	B. R. Puri& L. R. Sharma, *Principles of Physical Chemistry*, Shoban Lal Nagin chand and Co. 33rd Ed., 1992.
3.	P.W. Atkins, *Physical Chemistry*, 7th Ed., Oxford UniversityPress, 2001.
4.	S. K. Dogra & S. Dogra, *Physical Chemistry Through Problems*, 4th Ed., New age International, 1996.
5.	Irving M. Klotz & Robert M. Rosenberg, *Chemical Thermodynamics*, John Wiley and sons, Inc., 1994.
6.	Gilbert. W. Castellan, *Physical chemistry*, 3rd Ed., Narosa Publishing House, 1985.
7.	K. L. Kapoor, *A textbook of Physical chemistry*, Vol. – 2 & 3, Macmillan, India Ltd, 1994.

<table>
<tr><td colspan="3">School: School of Science</td><td colspan="3">Program: B.Sc. in Chemistry</td></tr>
<tr><td colspan="3">Course Code: CH 303</td><td colspan="3">Course Name: Spectroscopy and Separation Techniques</td></tr>
<tr><td>Year</td><td>III</td><td>Core Subject(Yes/No):</td><td>Yes</td><td>Lecture:</td><td>3</td></tr>
<tr><td>Semester</td><td>V</td><td>Elective Subject(Yes/No):</td><td>No</td><td>Tutorial</td><td>0</td></tr>
<tr><td rowspan="3">Typology of Course</td><td rowspan="3">Lectures and Tutorials</td><td>Foundation Subject(Yes/No):</td><td>No</td><td>Practical:</td><td>0</td></tr>
<tr><td>Year of Syllabus Revision:</td><td>2018</td><td>Total Credit:</td><td>3</td></tr>
<tr><td>Year of Introduction</td><td>2014</td><td>Prerequisites (If any)</td><td>SY B.Sc. Chemistry</td></tr>
</table>

Course Description:

It gives the basic idea of organic spectroscopy and its application to detect the organic compound having different functional groups. The first unit describes the basic principle of UV-visible and IR spectroscopy, their instrumentation, range etc. The types of electronic transitions and the method to find-out the λ_{max} is well discussed. In addition, fundamental, overtone, combination and coupled bands, fingerprint region, characteristic absorptions of various functional groups are also included in the chapter. The second unit deals with the basic principle of NMR and mass spectroscopy and their application to analyze the unknown compound. In the last unit principle of adsorption and partition chromatography and their applications are included.

Course Objectives:

The students will learn the basics principle of UV-visible, IR spectroscopy, Mass spectroscopy, and NMR their instrumentation, and basics of diverse types of chromatographic techniques like paper chromatography, column chromatography, TLC, Gas Chromatography, Ion Exchange Chromatography, etc.

Course Outcome (CO):

CO1: understand the interaction between UV and Visible radiation with organic compounds and its consequences in elucidation of the structure of organic compounds
CO2: appreciate the concept of IR spectroscopy in detecting some common functional groups during structural elucidation
CO3: investigate the basic principles, Instrumentation, Interpretation of mass spectroscopy and NMR and their application
CO4: learn the basic analytical methods and appreciate what is involved in an analysis like (paper chromatography, column chromatography, TLC, Gas Chromatography, Ion Exchange Chromatography, etc.)

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	**Ultra – Violet and InfraRed Spectroscopy** Electromagnetic spectrum, interaction of electromagnetic radiation with matter, atomic and molecular spectroscopy, absorption and emission spectroscopy. *Ultraviolet – Visible (UV – Vis) Spectroscopy*: Absorption laws, instrumentation, UV – Vis spectrum, types of electronic transitions, concept of chromophore and auxochrome, UV spectra of alkenes, conjugated enes, enones and aromatic compounds. *Infrared (IR) Spectroscopy:* Molecular vibrations, Hooke's Law, selection rules, instrumentation, and measurement of IR spectrum, Fundamental, overtone, combination and coupled bands, fingerprint region, characteristic absorptions of various functional groups.	15	1, 2, 3, 4, 5	CO1, CO2	PSO1, PSO3, PSO4
2	**Mass and Nuclear magnetic resonance (NMR) spectroscopy** Mass Spectrometry: Principle and instrumentation. Fragmentation of simple organic molecules. Nitrogen Rule. McLafferty rearrangement. Relevance of M+1 and M+2 peaks in mass spectra. Determination of molecular formula and structure of compound based on mass spectral data. Nuclear Magnetic Resonance (NMR) Spectroscopy: Nuclear magnetic resonance, instrumentation, proton NMR, nuclear shielding and deshielding, chemical shift, spin-spin splitting, interpretation of NMR spectra of simple organic molecules. Problems based on structure determination using NMR spectra.	15	1, 2, 3, 4, 5	CO3	PSO1, PSO3, PSO4

3	**Separation Techniques** Principle of adsorption and partition chromatography. *Column chromatography*: adsorbents, classification of adsorbents, solvents, preparation of column, adsorption and applications. *Thin Layer Chromatography*: choice of adsorbent, choice of solvent, R_f value and its applications. *Paper chromatography*: solvent used, R_f value, factors which affect R_f value. Ion exchange chromatography, resins used, experimental techniques, applications. *Gas Chromatography*: Principle, instrumentation Applications.	15	1, 2, 3, 4, 5	CO4	PSO1, PSO3, PSO4

Reference Books	
1.	D. A. Skoog, D. M. West & F.J. Holler, *Analytical Chemistry: An Introduction*, 5th Ed., Saunders college publishing, Philadelphia, 1990.
2.	S. M. Khopkar, *Basic concept of Analytical Chemistry*, 2nd Ed., New Age International, Publishers, New Delhi, 1998.
3.	P. S. Kalsi. Spectroscopy of Organic Compounds. New Age International Publishers, New Delhi. 6th Edition. 2005.

School: Science		**Program: B.Sc (Chemistry)**			
Course Code: CH 304		**Course Name: Chemistry laboratory-IX**			
Year	**III**	**Core Subject(Yes/No):**	**Yes**	**Lecture:**	**0**
Semester	**V**	**Elective Subject(Yes/No):**	**No**	**Tutorial**	**0**
Mode of Transaction	Laboratory	**Foundation Subject(Yes/No):**	**No**	**Practical:**	**8**
		Year of Syllabus Revision:	**2018**	**Total Credit:**	**4**
		Year of Introduction	**2014**	**Prerequisites (If any)**	**SY B.Sc. Chemistry**

Course Description:

An essential element of experimental organic chemistry is the identification of unknown organic compounds from the given mixture. This course covers the following topics: separation and purification of organic molecules; synthesis using diverse techniques; and functional group identification using various organic methods.

Physical chemistry practicals make up the second half of this course. Physical Chemistry is a branch of science that combines physics and chemistry to study the physical properties of molecules and the relationships between those properties and their composition. This course introduces students to the fundamental concepts of physical chemistry, chemical thermodynamics, Electrochemistry, Spectroscopy, Chemical kinetics, First and second-order reactions, Integrated rate laws, Reaction rate theories, solutions of electrolytes, Faraday's law of electrolysis, molar conductivity, Arrhenius theory, Ostwald's dilution law, thermodynamics of electrochemical cells, applications of emf measurements, surface chemistry, Langmuir Adsorption Isotherm, Chemical reactions on surfaces. The laboratory portion of the course teaches a variety of theoretical and applied physical chemistry techniques that are useful in both industrial and research contexts.

Course Outcome (CO):

CO1: Gain knowledge on organic qualitative analysis for a binary organic compound using various separation techniques like distillation, separation, crystallization derivatization and function group detection for both solid as well as liquid compounds.

CO2: Lastly identify given unknown organic compound by taking melting/boiling point depending on the state of the compounds and carry out crystallization and prepare derivative for purification of an organic compound.

CO3: To conduct the experiment on various instrumental techniques and to describe the principles behind the experiment performed in the laboratory.

CO4: understand the instrumentation techniques like conductometric titration, potentiometric titration, pHmetry, chemical kinetics, hydrolysis of sucrose using polarimetry, decomposition of H_2O_2 using gasometer, COD, etc.

CO5: Understanding the UV- spectroscopy and its theoretical aspect of the instrument that is been used for colored compounds. Lastly, to interpret the experimental results obtained by refractometer, spectrophotometer, Ph meter, potentiometer.

No.	**Experiment**	**Contact Hours**	**BT Level**	**CO**	**PSO**
	Identification of given Unknown Organic Compounds (Organic Spotting)				
1	Acid + Neutral (Benzoic Acid + Naphthalene)	4	1,2,3,4,5	CO1, CO2	PSO1, PSO2, PSO3 PSO4 PSO5
2	Acid + Neutral (Phthalic acid + Acetanilide)	4	1,2,3,4,5	CO1, CO2	PSO1, PSO2, PSO3 PSO4 PSO5
3	Phenol + Neutral (B-Naphthol + P-Toluidine)	4	1,2,3,4,5	CO1, CO2	PSO1, PSO2, PSO3 PSO4 PSO5

4	Acid + Base (Cinnamic acid + P-nitroaniline)	4	1,2,3,4,5	CO1, CO2	PSO1, PSO2, PSO3 PSO4 PSO5
5	Base+ Neutral (m-nitroaniline + Anthracene)	4	1,2,3,4,5	CO1, CO2	PSO1, PSO2, PSO3 PSO4 PSO5
6	Acid + Phenol (Salicylic acid + Resorcinol)	4	1,2,3,4,5	CO1, CO2	PSO1, PSO2, PSO3 PSO4 PSO5
7	Base+ Neutral (Aniline+ Toluene)	4	1,2,3,4,5	CO1, CO2	PSO1, PSO2, PSO3 PSO4 PSO5
8	Neutral+ Neutral (Ethyl acetate + Nitrobenzene)	4	1,2,3,4,5	CO1, CO2	PSO1, PSO2, PSO3 PSO4 PSO5
9	Neutral + Neutral (Benzaldehyde+ Benzophenone)	4	1,2,3,4,5	CO1, CO2	PSO1, PSO2, PSO3 PSO4 PSO5
10	Acid + Neutral (Salicylic acid + Acetamide)	4	1,2,3,4,5	CO1, CO2	PSO1, PSO2, PSO3 PSO4 PSO5
	Physical Chemistry Experiments				
11	To study the adsorption of oxalic acid on charcoal.	4	1,2,3,4,5	CO3, CO4, CO5	PSO1, PSO2, PSO3 PSO4 PSO5
12	To determine equivalent conductance, degree of dissociation and the dissociation constant of weak acid conductometrically.	4	1,2,3,4,5	CO3, CO4, CO5	PSO1, PSO2, PSO3 PSO4 PSO5
13	To determine the rate constant of acid catalyzed hydrolysis of sucrose	4	1,2,3,4,5	CO3, CO4, CO5	PSO1, PSO2, PSO3 PSO4 PSO5
14	To determine the Relative strength of two acids.	4	1,2,3,4,5	CO3, CO4, CO5	PSO1, PSO2, PSO3 PSO4 PSO5
15	To determine the Chemical oxygen demand (COD) for the given polluted sample.	4	1,2,3,4,5	CO3, CO4, CO5	PSO1, PSO2, PSO3 PSO4 PSO5

16	To determine the normality of acetic acid potentiometrically.	4	1,2,3,4,5	CO3, CO4, CO5	PSO1, PSO2, PSO3 PSO4 PSO5
17	To determine the λ_{max} and concentration of given unknown Potassium permanganate (KMnO4) using Visible Spectroscopy technique.	4	1,2,3,4,5	CO3, CO4, CO5	PSO1, PSO2, PSO3 PSO4 PSO5
18	To determine the strength of acetic acid and NaOH solution conductometrically	4	1,2,3,4,5	CO3, CO4, CO5	PSO1, PSO2, PSO3 PSO4 PSO5
19	Catalytic decomposition of hydrogen peroxide using metal ions as a catalyst.	4	1,2,3,4,5	CO3, CO4, CO5	PSO1, PSO2, PSO3 PSO4 PSO5
20	To find out surface tension of given liquid by drop number method at room temperature and calculate the Parachor.	4	1,2,3,4,5	CO3, CO4, CO5	PSO1, PSO2, PSO3 PSO4 PSO5
21	To determine the equilibrium constant of a reaction with the help of a spectrophotometer	4	1,2,3,4,5	CO3, CO4, CO5	PSO1, PSO2, PSO3 PSO4 PSO5
22	To find out the composition and viscosity of unknown liquid mixture by viscometer method.	4	1,2,3,4,5	CO3, CO4, CO5	PSO1, PSO2, PSO3 PSO4 PSO5

Reference Books	
1.	A. I. Vogel, A textbook of Practical Organic Chemistry, Fourth Edition.
2.	R.C. Shah’s Organic Spotting, Edited by P. Samnani, Ria Publishing House, Gujarat.
3.	A. Silbey, Physical Chemistry, Fourth Edition, Wiley, 2002.
4.	Puri, Sharma and Pathania, Principles of Physical Chemistry, 47th Edition. 1962-2016.

School: Science			**Program: B.Sc Chemistry**		
Course Code: CH 305			**Course Name: Chemistry Laboratory-X**		
Year	**III**	**Core Subject(Yes/No):**	**Yes**	**Lecture:**	**0**
Semester	**V**	**Elective Subject(Yes/No):**	**No**	**Tutorial**	**0**
Mode of Transaction	Laboratory	**Foundation Subject(Yes/No):**	**No**	**Practical:**	**8**
		Year of Syllabus Revision:	**2018**	**Total Credit:**	**4**
		Year of Introduction	**2014**	**Prerequisites (If any)**	**SY B.Sc. Chemistry**

Course Description:
Inorganic Quantitative Analysis (Gravimetric Analysis) is a branch of chemistry that is concerned with determining the amount and concentration of one or more constituents in a sample. Quantitative analyses are carried out using several methodologies, which can be classed as chemical or physical depending on which properties are used. Precipitation, neutralization, oxidation, and, in general, the production of a new compound is all used in chemical processes. Gravimetric analysis and volumetric, or titrimetric, analysis are the two most common forms of exclusively chemical procedures. In most cases, an analysis will involve a combination of methods: qualitative for isolating desirable constituents from a sample and quantitative for determining the amounts present. The analytical balance is the most important tool in all quantitative tests since it allows for the precise weighing of materials and precipitates.

Course Outcome (CO):
CO1 Gain knowledge on volumetric and gravimetric analysis, wherein gravimetric analysis and volumetric titration works on the idea of determining the mass of an ion in a pure compound and then using that information to calculate the mass percentage of that same ion in a known quantity of an impure compound.
CO2 The student will get in-hand experience of separating the element from the given sample and will calculate the amount and the concentration of elements.
CO3 Facilitate the students to make solutions of various molar concentrations. This may include: The concept of the mole; Converting moles to grams; Converting grams to moles; Defining concentration; Dilution of Solutions; Making different molar concentrations.
CO4 Students will explore the concept of Inorganic quantitative analysis to find out the concentrations of cations and anions.
CO5 Practical training in the field of Inorganic chemical analysis.

No.	**Experiment**	**Contact Hours**	**BT Level**	**CO**	**PSO**
	Quantitative separation and determination of the following pairs of metal ions using gravimetric and volumetric methods.				
1	Cu^{2+} (Volumetrically) and Fe^{3+}(Gravimetrically)	4	1,2,3,4,5	CO1, CO2, CO3, CO4, CO5	PSO1, PSO2, PSO3, PSO4, PSO5
2	Cu^{2+} (gravimetrically) and Ni^{2+}(Volumetrically)	4	1,2,3,4,5	CO1, CO2, CO3, CO4, CO5	PSO1, PSO2, PSO3, PSO4, PSO5
3	$^{Ni2+}$ (gravimetrically) and Cu^{2+}(Volumetrically)	4	1,2,3,4,5	CO1, CO2, CO3, CO4, CO5	PSO1, PSO2, PSO3, PSO4, PSO5
4	Cu^{2+} (gravimetrically) and Fe^{3+}(Volumetrically)	4	1,2,3,4,5	CO1, CO2,	PSO1, PSO2, PSO3,

				CO3, CO4, CO5	PSO4, PSO5
5	Al^{3+} (gravimetrically) and Cu^{2+}(Volumetrically)	4	1,2,3,4,5	CO1, CO2, CO3, CO4, CO5	PSO1, PSO2, PSO3, PSO4, PSO5
6	Mg^{2+} (gravimetrically) and Ca^{2+}(Volumetrically)	4	1,2,3,4,5	CO1, CO2, CO3, CO4, CO5	PSO1, PSO2, PSO3, PSO4, PSO5
7	Ba^{2+} (gravimetrically) and Ca^{2+}(Volumetrically)	4	1,2,3,4,5	CO1, CO2, CO3, CO4, CO5	PSO1, PSO2, PSO3, PSO4, PSO5
8	Al^{3+} (gravimetrically) and Ba^{2+} (gravimetrically)	4	1,2,3,4,5	CO1, CO2, CO3, CO4, CO5	PSO1, PSO2, PSO3, PSO4, PSO5
9	Cl^{-} Volumetrically (Mohr's, Volhard, Fajan's method)	4	1,2,3,4,5	CO1, CO2, CO3, CO4, CO5	PSO1, PSO2, PSO3, PSO4, PSO5
10	Ca^{2+} (gravimetrically) and Mg^{2+}(Volumetrically)	4	1,2,3,4,5	CO1, CO2, CO3, CO4, CO5	PSO1, PSO2, PSO3, PSO4, PSO5

Reference Books	
1.	A. I. Vogel, *Fundamentals of Quantitative Analysis*, 5th Ed., Addison Wesley longman., 1989.
2.	G. Suehla, *Vogel's Qualitative Inorganic Analysis*, 6th Ed., Orient Longman, 1989 J. Mendham, R. C. Denney, J. B. Barnes & M. J. K. Thomas, *Vogel's Textbook of Quantitative Chemical Analysis*, 6th Ed., Pearson Education, New Delhi, 2003.
3.	P. Samnani, *Experiments in Chemistry*, Anmol Publications, New Delhi 2007

School: School of Science			**Program: BSc. Chemistry**		
Course Code: SE201			**Course Name:** Essential Laboratory Practices		
Year	**III**	**Core Subject(Yes/No):**	**No**	**Lecture:**	**2**
Semester	**V**	**Elective Subject(Yes/No):**	**Yes**	**Tutorial**	**0**
Typology of Course	Lectures	**Foundation Subject(Yes/No):**	**No**	**Practical:**	**0**
		Year of Syllabus Revision:	**NA**	**Total Credit:**	**2**
		Year of Introduction	**2016**	**Prerequisites (If any)**	Basic knowledge about lab apparatus handling and SOPs which students have learned in their previous year laboratory sessions.

Course Description:
This Essential Laboratory Practice course provides an essential grounding in the way all types of non-clinical health and environmental safety studies should be planned, performed, monitored, recorded, archived and reported.

Course Objectives:
To provide students with good laboratory practice
To prepare student for Quality control training
To prepare students for Clinical Studies

Course Outcome (CO):
CO1: the role of Essential Laboratory Practices in the Biotechnology industry
CO2: the regulatory aspects of laboratories
CO3: importance of quality control
CO4: Food and Drug Regulations
CO5: In-vitro and In Vivo techniques principle and application

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	**Unit I** In vivo studies, In vitro studies, regulatory affairs, drug development, preclinical studies, clinical studies	15	1,2,3,5	CO1, CO5,	PSO1, PSO3, PSO5
2	**Unit II** Quality System Regulations (QSR), Good Clinical Practice (GCP), Good Laboratory Practices (GLP), Good Manufacturing Practice (GMP), FDA inspections	15	1,2,3,4	CO1, CO2, CO3, CO4	PSO1 PSO3, PSO5

Reference Books	
1.	Weinberg, S. (Ed.). (2003). Good laboratory practice regulations. Marcel Dekker.
2.	Seiler, J. P. (2006). Good Laboratory Practice: The why and the how. Springer Science & Business Media.
3.	McPherson, R. A., & Pincus, M. R. (2017). Henry's Clinical Diagnosis and Management by Laboratory Methods E-Book. Elsevier Health Sciences.
4.	Ezzelle, J., Rodriguez-Chavez, I. R., Darden, J. M., Stirewalt, M., Kunwar, N., Hitchcock, R., ... & D'souza, M. P. (2008). Guidelines on good clinical laboratory practice: bridging operations between research and clinical research laboratories. Journal of pharmaceutical and biomedical analysis, 46(1), 18-29.

School: School of Science	**Program: BSc Chemistry**
Course Code: SE202	**Course Name: Food and Nutrition**

Year	**III**	**Core Subject(Yes/No):**	No	**Lecture:**	2
Semester	**V**	**Elective Subject(Yes/No):**	Yes	**Tutorial**	0
Typology of Course	Lectures	**Foundation Subject(Yes/No):**	**No**	**Practical:**	0
		Year of Syllabus Revision:	**NA**	**Total Credit:**	**2**
		Year of Introduction	**2016**	**Prerequisites (If any)**	**SY BSc Chemistry**

Course Description:

Nutrition refers to the science which deals with the role of nutrients and other substances in health, growth, physiology and disease of an individual. A proper diet is determined by the proper proportions, requisite quantities, availability, method of cooking and palatability of the food.

Course Objectives:

To prepare students for successful career in industry and research institutes.
To enable students to work in a team with multidisciplinary approach.
To provide students with fundamental strength in analyzing, designing, and solving health related problems.

Course Outcome (CO):

CO1 Identify nutrition and health problems associated with diet
CO2 Importance of eating patterns and dietary needs both for people of different ages and for different groups within society
CO3 Understand the basis for different methods of cooking

Unit No.	**Topic/Unit**	**Contact Hours**	**BT Level**	**CO**	**PSO**
1	An understanding of the terms used in nutrition and the concept of diet and nutrition Balanced diet, My plate, Nutrition and dietetics. Nutritive value of foods - The sources and functions of: proteins, carbohydrates, fats, vitamins, Mineral elements, water, Sources and uses of food energy, Sources and functions of dietary fibre. Dietary guidelines - Factors affecting food requirements, Planning and serving of family meals. Meals for all ages and occupations. Special needs of pregnant and lactating women, convalescents, Vegetarians, Use of herbs, spices and garnishes. Composition and value of the main foods in the diet - Milk, meat, fish, cheese, eggs, margarine and Butter, Cereals, fruits and vegetables.	15	1,2	CO1	PSO1
2	Cooking of food Transfer of heat by conduction, convection and radiation. Principles involved in the different methods of cooking – boiling, stewing, grilling, baking, roasting, frying, steaming, pressure cooking, Preparation and cooking of food to preserve nutritional value and flavour. Traditional methods of cooking. Economical use of food, equipment, fuel and labour. Food spoilage, and hygiene in the handling and storage of food, Food preservation.	15	1,2	CO2,3	PSO1

Reference Books

1	N.W. Desrosier & J. N. Desrosier, The Technology of Food Preservation, Westport: Connecticut, Publishing Company, 1997. 2. Deaton, A., & Drèze, J. (2009).
2	Food and nutrition in India: facts and interpretations. Economic and political weekly, 42-65. 3. Duyff, R. L. (2012).
3	American dietetic association complete food and nutrition guide. Houghton Mifflin Harcourt. 4. Curry, K. R. (2000).
4	Multicultural competence in dietetics and nutrition. Journal of the Academy of Nutrition and Dietetics, 100(10), 1142.
5	E. Whitney, E. Hamiliton & S. Rolfes, Understanding Nutrition, St. Paul, MN: West Publishing Company, 1990. 6. Mahan, L. K. (2004).
6	Krause's food, nutrition, & diet therapy (Vol. 11). S. Escott-Stump (Ed.). Philadelphia: Saunders.

<table>
<tr><td colspan="3">**School: School of Science**</td><td colspan="3">**Program: B.Sc. Chemistry**</td></tr>
<tr><td colspan="3">**Course Code: SE204**</td><td colspan="3">**Course Name: Intellectual Property Rights and Patents Law**</td></tr>
<tr><td>**Year**</td><td>**III**</td><td>**Core Subject(Yes/No):**</td><td>**No**</td><td>**Lecture:**</td><td>**2**</td></tr>
<tr><td>**Semester**</td><td>**V**</td><td>**Elective Subject(Yes/No):**</td><td>**Yes**</td><td>**Tutorial**</td><td>**0**</td></tr>
<tr><td rowspan="3">**Typology of Course**</td><td rowspan="3">Lectures and Tutorials</td><td>**Foundation Subject(Yes/No):**</td><td>**No**</td><td>**Practical:**</td><td>**0**</td></tr>
<tr><td>**Year of Syllabus Revision:**</td><td>**2018**</td><td>**Total Credit:**</td><td>**2**</td></tr>
<tr><td>**Year of Introduction**</td><td>**2014**</td><td>**Prerequisites (If any)**</td><td>**12th Science**</td></tr>
</table>

Course Description:
This course deals with study of history of Intellectual Property system (International as well as India), introduction of various types of Intellectual Property Rights and laws governing them. It also deals with comprehensive understanding of patents law, its use during patent drafting and procedures underlying patent filing.

Course Objectives:
Comprehend the importance of intellectual property rights, intellectual property protection and significance with respect to economy and Scientific innovation. Distinguish between different intellectual property rights and utilization of intellectual property rights for leveraging financial benefits and seeking rights for intellectual creations.

Course Outcome (CO):
CO1 acquire basic understanding of intellectual property rights, historical perspective and evolution of Intellectual Property Rights at global level and in India
CO2 acquire knowledge on basic concepts of different intellectual properties, viz. copyrights, trademarks, geographical indications, Industrial Design Protection and Trade secrets. Protection of Plan Varieties and Farmers Rights Act etc.
CO3 gain insights into laws governing Intellectual Property Rights, especially Patents law
CO4 develop thorough understanding of Patents law, patentable inventions
CO5 use of patents law during patent drafting and procedures underlying patent filing

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	**Unit 1: Introduction to IPR** Understanding Intellectual Property Rights (IPRs), history of Intellectual Property (IP) system, development of IP law in India, evolution of IPR regime. Introduction to IP laws in India and an overview on Patents, Copyright, Trademarks, Geographical Indicators, Industrial Design Protection and Trade secrets. Protection of Plan Varieties and Farmers Rights Act.	13	1,2,3,4	CO1 CO2 CO3	PSO1 PSO4
2	**Unit 2: Patents Laws** Patenting: Important of Patent Policy, Patents Act 1970, Patents Amendment Act 1999, Patents Amendment Act, 2002. Patent Act 2005. Procedure for Patent Application. Patent Drafting and details therein, viz. Specifications, Claims. Grant of Patents, Opposition to Patents, Patent Licensing, Patent Search	17	1,2,3,4,5	CO3 CO4 CO5	PSO1 PSO4

Reference Books

1.	E. F. Charles Rickett & W. Austin Graeme, International intellectual property and the common law, World Ed., Hart Publishing, 2000.
2.	Robert P Merges, Peter S Menell & Mark A Lemley, Intellectual property in the new technological age, 2nd Ed., Aspen Law and Business, 2000.
3.	Prabudhha Ganguli, Gearing up for patents: The Indian Scenario, Universities Press (India) Ltd. 1998.
4.	T. Ramappa, Intellectual Property Rights under WTO: Tasks before India, Wheeler Publishing, 2000.
5.	Patent Office Manual, Department of Industrial Policy and Policy Protection, Government of India, New Delhi.

School: School of Science			**Program: BSc Chemistry**		
Course Code: SE213			**Course Name:** Introduction to Neuroscience and Cognition		
Year	**III**	**Core Subject (Yes/No):**	**No**	**Lecture:**	**2**
Semester	**V**	**Elective Subject (Yes/No):**	**Yes**	**Tutorial**	**0**
Typology of Course	Lectures	**Foundation Subject (Yes/No):**	**No**	**Practical:**	**0**
		Year of Syllabus Revision:	**NA**	**Total Credit:**	**2**
		Year of Introduction	**2019**	**Prerequisites (If any)**	**SY BSc Chemistry**

Course Description:
This course introduces basic neuroanatomy, neurophysiology, neural plasticity, functional imaging techniques. It also explains cognitive and neural processes that support attention, vision, language, motor control, navigation, and memory. Course explores behavioral measures of cognition and discusses methods by which inferences about the brain bases of cognition are made along with various neurological disorders.

Course Objectives:
Development and organization of nervous system, types of cells in CNS and PNS, understanding concept of neurophysiology, electric firing of neurons, and types of synapses- chemical and electrical. The course also describes neurobiology of sleep, memory and attention along with the various neurological disorders.

Course Outcome (CO):
CO1: Concepts of neuroanatomy, neurophysiology, development, and sensation/ perception
CO2: Principle of cognitive science, cognitive control, plasticity
CO3: Modes of learning and memory, attention and action, sleep, emotion and language
CO4: Various neurological disorders

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	**Unit I:** Nervous Physiology and Functions: Introduction to neuroscience, History of neuroscience and Introduction to Neurons, Neurology of biological cycle and techniques to study neurology, Types of Neurons, Circadian rhythm, Action Potential, Evolution of Neurons, Evolution of nervous system, Neuroanatomy-Structure of brain, spinal cord, medulla oblongata, Neurophysiology, Neurotransmitters	15	1,2,3	CO1	PSO1
2	**Unit II:** Cognition and Defects Sleep cycle and disorders, Neurology of Learning, Neurology of Memory, Neurology of Attention and Action, Neurology of Emotions and Language, Development of neurons, Plasticity of Neurons, Methods in Cognitive Science, Sensation and perception, Cognitive control, Object recognition, Neurological Disorder.	15	1,2,3	CO2, CO3, CO4	PSO1

Reference Books

1.	Bear, Connors, Paradiso-Neuroscience '16 58
2.	Development of the nervous system second edition dan h. Sanes thomas a. Reh, william a. Harris amsterdam, Academic Press is an imprint of Elsevier 3
3.	Basic Neurochemistry: Principles of Molecular, Cellular, and Medical Neurobiology (2011) Scott Brady. Elsevier Science & Technology
4.	Basic Neurochemistry: Molecular, Cellular and Medical Aspects (1994) George J. Siegel, Bernard W. Agranoff, R. Wayne Albers, Perry B. Molinoff. Raven Press
5.	Handbook of Neurochemistry (1969) A. Lajtha. Plenum Press
6.	Selected Topics from Neurochemistry (1985) N. N. Osborne. Elsevier Science Limited.

School: School of Science			**Program: B. Sc. Chemistry**		
Course Code: SE 302			**Course Name: Medicinal Chemistry-I**		
Year	**III**	**Core Subject(Yes/No):**	**No**	**Lecture:**	**2**
Semester	**V**	**Elective Subject(Yes/No):**	**Yes**	**Tutorial**	**0**
Typology of Course	Lectures	**Foundation Subject(Yes/No):**	**No**	**Practical:**	**0**
		Year of Syllabus Revision:	**2018**	**Total Credit:**	**2**
		Year of Introduction	**2014**	**Prerequisites (If any)**	**SY B.Sc. Chemistry**

Course Description:
This course is designed to introduce factors that play important roles in effect of drug in the body. Active principles in drug, excipients and other important constituents that go in drug making will be introduced. The journey of thousands of drug candidates screened for potential candidates that actually reach the market after numerous tests will be explained. Important antibiotics will be introduced with respect to their structures, activities and applications.

Course Objectives:
the student will have knowledge of: General structural features of agents belonging to the therapeutic class, Relevant physicochemical properties of active pharmacophores, their Relevant chemical reactions/synthetic pathways for selected drugs, moreover their Structural influences on mechanism of pharmacologic action (structure-activity relationship) and their toxicological profile.

Course Outcome (CO):
CO1: Knowledge of the connection between the structural features of the drugs and their physico-chemical characteristics, mechanism of action and use.
CO2: Application the gained knowledge about the therapeutic classes of drugs.
CO3: Describe the basics to understand active pharmacophore, mechanism of action, use and mode of application of the selected drugs on the basis of their structure.
CO4: Describe and perform synthesis of the drugs and determine its pharmacologic action (structure-activity relationship) and their toxicological profile

Unit No.	**Topic/Unit**	**Contact Hours**	**BT Level**	**CO**	**PSO**
1	Concept of drug, lead compound and lead modification, prodrugs and soft drugs; Structure activity relationship (SAR), quantitative structure-activity relationship (QSAR); Factors affecting bioactivity-resonance, inductive effect, isosterism, bio-isosterism, spatial considerations; Theories of drug activity – occupancy theory, rate theory, induced fit theory Concept of drug receptors – elementary treatment of drug –receptor interactions; Physicochemical parameters lipophilicity, partition coefficient, electronic ionization constants, steric, Shelton and surface activity parameters and redox potentials; Factors affecting modes of drug administration, absorption, metabolism and elimination; Significance of drug metabolism in medicinal chemistry.	15	1, 2, 3, 4, 5	CO1, CO2, CO3	PSO1, PSO3, PSO5
2	**Antibiotics** Cell wall biosynthesis, inhibitors of β-lactam rings, antibiotics inhibiting protein synthesis; Isolation, structure elucidation, synthesis, SAR and mode of action of penicillins; Synthesis of penicillin G, penicillin V, ampicillin, amoxicillin and cephalosporin. Isolation, structure elucidation, synthesis,	15	1, 2, 3, 4, 5	CO1, CO2, CO3, CO4	PSO1, PSO3, PSO5

	SAR and mode of action of following antibiotics: streptomycin, tetracyclines and chloramphanicol.				

Reference Books	
1.	Burger, *Medicinal Chemistry and Drug Discovery*, Vol. – 1, Ed., M. E. Wolff, John Wiley, 1994.
2.	Goodman & Gilman, *Pharmacological Basis of Therapeutics*, Mc Graw – Hill, 2005.
3.	S. S. Pandeya & J. R. Dimmock. *Introduction to Drug Design*, New Age International, 2000.
4.	D. Lednicer, *Strategies for Organic Drug Synthesis and Design*, John Wiley, 1998.
5.	Graham & Patrick. *Introduction to Medicinal Chemistry*, 3rd Ed., OUP, 2005.

School: School of Science			**Program: BSc Chemistry**		
Course Code: SE305			**Course Name: Introduction to Cell and Tissue Culture**		
Year	**III**	**Core Subject (Yes/No):**	**No**	**Lecture:**	**2**
Semester	**V**	**Elective Subject (Yes/No):**	**Yes**	**Tutorial**	**0**
Typology of Course	Lectures	**Foundation Subject (Yes/No):**	**No**	**Practical:**	**0**
		Year of Syllabus Revision:	**NA**	**Total Credit:**	**2**
		Year of Introduction	**2019**	**Prerequisites (If any)**	**SY B.Sc. Chemistry**

Course Description:
This course provides an expertise in animal and plant tissue culture theory and practice. It introduces the student to the theory and practice of plant tissue culture and their role from modifying plants in plant biotechnology to the propagation of endangered plants and from modifying cell lines to the propagation of all lines for use in medical, microbiological, and biochemical research. It also emphasizes on the importance and applications of stem cells.

Course Objectives:
To understand the concept of cell and tissue culture. The course describes various methods and aspects of plant tissue culture such as sterilization and media preparation, the composition of media for different cultures, types of tissue cultures and the creation of hybrid plants through micropropagation. The course also highlights the basics of animal cell culture, media sterilization, biology of cells in culture and various assays done to test compounds as a method of drug development studies.

Course Outcome (CO):
CO1: Understand the methods for plant and animal tissue culture and characterization.
CO2: Study the applications of plant and animal tissue cultures
CO3: Understand different types and methods of cell culture.
CO4: To study the culture and characterization of animal cell lines.

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	**Unit I:** Plant Tissue Culture History and scope of plant tissue culture. Laboratory requirements and organization. Sterilization methods. Media preparation-inorganic nutrients, organic supplements, carbon source, vitamins, gelling agents, phytohormones and growth regulators; composition of commonly used culture media. Types of tissue culture-plantlets, seedlings, callus, somatic embryogenesis. Micropropagation: Factors affecting morphogenesis and proliferation rate; technical problems in micropropagation. Organogenesis: formation of shoots and roots, production of virus free plants by meristem and shoot tip culture Hybrid plants: protoplast isolation, culture and fusion, selection of hybrid cells and regeneration of hybrid plants, symmetric and asymmetric hybrid, cybrid. Production of haploid plants: anther, pollen, and ovary cultures for production of haploid plants and homozygous lines.	15	1,2,3	CO1, CO2	PSO1
2	**Unit II:** Animal Cell Culture Introduction to Mammalian Cell Culture and its history, Application of cell culture, Equipments and materials for animal cell culture technology, Media composition for cell culture (Basal media and supplements), Characteristics of cells in culture: Contact inhibition, anchorage dependence (adherent and non-adherent, way to passage it), cell-cell communication (cell junction basics, co-culture), Cell senescence (telomerase and ageing), Types of culture (cell/tissue/organ).	15	1,2,3	CO3, CO4	PSO1

	Various systems of tissue culture, their distinguishing features, advantages and limitations, applications, measurement of viability and cytotoxicity, various cell cultures: primary, cell lines immortalized, transformed, haploid and diploid cell lines and Stem cells (based on potency- totiptent, multipotent, pleuripotent, oligopotent and based on their origin-embryonic, hematopoietic, somatic), iPSC (mechanism of its generation with eg. Human fibroblast to pluripotent-beta cell of pancrease), transfection methods (lipofection, calcium mediated, electroporation), Tissue engineering				

Reference Books	
1.	Introduction to plant tissue culture (1993) M. K. Razdan. Science Publishers Inc.
2.	Plant Cell and Tissue Culture (1994), Indra K. Vasil, Trevor A. Thorpe. Springer
3.	R. Ian Freshney -Culture of Animal Cells_ A Manual of Basic Technique and Specialized Applications, Sixth Edition-Wiley-Blackwell (2010)
4.	Masters, J. R. W. (Ed): Animal Cell Culture – Practical Approach, Oxford Univ. Press.
5.	Basega, R. (Ed): Cell Growth and Division: A Practical Approach. IRL Press.
6.	Clynes, M. (Ed.). (2012). Animal cell culture techniques. Springer Science & Business Media.
7.	Knoepfler, P. (2013). Stem cells: an insider's guide. World Scientific.
8.	Turksen, K. (Ed.). (2012). Adult and Embryonic Stem Cells. Springer Science & Business Media.
9.	Lanza, R., Gearhart, J., Hogan, B., Melton, D., Pedersen, R., Thomas, E. D., & West, M. (Eds.). (2005). Essentials of stem cell biology. Elsevier.

School: School of Science			**Program: B.Sc. (Chemistry)**		
Course Code:SE307			**Course Name: Number Theory**		
Year	**III**	**Core Subject(Yes/No):**	**No**	**Lecture:**	**2**
Semester	**V**	**Elective Subject(Yes/No):**	**Yes**	**Tutorial**	**0**
Typology of Course	Lectures and Discussions	**Foundation Subject(Yes/No):**	**No**	**Practical:**	**0**
		Year of Syllabus Revision:	**NA**	**Total Credit:**	**2**
		Year of Introduction	**2019**	**Prerequisites (If any)**	**SY B.Sc. Chemistry**

Course Description: This course is about the study of the fundamental properties of the Number systems and their application to the real-world problems

Course Objectives:

Understand some of the important theorems in Number Theory which helps them in solving some of the real-world problems with their applications.

Learn the basic properties of the number system such as the Euclid's Algorithm, congruences, residue classes and solve linear congruences

Course Outcome (CO):

CO1: Learn the properties of numbers and properties of numbers, prime numbers
CO2: Find greatest common divisors of numbers, solve linear Diophantine equations
CO3: Learn about linear congruences and Chinese remainder theorem
CO4: Learn about Wilson's theorem, Fermat's little theorem and their applications
CO5: Learn about the multiplicative functions and their applications
CO6: Find the primitive roots

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	Numbers and Sequences: Sums and Products, Mathematical Induction, The Fibonacci Numbers. Primes and Greatest Common Divisors: Prime Numbers, distribution of Primes	5	1,2,5	CO1	PSO1
2	Greatest Common Divisors, Euclidean Algorithm, Fundamental Theorem of Arithmetic, Factorization Methods and Fermat Numbers, Linear Diophantine Equations.	5	1,2,3,5	CO2	PSO1
3	Congruences: Introduction to Congruences, Linear Congruences, Chinese Remainder Theorem. Applications of Congruences: Divisibility Tests, Check Digits	5	1,2,3,4,5	CO3	PSO1
4	Some Special Congruences, Wilson's Theorem and Fermat's Little Theorem, Pseudoprimes, Euler's Theorem	5	2,3,5	CO4	PSO1
5	Multiplicative functions: The Euler Phi-Function, The Sum and Number of Divisors, Perfect Numbers and Mersenne Primes, Mobius Inversion	5	2,3,4,5	CO5	PSO1
6	Primitive Roots: Order of an Integer and Primitive Roots, Primitive Roots for Primes.	5	1,2,3,4,5	CO6	PSO1

Reference Books	
1.	T. Koshy, Elementary Number Theory with Applications, Harcourt/Academic Press (2002)

2.	G. Andrews, Number Theory, Dover Publications (1994)
3.	O. Ore, Number Theory and Its History, Dover Publications (1988)
4.	J. Havil, F. Dyson, Gamma: Exploring Euler’s Constant, Princeton University Press (2003)
5.	Euler: The Master of Us All, The Mathematical Association of America (1999)
6.	G. Dunnungton, J. Gray, Carl Friedrich Gauss: Titan of Science, The Mathematical Association of America (2004)
7.	K. Rosen, Elementary Number Theory and its Applications (5th Edition), Addison-Wesley (2005).

School: School of Science			**Program: B.Sc. Chemistry**		
Course Code: PS322			**Course Name: Scientific Inquiry and Research and Methodology**		
Year	**III**	**Core Subject(Yes/No):**	**Yes**	**Lecture:**	**3**
Semester	**VI**	**Elective Subject(Yes/No):**	**No**	**Tutorial**	**0**
Typology of Course	Lectures	**Foundation Subject(Yes/No):**	**No**	**Practical:**	**0**
		Year of Syllabus Revision:	**NA**	**Total Credit:**	**3**
		Year of Introduction	**2021**	**Prerequisites (If any)**	**SY B.Sc. Chemistry**

Course Description:

This course is designed to orient students to Research Methodology and develop a research aptitude in them. Topics included are an understanding of basic research methodology, problem identification; importance of literature review; types of research designs; tool and techniques of data collection; techniques of data analysis; reporting of findings; scientific and research writing. Section on review of different types of research provides the understanding to carry out the research work independently. Once equipped with this knowledge, students would have the requisite knowledge and understanding to conduct research in an area of their choosing

Course Objectives:

- Read, interpret and critically evaluate 'research'.
- Explain and apply research terminologies; describe the research process and the principle activities, skills and ethics associat with the research process.
- Identify and explain the difference between quantitative, qualitative & mixed methods research.
- Explain components of a research study and justify the theory as well as the methodological decisions, including samplin measurement, and analysis.
- Critically review a research study including an abstract, introduction, literature review, objectives of the study, research design and ethical considerations.

Course Outcome (CO):

CO1 Explain key research concepts and issues
CO2 Explain the difference between quantitative, qualitative & mixed methods research.
CO3 Relate the type of Study with methodology to be adopted – research design, tools / techniques of data collection and analysis.
CO4 Evaluate critically a research study and its various components
CO5 Read, comprehend, and explain research articles in their academic discipline
CO6 Explain the ethical issues that need to be addressed in the conducting of research

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	Definition of research and its importance. Steps in the process of research Identifying research problem. Discussion on importance, feasibility… Quantitative & Qualitative research characteristics	8	1,2,3,4,5	**CO1 CO2**	PSO1, PSO2, PSO3, PSO6
2	Reviewing related literature Understanding Concepts, Variables. Understanding Research questions Understanding Hypothesis, types of hypotheses; Framing of Objectives.	8	2,3,4,5	**CO1 CO4**	PSO1, PSO2, PSO3, PSO6

3	Research design – Experimental, Correlational Research design – Survey, Field study Research design – Mixed method Research design - Action research	9	2, 3, 4,5	**CO2** **CO3** **CO4**	PSO1, PSO2, PSO3, PSO6
4	Understanding Population, Sample, Sampling techniques Tools and techniques of data collection Designing tools with Reliability, Validity, Objectivity, Sensitivity Understanding Normal Probability curve; Implications.	10	2,3,4,5	**CO3**	PSO1, PSO2, PSO3, PSO6
5	Data Analysis - Qualitative Research. Data Analysis – Quantitative Research (Central Tendency – calculating Mean, Median, Mode)	4	1,2,3,4,5	**CO3**	PSO1, PSO2, PSO3, PSO6
6	Critically review a research proposal - including an abstract, introduction, literature review, objectives of the study, research design and ethical considerations. Ethical issues in conducting research Skills needed to design and conduct research	6	2,3,4,5	**CO4** **CO5** **CO6**	PSO1, PSO2, PSO3, PSO6

Reference Books	
1.	Anthony, M., Graziano, A.M. and Raulin, M.L., 2009. Research Methods: A Process of Inquiry, Allyn and Bacon.
2.	Best J.W., and Kahn J.V., (2003) Research in education Ninth edition, New Delhi: Prentice Hall of India
3.	Cresswell J.W. (2011) Educational Research New Delhi: PHI learning Pvt. Ltd.
4.	Day, R.A., 1992.How to Write and Publish a Scientific Paper, Cambridge University Press.
5.	Fink, A., 2009. Conducting Research Literature Reviews: From the Internet to Paper. Sage Publications.
6.	Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers
7.	Kothari C.R., (2008), Research Methodology- Methods and Techniques, Wiley and Eastern Ltd., New Delhi.
8	Koul Lokesh., (2009) Methodology of educational research fourth edition., New Delhi: Vikas publishing
9	Leedy, P.D. and Ormrod, J.E., 2004 Practical Research: Planning and Design, Prentice Hall.
10	Marshall Stephen D, Nick Green (2010) Your Ph.D companion New Delhi: Viva books
11	Mc Burney H. Donald., (2001) “Research Methodology “fifth edition., Australia: Thomson - Wadsworth
12	Pandya Shefali., (2010) Educational Research New Delhi: APH Publishing corporation
13	Panneerselvam R., (2010) Research Methodology New Delhi: Anmol Publication
14	Satarkar, S.V., 2000. Intellectual property rights and Copy right. Ess Ess Publications.
15	Sharma R. N., (2008) Statistical techniques in educational research Delhi: Surjeet publication.

SEMESTER VI

School: Science			**Program: B.Sc. (Chemistry)**		
Course Code: CH 312			**Course Name: Inorganic chemistry III**		
Year	**III**	**Core Subject(Yes/No):**	**Yes**	**Lecture:**	**3**
Semester	**VI**	**Elective Subject(Yes/No):**	**No**	**Tutorial**	**0**
Typology of Course	Lectures	**Foundation Subject(Yes/No):**	**No**	**Practical:**	**0**
		Year of Syllabus Revision:	**2019**	**Total Credit:**	**3**
		Year of Introduction	**2014**	**Prerequisites (If any)**	**SY B.Sc. Chemistry**

Course Description:
The first part elaborately explains the chemistry of boron, carbon, nitrogen, oxygen, halogen families as well as the chemistry of noble gases. It includes the preparation and properties of oxides, halides, oxyhalides of all p block elements as well as noble gases. In addition, the detailed study of boranes, borohydrides, carboranes, boron nitride, borazine, carbides, graphitic compounds, silicates, etc. are also included in the course. The course also deals with inorganic solids in research and day-to-day life which includes solid electrolytes, inorganic pigments, molecular material and fullerides, silicones, glass, ceramics, refractories, and rubber. It also deals with the metal-ligand equilibrium in the solution.

Course Objectives:
Understand the concept of Boron, Carbon, Nitrogen, Oxygen and Halogen Family. Understand the applications of inorganic solids in various field of chemistry. Detail understanding on metal complexation and effect of ligand on stability of metal ions.

Course Outcome (CO):
CO1: Detail understanding on periodic table elements.
CO2: Application of inorganic materials like zeolites, clays, feldspar, and ultramarines.
CO3: Understanding on Nobel gas, halogen elements and about the pseudohalogens and polyhalides,
CO4: Application of inorganic materials in the field of paint, separation, and catalysis.
CO5: Detail knowledge on stability of metal complexes and effect of ligand on the stability of metal complexes.

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	Unit 1: Boron and Carbon Family Chemistry of Boron family: Electron deficiency and acceptor behavior, Oxides, hydroxides and halides, boron nitride and borazole. Structure, bonding and important applications. Boranes, borohydrides and carboranes. Chemistry of Carbon family: Allotropy, trends in metallic properties and conduction, structure, bonding and properties of oxides. Carbides, graphitic compounds, silicates, zeolites, feldspars, ultramarines and clay minerals. Synthetic zeolites and clays. Ceramics, refractories and rubber.	15	1,2,3,4,5,	CO1 CO2 CO3	PSO1 PSO3 PSO4
2	Unit 2: Nitrogen, Oxygen, Halogen Family and Nobel Gases Nitrogen family: hydrazine, hydroxylamine and hydrazoic acid, hydrides of other elements, Oxides and halides, Oxyacids of nitrogen and phosphorous. Chemistry of Oxygen family : Ozone, oxides, peroxides and superoxides. Oxyacids and halides of sulphur, peracids and persalts of sulphur, Chemistry and applications of lead compounds, Chemistry of Halogens: Oxides and oxyacids of halogens, peracids and persalts, interhalogen compounds, pseudohalogens and polyhalides, basic properties of Iodine, Chemistry of Astatine. Chemistry of Noble Gases: Oxides, fluorides and oxyfluorides of xenon.	10	1,2,3,4,5,	CO3	PSO1 PSO3 PSO4
3	Unit 3: Inorganic Solids and Application Solid electrolytes-Cationic, anionic, mixed Inorganic pigments-coloured solids, white andblack pigments	5	1,2,3,4,5,	CO4	PSO1 PSO3 PSO4

	Molecular material and fullerides, molecular magnets, inorganic liquid crystal.				
4	Unit 4: Metal-ligand equilibria in solution, stepwise and overall formation constants and their interpretation, trends in stepwise formation constants. Factors affecting the stability of metal complexes with reference to the nature of central metal ion, Nature of the coordinating group (ligand), and the presence of ring structure (chelate effect and number of chelate rings and their size. Determination of stoichiometry of complex formation. Determination of binary formation constants of complexes by pH–metry. Stability of mixed ligand complexes, ring-size effect, inter ligand electron delocalization, intramolecular inter ligand interactions and their effect on the stability of ternary complexes.	15	1,2,3,4,5,	CO5	PSO1 PSO3 PSO4

Reference Books	
1.	J. D. Lee, Concise Inorganic Chemistry, 5th Ed., Blackwell Science, London, 1996.
2.	D. F. Shriver & P. W. Atkins, Inorganic Chemistry, 3rd Ed., W. H. Freeman and Co., London, 1999.
3.	B. R. Puri, L. R. Sharma & K. C. Kalia, Principles of Inorganic Chemistry, Shoban Lal Nagin Chand and Co., Delhi, 1996.
4.	G.Chatwal and M.S. yadav, Coordination Chemistry, Himalaya Publishing House. 1992.
5.	J. E. Huheey, E. A. Kieter& R. L. Keiter, Inorganic Chemistry, 4th Ed., Harper Collins, 1993.
6.	F. A. Cotton, G. Wilkinson, C. Murillo & M. Bochman, Advanced Inorganic Chemistry, 6th Ed., John Wiley, New York, 1999.
7.	T. Moeller, Inorganic Chemistry: A Modern Introduction, Wiley, New York, 1990.

<table>
<tr><td colspan="3">School: School of Science</td><td colspan="3">Program: BSc Chemistry</td></tr>
<tr><td colspan="3">Course Code: CH 313</td><td colspan="3">Course Name: Electrochemistry and Photochemistry</td></tr>
<tr><td>Year</td><td>III</td><td>Core Subject(Yes/No):</td><td>Yes</td><td>Lecture:</td><td>3</td></tr>
<tr><td>Semester</td><td>VI</td><td>Elective Subject(Yes/No):</td><td>No</td><td>Tutorial</td><td>0</td></tr>
<tr><td rowspan="3">Typology of Course</td><td rowspan="3">Lectures and Tutorials</td><td>Foundation Subject(Yes/No):</td><td>No</td><td>Practical:</td><td>0</td></tr>
<tr><td>Year of Syllabus Revision:</td><td>2018</td><td>Total Credit:</td><td>3</td></tr>
<tr><td>Year of Introduction</td><td>2014</td><td>Prerequisites (If any)</td><td>CH258, Thermodynamics and chemical equilibrium</td></tr>
</table>

Course Description:
This course mainly explains the basics and details of electro chemistry and photochemistry. The first part elaborately explains the different terms used in electrochemistry. Details of Kohlrausch's law, Debye – Hückel – Onsager equation, Wien effect, Debye – Falkenhagen effect, Grotthuss conductance, Hittorf and Moving Boundary methods are included in the chapter. In the last part, laws of photochemistry and different photochemical processes are included. Details of luminescence phenomenon, Frank – Condon principle, Stern – Volmer equation are included therein. Some practical applications such as photochemistry of stratospheric ozone, harvesting of light during plant photosynthesis, photochemistry of vision, solar energy conversion is included in the unit.

Course Objectives:
Gain thorough understanding about electrical conductivity of solutions, distinguish between different types of electrical conductance, applications of electrical conductance for quantitative analysis. Acquire insights regarding photochemical processes, laws of photochemistry, quantum yield of photochemical reaction, photochemical smog and photosynthesis.

Course Outcome (CO):

CO1 gain the knowledge of photochemistry and comprehend photochemical reactions

CO2 understand the different photo – physical processes responsible for phenomena like fluorescence and phosphorescence

CO3 gain insights pertaining to electrical conductance in solution, factors affecting electrical conductance, distinguish between molar, equivalent, specific conductance. Applications of electrical conductance for quantitative analysis.

CO4 construct various electrochemical cells based on electrochemical series displayed by the redox couples and the types of electrodes used

CO5 establish a correlation between thermodynamics and electrochemical cell reactions

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	**Unit 1: Electrolytic Conductance** Electrolytic and metallic conductance. Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. Molar conductivity at infinite dilution. Kohlrausch law of independent migration of ions. Grotthus conductance, transference numbers and their relation to ionic mobilities, determination of transference numbers using Hittorf and Moving Boundary methods. Ionic velocities, mobilities and their determinations. Debye – Hückel – Onsager equation, Wien effect, Debye – Flakenhagen effect. Walden's rule.	14	1,2,3,4,5	CO3	PSO1 PSO3 PSO4
2	**Unit 2: Chemical Cells** Chemical cells, reversible and irreversible cells with examples. Electromotive force of a cell and its measurement, Nernst equation; Standard electrode (reduction) potential and its application to different types of half-cells. Determination of exact value of half – cell potential,	16	1,2,3,4,5,6	CO4 CO5	PSO1 PSO3 PSO4 PSO5

	dissociation constant of weak acid, ionic product of water by graphical method. Application of EMF measurements in determining (i) Gibbs energy, enthalpy and entropy of a cell reaction, (ii) equilibrium constants, and (iii) pH values, using hydrogen, quinone hydroquinone and glass electrodes. Concentration cells with and without transference, liquid junction. Batteries as power storage devices.				
3	**Unit 3: Photochemistry** Photophysical and photochemical processes, Grothus -Draper law, Stark – Einstein's law of photochemical equivalence and quantum yield. Electronic excitation of molecules, Frank – Condon principle. Examples of low and high quantum yields. Photosensitization, Photochemical formation of HCl, HBr and HI and rate of photochemical reactions. Actinometry. Luminescence phenomenon: Timescales of photophysical processes, phosphorescence, fluorescence, chemiluminescence. Quenching of fluorescence, Stern – Volmer equation. Photochemistry of stratospheric ozone, harvesting of light during plant photosynthesis, photochemistry of vision. Solar energy conversion.	15	1,2,3,4,5	CO1 CO2	PSO1 PSO3 PSO4 PSO5

Reference Books	
1.	K. K.Rohatgi Mukherjee, *Fundamentals of photochemistry*, Revised Ed., Wiley Eastern Ltd., 1996.
2.	S. H. Maron & J.B. Lando, *Fundamentals of physical chemistry*, Macmillan limited, New York, 1966.
3.	Gilbert. W. Castellan, *Physical chemistry*, 3rd Ed., Narosa publishing house, 1985.
4.	P.W. Atkins, *Physical chemistry*, Oxford University Press, 1978.

School: School of Science			**Program: BSc Chemistry**		
Course Code: CH314			**Course Name: Organic Chemistry-IV**		
Year	**III**	**Core Subject (Yes/No):**	**Yes**	**Lecture:**	**3**
Semester	**VI**	**Elective Subject (Yes/No):**	**No**	**Tutorial**	**0**
Typology of Course	Lectures	**Foundation Subject (Yes/No):**	**No**	**Practical:**	**0**
		Year of Syllabus Revision:	2018	**Total Credit:**	**3**
		Year of Introduction	**2014**	**Prerequisites (If any)**	***See below**

Prerequisites (If any): Students should have cleared the previous year examination; in particular, course entitled *Organic Chemistry-III* (CH311). Students should have some prior knowledge and understanding of techniques and methodologies for the isolation and purification methods of organic compounds.

Course Description:
This course gives the information of naturally occurring organic compounds and macromolecules, drugs and dyes and their applications in day-to-day life. The first unit deals with the natural occurrence, classifications, method of isolation of terpenoids and alkaloids. Second unit describes various heterocyclic compounds and their chemistry. The last unit deals with the introduction, classification of carbohydrate and amino acids. In the first part of Unit 3 mutarotation and its mechanism, epimers, chain shortening and chain lengthening of aldose etc. discussed in detail, whereas in second part Gabriel phthalimide synthesis, details of peptides and proteins are discussed.

Course Objectives:
The objective of this course is to make the students aware of the many pharmaceutically active products of natural origin and about the richness and diversity of plants and animal around them.

Course Outcome (CO):
Upon completion of the course students are expected to demonstrate knowledge, skill and abilities in the following areas:

CO1	Gain the knowledge of naturally occurring organic compounds
CO2	Identify and characterize various classes of natural products by their structures.
CO3	Have acquired the skills to isolate and purify simple products that are derived from plants.
CO4	Understand the chemistry and importance of heterocyclic compounds
CO5	Describe/recognize Carbohydrate, Amino Acid and Nucleic Acid structures; describe their physical and chemical properties.

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	**Terpenoids and Alkaloids** Terpenoids: Natural occurrence, classification. Structure and specific uses of citral, limonene and α – terpineol. Alkaloids: Natural occurrence, general methods of Isolation and structural features. Medicinal importance of nicotine, quinine, morphine and reserpine.	12	1,2,3,4	CO1 CO2 CO3	PSO2 PSO3 PSO5
2	**Heterocyclic Compounds:** Classification: Five membered ring compounds: Preparation of Furan, pyrrole and thiophene. Reactions: electrophilic and nucleophilic substitutions, oxidation and reduction reactions. Six membered rings: Pyridine, Quinoline and isoquinoline: Preparation by ring closing	12	1,2,3,4,5	CO1 CO2 CO4	PSO2 PSO3 PSO5

	reactions. Reactions: Mechanism of electrophilic and nucleophilic substitutions, oxidation and reduction reactions.				
3	**Carbohydrates and Amino Acids** **Carbohydrates:** Classification and nomenclature, open chain and cyclic structure of glucose, determination of ring size, mutarotation and its mechanism, epimers, formation of glycosides, ethers and esters, erythro and threo diastereoisomers. Disaccharides and polysaccharides: Introduction to maltose, sucrose and lactose, starch and cellulose. **Amino Acids:** Introduction, Classification, Isoelectric point, Preparation: malonic acid synthesis, Gabrial phthalimide synthesis. Peptides and proteins: Structure of peptides and proteins, classification of proteins, peptide structure determination, end group analysis, selective hydrolysis of peptides, classical peptide synthesis, solid phase peptide synthesis, protein denaturation. **Nucleic acids:** Introduction, nucleoproteins, structure of nucleic acids, ribonucleosides and ribonucleotides, the double helical structure of DNA, genetic code.	21	1,2,3,4	CO1 CO2 CO4 CO5	PSO2 PSO3 PSO5

Reference Books	
1.	I. L. Finar, *Organic Chemistry, Volume 2: Stereochemistry and the Chemistry of Natural Products*, 5th Ed., Pearson Education, New Delhi, 1975.
2.	R. T. Morrison, R. N. Boyd and S. K. Bhattacharjee, *Organic Chemistry*, 7th Ed., Pearson New Delhi, 2012.
3.	M. K. Jain and S. C. Sharma, *Modern Organic Chemistry*, Vishal Publishing Co., New Delhi, 2018.
4.	U. Satyanarayana, *Biochemistry*, 2nd Edition, Books and Allied (P) Ltd., Kolkata, 2002.
5.	V. K. Ahluwalia, *Chemistry of Natural Products*, 2nd Edition, Vishal Publishing Co., New Delhi, 2013.
6.	O. P. Agarwal, *Chemistry of Natural Products*, Volume 1, Krishna Prakashan, 2015.
7.	Gurdeep Chatwal & Anand, *Chemistry of Natural Products*, Himalayan Publishing Co, 2001.

School: Science			**Program: B.Sc Chemistry**		
Course Code: CH 309			**Course Name: Chemistry Laboratory-XI**		
Year	**III**	**Core Subject(Yes/No):**	**Yes**	**Lecture:**	**0**
Semester	**VI**	**Elective Subject(Yes/No):**	**No**	**Tutorial**	**0**
Mode of Transaction	Laboratory	**Foundation Subject(Yes/No):**	**No**	**Practical:**	**8**
		Year of Syllabus Revision:	**2018**	**Total Credit:**	**4**
		Year of Introduction	**2014**	**Prerequisites (If any)**	**SY B.Sc. Chemistry**

Course Description:

It involves a systematic qualitative inorganic analysis where the identification of the cation and anion of inorganic salt is carried out. This is done by conducting a series of tests in a systematic manner and using observations to confirm the absence or presence of specific cations and anions. The segregation of different anions and cations and identification of the same in inorganic salts is known as salt analysis. This process is known via different names like qualitative analysis of inorganic salts or systematic qualitative analysis. Inorganic salts are separated into different ions with the help of different sorts of experiments done under laboratory conditions and putting the compounds under different distinct tests which confirm whether certain ions are present or not in the solution.

Course Outcome (CO):

CO1 Students will explore the concept of Inorganic qualitative analysis for the identification of cations and anions.
CO2 Hand-in Training on detection of rare earth elements.
CO3 Students will explore the experiments with semimicro qualitative analysis of inorganic mixture following the test in a sequential manner.
CO4 Gain knowledge to identify acid and basic radicals from the mixture.
CO5 Students will learn the separation and estimation of amount of metal ions in trinary or quaternary metal ion mixture

No.	**Experiment**	**Contact Hours**	**BT Level**	**CO**	**PSO**
	Inorganic Spotting (Identification of the cation and Anion in the given salt mixture)				
1	NH4Cl+ FeSO4+ NaCl	4	1,2,3,4,5	CO1, CO2, CO3, CO4, CO5	PSO1, PSO2, PSO3, PSO4, PSO5
2	CuSO4+ PB(NO3)2+ BaCl2	4	1,2,3,4,5	CO1, CO2, CO3, CO4, CO5	PSO1, PSO2, PSO3, PSO4, PSO5
3	Al2SO4+ CoCO3+ LiCO3	4	1,2,3,4,5	CO1, CO2, CO3, CO4, CO5	PSO1, PSO2, PSO3, PSO4, PSO5
4	WCl+ Na2CO3+ NH4Br	4	1,2,3,4,5	CO1, CO2, CO3, CO4, CO5	PSO1, PSO2, PSO3, PSO4, PSO5

5	MgCl2+ NaBr+ KI	4	1,2,3,4,5	CO1, CO2, CO3, CO4, CO5	PSO1, PSO2, PSO3, PSO4, PSO5
6	Al2(PO4)3+ CuCl2+ CaCO3	4	1,2,3,4,5	CO1, CO2, CO3, CO4, CO5	PSO1, PSO2, PSO3, PSO4, PSO5
7	MnPO4+ ZnCl2+ NaNO3+ NH4Cl	4	1,2,3,4,5	CO1, CO2, CO3, CO4, CO5	PSO1, PSO2, PSO3, PSO4, PSO5
8	CaCO3+ Mg(Cr2O7)+ NH4SO4	4	1,2,3,4,5	CO1, CO2, CO3, CO4, CO5	PSO1 PSO7 PSO8
9	NH4Ce(NO3)+ Al2SO4+ FeCl3	4	1,2,3,4,5	CO1, CO2, CO3, CO4, CO5	PSO1, PSO2, PSO3, PSO4, PSO5
10	KBr+ ZnS+ NH4V	4	1,2,3,4,5	CO1, CO2, CO3, CO4, CO5	PSO1, PSO2, PSO3, PSO4, PSO5
11	ThNO3+ ZrCl2+ LiCO3+ NH4V	4	1,2,3,4,5	CO1, CO2, CO3, CO4, CO5	PSO1, PSO2, PSO3, PSO4, PSO5
12	NaNO3+ NaNO2+ NH4Cl	4	1,2,3,4,5	CO1, CO2, CO3, CO4, CO5	PSO1, PSO2, PSO3, PSO4, PSO5
13	CdCl2+ MnCl2+ WCl+ Sr(NO3)2	4	1,2,3,4,5	CO1, CO2, CO3, CO4, CO5	PSO1, PSO2, PSO3, PSO4, PSO5
14	NH4V+ KCl+ KBr+KI	4	1,2,3,4,5	CO1, CO2, CO3, CO4, CO5	PSO1, PSO2, PSO3, PSO4, PSO5
Reference Books					
1.	G. Svehla, Vogel’s Qualitative Inorganic Analysis, 6th Ed., Orient Longman, 1989				
2.	R. C. Shah, Inorganic Qualitative Analysis, Fifth edition, 2000				

School: Science			**Program: B.Sc chemistry**		
Course Code: CH 310			**Course Name: Chemistry Laboratory-XII**		
Year	**III**	**Core Subject(Yes/No):**	**Yes**	**Lecture:**	**0**
Semester	**VI**	**Elective Subject(Yes/No):**	**No**	**Tutorial**	**0**
Mode of Transaction	Laboratory	**Foundation Subject(Yes/No):**	**No**	**Practical:**	**8**
		Year of Syllabus Revision:	**2018**	**Total Credit:**	**4**
		Year of Introduction	**2014**	**Prerequisites (If any)**	**SY B.Sc. Chemistry**

Course Description:

Handle organic chemicals in a safe and competent manner. Perform the standard techniques used in practical organic chemistry. Carry out organic preparation following a prescribed procedure. Read and explain the information labels on chemical bottles. Students will learn about the various preparations of the name reaction. Also, the % yield has been calculated to relate the product with the amount of the reagent that has been utilized.

Course Outcome (CO):

CO1 How to calculate a limiting reagent, yield, and percent yield by applying the preparation methods for useful compounds.

CO2 To perform the stoichiometry of various substrates required to carry named reactions and rearrangement. Also, to use the techniques involved in purification and identification of final product.

CO3 How to critically evaluate data collected to determine the identity, purity, and yield of products. And how to summarize findings in writing in a clear and concise manner.

CO4 How to use the scientific method to create, test, and evaluate a hypothesis andto engage in safe laboratory practices handling laboratory glassware, equipment, and chemical reagents.

CO5 How to perform common laboratory techniques, including reflux, distillation, steam distillation, recrystallization, vacuum filtration, aqueous extraction etc.

CO6 How to predict the outcome and mechanism of some simple organic reactions, using a basic understanding of the relative reactivity of functional groups

No.	**Experiment**	**Contact Hours**	**BT Level**	**CO**	**PSO**
	Organic Preparation				
1	Acetanilide to P-nitro acetanilide	4	1, 2, 3, 4, 5, 6	CO1, CO2, CO3, CO4, CO5, CO6	PSO1, PSO2, PSO3, PSO4, PSO5
2	Aniline to Benzene azo- B-Naphthol	4	1, 2, 3, 4, 5, 6	CO1, CO2, CO3, CO4, CO5, CO6	PSO1, PSO2, PSO3, PSO4, PSO5
3	Phthalic anhydride to Phthalimide	4	1, 2, 3, 4, 5, 6	CO1, CO2, CO3, CO4, CO5, CO6	PSO1, PSO2, PSO3, PSO4, PSO5
4	Aniline to 2, 4, 6 tribromo aniline	4	1, 2, 3, 4, 5, 6	CO1, CO2,	PSO1, PSO2,

				CO3, CO4, CO5, CO6	PSO3, PSO4, PSO5
5	2, 4, 6 tribromo aniline to 1, 3, 5 tribromo benzene	4	1, 2, 3, 4, 5, 6	CO1, CO2, CO3, CO4, CO5, CO6	PSO1, PSO2, PSO3, PSO4, PSO5
6	P- nitrotoluene to P- nitrobenzoic acid	4	1, 2, 3, 4, 5, 6	CO1, CO2, CO3, CO4, CO5, CO6	PSO1, PSO2, PSO3, PSO4, PSO5
7	P- nitrobenzoic acid to P- aminobenzoic acid	4	1, 2, 3, 4, 5, 6	CO1, CO2, CO3, CO4, CO5, CO6	PSO1, PSO2, PSO3, PSO4, PSO5
8	Malonic acid to Cinnamic acid	4	1, 2, 3, 4, 5, 6	CO1, CO2, CO3, CO4, CO5, CO6	PSO1, PSO2, PSO3, PSO4, PSO5

Reference Books	
1.	Named Organic Reactions 2nd Ed by Thomas Laue; Andreas Plagens
2.	J. Leonard,B. Lygo, G. procter, ‘ Advanced Practical Organic Chemistry;, Third edition, 2017.

School: Science			**Program: BSc Chemistry**		
Course Code: SE 208			**Course Name: Herbal Cosmetics**		
Year	**III**	**Core Subject(Yes/No):**	**No**	**Lecture:**	**2**
Semester	**VI**	**Elective Subject(Yes/No):**	**Yes**	**Tutorial**	**0**
Typology of Course	Lectures	**Foundation Subject(Yes/No):**	**No**	**Practical:**	**0**
		Year of Syllabus Revision:	**NA**	**Total Credit:**	**2**
		Year of Introduction	**2014**	**Prerequisites (If any)**	**SY BSc. Chemistry**

Course Description:

Students will learn to use scientific method to combine the cosmetic properties of plants with cosmetic making techniques to achieve health benefits and balance in the body. Plants of medicinal value will be introduced and how to process them will be shown. Safe use of herbs to make beauty products will be discussed.

Course Objectives:

The course will enhance knowledge regarding herbal products, their medicinal application, preparations, encourage students to prepare original, unadulterated good quality beauty products at home. Enterprising students may see ways to become entrepreneurs and develop signature products.

Course Outcome (CO):

CO1: illustrate the Fundamental knowledge on cosmetic and cosmeceuticals
CO2: Learn various skin problems and how to overcome through skin preparations
CO3: Learn about the formulation design, formulation, and evaluations of herbal cosmetics
CO4: Understand basics of Perfumery, and Aromatherapy. Moreover, sound knowledge of plants with aromatic compounds and herbal formulation for perfumery.

Unit No.	**Topic/Unit**	**Contact Hours**	**BT Level**	**CO**	**PSO**
1	Unit 1: Creams and Lotions: Cosmetics, definition, Structure of skin, various forms of cosmetics, main ingredients, preservatives, quality control measures, instrumentation for extraction and manufacture. Cosmetic creams: base cream, cleansing creams, Emollient creams, Finishing creams, cold cream, Preparation of creams. Cosmetic emulsions, properties of emulsions, emulsifiers, Creams: Cleansing creams (Cold creams, Quick liquifying creams, liquid cleaners), Emollient creams, finishing creams (Vanishing creams), Special creams (Astringent creams, Bleaching creams, Acne creams, All-purpose creams, Estrogenic creams, Industrial or protective creams) etc. Commercially available ingredients, retinoids, hydroxy acids, antioxidants etc., antimicrobial compounds from plants, Plants improving blood circulation etc.	15	1, 2, 3, 4, 5	CO1, CO2, CO3	PSO1, PSO3, PSO4
2	Unit 2: Perfumery and Aromatherapy: Perfumes, Flower perfumes, leaf perfumes, Fruit perfumes, root perfumes etc. Different perfumes from rose, jasmine, tuberose, sandalwood, kewda, Lavender, peppermint, Neroli, petit grain oils etc. constituent compounds, monoterpenes, methods of extraction, preparation of perfumes. Perfumes for soaps, detergents, incense, candles, household products, creams, powders, aerosols, industrial perfumes. Aromatherapy: Principles and practice.	15	1, 2, 3, 4, 5	CO1, CO3, CO4	PSO1, PSO3, PSO4

Reference Books	
1.	André O. Barel, Handbook of Cosmetic Science and Technology, 3rd Ed., Maibach, University of Calirfornia, San Francisco, CA, 2009
2.	P. K. Chattopadhyay, Herbal Cosmetics & Ayurvedic Medicines, (EOU), 1999.
3.	H. Panda, Herbal Cosmetics Handbook, 2004
4.	NIIR Board, Handbook on Herbal Products, (Medicines, Cosmetics, Toiletries, Perfumes)

School: School of Science			**Program: BSc Chemistry**		
Course Code: SE210			**Course Name: Food and Nutrition II**		
Year	**III**	**Core Subject(Yes/No):**	**No**	**Lecture:**	2
Semester	**VI**	**Elective Subject(Yes/No):**	Yes	**Tutorial**	0
Typology of Course	Lectures	**Foundation Subject(Yes/No):**	**No**	**Practical:**	0
		Year of Syllabus Revision:	**NA**	**Total Credit:**	**2**
		Year of Introduction	**2016**	**Prerequisites (If any)**	**SY B.Sc. Chemistry**

Course Description: This course emphasizes on importance of nutrition in health. It also focuses on importance of diet in preventing diseases, especially lifestyle disorders. It emphasizes on role of nutrition policies and programmes in boosting health.

Course Objectives:
To prepare students for successful career in clinical nutrition and dietetics
To help the students understand the importance of food safety
To enable students to apply the knowledge gained through the subject to improve their own lifestyle

Course Outcome (CO):
CO1: To understand the essentials of diet and health
CO2: To apply the knowledge on management of health

Unit No.	**Topic/Unit**	**Contact Hours**	**BT Level**	**CO**	**PSO**
1	Social, population and environmental influences on nutrition, the food chain, types of nutritional studies; Food Selection and meal Planning- Factors to be considered, Dietary Guidelines Normal Clinical Nutrition- malnutrition, obesity, inflammatory response, enteral and parenteral nutrition. Dietetics & Therapeutic Aspects of Clinical Nutrition	15	1,2	1	PSO1
2	Nutrition Policies & Programmes; Nutrigenetics- personalized nutrition, Nutrient Requirements Based on Genotype; Nutrition in Special Conditions: chronic diseases- diabetes, cardiovascular diseases. Health Promotion & Nutritional Education. Food Safety in Practice.	15	1,2	2	PSO1

Reference Books

1.	Desrosier, N.W. and Desrosier, J.N. (1997) *The Technology of Food Preservation*, Westport: Connecticut Publishing Company.
2.	Whitney, E., Hamilton, E., and Rolfes, S. (1990) *Understanding Nutrition*, St. Paul, MN: West Publishing Company.
3.	Sunetra Roday, (2012) *Food Science and Nutrition*, Oxford Publishing Company.

School: Science			**Program: B.Sc. (Chemistry)**		
Course Code: SE 218			**Course Name: Introduction to Polymer Science**		
Year	**III**	**Core Subject(Yes/No):**	**-No**	**Lecture:**	**2**
Semester	**VI**	**Elective Subject(Yes/No):**	**Yes**	**Tutorial**	0
Typology of Course	Lectures	**Foundation Subject(Yes/No):**	**-No**	**Practical:**	0
		Year of Syllabus Revision:	NA	**Total Credit:**	**2**
		Year of Introduction	**2016**	**Prerequisites (If any)**	**SY B.Sc. Chemistry**

Course Description:
This course deals with history of macromolecular science, basic concepts of polymerization, classification of polymers and various polymerization techniques. It also deals with physical properties of polymers, concept of molecular weight averages, polydispersity and their practical significance. The nuances of molecular weight determination by various method are also dealt with.

Course Objectives:
After completing this course students will be able to: Understand polymerization mechanisms, molecular weight, crystallinity affecting various properties they will also know about glass transition temperature and its role structure-property correlation in polymers/polymer blends.

Course Outcome (CO):
CO1 Different kind of polymers and their properties.
CO2 Concept of Molecular Weight and distribution.
CO3 Variation of properties of polymer by crystallinity and glass transition temperature.
CO4 Various Process to know the molecular weight of different polymers.

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	**Unit-1 Introduction to Polymer:** History of macromolecular science. Basic concept of polymers (monomer, oligomers, degree of polymerization), Classification of polymers based on structure, repeating units, source, nature and processing. Polymerization: Free radical, cationic, anionic, condensation and coordination polymerization. Techniques of polymerization: Bulk solution, suspension, emulsion, interfacial and ring opening polymerization. CRP techniques. Controlled Radical Polymerization techniques.	15	1,2,3,4,5	CO1 CO2	PSO1 PSO3 PSO4
2	Unit-2 Physical Properties of The Polymers and Average Molecular Weight Concepts and Measurement of Molecular Weights: Physical Properties of Polymers The amorphous state, the glass transition, factors affecting glass transition temperature. Concept of molecular weight averages: number average, weight and viscosity average molecular weight, molecular weight distribution, Polydispersity, Molecular weight distribution curves. Practical significance of molecular weight, Determination of molecular weight: End group analysis, viscosity; vapour pressure osmometry, light scattering, sedimentation and size exclusion chromatography. Blends, alloys and composites.	15	1,2,3,4,5	CO3 CO4	PSO1 PSO3 PSO4

Reference Books	
1.	Joel R Fried, *Polymer Science & Technology*, 2nd Ed., PHI learning Pvt. Ltd.,2009.
2.	J. Brydson, *Plastic Materials*, 7th Ed., CBS publishers and Distributors, 2005.
3.	G. Odien, *Principles of Polymerization*, 3rd Ed., Wiley Interscience Publications,1991.
4.	F. W. Billmeyer, *Textbook of Polymer Science*, 1st Ed., Wiley – India Pvt. Ltd., 2012
5.	G. Pritchard, *Plastics Additives*, *An A – Z reference*, Springer – Verlag Gmbh, 1997
6.	L. A. Utracki (Ed.), *Polymer Blends Handbook* (Part – 1 & 2), Springer, 2003.

<table>
<tr><td colspan="3">School: School of Science</td><td colspan="3">Program: Bachelor of Science</td></tr>
<tr><td colspan="3">Course Code: SE310</td><td colspan="3">Course Name: Introduction to Pharmacognosy</td></tr>
<tr><td>Year</td><td>II</td><td>Core Subject(Yes/No):</td><td>No</td><td>Lecture:</td><td>2</td></tr>
<tr><td>Semester</td><td>III</td><td>Elective Subject(Yes/No):</td><td>Yes</td><td>Tutorial</td><td>0</td></tr>
<tr><td rowspan="3">Typology of Course</td><td rowspan="3">Lectures</td><td>Foundation Subject(Yes/No):</td><td>No</td><td>Practical:</td><td>0</td></tr>
<tr><td>Year of Syllabus Revision:</td><td>NA</td><td>Total Credit:</td><td>2</td></tr>
<tr><td>Year of Introduction</td><td>2019</td><td>Prerequisites (If any)</td><td>FY B.Sc. Chemistry</td></tr>
</table>

Course Description:

This course is designed for study of medicinally important plants with their cultivation, collection and adulteration of crude drugs, and the role of these plants in national economy.

Course Objectives:

Introduction to medicinal compounds and raw materials of natural origin including biosynthesis, chemical structures and qualitative and quantitative analysis. Understanding the role of natural products in research and development of drugs as well as in disease prevention and treatment. Acquisition of basic knowledge and skills in quality control of herbal drugs and products.

Course Outcome (CO):

CO1 Recognize and define medicinal natural compounds according to their chemical structure and biosynthetic pathway
CO2 Associate medicinal compounds with their natural sources
CO3 Use basic pharmacognostical terminology in Latin
CO4 Understanding the quality control of herbal drugs with their effectiveness and safe use
CO5 Introduction to the Indian Pharmacopoeia and its usage in the area of herbal drug analysis

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	• Course Introduction: History, Scope and Development of Pharmacognosy • Classification of crude drugs • Sources of crude drugs: Crude drugs of Plant, Animal and Mineral origin • Different types of plant tissues and their functions • Morphological and Microscopical study: Leaf, root, stem, bark, wood, flower, fruit and seed • Modifications of leaf, root and stem	15	1, 2	CO1 CO2 CO5	PSO1
2	• Study of medicinally important plants belonging to the families with special reference to: Solanaceae, Umbelliferae, Leguminosae, Liliaceae • Cultivation, collection and adulteration of crude drugs: Methods of cultivation, Factors influencing cultivation of medicinal plants, methods of collection and different types of adulteration • Role of medicinal plants in national economy	15	1, 2	CO3 CO4	PSO1

Reference Books

1.	Text book of Pharmacognosy: T. E. Wallis; CBS publishers, New Delhi.
2.	The Ayurvedic Pharmacopoeia of India: Government of India, Ministry of Health & Family Welfare, 1st edition, Part-I, Vol. III, 2001.
3.	Quality Control Methods for Medicinal Plant Materials: 2002, WHO, Geneva.
4.	Trease and Evan’s Pharmacognosy: W. C. Evans, 14th edition, 1997, W. B. Saunders Company, Singapore.

5.	Cultivation of medicinal plants, C. K. Kokate, 4th edition, 2007, Nirali Prakashan, Pune
6.	Botany for Degree Student: A. C. Dutta; Oxford University Press, New Delhi.
7.	Pharmacognosy: C. K. Kokate; Nirali Prakashan, Pune

School: Science			**Program: B.Sc. (Chemistry)**		
Course Code: SE 311			**Course Name: Introduction to Paint Technology**		
Year	**III**	**Core Subject(Yes/No):**	No	**Lecture:**	**2**
Semester	**VI**	**Elective Subject(Yes/No):**	Yes	**Tutorial**	0
Typology of Course	Lectures	**Foundation Subject(Yes/No):**	No	**Practical:**	0
		Year of Syllabus Revision:	NA	**Total Credit:**	**2**
		Year of Introduction	**2016**	**Prerequisites (If any)**	**FY B.Sc. Chemistry**

Course Description:

This course deals basic concepts of Polymer Science, different components of coating formulation (Introductory ideas of emulsion polymerization and polymer dispersion). It also deals with various additives of coating. Finally, it focuses on paint formulations and their applications

Course Objectives:

The course offers a preliminary survey of Polymer chemistry as applicable to Paint Technology especially its components like resins, their method of preparation and properties, choice of pigments and their effect on film formation, and additional components like wetting agents, thickeners, dispersing agents etc. The overreaching objective is to give an idea about paint making process and testing.

Course Outcome (CO):

CO1 Develop basic understanding of polymer science especially applicable to Paint Technology
CO2 Correlate the properties of the additives with their function
CO3 Understanding of water and oil-based paint formulation and additives
CO4 Stages of making a paint and testing methods

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	**Unit 1: Introductory Polymer Science** Definition of Polymer, Polymer types and Polymerization mechanisms, Glass transition temperature, Factors affecting glass transition temperature, Film formation, Minimum film formation temperature (MFFT), Rheology of polymer solutions, Viscometers, Mechanical properties of polymer film	7	1,2,3,4,5	CO1	PSO1
2	**Unit 2: Components of coating formulation** Different components of coating formulation. Resin, Pigments, Extenders, Solvents, Additives and their scope. Introductory ideas of emulsion polymerization and polymer dispersion especially for water borne coatings, Hiding, Refractive index of pigments, Effect of pigments on coating properties, Pigment volume concentration (PVC), Critical pigment volume concentration (CPVC), Relationship between film properties and PVC, Pigment dispersion, Extenders	8	1,2,3,4,5	CO1 CO2	
3	**Unit –III: Additives for coatings** Wetting and dispersing agents, Pigment wetting, Polymeric dispersing agents, Surfactants, types of surfactants, Angle of contact, HLB rating, Fluoro surfactants, Foam formation in paints, Defoamers, Thickeners-inorganic and organic thickeners, Sagging and leveling, Coalescing agents, Different stages of film formation, Driers, Biocides, Adhesion promoters, Problems encountered with additives content.	8	1,2,3,4,5	CO1 CO2 CO3	

4	**Unit-IV: Paint formulation and colour** Stages of making paint: Grind and let down. Components to be added in grind and letdown. Formulation of Exterior/Interior water borne paints. Properties of paint for various applications, Sheen and gloss, Industrial standards, Testing standards, Primers and colour basics.	7	1,2,3,4,5	CO1 CO2 CO3 CO4	

Reference Books	
1.	Zeno W. Wicks, Douglas A. Wicks, Frank N. Jones & S. Peter Pappas, *Organic Coatings Science and Technology*, 3rd Ed., John Wiley and Sons Inc.
2.	Johan Bieleman, *Additives for coatings*, Wiley –vch Verlag Gmbh, 2000.
3.	V. C. Malshe & Meenal Sikchi, *Basics of Paint Technology,* Part – 2, Antar Prakash Centre for Yoga, 2008.
4.	Bodo M. Ller and Ulrich Poth, *Coatings Formulation*, Vincentz Network, 2006.
5.	W. M. Morgans, *Outlines of Paint Technology*, 3rd Ed., CBS publishers, 2000.

School: School of Science			**Program: B.Sc. Chemistry**		
Course Code: SE 312			**Course Name: Medicinal Chemistry-II**		
Year	**III**	**Core Subject(Yes/No):**	**No**	**Lecture:**	**2**
Semester	**VI**	**Elective Subject(Yes/No):**	**Yes**	**Tutorial**	**0**
Typology of Course	Lectures and Tutorials	**Foundation Subject(Yes/No):**	**No**	**Practical:**	**0**
		Year of Syllabus Revision:	**2019**	**Total Credit:**	**2**
		Year of Introduction	**2014**	**Prerequisites (If any)**	**SY B.Sc. Chemistry**

Course Description:
This course introduces synthetic strategies used to manufacture important drugs. Types of drugs used to treat fever, pain, anxiety, cancer, malaria etc. will be introduced in this course. Structures and synthesis of these naturally occurring and synthetic drugs form an important aspect of this course.

Course Objectives:
After completing this course students will be able to gain the knowledge of drugs / pharmaceuticals as well as gain the knowledge about synthetic routes to form different group of drug molecules.

Course Outcome (CO):

CO1: To understand causes of different diseases
CO2: To study various synthetic routes of drug molecules
CO3: To study mode of action of various drugs
CO4: To study SAR of different drug molecules

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	**Sulpha Drugs:** Introduction. Synthesis of sulphapyridine, sulphathaizole, phthalyl sulphathiazole, succinyl sulphathiazole, sulphadiazine, sulphamerazine, sulphamethazine and sulphasalazine. Mode of action of sulpha drugs. **Antipyretics and analgesics:** Introduction. *Aniline derivatives:* synthesis of paracetamol. *Salicylic acid derivatives*: Synthesis and mode of action of aspirin. Salol Principle (true and partial salol). Salsalate. *Aryl acetic acid derivatives:* Synthesis of ibuprofen, ibufenac, diclofenac. *Quinoline derivatives:* cinchophen and neocinchophen (only structures). *Pyrazolone derivatives:* Phenazone and aminophenazone (only structures). **Anaesthetics:** General classification of anaesthetics (general, local and regional). Spinal and epidural anaesthetics. Stages of anaesthesia. *Inhalation anaesthetics:* Synthesis of nitrous oxide, diethyl ether, divinyl ether, cyclopropane, chloroform, haloethane. *Injection anaesthetics:* Synthesis of thiopental sodium, thiamylal sodium, tribromoethanol, paraldehyde. *Local anaesthetics:* Synthesis of α- eucaine, β-eucaine, benzocaine, procaine, and tetracaine.	15	1,2,3,4,5	CO1, CO2, CO3, CO4	PSO1, PSO2, PSO3, PSO4, PSO5
2	**Sedatives and hypnotics:** Difference between sedatives and hypnotics. Classification of barbiturates. *Long acting barbiturates:* Synthesis of veronal, phenobarbital, methylphenobarbital. *Intermediate acting barbiturates:* Synthesis of butobarbital, allobarbital and amobarbital. *Short acting barbiturates:* Synthesis of pentobarbital and cyclobarbital. *Ultrashort*	15	1,2,3,4,5	CO1, CO2, CO3, CO4, CO5	PSO1, PSO2, PSO3, PSO4, PSO5

	acting barbiturates: Synthesis of thiopental. Mode of action of barbiturates. *Non-barbiturates:* Synthesis of paraldehyde, chloral hydrate, glutethimide and nitrazepam. **Antimalarials:** Types of plasmodium. Malarial cycle. *Quinine derivatives:* Structure and properties of quinine. *4-Aminoquinolines:* Structures of chloroquine, nivaquine, hydroxychloroquine and amodiaquine. Synthesis of chloroquine and amodiaquine. *8-Aminoquinolines:* Structures of pentaquine, isopentaquine and primaquine. SAR of aminoquinoline derivatives. *Guanidine derivatives:* Synthesis of chloroguanil and bromoguanil. *Sulphones:* Preparation of dapsone. *Pyrimidine derivatives:* Synthesis of pyrimethamine and trimethoprim. **Anticancer drugs:** Types of cancers. Incidence of tumours. Types of cancer treatment therapies: Radiation, chemotherapy, hormone therapy and gene therapy. Synthesis of nitrogen mustards: mechlorethamine, mepJhalan, cyclophosphamide and chlorambucil. Synthesis of busulfan (methansulphonate derivative), triethylenemelamine (ethylimine derivative), Mercaptopurine and Azathiopurine (purine derivatives).				

Reference Books	
1.	Ashutosh Kar, *Medicinal Chemistry.* New Age International Publishers, New Delhi. 4th Edition, 2007.
2.	Burger, *Medicinal Chemistry and Drug Discovery*, Vol. – 1, Ed., M. E. Wolff, John Wiley
3.	Graham & Patrick. *Introduction to Medicinal Chemistry*, 3rd Ed., OUP, 2005.

School: Science			**Program: B.Sc. Chemistry**		
Course Code: SE 313			**Course Name: Green Chemistry**		
Year	No	**Core Subject(Yes/No):**	No	**Lecture:**	2
Semester	Yes	**Elective Subject(Yes/No):**	Yes	**Tutorial**	0
Typology of Course	No NA	**Foundation Subject(Yes/No):**	No	**Practical:**	0
		Year of Syllabus Revision:	NA	**Total Credit:**	2
		Year of Introduction	2015	**Prerequisites (If any)**	**High school science**

Course Description:
Green Chemistry is the design of chemical products and processes that reduce or eliminate the use and generation of hazardous substances. This course will present the fundamentals of the 12 principles of green chemistry, and explore relevant examples of their practical use in commercial applications mainly in the area of chemical and pharmaceutical synthesis, catalysis, alternative energy sources and solvents

Course Objectives:
Students learn the basic principles of green and sustainable chemistry. They must be able to do and understand stoichiometric calculations and relate them to green process metrics. The course is designed to familiarize them to alternative solvent media and energy sources for chemical processes & renewable feedstocks for the chemical industry, present and under development. The course reviews the principles of catalysis, photochemistry and other interesting processes from the viewpoint of green chemistry

Course Outcome (CO):
CO1: The students are expected to be familiar with different types of green metrices and related calculations.
CO2: Designing and planning atom economical synthetic reactions.
CO3: Gain understanding of environmentally friendly solvents and reaction systems.
CO4: Renewable feed stocks in chemical Industry novel catalytic systems and alternative chemical systems.

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	**Green Chemistry** **Unit 1: I**ntroduction**:** Principles and concepts of Green Chemistry: need for green chemistry, Definition and twelve guiding principles of Green Chemistry, Prospects and future of Green Chemistry, Green synthesis – Real world cases (Traditional Vs. Green processes) Synthesis of Ibuprofen, Adipic acid. Green Chemistry Metrics, Green solvents: Enhancement of selectivity, efficiency, and industrial applicability of green solvents Supercritical fluids, Aqueous medium, Ionic liquids, Solvent free neat reactions in liquid phase, Solvent free neat reactions, Flourous phase reactions.	15	1,2,3,4,5	CO1 CO2 CO3	PSO1 PSO5
2	**Unit II: Green catalysis, alternative energy resources and future trend in Green Chemistry** **Green Catalysis:** Introduction to catalysis, heterogeneous and homogeneous catalysis, Heterogeneous catalysis: Use of zeolites, catalytic cracking, commercial use of ZSM-5, catalytic convertors. Homogeneous catalysis: transition metal catalysts, lewis acid catalyst, asymmetric catalyst Phase-transfer catalysis (micellar/ surfactant), Biocatalysis: enzymes, microbes. Photocatalysis. **Alternative energy sources:** photochemical reactions, Microwave assisted reactions, Sonochemistry, Electrochemical synthesis.	15	1,2,3,4,5	CO1 CO4	PSO1 PSO5

	Future trends in Green Chemistry: Biomimetic, multifunctional reagents; Combinatorial green chemistry; Non–covalent derivatization, Biomass conversion, emission control. Bio – catalysis				

Reference Books	
1.	P.T. Anastas & J.C. Warner, *Green Chemistry: Theory and Practice*, Oxford University Press, 1998.
2.	M. Kirchoff & M. A. Ryan, *Greener approaches to undergraduate chemistry experiment*, American Chemical Society, Washington DC, 2002
3.	M. Lancaster, *Green Chemistry an Introductory text*, Royal Chemical Society, TJ International Ltd, Padstow, Cornwall, UK.

School: School of Science	**Program: BSc Chemistry**
Course Code: SE-314	**Course Name:** Conservation Biology

Year	**III**	**Core Subject (Yes/No):**	**No**	**Lecture:**	**2**
Semester	**VI**	**Elective Subject (Yes/No):**	**Yes**	**Tutorial**	**0**
Typology of Course	Lectures	**Foundation Subject (Yes/No):**	**No**	**Practical:**	**0**
		Year of Syllabus Revision:	**NA**	**Total Credit:**	**2**
		Year of Introduction	**2019**	**Prerequisites (If any)**	**FY B.Sc. Chemistry**

Course Description:

This course will demonstrate the basics of ecological understanding as well as teaches the basic nature of conservation biology pertaining to protection and restoration of biodiversity. The course will also teach loss of biodiversity due to anthropogenic activities and the ways to control the devastating effect pollution on biodiversity.

Course Objectives:

The students will enable the use of various unique ideas in order to conserve the biodiversity of the planet. Students will also be able to understand the role of ex-situ and in-situ conservation methods in protecting the wildlife.

Course Outcome (CO):

CO1 Demonstrate critical analysis skills through the analysis and interpretation of conservation case studies.

CO2 Understand and respond to issues of local, national, and global significance through the knowledge that the causes of and solutions to the loss of biodiversity have a cultural and societal context

CO3 The role of conservation biologist in making ethical policies

CO4 Demonstrate the role of in-situ and ex-situ conservation strategies

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	**Introduction of Conservation biology** ➢ Role of Conservation biologist ➢ Brief idea on Conservation ethics **Understanding Biodiversity** ➢ Introduction to biodiversity ➢ Biodiversity distribution ➢ Value of Biodiversity **Biodiversity Crisis** ➢ Brief idea on cause of biodiversity loss ■ Case studies: 5 major extinctions ➢ IUCN and Red Data list ➢ Ecological consequences of Biodiversity loss ■ Case study: Ecological service of crow.	15	1,2,3	CO1, CO2	PSO1
2	**Maintaining and Restoring Biodiversity** ➢ In-Situ conservation: Reserve Selection, Design & Management ➢ Brief idea on restoration ecology ■ Case study: Turtle ➢ Ex-Situ conservation ■ Case Studies	15	1,2,3	CO3, CO4	PSO1

Reference Books	
1.	Hunter Jr, M. L., & Gibbs, J. P. (2006). Fundamentals of conservation biology. John Wiley & Sons.
2.	Primack, R. B. (2012). A primer of conservation biology. Sinauer Associates.
3.	Conservation Biology for All (2010) N. S. Sodhi. Oxford University Press
4.	Fiedler, P. L. (Ed.). (2012). Conservation biology: the theory and practice of nature conservation preservation and management. Springer Science & Business Media.

School: School of Science	**Program: BSc Chemistry**
Course Code: SE316	**Course Name:** Bioinformatics

Year	**III**	**Core Subject (Yes/No):**	**No**	**Lecture:**	**2**
Semester	**VI**	**Elective Subject (Yes/No):**	**Yes**	**Tutorial**	**0**
Typology of Course	Lectures	**Foundation Subject (Yes/No):**	**No**	**Practical:**	**0**
		Year of Syllabus Revision:	**NA**	**Total Credit:**	**2**
		Year of Introduction	**2019**	**Prerequisites (If any)**	**SY B.Sc. Chemistry**

Course Description:

The course focuses on algorithmic aspects of modern bioinformatics and covers the following topics: computational gene sequencing, DNA arrays, sequence comparison, pattern discovery in DNA, genome rearrangements, molecular evolution, computational proteomics, and others. It encompasses the multidisciplinary approach which makes this subject a dynamic entity. It involves analysis of various factors which affects the movement in our biological systems.

Course Objectives:

The students will use the role of software in deciphering the sequence of nucleotides using various databases online. Students will also learn the approaches from various discipline like computer science, chemistry, and biology.

Course Outcome (CO):

CO1.	Concepts of fundamental concepts of bioinformatics.
CO2.	Gain the knowledge of gene sequences and molecular evolution.
CO3.	Introduction to database
CO4.	Softwares to use for sequence alignment

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	**Introduction to Bioinformatics** - Historical perspectives, Scope and importance, Commercial potential. Introduction to biological Databases (Accession codes & identifications). Examples of Biological. Database (A) Nucleotide sequence Databases (B) Protein sequence databases (EMBL, SWISS Port). cord, medulla oblongata, Neurophysiology, Neurotransmitters	15	1,2,3	CO1, CO2	PSO1
2	Primary Nucleotide sequence, databases. Molecular phylogenetics, Phylogenetics tree constructing methods. Introduction to NCBI Software. Elucidating the functions of NCBI (BLAST, Primer designing, FASTA alignment, DNA Homology, studying of exons and introns). BOLD nucleotide sequence database, Gene bank (DNA and mRNA sequence, protein Sequence).	15	1,2,3	CO3, CO4	PSO1

Reference Books

1.	Essentials of Bioinformatics by Jin Xiong
2.	The Ten Most Wanted Solutions in Protein Bioinformatics by Anna Tramontano
3.	Bioinformatics Basics by Hooman Rashidi, Lukas K. Buehler
4.	Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins by Andreas D. Baxevanis, B. F. Francis Ouellette jones

<table>
<tr><td colspan="3">School: School of Science</td><td colspan="3">Program: B. Sc. Chemistry</td></tr>
<tr><td colspan="3">Course Code: SE 318</td><td colspan="3">Course Name: Introduction to Forensic Science</td></tr>
<tr><td>Year</td><td>III</td><td>Core Subject(Yes/No):</td><td>No</td><td>Lecture:</td><td>2</td></tr>
<tr><td>Semester</td><td>VI</td><td>Elective Subject(Yes/No):</td><td>Yes</td><td>Tutorial</td><td>0</td></tr>
<tr><td rowspan="3">Typology of Course</td><td rowspan="3">Lectures and Tutorials</td><td>Foundation Subject(Yes/No):</td><td>No</td><td>Practical:</td><td>0</td></tr>
<tr><td>Year of Syllabus Revision:</td><td>NA</td><td>Total Credit:</td><td>2</td></tr>
<tr><td>Year of Introduction</td><td>2018</td><td>Prerequisites (If any)</td><td>SY B.Sc. Chemistry</td></tr>
</table>

Course Description:
This course is an applicative course and gives an insight to the working in a forensic laboratory. Through this course students shall gain exposure to different techniques and methods used in forensics as well as its several levels of applications in crime detection and analysis.

Course Objectives:
This course focusses on the steps of collection of evidence in Crime Scene Investigation. It also deals with collection and analysis of fingerprints, biological samples and various signs to observe in a dead body. High end instrumental techniques involved in forensic analysis has also been discussed.

Course Outcome (CO):
CO1: explain the importance of forensic analysis.
CO2: understand the application of analytical techniques in forensic analysis.
CO3: to understand how to analyze samples in forensic laboratory
CO4: to understand changes in body post death

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	Introduction: Basis of forensic sciences. Types of forensic scientists. Role of Forensic Scientists. Sub-specialities of forensic science- forensic pathology, forensic toxicology, forensic psychology, forensic odontology, digital forensics, and criminology. Crime-scene investigation: Locard's Principle. Steps to be followed in CSI. Fingerprint analysis: Fingerprint ridges and their analysis. Loops (radial and ulnar), whorls (plain, central pocket loop, double loop, accidental loop) and arches (plain and tented). Latent and patent prints. Methods of visualizing and collecting fingerprints. Calculation of fingerprint classification ratio. Forensic pathology: Introduction and relation to postmortem study. Types of trauma- mechanical, electrical, thermal and chemical. Changes in body after death- Rigor mortis, Algor mortis, lividity. Internal examination and dissection. Determination of time of death. Decomposition of the body. Exhumations. Drug analysis: Postmortem redistribution of drug in body. Specificity and selectivity of method. Use of GC, HPLC, IR, MS, electrophoresis in analysis. Determination of alcohol in breath and blood.	15	1,2,3,4,5	CO1, CO2, CO3, CO4	PSO1, PSO2, PSO3, PSO4, PSO5
2	Biological material – collection, characterization and storage: Evaluation of blood strain in patterns: identification and characterization of fluids and examination of trace evidence. The Microscope and Its Forensic Applications, Evidentiary Value of Hair and Fibers.	15	1,2,3,4,5	CO1, CO2, CO3, CO4	PSO1, PSO2, PSO3, PSO4, PSO5

	Serology: Presumptive and confirmatory tests for blood, saliva and semen samples. Forensic genetics Introduction to Forensic genetics, A brief history of forensic genetics Role of DNA structure and the genome in analysis, Polymerase chain reaction, The analysis of short tandem repeats, Assessment of STR profiles, Statistical interpretation of STR profiles, Kinship testing Single nucleotide polymorphisms, Lineage markers, Non-human DNA typing DNA analysis: Overview of nuclear DNA. Tandem repeats. Mitochondrial DNA. DNA databases. Anthropology: Basis, determination of bone sample. Difference between male and female skeletons. Age determination by skeleton study. Importance of odontology in identification of individual. Drug Abuse and Drug Evidence: Determination of drugs traces in unconventional samples such as hair and oral fluids with respect to cocaine, opioids, amphetamines, cannabis, benzodiazepines etc.				

Reference Books	
1.	W.J. Welcher (Ed.), Scott’s Standard Methods of Chemical Analysis, Vol. III A, 6th Edition (1966), and vol. III B, 5th Edition (1975), Van Nostrand Reinhold Co. London.
2.	Peter Fordham, Non-destructive Testing Techniques, 1st edition (1968), London Business Publications Ltd., London
3.	W. Horwitz, Official Methods of Analysis, 11th Edition (1970), Association of Official Analytical Chemists, Washington DC.
4.	K. Simpson and B. Knight, Forensic Medicine, 9th Edition (1985), Edward Arnold Publishers Ltd., London.

<table>
<tr><td colspan="3">School: Science</td><td colspan="3">Program: BSc (Chemistry)</td></tr>
<tr><td colspan="3">Course Code: MG321</td><td colspan="3">Course Name: Entrepreneurship</td></tr>
<tr><td>Year</td><td>II</td><td>Core Subject(Yes/No):</td><td>No</td><td>Lecture:</td><td>3</td></tr>
<tr><td>Semester</td><td>IV</td><td>Elective Subject(Yes/No):</td><td>No</td><td>Tutorial</td><td>0</td></tr>
<tr><td rowspan="3">Typology of Course</td><td rowspan="3">Lectures</td><td>Foundation Subject(Yes/No):</td><td>Yes</td><td>Practical:</td><td>0</td></tr>
<tr><td>Year of Syllabus Revision:</td><td>NA</td><td>Total Credit:</td><td>3</td></tr>
<tr><td>Year of Introduction</td><td>2015</td><td>Prerequisites (If any)</td><td>SY B.Sc. Chemistry</td></tr>
</table>

Course Description:

Introductory course on Entrepreneurship aims at sensitizing students to the spirit of entrepreneurship. The course includes discussion on the entrepreneurial journeys of various entrepreneurs in diverse fields so as to help students understand different aspects of an entrepreneur as well as entrepreneurial venture. Further it aims at systematically identifying opportunities and developing new business ideas. The course also deals with the issues concerning entrepreneurial ventures at a broad level like entrepreneurial ecosystem in India, marketing of a new venture, sources of finance etc.

Course Objectives:

The objective of the course is to :

- Introduce students to the idea of entrepreneurship and exposing learners to take entrepreneurship as a career choice.
- To help students develop better understanding about the various stages of entrepreneurial process.
- Develop creativity, problem solving and opportunity recognition skills.
- Provide students with first-hand experience of entrepreneurship
- To help them introspect about their own entrepreneurial capabilities

Course Outcome (CO):

Upon completion of the course students are expected to demonstrate knowledge, skill and abilities in the following areas:

CO 1: Foresee Entrepreneurship as one of the possible career paths for themselves
CO 2: Recognize the innate entrepreneurial potential within themselves
CO 3: Recognize and assess opportunities in their environments
CO 4: Evaluate the feasibility of any innovative idea
CO 5: Conduct Concept Test and Buying Intention Survey
CO 6: Identify appropriate sources of finance for their business
CO 7: Determine appropriate legal form of business for establishing their venture
CO 8: Select and apply for required intellectual property right
CO 9: Prepare Business Model Canvas
CO 10: Present Elevator Pitch

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	**Introduction to Entrepreneurship**	10	2,3,4	CO1 CO2	PSO1 PSO5
2	**Creativity and Innovation**	10	4,5,6	CO1 CO2 CO3 CO4 CO5	PSO1 PSO5
3	**Marketing, Financial and Legal aspects of new venture**	12	2,3,4,5	CO1	PSO1

				CO6 CO7 CO8	PSO5
4	**Business Plan and Pitching**	8	2,3,4,5,6	CO1 CO2 CO9 CO10	PSO1 PSO5

Reference Books	
1.	Bansal, R. (2011). *Connect The Dots*. Westland
2.	Bansal, R. (2011). *I have a dream*. *Westland*
3.	Barringer, B. R., Ireland,R.D. (2015). *Entrepreneurship: Successfully launching new ventures*. Pearson Education India
4.	Bygrave , W. D., & Zacharakis , A. (2011). *Entrepreneurship.* John Wiley & Sons, Inc
5.	Hisrich, R. D., Peters, M. P., & Shepherd, D. A. (2018). *Entrepreneurship*. McGraw Hill Education
6.	Kawasaki, G. (2004). *The art of the start: The time-tested, battle-hardened guide for anyone starting anything*. Penguin.
7.	Kuratko, D. F., & Rao, T. V. (2012). *Entrepreneurship: A South-Asian Perspective*. Cengage Learning
8.	Mauborgne, R., & Kim, W. C. (2005). *Blue Ocean Strategy- How to Create Uncontested Market Space and Make the Competition Irrelevant.* Harvard Business School Publishing Corporation. Boston, Massachusetts.
9.	Harvard Business Publishing Articles – Class readings

School: Science			**Program:** BSc (Chemistry)		
Course Code: SE319			**Course Name:** Fuzzy Logic		
Year	**III**	**Core Subject(Yes/No):**	**No**	**Lecture:**	**2**
Semester	**VI**	**Elective Subject(Yes/No):**	**Yes**	**Tutorial**	**0**
Typology of Course	Lectures and Tutorials	**Foundation Subject(Yes/No):**	**No**	**Practical:**	**0**
		Year of Syllabus Revision:	**NA**	**Total Credit:**	**2**
		Year of Introduction	**2018**	**Prerequisites (If any)**	**SY B.Sc. Chemistry**

Course Description:

This course aims at introducing the fundamental theory and concepts of fuzzy set theory. Student will learn basic set operations on fuzzy sets and elementary properties of them. Fuzzy numbers and arithmetic operations on fuzzy numbers will also be studied in the course. Fuzzy relation and properties will be discussed in detail.

Course Objectives:

1. Understand the importance of fuzzy theory
2. Learn basics of fuzzy sets and operations
3. Learn and apply concepts of fuzzy numbers and fuzzy relation to solve problems

Course Outcome (CO):

CO1	Understand the concept of fuzzy sets
CO2	Learn crisp and fuzzy set theory
CO3	Decide the difference between crisp set and fuzzy set theory.
CO4	Able to solve problems on fuzy set theory, fuzzy numbers and fuzzy relation

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	**Fuzzy sets** From crisp sets to fuzzy sets: a paradigm shift: Introduction-crisp sets: an overview-fuzzy sets: basic types and basic concepts of fuzzy sets, Fuzzy sets versus crisp sets, Additional properties of cuts, Representation of fuzzy sets.	14	1	CO1, CO2, CO3	PSO1
2	**Operations on fuzzy sets and Fuzzy Arithmetic** Operations on fuzzy sets-types of operations, fuzzy complements, fuzzy intersections, Fuzzy numbers, Linguistic variables, Arithmetic operations on intervals, Arithmetic operations on fuzzy numbers	10	2	CO4	PSO1
3	**Fuzzy relations** Crisp versus fuzzy relations, projections and cylindric extensions, Binary fuzzy relations, Binary relations on a single set, Fuzzy equivalence relations	6	3	CO4	PSO1 PSO2

Reference Books	
1.	Fuzzy sets, Fuzzy Logic and Applications by George Klir and Be Yaun
2.	First Course in Fuzzy Theory and Applications by Kwang H. Lee

School: School of Science	**Program: B.Sc. Chemistry**
Course Code: CH262	**Course Name: Industrial Hygiene and Safety**

Year	III	**Core Subject (Yes/No):**	No	**Lecture:**	2
Semester	VI	**Elective Subject (Yes/No):**	Yes	**Tutorial**	0
Typology of Course	Lectures and Tutorials	**Foundation Subject (Yes/No):**	No	**Practical:**	0
		Year of Syllabus Revision:	**NA**	**Total Credit:**	2
		Year of Introduction	**2021**	**Prerequisites (If any)**	**SY B.Sc. Chemistry**

Course Description:

The course will help students to gain knowledge of carious hazards related to fire, mechanical, electrical, chemical and pharmaceutical field. It will also provide the knowledge of industrial safety and preventions from various accidents and toxin eliminations.

Course Outcome (CO):

CO1: Get an insight into the area of hazards and safety
CO2: learn the basic of monitoring and prevention during lab and industrial accidents

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	**Hazards:** Classification Hazardous chemical, transportation of Hazardous chemicals, Storage, Handling and control measures for hazardous chemicals. Hazards and controls in Unit process and Unit Operations. **Hazards -** fire, mechanical, electrical, chemical and pharmaceutical, Monitoring & prevention systems, industrial effluent testing & treatment. Control of environmental pollution. **Fire and Safety:** Fire: Chemistry of fire, Personal protective equipment, Fire extinguishers, type of fire extinguishers, and use of fire extinguishers. **Safety:** Safety work permits, safety of pipelines, safety industrial equipment, safe start up and shut down procedures, emergency shutdown.	15	1,2,3,4,5	CO1, CO2	PSO1, PSO2, PSO3,
2	**Concept of Industrial Safety:** Accident's investigation and Analysis, Statutory provisions, Types of chemical hazards and control, control techniques, process flow chart and its importance for safety inspection, interpretation, use and training of MSDS, UN, HAZCHEM. **Safety in chemical industry:** General introduction, type of chemical hazards, Safety and risk phrases, Storage hazards and control, Prevention of overflow pressure-temperature and process flow, Types of guards and valves for the vessel, its inlet and outlet, need of remote and auto control valves, Process hazards and controls. **Housekeeping and First aid:** Housekeeping and toxicology First aid training, First aid measures.	15	1,2,3,4,5	CO1, CO2	PSO3. PSO4, PSO5

Reference Books

1.	Deshmukh, L.M., Industrial Safety Management, Tata McGraw-Hill Education, 2005.
2.	Gupta, A., Industrial Safety and Environment, Firewall Media, 2006.
3.	King, R. W., Magid, J., Industrial hazard and safety handbook, Elsevier, 2013.
4.	Dalton, A. J. P., Safety, Health and Environmental Hazards at the Workplace, Cengage Learning EMEA, 1998.
5.	Shearer P., Freedman, J., Good Housekeeping Family First Aid, Hearst Books, 2004.
6.	DK, First Aid Manual, Dorling Kindersley Ltd, 2016.

NAVRACHANA UNIVERSITY
a UGC recognized University

Curriculum

School:	**School of Science**
Program Code:	**163**
Program Name:	**BSc Chemistry**
Academic Year:	**2021-24**

GLOSSARY:

Programme Outcomes (POs): POs are statements that describe what the students graduating from any of the educational Programmes of the institution should be able to do on completion.

Programme Specific Outcomes (PSOs): PSOs are statements that describe what the graduates of a specific educational Programme should be able to do on completion.

Course Outcomes (COs): COs are statements that describe what students should be able to do on completion of the course.

NOTE:

Programme Outcomes (POs): Programme Outcomes (POs) are what knowledge, skills and attitudes a graduate should have at the time of graduation. While as at present, no agency has formally defined the POs of General Higher Education in a 3-year degree Programmes in India, POs of all professional Programmes in engineering and other areas are identified at the national level, by the concerned accrediting agency. POs are not specific to a discipline.

Course Outcomes (COs): COs are statements that describe what students should be able to do at the end of a course. They can be 6±2 for courses with 2 to 4 credits, and 8±2 for courses with 5 to 6 credits.

Vision of School:
A premier Science School of Excellence in Research and Innovation

Mission of School:

- To focus on developing Undergraduate, Post-graduate and Doctoral Research
- Faculty Development and Empowerment
- Push for Innovation and Entrepreneurship through Industry and Academia connect
- To focus on social issues and society concerns through various activities at SOS and NUCERI

Programme Outcomes (POs):

PO1:	**Critical Thinking**: Take informed actions after identifying the assumptions that frame our thinking and actions, checking out the degree to which these assumptions are accurate and valid, and looking at our ideas and decisions (intellectual, organizational, and personal) from different perspectives.
PO2:	**Effective Communication**: Speak, read, write and listen clearly in person and through electronic media in English and in one Indian language, and make meaning of the world by connecting people, ideas, books, media and technology.
PO3:	**Social Interaction**: Elicit views of others, mediate disagreements and help reach conclusions in group settings.
PO4:	**Effective Citizenship**: Demonstrate empathetic social concern and equity centred national development, and the ability to act with an informed awareness of issues and participate in civic life through volunteering.
PO5:	**Ethics**: Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them.
PO6:	**Environment and Sustainability**: Understand the issues of environmental contexts and sustainable development.
PO7:	**Self-directed and Life-long Learning**: Acquire the ability to engage in independent and life-long learning in the broadest context socio-technological changes

Program Specific Outcome (PSO): CHEMISTRY

PSO1:	Understand the nature and basic concepts of physics, life sciences, mathematical sciences and their significance with respect to understanding fundamentals and applications of chemical sciences. Students will also acquire fundamental understanding of basic concepts of humanities, communication skills, critical thinking, accounts, intellectual property rights and principles of management.
PSO2:	Apply appropriate techniques for the qualitative and quantitative analysis of chemicals in laboratories and in industries. Acquires the ability to synthesize, separate and characterize compounds using laboratory and instrumentation techniques.
PSO3:	Students will have a firm foundation in the fundamentals and application of current chemical and scientific theories including those in Analytical, Inorganic, Organic, Physical, environmental, polymer and biochemistry.
PSO4:	Develops analytical skills and problem-solving skills requiring application of chemical sciences principles.
PSO5:	Students will appreciate the central role of chemistry in our society and use this as a basis for ethical behavior in issues facing chemists including an understanding of safe handling of chemicals, environmental issues and key issues facing our society in energy, health and medicine. Also, students will be able to explain why chemistry is an integral activity for addressing social, economic, and environmental problems.
PSO6	Students will also acquire basic understanding of research methodology and acquire research skills through research projects.

Course Structure

L = Lecture	**T = Tutorial**	**P = Practical**	**C = Credit**
number of hours per week	number of hours per week	number of hours per week	Total Credits

Semester	**I**	**II**	**III**	**IV**	**V**	**VI**	**Total**
Credits	22	24	23	27	27	26	149

Total Credits	**149**
Minor Specialization Credits	
Total Credits Including Minor	

CURRICULUM AND TEACHING SCHEME

Semester-I													
Teaching Scheme											**Elements of** Employability (Emp)/ Entrepreneurship (Ent)/ Skill Development (SD)	**Relevance to** Local (L)/ National (N)/ Regional(R)/ Global developmental needs (G)	**Relation to** Gender (G)/ Environment and Sustainability (ES)/ Human Values (HV)/ Professional Ethics (PE)
						Theory Course		**Practical Course**		**Total marks**			
Course Code	***Course Name***	**L**	**T**	**P**	**C**	**Internal Examination (%)**	**End semester Examination (%)**	**Internal Examination (%)**	**End semester Examination (%)**				
CH138	Inorganic Chemistry-I	3	0	0	3	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	
CH103	Chemistry Laboratory-I	0	0	2	2	-NA-	-NA-	60	40	100	Emp, SD	L, N, R, G	
PH 109	Mechanics Elasticity & Special Theory of Relativity	3	0	0	3	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	
PH108	Physics Laboratory: Mechanics, Elasticity, Sound and Thermodynamics	0	0	1	1	-NA-	-NA-	60	40	100	Emp, SD	L, N, R, G	
MA125	Elementary Calculus	2	0	0	2	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	
MA145	Matrix Theory	2	0	0	2	-NA-	-NA-	60	40	100	Emp, SD	L, N, R, G	
BY102	Foundation course in Biology I	3	0	0	3	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	
MG117	Principles of Management, Accounts	3	0	0	3	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	PE
LC 119	Communication I	3	0	0	3	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	PE
	Total Credits	**19**	**0**	**3**	**22**								

SEMESTER II													
CH139	States of Matter	3	0	0	3	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	
CH106	Chemistry Laboratory III	0	0	2	2	-NA-	-NA-	60	40	100	Emp, SD	L, N, R, G	
PH114	Electricity Magnetism and Optics	3	0	0	3	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	
PH115	Physics Laboratory: Electricity Magnetism and Optics	0	0	1	1	-NA-	-NA-	60	40	100	Emp, SD	L, N, R, G	
MA147	Ordinary Differential Equations	2	0	0	2	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	
MA148	Advanced Calculus	2	0	0	2	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	
BY103	Foundation course in Biology II	3	0	0	3	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	
MG108	Economics & Finance	3	0	0	3	-NA-	-NA-	60	40	100	Emp, SD	L, N, R, G	PE
HS106	Humanities	2	0	0	2	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	HV
LC120	Communication II	3	0	0	3	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	PE
	Total Credits	**21**	**0**	**3**	**24**								
SEMESTER III													
CH255	Organic Chemistry I	**3**	**0**	**0**	**3**	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	
CH 256	Inorganic Chemistry-II	**3**	**0**	**0**	**3**	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	
CH204	Chemistry Laboratory V	**0**	**0**	**3**	**3**	-NA-	-NA-	60	40	100	Emp, SD	L, N, R, G	
PH204	Quantum Mechanics & Solid State Physics	**3**	**0**	**0**	**3**	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	
PH205	Analog & Digital Electronics	**1**	**0**	**2**	**2**	-NA-	-NA-	60	40	100	Emp, SD	L, N, R, G	
MA150	Abstract Algebra I	**3**	**0**	**0**	**3**	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	ES
MA151	Numerical Methods	**2**	**0**	**0**	**2**	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	
HR226	HR & Marketing I	**2**	**0**	**0**	**2**	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	PE
ID	University ID	**2**	**0**	**0**	**2**	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	PE, HV, ES
	Total Credits	**18**	**0**	**5**	**23**								
SEMESTER IV													
CH257	Organic Chemistry II	**3**	**0**	**0**	**3**	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	
CH258	Thermodynamics and Chemical Equilibrium	**3**	**0**	**0**	**3**	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	
CH209	Chemistry Laboratory VII	**0**	**0**	**3**	**3**	-NA-	-NA-	60	40	100	Emp, SD	L, N, R, G	

PH201	Atomic & Nuclear Physics	**3**	**0**	**0**	**3**	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	ES
PH206	Experimental Techniques	**2**	**0**	**0**	**2**	-NA-	-NA-	60	40	100	Emp, SD	L, N, R, G	
MA221	Linear Algebra I	**3**	**0**	**0**	**3**	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	
MA222	Linear Programming Problems	**2**	**0**	**0**	**2**	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	
HR311	Introduction to HR & Marketing II	**2**	**0**	**0**	**2**	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	PE
ES201	Environmental Studies	**4**	**0**	**0**	**4**	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	PE, ES
ID	University ID	**2**	**0**	**0**	**2**	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	PE, HV, ES
	Total Credits	**24**	**0**	**3**	**27**								
SEMESTER V													
CH311	Organic Chemistry III	**3**	**0**	**0**	**3**	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	
CH302	Physical Chemistry II	**3**	**0**	**0**	**3**	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	
CH303	Spectroscopy & Separation Techniques	**3**	**0**	**0**	**3**	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	
CH304	Chemistry Laboratory IX	**0**	**0**	**4**	**4**	-NA-	-NA-	60	40	100	Emp, SD	L, N, R, G	
CH305	Chemistry Laboratory X	**0**	**0**	**4**	**4**	-NA-	-NA-	60	40	100	Emp, SD	L, N, R, G	
PS310	KHOJ	**3**	**0**	**0**	**3**	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	PE, HV, ES
PS322	Scientific Enquiry and research Methodology	**3**	**0**	**0**	**3**	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	PE, HV, ES
Elective Courses (any two)													
SE201	Essential Laboratory Practices	**2**	**0**	**0**	**2**	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	
SE202	Food and Nutrition	**2**	**0**	**0**	**2**	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	
SE204	Intellectual Property Rights and Patents Law	**2**	**0**	**0**	**2**	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	
SE213	Introduction to Neuroscience and Cognition	**2**	**0**	**0**	**2**	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	
SE302	Medicinal Chemistry-I	**2**	**0**	**0**	**2**	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	
SE305	Introduction to cell /tissue culture	**2**	**0**	**0**	**2**	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	
SE307	Number Theory	**2**	**0**	**0**	**2**	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	
	Total Credits	**19**	**0**	**8**	**27**								
SEMESTER VI													
CH312	Inorganic Chemistry-III	**3**	**0**	**0**	**3**	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	

CH313	Electrochemistry and Photochemistry	**3**	**0**	**0**	**3**	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	
CH314	Organic Chemistry-IV	**3**	**0**	**0**	**3**	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	
CH309	Chemistry Laboratory-XI	**0**	**0**	**8**	**4**	-NA-	-NA-	60	40	100	Emp, SD	L, N, R, G	
CH310	Chemistry Laboratory-XII	**0**	**0**	**8**	**4**	-NA-	-NA-	60	40	100	Emp, SD	L, N, R, G	
MG321	Entrepreneurship	**3**	**0**	**0**	**3**	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	ES, HV, PE
	Project Work	**0**	**0**	**2**	**2**	-NA-	-NA-	-NA-	-NA-	100	Emp, SD	L, N, R, G	HV, ES, PE
Elective Courses (any two)													
SE208	Herbal Cosmetics	**2**	**0**	**0**	**2**	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	
SE210	Food and Nutrition-II	**2**	**0**	**0**	**2**	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	
SE218	Introduction to Polymer Science	**2**	**0**	**0**	**2**	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	
SE310	Introduction to Pharmacognosy	**2**	**0**	**0**	**2**	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	
SE311	Introduction to Paint Technology	**2**	**0**	**0**	**2**	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	
SE312	Medicinal Chemistry-II	**2**	**0**	**0**	**2**	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	
SE313	Green Chemistry	**2**	**0**	**0**	**2**	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	ES
SE314	Conservation Biology	**2**	**0**	**0**	**2**	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	ES
SE316	Bioinformatics	**2**	**0**	**0**	**2**	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	
SE319	Fuzzy Logic	**2**	**0**	**0**	**2**	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	
SE318	Introduction to forensic Science	**2**	**0**	**0**	**2**	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	
CH264	Industrial Hazards, Hygiene and Safety	**2**	**0**	**0**	**2**	60	40	-NA-	-NA-	100	Emp, SD	L, N, R, G	ES, HV, PE
	Total Credits	**16**	**0**	**18**	**26**								

Core Elective Subjects (For example)

Course code	**Course Name**

Articulation Matrix COs and POs Mapping

Semester-I	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
Inorganic Chemistry-I	√					√	√
Chemistry Laboratory-I	√					√	√
Mechanics Elasticity & Special Theory of Relativity	√						
Physics Laboratory: Mechanics, Elasticity, Sound and Thermodynamics	√						
Elementary Calculus	√						
Matrix Theory	√						
Foundation course in Biology I	√						
Principles of Management, Accounts	√	√					
Communication I	√	√	√	√			
Semester-II	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
States of Matter	√						√
Chemistry Laboratory III	√						√
Electricity Magnetism and Optics	√						
Physics Laboratory: Electricity Magnetism and Optics	√						
Ordinary Differential Equations	√						
Advanced Calculus	√						
Foundation course in Biology II	√						
Economics & Finance	√	√					
Humanities	√	√	√	√			
Communication II	√	√	√	√			√
Semester-III	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
Organic Chemistry I	√						√

Inorganic Chemistry-II	√						√
Chemistry Laboratory V	√						√
Quantum Mechanics & Solid State Physics	√						
Analog & Digital Electronics	√						
Abstract Algebra I	√						
Numerical Methods	√						
HR & Marketing I	√	√	√				
University ID	√	√	√	√		√	
Semester-IV	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
Organic Chemistry II	√						√
Physical Chemistry I	√						√
Chemistry Laboratory VII	√						√
Atomic & Nuclear Physics	√				√	√	
Experimental Techniques	√					√	
Linear Algebra I	√						
Linear Programming Problems	√						
Introduction to HR & Marketing II	√	√	√				
Environmental Studies	√		√	√		√	√
University ID	√	√	√	√		√	
Semester-V	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
Organic Chemistry III	√						√
Physical Chemistry II	√						√
Spectroscopy & Separation Techniques	√						√
Chemistry Laboratory IX	√						√

Chemistry Laboratory X	√						√
Essential Laboratory Practices	√					√	√
Food and Nutrition	√						√
Intellectual Property Rights and Patents Law	√					√	√
Introduction to Neuroscience and Cognition	√						
Medicinal Chemistry-I	√						√
Introduction to cell /tissue culture	√						
Number Theory	√						
KHOJ	√		√	√	√	√	√
Scientific Enquiry and research Methodology	√		√	√	√	√	√

Semester-VI	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
Inorganic Chemistry-III	√						√
Electrochemistry and Photochemistry	√						√
Organic Chemistry-IV	√						√
Chemistry Laboratory-XI	√						√
Chemistry Laboratory-XII	√						√
Herbal Cosmetics	√			√			√
Food and Nutrition-II	√			√			
Introduction to Polymer Science	√						
Introduction to Pharmacognosy	√			√			
Introduction to Paint Technology	√						√
Medicinal Chemistry-II	√			√			√
Green Chemistry	√			√		√	√
Conservation Biology	√			√		√	

Bioinformatics	√						
Fuzzy Logic	√						
Introduction to forensic Science	√						√
Entrepreneurship	√	√		√	√		√
Project Work	√	√		√	√		√
Industrial Hazards, Hygiene, and Safety	√	√		√	√		√

PSO's - PO's Mapping

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
PSO1	√	√		√	√		√
PSO2	√					√	√
PSO3	√					√	√
PSO4	√	√		√	√	√	√
PSO5		√		√	√	√	√
PSO6	√	√	√		√	√	√

Syllabus of Courses

Bloom's Taxonomy Levels (BT Level):
1. Remember 2. Understand 3. Application 4. Analysis 5. Evaluation 6. Creation

SEMESTER I

School: Science			**Program: B.Sc. (Chemistry)**		
Course Code: CH 138			**Course Name:** Inorganic Chemistry-I		
Year	**I**	**Core Subject (Yes/No):**	**Core**	**Lecture:**	**3**
Semester	**I**	**Elective Subject(Yes/No):**	**No**	**Tutorial**	**0**
Typology of Course	Lectures	**Foundation Subject(Yes/No):**	**No**	**Practical:**	**0**
		Year of Syllabus Revision:	**2019**	**Total Credit:**	**3**
		Year of Introduction	**2014**	**Prerequisites (If any)**	**12th Science**

Course Description:
In the first unit, the basics of quantum mechanics are discussed. It mainly deals with Schrödinger wave equation and its interpretation, shapes of orbitals – s, p, d orbitals etc. In the second unit the details of periodic properties are discussed and in addition, the comparative study of each block is discussed. The second unit deals with the concept of chemical bonding, hybridization and the factors affecting the same are elaborately discussed. The detailed study of Valence Shell Electron Pair Repulsion (VSEPR) theory and Valence Bond Theory (VBT) are also involved in the last section. The third unit deals with nuclear chemistry, it will give an idea about the fundamental particles of a nucleus, isotopes, natural abundance, stability of the nucleus, n/p ratio, mass defect and nuclear binding energy etc.

Course Objectives:
The course will provide you with the necessary skills to understand the theoretical basis of structure and bonding as well as the physical and chemical properties of inorganic compounds.

Course Outcome (CO):
CO1 Explain the importance of quantum chemistry in developing the model of the atom.
CO2 Understand the origin of Schrodinger wave equation and its application in calculating the energy and wave functions of various atomic and molecular systems.
CO3 Acquire competency to predict the patterns in the properties exhibited by the elements.
CO4 Understand the concept of chemical bonding and hybridization.
CO5 Understand the fundamentals of nuclear chemistry and their application in today's life.

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	**Unit-I: Atomic Structure and Quantum Mechanics:** Atomic Structure: Dual nature of radiation and matter, de Broglie's principle, Heisenberg's Uncertainty principle, Schrödinger wave equation and its interpretation, origin of quantum numbers and symbols for orbitals, shapes of orbitals – s, p, d. Radial and angular probabilities.	15	1,2,3,4,5	CO1 CO2	PSO1 PSO3 PSO4
2	**Unit-II: Chemical Bonding and Molecular Structure:** Ionic Bonding: Energy consideration in ionic bonding, Lattice Energy, and Solvation Energy and their importance in the context of Stability and Solubility of ionic compounds. Fajan's rule, Bond moment, dipole moment and percentage ionic character. Hydrogen Bonding. Covalent Bonding: Valence Shell Electron Pair Repulsion (VSEPR) theory and shapes of simple covalent molecules like H2O, NH3, BF3, CH4, PCI5, SF6, IF7.Valence Bond Theory (VBT) – assumptions, linear combination of atomic orbitals and properties of hybrid	15	1,2,3,4,5	CO2 CO3 CO4	PSO1 PSO3 PSO4

	orbitals. hybridization involving s, p and d orbitals (dsp2, sp3d, dsp3, d2sp3, sp3d2, sp3d3) and shapes of simple molecules like SF6, IF5, PCl5, IF7. Molecular Orbital Theory (MOT) – Formation of bonding and antibonding molecular orbitals and bond order. Graphical representation of orbital energies (MO diagram). Bonding in homodiatomic molecules/ions like N2, F2, B2, C2, O2, O2 -, O2 + with MO diagrams, relation between bond order and bond lengths, magnetic properties. Bonding in hetero – diatomic molecules/ions like CO, NO, NO+ and HX.				
3	**Unit-III: Nuclear Chemistry:** Fundamental particles of nucleus, isotopes, natural abundance, stability of nucleus, n/p ratio, mass defect and nuclear binding energy, Einstein's mass energy relationship. Natural radioactivity and disintegration rate, half-life, average life, artificial transmutation and radioactivity. Radioactive series. Nuclear reactions, nuclear fission, nuclear fusion, thermonuclear radiation. Applications of radioactivity in chemistry and industry.	15	1,2,3,4,5	CO5	PSO1 PSO3 PSO4

Reference Books	
1.	J. D. Lee, Concise Inorganic Chemistry, 5th Ed., Blackwell Science, London, 1996.
2.	F. A. Cotton, G. Wilkinson & P. L. Guas, Basic Inorganic Chemistry, 3rd Ed., John Wiley, 1994.
3.	B. R. Puri, L. R. Sharma & K. C. Kalia, Principles of Inorganic Chemistry, Shoban Lal Nagin Chand and Co., 1996.
4.	J. E. Huheey, E. A. Kieter& R. L. Keiter, Inorganic Chemistry, 4th Ed., Harper Collins, New York, 1993.
5.	D. F. Shriver & P. W. Atkins, Inorganic Chemistry, 3rd Ed., W. H. Freeman and Co, London, 1999.

School: School of science			**Program: B.Sc chemistry**		
Course Code: CH 103			**Course Name:** Chemistry Laboratory-I		
Year	**I**	**Core Subject (Yes/No):**	**Yes**	**Lecture:**	**0**
Semester	**I**	**Elective Subject (Yes/No):**	**No**	**Tutorial**	**0**
Mode of Transaction	Laboratory	**Foundation Subject (Yes/No):**	**No**	**Practical:**	**4**
		Year of Syllabus Revision:	**2018**	**Total Credit:**	**2**
		Year of Introduction	**2014**	**Prerequisites (If any)**	**12th Science**

Course Description:

This laboratory course deals with Handson training of two distinct aspects of chemistry, (i) Titrimetric analysis and (ii) Organic qualitative analysis. Titrimetric analysis_section is dealing with quantitative chemical analysis, carried out to determine the concentration of a substance in given solution. Organic qualitative analysis includes the characterization and elucidation of unknown organic compounds.

Course Outcome (CO):

CO1 To understand the fundamentals of volumetric titrations specifically Acidimetry – Alkalimetry titrations

CO2 Describe the knowledge of the fundamentals of Redox Titrations, complexometric titrations in volumetric analysis for various analysis including water samples)

CO3 comprehended the Hands-on training related to Organic qualitative analysis.

CO4 Record observations and write laboratory reports according to disciplinary standards.

No.	Experiment	Contact Hours	BT Level	CO	PSO
1	Benzoic acid	2	1, 2, 3, 4, 5, 6	CO3, CO4	PSO1, PSO2
2	Cinnamic acid	2	1, 2, 3, 4, 5, 6	CO3, CO4	PSO1, PSO2
3	Phenol	2	1, 2, 3, 4, 5, 6	CO3, CO4	PSO1, PSO2
4	Benzaldehyde	2	1, 2, 3, 4, 5, 6	CO3, CO4	PSO1, PSO2
5	Cinnamaldehyde	2	1, 2, 3, 4, 5, 6	CO3, CO4	PSO1, PSO2
6	Benzophenone	2	1, 2, 3, 4, 5, 6	CO3, CO4	PSO1, PSO2
7	Acetone	2	1, 2, 3, 4, 5, 6	CO3, CO4	PSO1, PSO2
8	Acetophenone	2	1, 2, 3, 4, 5, 6	CO3, CO4	PSO1, PSO2
9	Acetanilide	2	1, 2, 3, 4, 5, 6	CO3, CO4	PSO1, PSO2
10	Methyl alcohol	2	1, 2, 3, 4, 5, 6	CO3, CO4	PSO1, PSO2
11	Aniline	2	1, 2, 3, 4, 5, 6	CO3, CO4	PSO1, PSO2
12	Nitrobenzene	2	1, 2, 3, 4, 5, 6	CO3, CO4	PSO1, PSO2
13	Acetamide	2	1,2,3,4,5	CO3, CO4	PSO1, PSO2

14	Benzamide	2	1, 2, 3, 4, 5, 6	CO3, CO4	PSO1, PSO2
15	Bromo benzene	2	1, 2, 3, 4, 5, 6	CO3, CO4	PSO1, PSO2
16	Sulphanilic acid	2	1, 2, 3, 4, 5, 6	CO3, CO4	PSO1, PSO2
17	Thiourea	2	1, 2, 3, 4, 5, 6	CO3, CO4	PSO1, PSO2
18	chlorobenzene	2	1, 2, 3, 4, 5, 6	CO3, CO4	PSO1, PSO2
19	Redox titration	2	1, 2, 3, 4, 5, 6	CO2, CO4	PSO1, PSO2
20	*Acidimetry-Alkalimetry titrations*	2	1, 2, 3, 4, 5, 6	CO1, CO4	PSO1, PSO2
21	Complexometric titration	2	1, 2, 3, 4, 5, 6	CO2, CO4	PSO1, PSO2

Reference Books	
1.	R. C. Shah, *Organic Analysis Part I Qualitative Analysis*, Baroda Book Depot, Vadodara, 2001.
2.	A. I. Vogel, *Fundamentals of Quantitative Analysis*, 5th Ed., Addison Wesley longman., 1989.

<table>
<tr><td colspan="2">School: School of Science</td><td colspan="4">Program: B.Sc. Chemistry</td></tr>
<tr><td colspan="2">Course Code: PH109</td><td colspan="4">Course Name: Mechanics, Elasticity and Special Theory of Relativity</td></tr>
<tr><td>Year</td><td>I</td><td>Core Subject(Yes/No):</td><td>No</td><td>Lecture:</td><td>2</td></tr>
<tr><td>Semester</td><td>I</td><td>Elective Subject(Yes/No):</td><td>No</td><td>Tutorial</td><td>1</td></tr>
<tr><td rowspan="3">Typology of Course</td><td rowspan="3">Lectures and Tutorials</td><td>Foundation Subject(Yes/No):</td><td>Yes</td><td>Practical:</td><td>0</td></tr>
<tr><td>Year of Syllabus Revision:</td><td>NA</td><td>Total Credit:</td><td>3</td></tr>
<tr><td>Year of Introduction</td><td>2018</td><td>Prerequisites (If any)</td><td>12th Science</td></tr>
</table>

Course Description:

This course is intended to teach basics of college level physics in order to appreciate some path breaking discoveries in science which are not immediately intuitive. Mechanics is at the heart of science of moving bodies, and it is essential that one learns about the basic laws of physics to build a knowledge base in science. This course describes various physics principles of mechanics, elasticity and special theory of relativity. It is well supported by mathematical derivations, historical background of physical concepts. Students will develop their problem-solving skills by solving out various numerical.

Course Objectives:

Physics is a science to fundamentally understand how things work in nature and around us. The importance of the subject is thus unparalleled for a science student of any branch. Some of the immediate and direct objectives are listed below.

1. To develop knowledge about new concepts in physics which have revolutionized science and cutting-edge technology.
2. To develop problem solving skills.
3. To learn and strengthen concepts needed for applied mechanics.

Course Outcome (CO):

CO1 To draw free body diagrams for two- and three-dimensional force systems.
CO2 To learn motion of particles in linear and curved paths.
CO3 To learn to use curvilinear coordinates in problems
CO4 To determine the location of center of mass for a system of discrete particles and for objects of arbitrary shape.
CO5 To calculate moments of inertia for lines, areas, and volumes.
CO6 To learn various elastic constants, concept of beam and cantilever
CO7 To learn to analyze bodies in relative motion.
CO8 To learn relativistic effects on the objects.

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	Unit I: **Mechanics** Review of vector analysis, projectile motion, uniform circular motion, Newton's laws of motion-Free body diagrams and applications, forces of nature, kinetic energy and work, conservative and non-conservative forces, system of particles, centre of mass, elastic and inelastic collisions, moment of inertia- parallel axis theorem, perpendicular axis theorem, rolling motion, torque and angular momentum, gravitation escape velocity, simple harmonic oscillations, curvilinear coordinates- polar coordinates, spherical coordinates, cylindrical coordinates	15	2,3,4	CO1 CO2 CO3 CO4 CO5	PSO1 PSO3 PSO4 PSO5
2	Unit II: **Elasticity**	15	2,3,4	CO6	PSO1

	Stress and strain, Hook's law, three types of elasticity, equivalence between shear stress and tensile/compressive stress, bulk modulus, Young's modulus, modulus of rigidity, relation connecting elastic constants, Poisson's ratio, beams supported at both the ends, bending of beams, cantilever				PSO3 PSO4 PSO5
3	Unit III: **Special Theory of Relativity** Limitations of Newtonian mechanics, Michelson-Morley experiment, Galilean (Classical) and Lorentz transformations, Time dilation, Length contraction, Mass-Energy relation.	15	2,3,4	CO7 CO8	PSO1 PSO3 PSO4 PSO5

Reference Books

1.	Huge D. Young, Roger A. Freedman, and A. Lewis Ford, Sears and Zemansky's University Physics,13th Ed., Pearson, 2013.
2.	H.C. Verma, Concepts of Physics, Vol. – 1, Bharati Bhawan Publishers, 1st Ed., 2011.
3.	D.S. Mathur, Elements of Properties of Matter,11th Ed., S.Chand and Co.
4.	Charles Kittel, Walter Knight, Malvin Ruderman, Carl Helmholz, and Burton Moyer, Mechanics Berkeley Physics Course, Vol. – 1, Tata McGraw – Hill, 2007.
5.	Daniel Kleppner, and Robert J. Kolenkow, An introduction to mechanics, Tata McGraw Hill, 1973.
6.	D.S. Mathur, Mechanics, S. Chand Company Ltd. 2000.
7.	R. Resnick: Introduction to Special Relativity, 1st Edition, Wiley India Pvt.Ltd., 2007
8.	K.S. Krane: Modern Physics, 2nd Edition, Wiley India Pvt. Ltd., 2009
9.	J. Bernstein, P.M. Fishbane and S. Gasiorowicz: Modern Physics, 1st Edition, Pearson Education, 2009
10.	A. Beiser: Concepts of Modern Physics, 6th Edition, Tata Mcgraw Hill Education Pvt. Ltd., 2009

School: School of Science		**Program: B.Sc. Chemistry**			
Course Code: PH108		**Course Name: Physics Laboratory: Mechanics, Elasticity, Sound and Thermodynamics**			
Year	**I**	**Core Subject(Yes/No):**	**No**	**Lecture:**	**0**
Semester	**I**	**Elective Subject(Yes/No):**	**No**	**Tutorial**	**0**
Mode of Transaction	Laboratory	**Foundation Subject(Yes/No):**	**Yes**	**Practical:**	**2**
		Year of Syllabus Revision:	**NA**	**Total Credit:**	**1**
		Year of Introduction	**2018**	**Prerequisites (If any)**	**12th Science**

Course Description:
The laboratory course will be based on a variety of experiments related to mechanics, elasticity, sound and thermodynamics. It will develop practical skills of the students by taking measurements individually and compare their result with the standard one. They can realize that there can be various experiments to determine single parameter.

Course Outcome (CO):
CO1 To perform experiments chosen from diverse areas like mechanics, elasticity, sound and thermodynamics along with theoretical concepts that they would be learning in the theory course
CO2 To gain working knowledge of some instruments.

No.	Experiment	Contact Hours	BT Level	CO	PSO
1	Gravesand's Apparatus	2	1,2,3,4	CO1 CO2	PSO1 PSO4 PSO5
2	Universal Force stable	2	1,2,3,4	CO1 CO2	PSO1 PSO4 PSO5
3	Coefficient of friction	2	1,2,3,4	CO1 CO2	PSO1 PSO4 PSO5
4	Compound pendulum	2	1,2,3,4	CO1 CO2	PSO1 PSO4 PSO5
5	Torsional pendulum	2	1,2,3,4	CO1 CO2	PSO1 PSO4 PSO5
6	Young's modulus by Koenig's method	2	1,2,3,4	CO1 CO2	PSO1 PSO4 PSO5
7	Young's modulus by Searle's apparatus	2	1,2,3,4	CO1 CO2	PSO1 PSO4 PSO5
8	Thermal conductivity by Lee's disk	2	1,2,3,4	CO1 CO2	PSO1 PSO4 PSO5
9	Kundt's Tube	2	1,2,3,4	CO1 CO2	PSO1 PSO4 PSO5
10	Moment of inertia of flywheel	2	1,2,3,4	CO1 CO2	PSO1 PSO4 PSO5
11	Stokes Law	2	1,2,3,4	CO1 CO2	PSO1 PSO4 PSO5
12	Space frame	2	1,2,3,4	CO1	PSO1

				CO2	PSO4 PSO5

Reference Books	
1.	Huge D. Young, Roger A. Freedman, and A. Lewis Ford, Sears and Zemansky's University Physics,13th Ed., Pearson, 2013.
2.	M. W. Zemansky & R. H. Dittman Heat and Thermodynamics, 8th Ed.,Tata McGraw Hill Education Private Limited.
3.	N. Subramaniam Brijlal and P. S. Hemne, Heat Thermodynamics and Statistical Physics, 1st Edition, Sulthan Chand Publishers, 2010.

School: School of Science		**Program:** BSc Chemistry			
Course Code: MA125		**Course Name:** Elementary Calculus			
Year	**I**	**Core Subject(Yes/No):**	**No**	**Lecture:**	**2**
Semester	**I**	**Elective Subject(Yes/No):**	**No**	**Tutorial**	**0**
Typology of Course	Lectures and Tutorials	**Foundation Subject(Yes/No):**	**Yes**	**Practical:**	**0**
		Year of Syllabus Revision:	NA	**Total Credit:**	**2**
		Year of Introduction	2018	**Prerequisites (If any)**	**12th Science**

Course Description:
This elementary calculus course covers fundamentals of differentiation and integration, partial differentiation of functions of several variables and concludes with a brief discussion of successive
differentiation as well as reduction formulae for Integration. Calculus is fundamental to all scientific disciplines including physics, engineering, and economics. This course also includes some applications of this study.

Course Objectives:

- Use both the limit definition and rules of differentiation to differentiate functions.
- Apply differentiation to solve applied max/min problems.
- Evaluate integrals both by using Riemann sums and by using the Fundamental Theorem of Calculus.
- Evaluate integrals using advanced techniques of integration, such as inverse substitution, partial fractions and integration by parts.
- Use L'Hospital's rule to evaluate certain indefinite forms.
- Learn the methods of successive differentiation and apply the reduction formulae for Integration.

Course Outcome (CO):

CO1	Apply differentiation to solve related rates problems.
CO2	Apply integration to compute arc lengths, volumes of revolution and surface areas of revolution.
CO3	Determine the convergence/divergence of an infinite series and find the Taylor series expansion of a function near a point.
CO4	Able to find partial derivatives.

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	Differential Calculus Orientation: Function Definition of Functions, Inverse Functions, Trigonometric Functions, Exponential and Logarithmic Functions, Exponential and Logarithm Equations, Graphs of commonly used functions. Limits Concept and the properties of limit, Evaluating the Limits, Infinite Limits, Limit at Infinity, Concept of Continuity. Derivative Definition and Interpretation of Derivatives, Differentiation Formulae, Product and Quotient Rule, Chain Rule, Differentiation of Explicit and Implicit functions. Successive Differentiation Higher Order Derivatives, The nth derivative of standard Functions, Leibnitz theorem, Differentiation of Inverse, Implicit and Parametrically Represented Functions	15	1,2	CO1, CO3	PSO1
2	Integral Calculus Orientation: Indefinite Integrals: Direct Integration and method of expansion, Integration by Substitution, Integration by parts, Reduction formulae Basic Classes of Integrable Functions: Integration of Rational Functions, Integration of Certain Irrational Expressions, Euler's Substitutions, Other Method of Integrating Irrational Expressions, Integration of a Binomial Differential. The Definite Integral: Evaluating Definite Integrals by the Newton-Leibnitz Formula, Estimating Integrals: The Definite Integral as a Function of its Limits,	15	1,2	CO2, CO4	PSO1

	Changing the Variable in a Definite Integral, Simplification of Integrals using the Symmetry of Integrands, Reduction formula of Integration by Parts, Approximation of Definite Integrals. Functions of Two Variables Definition, Common Graphs, Partial Differentiation Definition, Geometrical Interpretation, Higher Order Partial Derivatives, Total Derivative, Chain Rule for Partial Differentiation, Partial Differentiation of Composition of Functions: Change of Variables, Partial Differentiation of an Implicit Function (Functions of Three Variables				

Reference Books	
1.	Calculus – James Stewart, Sixth edition, (E-Book)
2.	Calculus and Analytic Geometry – G. B. Thomas and R. L. Finney. Pearson Education. Indian Reprint

School: School of Science	**Program: BSc Chemistry**
Course Code: MA145	**Course Name: Matrix Theory**

Year	I	**Core Subject(Yes/No):**	**No**	**Lecture:**	**2**
Semester	I	**Elective Subject(Yes/No):**	**No**	**Tutorial**	**0**
Typology of Course	Lectures and Tutorials	**Foundation Subject(Yes/No):**	**Yes**	**Practical:**	**0**
		Year of Syllabus Revision:	**NA**	**Total Credit:**	**2**
		Year of Introduction	**2018**	**Prerequisites (If any)**	**12th Science**

Course Description:
This course covers the basic concepts and computation techniques of linear algebra that are essential for various applications in science and engineering subjects. This study includes the methods of finding solutions to linear system of equations using Fundamental Theorem of Algebra and theory of matrices.

Course Objectives:
To teach ability to deal with matrices, including the technique to express system of linear equations in matrix format and solve them using matrix multiplication, matrix inverse, rank of a matrix and eigen value problem. Also, learn to count and solve system of linear equations by using analytical methods of algebra.

Course Outcome (CO):
CO1: Find roots, find multiplicity of roots.
CO2: Determine the relation between roots and coefficients
CO3: Find the rank of a matrix
CO4: Solve system of linear equations, application to chemistry
CO5: Find Eigenvalues and eigenvectors of the matrix
CO6: Diagonalize matrix
CO7: Find various powers of matrix using the Cayley Hamilton theorem

Unit No.	**Topic/Unit**	**Contact Hours**	**BT Level**	**CO**	**PSO**
1	Statement of fundamental theorem of algebra (without proof), multiple roots and test for multiplicity, Relation between roots and coefficients, Imaginary roots of an equation with real coefficients.	8	1, 2, 5	CO1, CO2	PSO1, PSO4
2	Special types of matrices and their properties, Elementary operations and Elementary matrices, Rank of a matrix, rank of product of matrices, Invariance of rank under elementary operations, Row reduced echelon form of a matrix, Homogeneous and Non-homogeneous linear equations.	10	1, 2, 3, 4, 5	CO3, CO4	PSO1, PSO2, PSO4
3	Eigen values and Eigen vectors of a matrix, Orthogonality of Eigen vectors associated with distinct Eigen values, Properties of Eigen vectors of a real symmetric matrix, Diagonalization of a symmetric matrix, application to reductions of quadrics to principal axes, Cayley-Hamilton theorem (without proof).	12	1, 2, 3, 5	CO5, CO6, CO7	PSO1, PSO4

Reference Books	
1.	Advanced Engineering Mathematics (10th Edition) Erwin Kreyszig
2.	Higher Engineering Mathematics, B.V.Ramana, McGraw Hill Pvt. Lt. (19th Edition)
3.	A text book of engineering mathematics by N P Bali
4.	An Introduction to Linear Algebra – I. K. Rana, Ane Books Pvt. Ltd.
5.	Linear Algebra Theory and Applications – Ward Cheney, David Kincaid. Jones and Bartlet India Pvt. Ltd.

6.	Introduction to Linear Algebra – Serge Lang. Springer (India).
7.	Matrix and Linear Algebra – K. B. Dutta, Prentice Hall.
8.	A Textbook of Matrices – Shanti Narayan, P K Mittal, S. Chand Group.
9.	Introduction to Linear Algebra – V. Krishnamurthy, Affiliated East-west Press Pvt Ltd.

<table>
<tr><td colspan="3">School: School of Science</td><td colspan="3">Program: BSc Chemistry</td></tr>
<tr><td colspan="3">Course Code: BY102</td><td colspan="3">Course Name: Foundation Biology - I</td></tr>
<tr><td>Year</td><td>I</td><td>Core Subject(Yes/No):</td><td>No</td><td>Lecture:</td><td>3</td></tr>
<tr><td>Semester</td><td>I</td><td>Elective Subject(Yes/No):</td><td>No</td><td>Tutorial</td><td>0</td></tr>
<tr><td rowspan="3">Typology of Course</td><td rowspan="3">Lectures and Tutorials</td><td>Foundation Subject(Yes/No):</td><td>Yes</td><td>Practical:</td><td>0</td></tr>
<tr><td>Year of Syllabus Revision:</td><td>NA</td><td>Total Credit:</td><td>3</td></tr>
<tr><td>Year of Introduction</td><td>2018</td><td>Prerequisites (If any)</td><td>12th Science</td></tr>
</table>

Course Description:
This foundation course provides students with a basic understanding of structure and function of cell and cell organelles, function and role of nutrients in balanced diet and environmental science.

Course Objectives:
The course objective is to provides students with a basic understanding of structure and function of cell and cell organelles, function and role of nutrients in balanced diet and environmental science.

Course Outcome (CO):
CO1: Describe cytological, biochemical, physiological and genetic aspects of the cell, including cellular processes common to all cells, to all eucaryotic cells as well as processes in certain specialized cells.
CO2: Relate normal cellular structures to their functions.
CO3: Describe the function and structure of cells including the metabolic reactions that occur in cells.
CO4: Introduction to macro and micronutrients
CO5: Basic information of Environment

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	Unit 1: Cell as a unit of Life: The Cell Theory; Cell size, shape and structure of prokaryotic and eukaryotic cell; structure and functions of cell components: • Mitochondria • Chloroplast • ER, Golgi body & Lysosomes • Peroxisomes and Glyoxisomes • Nucleus • Cell Membrane • Cell Wall	15	1, 2, 4	CO1 CO2 CO3	PSO1 PSO5
2	Unit 2: Balanced Diet: Nutritive value of food-The sources and functions of: proteins, carbohydrates, fats, vitamins, Mineral elements, later. Sources and uses of food energy, Sources and functions of dietary fiber.	15	1, 2, 3, 4, 5, 6	CO3 CO4	PSO1 PSO5
3	Unit 3: Environment: Importance and problem faced in our environment. Remedies for the challenges faced in the environment	15	1, 2, 4	CO3 CO4 CO5	PSO1 PSO3 PSO4 PSO5

Reference Books	
1.	Reece, Jane B., Taylor, Martha R.,Simon, Eric J., Dickey, Jean L., Hogan, Kelly.(2016). Campbell Biology: Concepts & connections. 4th ed., Essex, Pearson Education Ltd
2.	Verma, P.S., Agarwal, V.V.K., (2008). Cell biology, genetics, molecular biology, evolution and ecology, New Delhi, S.Chand.
3.	Cox, Michael M., Nelson, David L., (2008). Principles of biochemistry. 5th ed., New York: W. H. Freeman and Company.

4.	Satyanarayana, U, Chakrapani, U., (2013). Biochemistry- with clinical concept & case studies, 4th. ed., Elsevier India Pvt. Ltd.
5.	Ferrier, Denise R., (2014). Lippincott`s illustrated reviews: Biochemistry. 6th ed., New Delhi: Wolters kluwer pvt. Ltd.
6.	Prasanthrajan, M. Mahendran,P.P. A text book on ecology & environmental science. Udaipur: Agrotech Publishing Academy.
7.	Rajagopalan, R. Basics of environmental studies. New York: Oxford University Press.

School: School of Science			**Program: Data Science**		
Course Code:LC119			**Course Name: Communication I**		
Year	**I**	**Core Subject(Yes/No):**	**No**	**Lecture:**	**02**
Semester	**I**	**Elective Subject(Yes/No):**	**No**	**Tutorial**	**0**
Typology of Course	Lectures	**Foundation Subject(Yes/No):**	**Yes**	**Practical:**	**0**
		Year of Syllabus Revision:	**NA**	**Total Credit:**	**02**
		Year of Introduction	**2018**	**Prerequisites (If any)**	**Knowledge of basic grammar components and vocabulary.**

Course Description:

This Communication course is conceptualized as a course aimed at enhancing English language as a tool of learning and English language as a tool of communication in a professional context. It offers a framework for English language proficiency required of a student in academic work in general as well as in discipline specific perspective. As a tool of learning, the four skills of language and learning: listening, speaking, reading, and writing are practiced. The practice of communication in the professional context deals with understanding the mechanics of language. The focus is on building the language skills required in discipline specific areas. It is a workshop-based course providing hands-on experience to learners. This course focuses largely on training the students in writing and speaking proficiency, usage of English language in academic context as well as preparing them for the outside world of work.

Course Objectives:

- Develop their overall listening, speaking, reading and writing skills,
- Develop knowledge of vocabulary and grammar,
- Read and comprehend texts of varying length at basic/low intermediate level.
- Understand and use effective writing skills to express ideas/give information.
- Develop students' general capacity to a level that enables them to use English for their academic and professional requirements.

Course Outcome (CO):

CO1 Explain the prerequisites of effective communication
CO2 Identify people’s communication styles and needs
CO3 Summarize a passage of text in their own words highlighting the embedded ideas, facts, supportive arguments
CO4 Describe the need for Emotional Intelligence in professional settings.
CO5 Make effective presentations with appropriate verbal and non-verbal communication.
CO6 Explain the importance of information acquisition, processing and dissemination.
CO7 Justify the importance of Knowing and upholding the policies, laws and regulations relevant to professional practice regardless of personal views.

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	Comprehension Paragraphs writing including all grammar Paraphrasing and notetaking Revision of all Communication skills – LSRW with activities Communication skills - Precis / Abstract writing Letter Writing – formal, informal. Digital Literacy, Use of social media Report Writing	7	1 2 3 4 5	CO1 CO2 CO3 CO4 CO5 CO6 CO7	PSO1 PSO3
2	Professional skills - A	7	1,2,3,4,5	CO1	PSO3

	Resume writing, Interview and Group Discussion			CO2 CO4	
3	**Professional skills B –** Presentation, Oral presentation • Preparation • Using the report as guideline • Formulating the central message • Arranging the ideas, facts and supportive arguments • Making a positive impact (appearance, gestures, eye contact, body language, style of speaking) • Effective use of visual aids y (types of visual aid equipment, using the equipment correctly) • Maximizing delivery (fielding questions, managing answers, handling difficult situations, short talk guidelines, impromptu sessions) • Practical Session: Delivery of a two-minute presentation (each delegate delivers a presentation on a particular aspect of the technical report)	8	1,2, 3, 4,5	CO1 CO2 CO3 CO4 CO5 CO6	PSO2 PSO3
4	SOCIAL SKILLS Leadership and Management skills	8	1, 2, 3,4	CO1 CO2 CO4 CO7	PSO3

Reference Books	
1.	John Seely; **Oxford Guide to Effective Writing and Speaking**; Oxford University Press; 2009 Ed
2.	L. Gartside; **Modern Business Correspondence**; The English Language Book Society and Macdonald and Evans Ltd.
3.	Lester and Beason; **The McGraw Hill Handbook of English Grammar and Usage**; Tata McGraw Hill Education Private Limited; 2010 Ed
4.	Ellet, William; **The case Study Handbook**; Harvard Business Review Press
5.	Bovee, Thill and Chaturvedi; **Business Communication Today;** Pearson Education; 2009 9TH ed
6	Scot Ober; **Contemporary Business Communication**; Biztantra Publications; 2009 5th ed.
7	Inch. E.S. & Warnick Barbara; **Critical Thinking and Communication**; Perason;2011 ed.
8	Herrmann Robert Ned; **The Whole Business Brain**; McGraw-Hill, 1998.
9	Clemen, T Robert; **Making Hard Decisions**; Duxbury Press, 1996

School: School of Science			**Program: BSc Chemistry**		
Course Code: MG117			**Course Name:** Principles of Management and Accounting		
Year	**I**	**Core Subject(Yes/No):**	**No**	**Lecture:**	**3**
Semester	**I**	**Elective Subject(Yes/No):**	**No**	**Tutorial**	**0**
Typology of Course	Lectures and Tutorials	**Foundation Subject(Yes/No):**	**Yes**	**Practical:**	**0**
		Year of Syllabus Revision:	**NA**	**Total Credit:**	**3**
		Year of Introduction	**2014**	**Prerequisites (If any)**	**12th Science**

Course Description:
The course outline has been designed to serve the purpose of understanding basics of management and accounting

Course Objectives:
The overall all objective of this course is to educate students about the management as an activity and have a holistic approach to the concept. Accountancy basics are the requirement of the generation.

Course Outcome (CO):

CO1 Become an efficient learner of management

CO2 Develop and understand methods of management.

CO3 Gain knowledge managing finance through Accounts

Unit No.	**Topic/Unit**	**Contact Hours**	**BT Level**	**CO**	**PSO**
1	Unit 1- Management Basics, Management theories, Process of management, Managers qualities	11	1,2	CO1	PSO1
2	Unit 2- Evolution of Management, Functions – Planning, Planning process, Decision making, principles of organizations, Coordination and controlling, Directing	11	1,2,3	CO1, CO2	PSO1, PSO2
3	Unit 3- Accounting Basics, Rules of accounting, Principles Accounting process, Journal, Journal entries, Ledger, Trial Balance	11	2, 3, 4	CO1, CO3	PSO1, PSO2
4	Unit 4- Financial Statements, Books of accounts, Profit and loss statement, Balance sheet, Analysis	12	1, 2, 3	CO3	PSO1, PSO2, PSO4
Reference materials					
	Principles of Management Book by Dan Voich and Daniel A. Wren				
	ICAI ONLINE PDF				

SEMESTER II

School: Science			**Program: B.Sc. (Chemistry)**		
Course Code: CH 139			**Course Name:** States of Matter		
Year	**I**	**Core Subject(Yes/No):**	**Yes**	**Lecture:**	**3**
Semester	**II**	**Elective Subject(Yes/No):**	**No**	**Tutorial**	**0**
Typology of Course	Lectures	**Foundation Subject(Yes/No):**	**No**	**Practical:**	**0**
		Year of Syllabus Revision:	**2020**	**Total Credit:**	**3**
		Year of Introduction	**2014**	**Prerequisites (If any)**	**12th Science**

Course Description:
This course illustrates different states of matter such as gaseous, liquid, solid states etc. Gaseous state includes the fundamentals as well as Maxwell distribution of molecular velocity, deviation from ideal behaviour, critical phenomenon, Joule Thompson effect and Inversion Temperature etc. Surface tension and Viscosity Effect of temperature on surface tension and coefficient of viscosity of a liquid are included in the second unit. The last unit is mainly based on the solid-state chemistry and a little description of other states and their applications therein.

Course Objectives:
Students can Illustrate how a scientific model can be constructed based on the experimental observations of the behaviour of gases and to explain the properties in terms of microscopic organization. explain the properties liquid state using intermolecular forces and to differentiate the colloidal state from true solutions in terms of size of the particles and to relate this attribute with their properties with the number of particles to the colligative properties. Explain different structures of solid based on solid states' chemistry.

Course Outcome (CO):
CO1 Ability to understand the weak forces of interaction amongst gaseous molecules.
CO2 Explore the different theories to understand the gaseous molecule’s chemistry.
CO3 Ability to use a variety of theories to understand important properties of liquid state.
CO4 Grasp the concepts of Solid-state chemistry and their applications in exploring morphology of solid materials.
CO5 Ability to understand the Colloidal and emulsion state of materials.

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	**Unit-I: Gaseous State:** Derivation of Kinetic gas equation, deduction of simple problems on – root mean square velocity, most probable velocity, collision frequency, collision diameter, mean free path heat capacity of gases, Maxwell distribution of molecular velocity (Derivation not required). Deviation from ideal behavior, Van der Waals equation, critical phenomenon, Law of corresponding states, Reduced Equation of states, Joule Thompson effect and Inversion Temperature, Methods of Liquefaction of gases – Faraday’s, Linde’s, and Claude’s method.	15	1,2,3,4,5	CO1 CO2	PSO1 PSO2 PSO3 PSO4
2	**Unit-II Liquid State:** Qualitative treatment of the structure of liquids, Definition and determination of Surface tension and Viscosity Effect of temperature on surface tension and coefficient of viscosity of a liquid (qualitative treatment) Parachor – determination and application	5	1,2,3,4,5	CO3	PSO1 PSO2 PSO3 PSO4
3	**Unit-III Solid State:** Symmetry elements, unit cells, crystal systems. Laws of crystallography-Law of constancy of interfacial angles. Law of rational indices. Miller indices X-Ray diffraction by crystals. Bragg’s law. Structure of NaCl, KCl and CsCl (qualitative treatment only). Defects in crystals	10	1,2,3,4,5	CO4	PSO1 PSO2 PSO3 PSO4

4	**Unit-IV Colloids and Liquid crystals:** Colloidal State, Classification of colloids, Preparation and purification of sols, Stability of sols, Schulze-Hardy rule, Gold Number. Emulsions, gel and foam. Association colloids, Surfactants, Micelle formation and critical micelle concentration, Action of soap. Applications. Mesomorphic state: Difference between liquid crystal, liquid and solid. Classification and structure of nematic, smectic and cholesteric phases. Non-conventional liquid crystals. Applications.	15	1,2,3,4,5	CO5	PSO1 PSO2 PSO3 PSO4

Reference Books	
1.	B. R. Puri& L. R. Sharma, Principles of Physical Chemistry, Shoban Lal Nagin Chand and Co. 33rd Ed., 1992
2.	Arther Adamson, A Textbook of Physical chemistry, 2nd Ed., Academic Press, New York, 1979
3.	ArunBahl, B. S. Bahl& G. D. Tuli, Essentials of Physical Chemistry, S. Chand and Sons, New Delhi, 2010.
4.	S. H. Maron& J. F. Prutton, Principles of Physical Chemistry, 4th Ed., Oxford and IBH, New Delhi, 1972.
5.	P.W. Atkins, Physical chemistry, Oxford University Press, 1978.

School: School of Science		**Program: B.Sc Chemistry**			
Course Code: CH 106		**Course Name: Chemistry Laboratory-IV**			
Year	**I**	**Core Subject(Yes/No):**	**Yes**	**Lecture:**	**0**
Semester	**II**	**Elective Subject(Yes/No):**	**No**	**Tutorial**	**0**
Mode of Transaction	Laboratory	**Foundation Subject(Yes/No):**	**No**	**Practical:**	**2**
		Year of Syllabus Revision:	2018	**Total Credit:**	**1**
		Year of Introduction	2014	**Prerequisites (If any)**	**12th Science**

Course Description:
Semi-micro qualitative analysis of Inorganic compounds containing single salt.

Course Outcome (CO):
CO1 Identify unknown radicals in a given inorganic salt
CO2 understand the basic concepts associated with separation and identification of radicals

No.	Experiment	Contact Hours	BT Level	CO	PSO
1	CdCl2	2	1,2,3,4,5	CO1, CO2	PSO2, PSO3
2	KCl	2	1,2,3,4,5	CO1, CO2	PSO2, PSO3
3	CuSO4	2	1,2,3,4,5	CO1, CO2	PSO2, PSO3
4	NH4Cl	2	1,2,3,4,5	CO1, CO2	PSO2, PSO3
5	MnCl2	2	1,2,3,4,5	CO1, CO2	PSO2, PSO3
6	FeSO4	2	1,2,3,4,5	CO1, CO2	PSO2, PSO3
7	BaCl2	2	1,2,3,4,5	CO1, CO2	PSO2, PSO3
8	Sr (NO3)2	2	1,2,3,4,5	CO1, CO2	PSO2, PSO3
9	CaCl2	2	1,2,3,4,5	CO1, CO2	PSO2, PSO3
10	Na3PO4	2	1,2,3,4,5	CO1, CO2	PSO2, PSO3
11	Pb (NO3)2	2	1,2,3,4,5	CO1, CO2	PSO2, PSO3
12	NaBr	2	1,2,3,4,5	CO1, CO2	PSO2, PSO3
13	MgCO3	2	1,2,3,4,5	CO1, CO2	PSO2, PSO3

Reference Books	
1.	R. C. Shah, Ino*rganic Analysis Part I Qualitative Analysis*, Baroda Book Depot, Vadodara, 2001
2.	J. Mendham, R. C. Denney, J. B. Barnes & M. J. K. Thomas, Vogel’s Textbook of Quantitative Chemical Analysis, 6th Ed., Pearson Education, New Delhi, 2003.

School: School of Science			**Program: B.Sc. (Chemistry)**		
Course Code: PH114			**Course Name: Electricity, Magnetism and Optics**		
Year	**I**	**Core Subject(Yes/No):**	**No**	**Lecture:**	**2**
Semester	**II**	**Elective Subject(Yes/No):**	**No**	**Tutorial**	**1**
Typology of Course	Lectures and Tutorials	**Foundation Subject(Yes/No):**	**Yes**	**Practical:**	**0**
		Year of Syllabus Revision:	**NA**	**Total Credit:**	**3**
		Year of Introduction	**2018**	**Prerequisites (If any)**	**12th Science**

Course Description:

This is an advanced course above college level physics meant for developing knowledge base for engineering. It mainly comprises of fundamentals of electricity, magnetism and optics. Exposure to various applications based on those concepts will be given.
Electromagnetic principles and optics have tremendous applications in technology especially in experimental research, optical characterization of materials, non-destructive techniques and communication. This course will give a wide understanding about fundamental principles of (i) electricity and magnetism, like Coulomb's law, Faraday's law, Gauss' law and their applications in understand functioning of motors, electromagnets, magnetic materials and (ii) optical phenomena, classical, modern as well as technology like optical fibres, lasers etc. Several problems will be solved which would give the students a better spirit of applying the newly learnt concepts and build their analytical powers!

Course Objectives:
Physics is a science to fundamentally understand how things work in nature and around us. The importance of the subject is thus unparalleled for an engineering student of any branch. Some of the immediate and direct objectives of this course are listed below.
1. To develop clear understanding about concepts in physics which form basis of present day industrial practices and cutting edge technology.
2. To develop problem solving skills.
3. To have sufficient knowledge base for research and development work in the field of electromagnetic radiation, waves, optics and communication.

Course Outcome (CO):

CO1 To use Coulomb's law and Gauss' law to calculate electrostatic force.
CO2 To apply Lorentz force law to calculate magnetic force and use Ampere's law to calculate magnetic fields.
CO3 To use Faraday's law in induction problems
CO4 To understand two important optics phenomena- interference and diffraction.
CO5 To understand how to resolve optical images of two closely spaced objects.

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	**Electricity and Magnetism** Coloumb's Law, electric field, Gauss's law and its applications, electric potential, conductors, dielectrics	8	2,3,4	CO1	PSO1 PSO3 PSO4 PSO5
2	**Electricity and Magnetism** Parallel plate capacitors, electric displacement vector D, Lorentz force law and definition of magnetic field, force on a current carrying straight wire, Biot-Savart's law, Ampere's law	10	2,3,4	CO2	PSO1 PSO3 PSO4 PSO5
3	**Electricity and Magnetism** Faradays Laws of electromagnetic induction, self and Mutual inductance, series and parallel LCR circuits, magnetism and electrons; diamagnetism, paramagnetism and ferromagnetism	10	2, 3, 4	CO3	PSO1 PSO3 PSO4 PSO5
4	**Optics**	10	2,3,4	CO4	PSO1 PSO3

	Huygen’s principle, Division of wavefront, Young’s double slit experiment, Newton’s rings method of determination of wavelength and refractive index. Diffraction principle, Types of diffraction: Fresnel and Fraunhofer, Fraunhofer diffraction at a slit, Half period zones, Diffraction at a circular aperture and circular disc, Diffraction grating, Diffraction at N parallel slits intensity distribution				PSO4 PSO5
5	**Optics** Resolution of images, Resolving power: Rayleigh’s criterion, Resolving power of telescope.	7	2,3,4	CO5	PSO1 PSO3 PSO4 PSO5

Reference Books

1.	David J. Griffiths, *Introduction to Electrodynamics*, 3rd Ed., Prentice – Hall, 2009.
2.	Edward M. Purcell, *Electricity and Magnetism*, Tata McGraw Hill Education Private Limited, 2011.
3.	D C Tayal, *Electricity and Magnetism*, Himalaya Publishing House, 1988.
4.	Francis Arthur Jenkins & Harvey Elliott White, *Fundamentals of Optics*, 4th Ed., Tata McGraw Hill Education Pvt. Ltd., 2011.
5.	Huge D. Young, Roger A. Freedman & A. Lewis Ford, *Sears and Zemansky’s University Physics*, 13th Ed., Pearson, 2013.
6.	Ajoy Ghatak, *Optics*, 5th Ed., Tata McGraw Hill Publishing Co. Ltd., 2012.
7.	B. R. Subramaniam and M. N. Avadhanalu, *A Text Book of Optics,* 4th Edition, S. Chand, 2008.

School: School of Science		**Program: B.Sc. Chemistry**			
Course Code: PH115		**Course Name: Physics Laboratory: Electricity, Magnetism and Optics**			
Year	**I**	**Core Subject(Yes/No):**	**No**	**Lecture:**	**0**
Semester	**II**	**Elective Subject(Yes/No):**	**No**	**Tutorial**	**0**
Mode of Transaction	Laboratory	**Foundation Subject(Yes/No):**	**Yes**	**Practical:**	**2**
		Year of Syllabus Revision:	**NA**	**Total Credit:**	**1**
		Year of Introduction	**2018**	**Prerequisites (If any)**	**12th Science**

Course Description:
The laboratory course will be based on a variety of experiments related to quantum mechanics, electricity, magnetism, waves, optics and lasers. These experiments are chosen so as to develop a well rounded knowledge for theoretical concepts that they would be learning in the theory course on electricity, magnetism, optics and lasers. Also the students will gain working knowledge of some instruments.

Course Outcome (CO):
CO1 To understand the concepts of particle nature of light and discretization of energy levels.
CO2 To understand the concepts of magnetism, resonance frequency and Q-factor.
CO3 To understand two important optics phenomena- interference and diffraction.
CO4 To get an exposure of virtual labs

No.	Experiment	Contact Hours	BT Level	CO	PSO
1	Photoelectric effect	2	1,2,3,4	CO1	PSO1 PSO4 PSO5
2	Frank-Hertz experiment	2	1,2,3,4	CO1	PSO1 PSO4 PSO5
3	Helmholtz coils	2	1,2,3,4	CO2	PSO1 PSO4 PSO5
4	LCR Circuit	2	1,2,3,4	CO2	PSO1 PSO4 PSO5
5	Fresnel’s biprism1	2	1,2,3,4	CO3	PSO1 PSO4 PSO5
6	Fresnel’s biprism2	2	1,2,3,4	CO3	PSO1 PSO4 PSO5
7	Single slit diffraction1	2	1,2,3,4	CO3	PSO1 PSO4 PSO5
8	Single slit diffraction 2	2	1,2,3,4	CO3	PSO1 PSO4 PSO5
9.	Grating spectrometer	2	1,2,3,4	CO3	PSO1 PSO4 PSO5
10.	Virtual lab1	2	1,2,3,4	CO4	PSO1 PSO4 PSO5
11.	Virtual lab2	2	1,2,3,4	CO4	PSO1

<table>
<tr><td></td><td></td><td></td><td></td><td></td><td>PSO4
PSO5</td></tr>
<tr><td colspan="6">Reference Books</td></tr>
<tr><td>1.</td><td colspan="5">Beiser, Arthur, <i>Concepts of Modern Physics</i>, 5th Ed., Tata McGraw Hill Education Private Limited, 2009.</td></tr>
<tr><td>2.</td><td colspan="5">Charles Kittel, <i>Introduction to Solid State Physics</i>, 8th Ed., Wiley India Pvt. Ltd., 2012.</td></tr>
<tr><td>3.</td><td colspan="5">David J. Griffiths, <i>Introduction to Electrodynamics</i>, 3rd Ed., Prentice – Hall, 2009.</td></tr>
<tr><td>4.</td><td colspan="5">AjoyGhatak, <i>Optics</i>, 5th Ed., Tata McGraw Hill Publishing Co. Ltd., 2012.</td></tr>
<tr><td>5.</td><td colspan="5">B. R. Subramaniam and M. N. Avadhanalu, <i>A Text Book of Optics,</i> 4th Edition, S. Chand, 2008.</td></tr>
</table>

School: School of Sciences	**Program: B.SC (Chemistry)**
Course Code: MA147	**Course Name: Ordinary Differential equations**

Year	**I**	**Core Subject(Yes/No):**	**No**	**Lecture:**	**2**
Semester	**II**	**Elective Subject(Yes/No):**	**No**	**Tutorial**	**0**
Typology of Course	Lectures and Discussions	**Foundation Subject(Yes/No):**	**Yes**	**Practical:**	**0**
		Year of Syllabus Revision:	**NA**	**Total Credit:**	**2**
		Year of Introduction	**2018**	**Prerequisites (If any)**	**12th Science**

Course Description: The course includes Ordinary differential equations of first and second order and the methods of solving these equations. Also, applications of first and second order differential equations to various systems or models such as the spring mass system or the growth-decay model, predictor-prey model are discussed.

Course Objectives: The objective of the course is to

- Understand the first order differential equations, methods of solving them and their real life applications
- Understand the second order differential equations, methods of solving them and their real life applications

Course Outcome (CO):

CO1	Learn about ordinary Differential equations of first order and their types
CO2	Find conditions for existence and uniqueness of solution and solve Linear and Bernoulli equations
CO3	Apply first order differential equations to various models
CO4	Learn about second order ordinary differential equations
CO5	Understand methods of solving second order ODE and their applications
CO6	Learn about system of differential equations and solving them

Unit No.	**Topic/Unit**	**Contact Hours**	**BT Level**	**CO**	**PSO**
1	Ordinary Differential equations of first order, Separable differential equations, Exactness and Integrating factor	5	1,2,3,5	CO1	PSO1
2	Linear and Bernoulli differential equations, Initial and Boundary value Problems, existence and uniqueness of solution	5	1,2,3,5	CO2	PSO1
3	Application of first order differential equation in growth and decay model.	5	1,2,3,4,5	CO3	PSO1
4	Ordinary Differential Equations of 2nd order, Homogeneous and non homogeneous equations	5	1,2,3,4,5	CO4	PSO1
5	Characteristic equations, Auxiliary equations, Methods of Undetermined Coefficients and Variation of Parameters	5	1,2,3,5	CO5	PSO1
6	Systems of Differential Equations, existence and uniqueness of solution	5	1,2,3,4,5	CO6	PSO1

Reference Books

1.	Apostol T.M., 1967, *Calculus,* Vol. II, IInd Edition, John Willey, New York
2.	S. L. Ross, Differential equations, Wiley.
3.	Erwin Kreszig, Advanced Engineering Mathematics, Wiley, India

<table>
<tr><td colspan="3">School: School of Sciences</td><td colspan="3">Program: B.SC (Chemistry)</td></tr>
<tr><td colspan="3">Course Code: MA148</td><td colspan="3">Course Name: Advanced Calculus</td></tr>
<tr><td>Year</td><td>I</td><td>Core Subject(Yes/No):</td><td>No</td><td>Lecture:</td><td>2</td></tr>
<tr><td>Semester</td><td>II</td><td>Elective Subject(Yes/No):</td><td>No</td><td>Tutorial</td><td>0</td></tr>
<tr><td rowspan="3">Typology of Course</td><td rowspan="3">Lectures and Discussions</td><td>Foundation Subject(Yes/No):</td><td>Yes</td><td>Practical:</td><td>0</td></tr>
<tr><td>Year of Syllabus Revision:</td><td>NA</td><td>Total Credit:</td><td>2</td></tr>
<tr><td>Year of Introduction</td><td>2018</td><td>Prerequisites (If any)</td><td>12th Science</td></tr>
</table>

Course Description: The course contains the fundamentals of vector calculus in which the vector differentiation and vector integration are included with their applications to scalar and vector valued functions. Also, functions of several variables along with the methods of partial differentiation are included in this course.

Course Objectives: The objective of the course is to

- Learn about scalar and vector functions and methods of differentiating and integrating such functions
- Learn to apply vector calculus to various vector valued functions
- Learn about functions of several variables and methods of differentiation and integration

Course Outcome (CO):

CO1 Differentiate vector functions, calculate directional derivatives and gradients
CO2 Find out divergence, curl of vector valued functions and learn the properties of divergence and curl
CO3 Learn about vector integration and apply in calculating work, potential in a force field
CO4 Calculate area, flux using surface integrals
CO5 Learn partial differentiation and total differentiation
CO6 Learn chain rule, error and approximation using partial differentiation

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	Vector Differentiation, Directional Derivative, Gradient of Scalar function	5	1,2,3,5	CO1	PSO1
2	Conservative Field, Divergence, Curl, Properties of Gradient, divergence and curl	5	1,2,3,5	CO2	PSO1
3	Vector Integration, Line Integral: Work, Potential, Conservative Field	5	1,2,3,4,5	CO3	PSO1
4	Area, Surface Integral: Surface Area and Flux .	5	1,2,3,4,5	CO4	PSO1
5	Partial Differentiation: Definition, Geometrical Interpretation, Higher Order Partial Derivatives, Total Derivative	5	1,2,3,5	CO5	PSO1
6	Chain Rule for Partial Differentiation, Partial Differentiation of Composition of Functions, Error and approximation	5	1,2,3,4,5	CO6	PSO1

Reference Books	
1.	Apostol T.M., 1967, *Calculus*, Vol. II, IInd Edition, John Willey, New York
2.	Narayan Shanti and Mittal P.K., 1979, *A Course of Mathematical Analysis*, 12th Edition. S. Chand and Co
3.	Spiegel M.R., *Advanced Calculus*, Schaum Series
4.	Widder D.V., 1944, *Advanced Calculus*, IInd Edition, Prentice Hall of India, New Delhi.
5.	James T. Shea, 1991.*Basic Essentials of Mathematics, Book 2: Percent, Measurement & Formulas, Equations, Ratio & Proportion*, sold by Amazon.com
6.	Silvio Belli, Stephen R. Wassell, Kim Williams.,2007. *On ratio and proportion: the common properties of quantity Nexus, architecture and mathematics*. Kim Williams Books, 2002

School: School of Science	**Program: BSc Chemistry**
Course Code: BY103	**Course Name: Foundation Biology - II**

Year	**I**	**Core Subject(Yes/No):**	**No**	**Lecture:**	**3**
Semester	**II**	**Elective Subject(Yes/No):**	**No**	**Tutorial**	**0**
Typology of Course	Lectures and Tutorials	**Foundation Subject(Yes/No):**	**Yes**	**Practical:**	**0**
		Year of Syllabus Revision:	**NA**	**Total Credit:**	**3**
		Year of Introduction	**2018**	**Prerequisites (If any)**	**12th Science**

Course Description:
This foundation course provides students with a basic understanding of structure and function of biomolecules; physiological processes and various body system as well as interactions of plants and animals.

Course Objectives:
This course describes the structure and function of different types of biomolecules, physiological processes and population interaction.

Course Outcome (CO):
CO1: Outline the structure of the biomolecules found in all living organisms.
CO2: Categorization of macronutrient molecules and their function and significance.
CO3: Explain the structure and function of organ systems in the human body.
CO4: Define basic biological concepts and processes occur in human body collectively known as system.
CO5: Describe levels of organization and related functions in plants and animals.

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	Unit 1: Biomolecules • Carbohydrates: Structure and functional significance of mono, di-and polysaccharides. • Lipids: structure, nomenclature, and functional significance of fatty acids, triglycerides, phospholipids, glycolipids and steroids. • Amino acids and Proteins: structure and general properties • Nucleic Acids –Basic structure of DNA and RNA	15	1, 2, 4, 5	CO1 CO2 CO3	PSO1 PSO5
2	Unit 2: Physiological processes • Digestive system • Circulatory system • Excretory system • •Photosynthesis • Transpiration • Respiration • Endocrine system • Nervous system • Homeostasis	15	1, 2, 3, 4, 5, 6	CO3 CO4	PSO1 PSO5
3	Unit 3: Biotic Interactions • Plant –Plant Associations: Mutualism, Competition and Parasitism • Plant –Animal Associations: Herbivory, Pollination, Seed dispersion, Pests and Parasitism • Animal –Animal Associations: Mutualism, Commensalism, Ammensalism, Parasitism, Competition and Predation.	15	1, 2	CO3 CO4 CO5	PSO1 PSO3 PSO4 PSO5

Reference Books	
1.	Cox, Michael M., Nelson, David L., (2008). Principles of biochemistry. 5th ed., New York: W. H. Freeman and Company
2.	Satyanarayana, U, Chakrapani, U., (2013). Biochemistry-with clinical concept & case studies, 4th. ed., Elsevier India Pvt. Ltd
3.	Prasanthrajan, M. Mahendran, P.P. A textbook on ecology & environmental science. Udaipur: Agrotech Publishing Academy.
4.	Moyes, Christopher D., Schulte, Patricia M., (2007). Principles of animal physiology. New Delhi: Pearson
5.	Tortora, G., Derrickson, B., (2012). Principles of anatomy and physiology. 13thed.Hoboken, NJ : Wiley,
6.	Russell, Peter J., Wolfe, Stephen L., Hertz, Paul E., McMillan, Beverly, (2008). Ecology. New Delhi: Cengagae Learning India Pvt. Ltd.

School: School of Science		**Program: BSc Chemistry**			
Course Code: HS 106		**Course Name: Humanities**			
Year	**I**	**Core Subject(Yes/No):**	**No**	**Lecture:**	**2**
Semester	**II**	**Elective Subject(Yes/No):**	**No**	**Tutorial**	**0**
Typology of Course	Lectures	**Foundation Subject(Yes/No):**	**Yes**	**Practical:**	**0**
		Year of Syllabus Revision:	**2020, 2021**	**Total Credit:**	**2**
		Year of Introduction	**2019**	**Prerequisites (If any)**	**12th Science**

Course Description:

The Course on Humanities entails the study of the human world and society from a critical perspective. The Humanities Course provides a broad understanding of the world in which we live, and how people can participate as active and informed citizens with the skills needed for the 21st century. The course focuses on the relationship between education, technology, and society. The course also makes students aware about the theories and approaches to learning in view of 21st century requirements. The Course highlights the need to develop an understanding of ethical considerations and the implications of decisions that are made for individuals, society, the economy, and the environment.

Course Objectives:

1. To enable students to understand the impact of education on the Individual and society.
2. To enable students to understand the interdependence between education and society.
3. To make students aware about the theories and approaches to learning in view of 21st century requirements.
4. To enable students to identify the impact of technology on their life and society.
5. To enable students to develop the skill of ethical reasoning and/or ethical decision making.

Course Outcome (CO):

CO1	Describe the necessity of education and its impact on society
CO2	Explain various theories of learning and their implications
CO3	Relate the theories of learning with the present societal contexts (eg Make in India/Digital India/ Skill India)
CO4	Justify the need for EQ to achieve career and professional goals
CO5	Explain the inter-dependence between education and technology in shaping society.
CO6	Explain the importance of ethical decision making and academic integrity.

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	Necessity of Education for human life, Impact of Education on society. Necessity of education in Human life - UNESCO 4 Pillars of Education Impact of education on society - Make in India/Digital India/ Skill India. Necessity: Individual vs. citizen. (Russel - Ability to read & write, Decent livelihood, better communication, Use of technology, Secure transactions, Serve society, Knowledge Propagation, Social harmony)	8	2,3,4,5	CO1 CO3	PSO3
2	Knowledge of the different types of education - Formal, Informal & Non formal education; Liberal, Professional, Vocational & Technical education Emotional Intelligence: Models of Emotional Intelligence. Domains of Learning: Cognitive, Effective & Psychomotor Approaches to Learning: Behaviorism; Constructivism. Theories of Learning: Multiple Intelligence; Information processing theory.	10	2,3,4,5	CO2 CO4	PSO3

3	Impact of technology on education and society (Technology and Social Change; Technological Determinism; Technology and Inequality; Technology & Human Well-being; Technology and Environmental Change)	6	2,3,4,5	CO5	PSO3
4	Ethical and value implications of education and technology on individual and society. Professional ethics, Plagiarism. Professional ethics (Durkheim), Positive & Negative Thinking, Assertiveness, Assertive rights	6	2,3,4	CO6	PSO3

Suggested Reading	
1.	Bucchi, Massimiano (2004) *Science in society: An introduction to social studies of science.* London & NY: Routledge Taylor & Francis group.
2.	Durkheim, Emile (1957/2003) *Professional ethics and civic morals*. (Tr.) Cornelia Brookfield (Prefaced by) Bryan S. Turner. London & NY: Routledge (2nd Edition)
3.	Matthew H. Olson, Julio J. Ramirez (2020), *An Introduction to Theories of Learning*, London & NY: Routledge Taylor & Francis group, (10th Edition)
4.	Rethinking education: Towards a global common good? by UNESCO publishing.
5.	Richard Paul Janaro & Thelma C. Altshuler (2011). The Art of Being Human: Humanities as a Technique for Living Person. Pearson Publication.
6	Rohan Dsouza. Environment, Technology and Development. Orient Blackswan, 2012.
7	Russel, Bertrand (1932/2010) *Education and social order.* London & NY: Routledge Classics
8	R.V.G. Menon. Technology and Society. Pearson, 2011

School: School of Science			**Program: B.Sc. Chemistry**		
Course Code: LC120			**Course Name: Communication II**		
Year	**I**	**Core Subject(Yes/No):**	**No**	**Lecture:**	**03**
Semester	**II**	**Elective Subject(Yes/No):**	**No**	**Tutorial**	**00**
Typology of Course	Lectures	**Foundation Subject(Yes/No):**	**YES**	**Practical:**	**00**
		Year of Syllabus Revision:	**2020**	**Total Credit:**	**03**
		Year of Introduction	**2019**	**Prerequisites (If any)**	**Knowledge of basic grammar components and vocabulary.**

Course Description:
This Communication course is conceptualized as a course aimed at enhancing English language as a tool of learning and English language as a tool of communication in a professional context. It offers a framework for English language proficiency required of a student in academic work in general as well as in discipline specific areas. As a tool of learning, the four skills of language and learning: listening, speaking, reading and writing are practiced. The focus is on building language skills required in discipline specific areas.
The practice of communication in the professional context deals with understanding hierarchy, tone and appropriate vocabulary. This Course focuses largely on training the students in writing and speaking proficiency, usage of English language in academic context as well as preparing them for the world of work.

Course Objectives:
This course will enable students to …..
Develop their overall listening, speaking, reading and writing skills,
Develop knowledge of vocabulary and grammar,
Read and comprehend texts of varying length at basic/low intermediate level.
Understand and use effective writing skills to express ideas/give information.
Develop students' general capacity to a level that enables them to use English for their academic and professional requirements.

Course Outcome (CO):

CO1	Describe the Communication cycle, types of communication, barriers and ways to address these.
CO2	Read and analyze texts and evaluate ideas therein
CO3	Express oneself clearly while communicating with others (reports, letters, …)
CO4	Participate constructively in class discussions
CO5	Illustrate communication and techno skills while making presentations
CO6	Refer to authentic sources of information and cite the same ethically.

Unit No.	**Topic/Unit**	**Contact Hours**	**BT Level**	**CO**	**PSO**
1	**<u>Communication Skills –</u>** Comprehension (including all grammar components) Essay writing Precis writing / Abstract writing Report Writing (Compiling the report & Report structure) Importance of Digital Literacy; Use of social media Capstone Paper and presentation	15	1,2,3,4,5,6	CO1 CO2 CO3 CO4 CO5 CO6	PSO1 PSO5
2	**<u>Professional Skills - A</u>** Letter Writing Resume writing, Interview	5	1,2,3,4,5	CO3 CO4 CO6	PSO1 PSO5

	Group Discussion skills.				
3	**Professional Skills - B** Designing the KWL Chart - Formulating the central message Arranging the ideas, facts & supportive arguments Making a positive impact (appearance, gestures, eye contact, body language, style of speaking) Effective use of visual aids (types of visual aid equipment, using the equipment correctly) Maximizing delivery (fielding questions, managing answers, handling difficult situations, short talk guidelines, impromptu sessions) Practical Session: Delivery of a two-minute presentation (each student delivers a presentation on the KWL Chart) **Professional Ethics** Understanding academic integrity Plagiarism rules	10	1,2, 3, 4,5	CO4 CO5 CO6	PSO1 PSO5
4	**Social Skills** Leadership and Management skills	5	1,2,3,4,5	CO4 CO5 CO6	PSO1 PSO5
5	**Critical thinking skills** Significance of Critical thinking skills Concept map designing Fishbone Diagram	10	1,2,3,4,5,6	CO2 CO3 CO4 CO5	

Additional Reading material:

1.	John Seely; **Oxford Guide to Effective Writing and Speaking**; Oxford University Press; 2009 Ed.
2.	L. Gartside; **Modern Business Correspondence**; The English Language Book Society and Macdonald and Evans Ltd.
3.	Lester and Beason; **The McGraw Hill Handbook of English Grammar and Usage**; Tata McGraw Hill Education Private Limited; 2010 Ed.
4.	Ellet, William; **The case Study Handbook**; Harvard Business Review Press
5.	Bovee, Thill and Chaturvedi; **Business Communication Today;** Pearson Education; 2009 9TH ed.
6.	Scot Ober; **Contemporary Business Communication**; Biztantra Publications; 2009 5th ed.
7.	Inch. E.S. & Warnick Barbara; **Critical Thinking and Communication**; Perason;2011 ed.
8.	Herrmann Robert Ned; **The Whole Business Brain**; McGraw-Hill, 1998
9.	Clemen, T Robert; **Making Hard Decisions**; Duxbury Press, 1996

School: School of Science	**Program: BSc Chemistry**
Course Code: MG108	**Course Name: Economics and Finance**

Year	**II**	**Core Subject(Yes/No):**	**No**	**Lecture:**	**2**
Semester	**II**	**Elective Subject(Yes/No):**	**No**	**Tutorial**	**0**
Typology of Course	Lectures and Tutorials	**Foundation Subject(Yes/No):**	**Yes**	**Practical:**	**0**
		Year of Syllabus Revision:	**2021**	**Total Credit:**	**2**
		Year of Introduction	**2009**	**Prerequisites (If any)**	**12th Science**

Course Description:
The course outline has been designed to serve the purpose of understanding basics of management and accounting

Course Objectives:
The overall all objective of this course is to educate students about the management as an activity and have a holistic approach to the concept. Accountancy basics are the requirement of the generation.

Course Outcome (CO):
CO1 Efficiency in concept of Micro and Macro economics
CO2 Develop and understand methods of financial management.
CO3 Identify sources and application of Finance

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	Unit 1- Economics: Basics, Concept of scarcity, Opportunity Costs, Relation with other disciplines, Microeconomics –Demand, Supply, Diminishing utility	9	1,2	CO1	PSO1
2	Unit 2- Economics: Macro Economics, National Income, Unemployment, GDP	8	1,2,3	CO1, CO2	PSO1, PSO2
3	Unit 3- Finance: Basic concepts, Relation with other disciplines	6	2, 3, 4	CO2, CO3	PSO1, PSO2
4	Unit 4- Finance: Sources of Finance, Long, Medium, Short Term, Application of finance	8	1, 2, 3	CO2, CO3	PSO1, PSO2, PSO3, PSO4

Reference Books	
1	Economics for Beginners
2	Financial Management by Prasanna Chandra

SEMESTER III

School: Science	**Program: BSc Chemistry**
Course Code: CH 255	**Course Name: Organic Chemistry I**

Year	**II**	**Core Subject(Yes/No):**	**Yes**	**Lecture:**	**3**
Semester	**III**	**Elective Subject(Yes/No):**	**No**	**Tutorial**	**0**
Typology of Course	Lectures and Tutorials	**Foundation Subject(Yes/No):**	**No**	**Practical:**	**0**
		Year of Syllabus Revision:	**2019**	**Total Credit:**	**3**
		Year of Introduction	**2014**	**Prerequisites (If any)**	**12th science**

Course Description:

This course deals with the basic properties of organic compounds, their nomenclature and the method of naming organic compounds learn various methods of preparation of hydrocarbons. It includes the reaction as well as mechanisms so that the concept will be better understood. It is broadly divided into two distinct parts. The first part involves the chemistry of aliphatic alkane, alkene, and alkynes. For example, Wurtz reaction, Corey – House method, petroleum refining, Dieckmann's ring closure, substitution, and ring-opening reactions. Baeyer's strain theory and theory of strain less rings etc. The last part is based on the chemistry of aromatic systems. It involves Hückel's rule of aromaticity, electrophilic substitution reactions and oxidation chemistry.

Course Objectives:

The students can be able to demonstrate an understanding of basic principles of organic chemistry and how they relate to everyday experiences

Course Outcome (CO):

CO1 understands the basic properties of nomenclature, organic compounds
CO2 comprehends the knowledge of nomenclature, synthesis, and applications of alkanes and cycloalkanes
CO3 comprehend the knowledge of nomenclature, synthesis, and applications of alkenes, Alkyne, and dienes
CO4 understands the knowledge of nomenclature, synthesis, and applications of Benzene, and arenes

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	Unit 1: Alkanes and Cycloalkanes: Hybridization of organic molecules. Preparation of alkanes: Wurtz reaction, reduction or hydrogenation of alkenes, Corey – House method, petroleum refining. Reactions: Halogenation, Mechanism of free radical halogenation. Cycloalkanes: Preparation using Wurtz reaction, Dieckmann's ring closure and reduction of aromatic hydrocarbons. Reactions: Mechanism of substitution and ring-opening reactions. Baeyer's strain theory and theory of strain less rings	15	1, 2, 3, 4, 5	CO1, CO2	PSO1, PSO3, PSO4
2	Unit 2: Alkenes, Alkynes and Dienes: Alkenes: General methods of preparation, dehydrogenation, dehydrohalogenation, dehydration, Hoffmann and Saytzeff's rules, cis and trans eliminations. Reactions: Mechanism of electrophilic and free radical addition – the addition of hydrogen, halogen, hydrogen halide (Markovnikov's rule), hydrogen bromide (peroxide effect), sulphuric acid, water, hydroboration, Ozonolysis, dihydroxylation with KMnO4, allylic bromination by NBS. Mechanism of hydroboration-oxidation and oxymercuration-demercuration. Oxidative cleavage of alkenes. Dienes: Stability of dienes (conjugated, isolated and cumulative dienes) 1,2- and 1,4-addition reactions in conjugated dienes, Diels-Alder reaction. Alkynes: Preparation, Mechanism of dehydrohalogenation and dehydrogenation. Reactions: Acidity of alkynes, formation of acetylides, Mechanism of addition of water, hydrogen halides and halogens, oxidation, ozonolysis and hydroboration/oxidation, oxidative cleavage of alkynes.	15	1, 2, 3, 4, 5	CO1, CO3	PSO1, PSO3, PSO4

3	Unit 3: Benzene and Arenes: Benzene: Kekulé structure, stability of benzene, resonance Aromaticity: Hückel’s rule, aromaticity in benzene and other cyclic systems with examples of aromatic, non-aromatic and antiaromatic systems of cyclic hydrocarbons (C3 to C8) Electrophilic substitution reactions: halogenation, nitration, sulphonation, Friedel–Crafts alkylation and acylation. Oxidation reactions: With oxygen and ozone, mercuration. Oxidation and halogenation (ring vs side chain) of alkylbenzenes. Disubstitution reactions of aromatic compounds, orientation and reactivity. Polynuclear aromatic hydrocarbons: Preparation and properties of naphthalene, anthracene and phenanthrene. Synthetic uses.	15	1, 2, 3, 4, 5	CO1, CO4	PSO1, PSO3, PSO4

Reference Books	
1.	R. T. Morrison, R. N. Boyd and S. K. Bhattacharjee, Organic Chemistry, 7th Ed., Pearson New Delhi, 2012.
2.	M. K. Jain and S. C. Sharma, Modern Organic Chemistry, Vishal Publishing Co., New Delhi, 2018
3.	J. Clayden, N. Greeves, S. Warren, P. Wothers, Organic Chemistry, 1st Ed., Oxford University Press, New York, 2001
4.	B. Y. Paula, Organic Chemistry, 3rd Ed., Pearson Education, Inc. (Singapore), New Delhi, reprint, 2002.
5.	T. W. Graham Solomons, Organic Chemistry, 6th Ed., John Wiley and sons, 1996
6.	Jerry March, Advanced Organic Chemistry, 4th Ed., John Wiley and Sons, New York, 1992.
7.	S. H. Pine, Organic Chemistry, 5th Ed., McGraw Hill International Edition, Chemistry Series, New York, 1987
8.	Francis A. Carey, Organic Chemistry, 3rd Ed., Tata – McGraw Hill Publications, New Delhi, 1999.

School: Science			**Program: B.Sc. (Chemistry)**		
Course Code: CH 256			**Course Name: Inorganic Chemistry II**		
Year	**II**	**Core Subject(Yes/No):**	**Yes**	**Lecture:**	**3**
Semester	**III**	**Elective Subject(Yes/No):**	**No**	**Tutorial**	**0**
Typology of Course	Lectures	**Foundation Subject(Yes/No):**	**No**	**Practical:**	**0**
		Year of Syllabus Revision:	**2020**	**Total Credit:**	**3**
		Year of Introduction	**2014**	**Prerequisites (If any)**	**12th Science**

Course Description:
The first part of the course explains characteristic properties of s, p, d and f block elements including noble gas family and their compounds particularly keeping the focus on the recent discoveries. It also gives information of similarity and difference in behaviour among each and every block of the periodic table. In addition, in d- block it includes the difference between 3d and other transition elements. Besides that, it covers their wide applications in day today life. The second part covers basic terminologies of coordination compounds, capability and limitations valence bond theory and crystal field theory in details.

Course Objectives:
The objective of this course is to develop abilities of students to understand elements presents into periodic table in detail and understand the coordination chemistry of complex molecules.

Course Outcome (CO)
CO1 Explain the structure and properties of the compounds of p – block elements including noble gas family particularly keeping focus on the recent discoveries.
CO2 Understand the characteristic properties of transition elements and explain the properties in terms of oxidation states exhibited by the elements.
CO3 They will be able to explain the properties of d-block elements and application of these complexes in various industries.
CO4 Ability to give the IUPAC name to coordination compounds. Further they will be able to explain the nature of ligand based on splitting of d-orbital.

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	**Unit 1: s and p block elements:** Characteristic and distinctive properties of s and p block elements. Chemistry of s Block elements: Hydrogen. Hydrides – Classification and Chemistry. Heavy water – manufacture and properties. Alkali Metals: Li, Na, K, Rb and Cs – occurrence, comparative study of elements, oxides, halides, hydroxides and carbonates. Exceptional property of Lithium. Alkaline Earth Metals: Be, Mg, Ca, Sr and Ba – occurrence and comparative study of the elements, oxides, hydroxides, halides, sulphates and carbonates. Exceptional property of Beryllium. p-Block elements: Comparative study of the p – Block elements – Groups 13 – 18 with special reference to electronic configuration, structure of elements and trends in atomic and ionic radii, ionization potential, electron affinity, electronegativity and oxidation states. Inert pair effect. Occurrence, extraction and important uses of p-Block elements.	15	1,2,3,4,5	CO1 CO2	PSO1 PSO2 PSO3 PSO4
2	**Unit 2: d-Block Elements Chemistry of Transition elements:** Characteristics properties of d – block elements. Electronic configuration. Comparative account of atomic and ionic radii, density, M.P., B.P., metallic character, reactivity of metals, ionization energies. Difference between the properties of the elements of first and the other two transition Series. Application of coordination compounds in analysis and industry. Lanthanides and Actinides: Abundance, occurrence and extraction of lanthanides and actinides. Separation of lanthanides. Metallurgy of thorium and uranium.	15	1,2,3,4,5	CO3 CO4	PSO1 PSO2 PSO3 PSO4

	Preparation of transuranium elements. Electronic configuration, oxidation states, atomic & ionic radii. Lanthanide contraction and its consequences.				
3	**Unit 3: Coordination Compounds Coordination compounds:** Introduction to basic terminologies (primary and secondary coordination spheres, ligands and their types, Coordination number and coordination geometry, chelation, sequestering agents), Effective Atomic Number (EAN) and 18 electron rules. Bonding in complexes with coordination number 4 & 6 in terms of VBT, high and low spin complexes. Capability and limitations of VBT. Electrostatic concept of complex formation: Crystal field theory (CFT), energy of the d or the d orbitals in spherical, octahedral, tetrahedral, tetragonal and square planar fields. Extrinsic and intrinsic distortion in octahedral geometry, Weak field and strong field complexes. Spectrochemical series, agnetism and geometry of complexes on the basis of CFT. Factors affecting the crystal field splitting. Geometry preferred by various transition metal ions in strong and weak fields. Limitations of crystal field theory (qualitative approach).	15	1,2,3,4,5	CO1 CO3 CO4	PSO1 PSO2 PSO3 PSO4

Reference Books	
1.	D. F. Shriver and P. W. Atkins, Inorganic Chemistry, 3rd Edn. (1999), ELBS, London.
2.	F. A. Cotton and G. Wilkinson, Advanced Inorganic Chemistry, 6th Edn. (1999), John Wiley & Sons, New York.
3.	D.N. Sathyanarayana, Electronic Absorption Spectroscopy and Related Techniques (2001), Universities Press (India) Ltd., Hyderabad.
4.	J. D. Lee, Concise Inorganic Chemistry, 5th Ed., Blackwell Science, London, 1996.
5.	B. R. Puri, L. R. Sharma &, K. C. Kalia, Principles of Inorganic Chemistry, Shoban Lal Nagin Chand and Co., Delhi, 1996.

School: School of Science			**Program: B.Sc Chemistry**		
Course Code: CH 204			**Course Name: Chemistry Laboratory-V**		
Year	**II**	**Core Subject (Yes/No):**	**Yes**	**Lecture:**	**0**
Semester	**III**	**Elective Subject (Yes/No):**	**NO**	**Tutorial**	**0**
Mode of Transaction	Laboratory	**Foundation Subject (Yes/No):**	**NO**	**Practical:**	**6**
		Year of Syllabus Revision:	**2018**	**Total Credit:**	**3**
		Year of Introduction	**2014**	**Prerequisites (If any)**	**12th science**

Course Description:
It includes determination of organic compounds having different nature such as acid, base and neutral organic compound and also includes analysis of water samples as well as quantitative analysis of using redox, complexometric and precipitation titration

Course Outcome (CO):
CO1 gain knowledge on organic qualitative analysis
CO2 To understand the fundamentals of volumetric titrations specifically Acidimetry – Alkalimetry titrations.
CO3 Describe the knowledge of the fundamentals of Redox Titrations, complexometric titrations, Precipitation titration in volumetric analysis.
CO4 comprehended the titration related to Argentometry titrations, Iodometry and Iodimetry titration using volumetric analysis.
CO5 Record observations and write laboratory reports according to disciplinary standards.

No.	Experiment	Contact Hours	BT Level	CO	PSO
1	Organic spotting (Benzoic acid)	3	1, 2, 3, 4, 5, 6	CO1, CO5	PSO1, PSO2, PSO3, PSO4
2	Organic spotting (Urea)	3	1, 2, 3, 4, 5, 6	CO1, CO5	PSO1, PSO2, PSO3, PSO4
3	Organic spotting (Beta – naphthol)	3	1, 2, 3, 4, 5, 6	CO1, CO5	PSO1, PSO2, PSO3, PSO4
4	Organic spotting (Naphthalene)	3	1, 2, 3, 4, 5, 6	CO1, CO5	PSO1, PSO2, PSO3, PSO4
5	Organic spotting (Salicylic Acid)	3	1, 2, 3, 4, 5, 6	CO1, CO5	PSO1, PSO2, PSO3, PSO4
6	Organic spotting (Thiourea)	3	1, 2, 3, 4, 5, 6	CO1, CO5	PSO1, PSO2, PSO3, PSO4
7	Organic spotting (Bromo Benzene)	3	1, 2, 3, 4, 5, 6	CO1, CO5	PSO1, PSO2, PSO3, PSO4

8	Organic spotting (Para nitro aniline)	3	1, 2 3, 4, 5, 6	CO1, CO5	PSO1, PSO2, PSO3, PSO4
9	Organic spotting (Aniline)	3	1, 2, 3, 4, 5, 6	CO1, CO5	PSO1, PSO2, PSO3, PSO4
10	Organic spotting (m- nitro Aniline)	3	1, 2, 3, 4, 5, 6	CO1, CO5	PSO1, PSO2, PSO3, PSO4
11	Organic spotting (p- nitro Aniline)	3	1, 2, 3, 4, 5, 6	CO1, CO5	PSO1, PSO2, PSO3, PSO4
12	Organic spotting (Sulfanilic acid)	3	1, 2, 3, 4, 5, 6	CO1, CO5	PSO1, PSO2, PSO3, PSO4
13	Organic spotting (Acetanilide)	3	1, 2, 3, 4, 5, 6	CO1, CO5	PSO1, PSO2, PSO3, PSO4
14	Organic spotting (Ethyl Acetate)	3	1, 2, 3, 4, 5, 6	CO1, CO5	PSO1, PSO2, PSO3, PSO4
15	Organic spotting (Benzaldehyde)	3	1, 2, 3, 4, 5, 6	CO1, CO5	PSO1, PSO2, PSO3, PSO4
16	Iodometry titration	3	1, 2, 3, 4, 5, 6	CO1, CO2, CO3, CO4, CO5	PSO1, PSO2, PSO3, PSO4
17	Iodimetry titration	3	1, 2, 3, 4, 5, 6	CO1, CO2, CO3, CO4, CO5	PSO1, PSO2, PSO3, PSO4
18	Hardness of water	3	1, 2, 3, 4, 5, 6	CO1, CO2, CO3, CO4, CO5	PSO1, PSO2, PSO3, PSO4
19	Estimation of chloride	3	1, 2, 3, 4, 5, 6	CO1, CO2, CO3, CO4, CO5	PSO1, PSO2, PSO3, PSO4

Reference Books

1. J. Mendham, R. C. Denney, J. B. Barnes & M. J. K. Thomas, Vogel’s Textbook of Quantitative Chemical Analysis, 6th Ed., Pearson Education, New Delhi, 2003.
2. R. C. Shah, Organic Qualitative Analysis, 5 th Ed., Baroda Book Depot, Vadodara, 1996

School: Science		**Program: B.Sc. (Chemistry)**			
Course Code: PH204		**Course Name: Quantum Mechanics and Solid State Physics**			
Year	**II**	**Core Subject(Yes/No):**	**No**	**Lecture:**	**2**
Semester	**III**	**Elective Subject(Yes/No):**	**No**	**Tutorial**	**1**
Typology of Course	Lectures and Tutorials	**Foundation Subject(Yes/No):**	**Yes**	**Practical:**	**0**
		Year of Syllabus Revision:	**NA**	**Total Credit:**	**3**
		Year of Introduction	**2019**	**Prerequisites (If any)**	**12th science**

Course Description:

This is an advanced course above college level physics meant for developing a knowledge base required for deep understanding of subatomic phenomena from quantum mechanical perspective. The course also aims to teach basic understanding about crystal structure and symmetries associated. It mainly comprises of fundamentals of quantum mechanics and solid state physics. The course will focus on basic concepts and formalism of quantum mechanics and also its use in understanding band theory of solids. Exposure to various applications based on those concepts important from technology point of view will be given. Several problems will be solved which would give the students a better spirit of applying the newly learnt concepts and build their analytical powers!

Course Objectives:

Physics is a science to fundamentally understand how things work in nature and around us. The importance of the subject is thus unparalleled for a science student of any branch. Some of the immediate and direct objectives of this course are listed below.

1. To develop clear understanding of the subject which is crucial for understanding subatomic phenomena as well as material properties owing to crystal structure and band theory.
2. To develop clear understanding about concepts in Quantum Mechanics and Solid State Physics which form basis of present day industrial practices and cutting edge technology.
3. To develop problem solving skills.
4. To have sufficient knowledge base for research and development work in the field of semiconductors, nanotechnology, materials, electromagnetic radiation, waves, optics and communication.

Course Outcome (CO):

CO1 To realize the need to replace classical mechanical equations of motion meant for particles by wave like equation of motion (Schrödinger equation).
CO2 To express wavefunction for a particle and study its evolution with time at different locations.
CO3 To understand formalism and language of quantum mechanics.
CO4 To understand basic crystal physics and apply the acquired knowledge to analyze unknown crystal structures.
CO5 To understand how bands are formed from quantitative theory based on the principles of quantum mechanics
CO6 To learn basics of semiconductors.

Unit No.	**Topic/Unit**	**Contact Hours**	**BT Level**	**CO**	**PSO**
1	**Quantum Mechanics** Historical development of quantum mechanics- blackbody Radiation, photo electric effect, Compton effect, pair production, wave particle duality and Heisenberg's uncertainty principle for position-momentum and its extension to energy-time	7	2,3,4	CO1	PSO1 PSO3 PSO4 PSO5
2	**Quantum Mechanics** de Broglie's hypothesis for matter waves, wave packets and group velocities, postulates of quantum mechanics, Schrödinger's Wave equation (Both time dependent and time independent equations without derivation)	8	2,3,4	CO2	PSO1 PSO3 PSO4 PSO5
3	**Quantum Mechanics** Operators, expectation values, applications to particle in one and three dimensional boxes, rectangular potential well, tunneling.	7	2, 3, 4	CO3	PSO1 PSO3 PSO4 PSO5

4	**Solid State Physics** Amorphous and crystalline solids, Concept of crystal lattice, Elements of symmetry, Unit cells and Bravais lattice, Coordination number, Packing fraction of sc, bcc and fcc structures, Crystal planes and directions,	8	2,3,4	CO4	PSO1 PSO3 PSO4 PSO5
5	**Solid State Physics** Types of bonds, Lattice vibrations, Phonons (Qualitative), Electrical Properties of solids: Band theory of solids (Qualitative),	7	2,3,4	CO5	PSO1 PSO3 PSO4 PSO5
6	**Solid State Physics** Classification of solids on the basis of band gap, Concept of holes and effective mass in semiconductors, Direct and Indirect band gap semiconductors. Intrinsic and extrinsic semiconductors, Hall effect.	8	2,3,4	CO6	PSO1 PSO3 PSO4 PSO5

Reference Books

1. Beiser, Arthur, *Concepts of Modern Physics*, 5th Ed., Tata McGraw Hill Education Private Limited, 2009.
2. Kenneth Krane, *Modern Physics*, Wiley India Pvt. Ltd., 2006.
3. H. S. Mani & G. K. Mehta, *Introduction to Modern Physics*, Affiliated East – West Press Pvt. Ltd., 1990.
4. D. J. Griffiths, *Introduction to quantum mechanics*, Pearson, 2005.
5. Charles Kittel, *Introduction to Solid State Physics*, 8th Ed., Wiley India Pvt. Ltd., 2012.
6. A J Dekkar, *Solid State Physics*, Macmillan India Limited, 2000.
7. M. Ali Omar, *Elementary solid state physics: principles and applications*, Pearson Education, 1999.
8. M.S. Vijaya and G. Rangarajan: Materials Science, 1st edition, Tata McGraw Hill Publishing Company Ltd., 2004.

School: School of Science			**Program: B.Sc. Chemistry**		
Course Code: PH205			**Course Name: Analog and Digital Electronics**		
Year	**II**	**Core Subject(Yes/No):**	**No**	**Lecture:**	**1**
Semester	**III**	**Elective Subject(Yes/No):**	**No**	**Tutorial**	**1**
Typology of Course	Lectures and Tutorials	**Foundation Subject(Yes/No):**	**Yes**	**Practical:**	**0**
		Year of Syllabus Revision:	**NA**	**Total Credit:**	**2**
		Year of Introduction	**2019**	**Prerequisites (If any)**	**12th science**

Course Description:
This course addresses to acquire basic knowledge in solid state electronics including diodes, rectifiers, BJT, and filter circuits. It helps to develop the ability to analyze and design analog electronic circuits and to observe the amplitude and frequency responses of common amplification circuits. It will develop practical skills of the students by taking measurements of various analog circuits to compare experimental results in the laboratory with theoretical analysis. Further, drawing conclusions regarding digital electronic circuits using Boolean mathematical techniques and construct, measure and evaluate digital electronic circuits.

Course Objectives:

- To understand concepts of Analog Electronics
- To apply concepts of Electronics to design circuits
- To understand the basics of digital electronics and its importance

Course Outcome (CO):

CO1 To acquire basic knowledge in solid state electronics including diodes, rectifiers, BJT, and filter circuits

CO2 To develop the ability to analyze and design analog electronic circuits

CO3 To observe the amplitude and frequency responses of common amplification circuits

CO4 To draw conclusions regarding digital electronic circuits using Boolean mathematical techniques.

CO5 To construct, measure and evaluate digital electronic circuits

Unit No.	**Topic/Unit**	**Contact Hours**	**BT Level**	**CO**	**PSO**
1	Unit I: **Solid State Devices** Semiconductors: electrons and holes, p-n junction diode, zener and tunnel diodes, light emitting diode, photovoltaic cell, rectification, ripple factor	4	1,2,3	CO1 CO2 CO3	PSO1 PSO3 PSO4 PSO5
2	Unit II: **Transistors** Characteristics of transistors in CB, CE and CC mode, transistor as amplifier	4	1,2,3	CO1 CO2 CO3	PSO1 PSO3 PSO4 PSO5
3	Unit III: **Electronic Circuits** Types of filters- choke filter, capacitor filter, pi filter, classification of filters: (i) Low Pass, (ii) High Pass, and (iii) Band pass filters	3	1,2,3	CO1 CO2 CO3	PSO1 PSO3 PSO4 PSO5
4	Unit IV: **Digital electronics** Boolean identities, DE Morgan's laws, Logic gates and truth tables, Simple logic circuits, Binary, Hexadecimal and Octal number systems and their conversions, Concepts of Boolean algebra, AND, OR, NAND, NOR, EX-OR gates, and Nor gate as Universal Gates	4	1, 2, 3	CO4 CO5	PSO1 PSO3 PSO4 PSO5

Reference Books	
1.	Boylestad & Nashlesky, Electronic Devices & Circuit Theory, 2nd Ed., PHI Publication, 2000.
2.	Sanjeev Gupta, Electronic Devices and Circuits, Dhanpat Rai Publications.
3.	Morris Mano, Digital Logic and Computer Design, Prentice Hall Of India, 2005.
4.	George Kennedy, Communication Systems, Tata McGraw – Hill Education, 1999.
5.	V.K. Mehta, Principles of Electronics, 7th ED., S. Chand and Company, 2005.
6.	A. Malvino, Electronic Principles, 6th Ed., McGraw Hill Inc, US, 1998.
7.	A. Malvino and D. Leach, Digital Principles and Applications, 5th Ed., McGraw Hill Inc, US, 1994.

School: School of Science	**Program: BSc Chemistry**
Course Code: MA150	**Course Name: Abstract Algebra – I**

Year	**II**	**Core Subject(Yes/No):**	**No**	**Lecture:**	**3**
Semester	**III**	**Elective Subject(Yes/No):**	**No**	**Tutorial**	**0**
Typology of Course	Lectures and Tutorials	**Foundation Subject(Yes/No):**	**Yes**	**Practical:**	**0**
		Year of Syllabus Revision:	**2018**	**Total Credit:**	**3**
		Year of Introduction	**2014**	**Prerequisites (If any)**	**Algebra**

Course Description:

Abstract algebra has applications in a variety of diverse fields, including computation, physics, and economics and hence, is an important area in mathematics. We will begin this course by reviewing basic set theory, integers and functions in order to understand how algebraic operations arise and are used. We then will proceed to the heart of the course, which is an exploration of the fundamentals of groups, rings, and fields.

Course Objectives:

1. Study the concepts of Abstract Algebra
2. Develop understanding of finite and infinite Groups.
3. Understand rigorous handling of Abstract algebraic operations

Course Outcome (CO):

CO1	Understand elements of modular arithmetic and learn basic concepts of groups and its properties and examples
CO2	Relate symmetry of shapes with the permutation groups, learn various properties of it, application in chemistry.
CO3	Learn properties of homomorphism, isomorphism
CO4	Study various concepts of groups like normal subgroups, quotient groups, automorphism etc

Unit No.	**Topic/Unit**	**Contact Hours**	**BT Level**	**CO**	**PSO**
1	Equivalence relation and equivalence class, congruence modulo n, Definition and examples of groups, Elementary properties of a group, finite groups and their tables, Subgroups, centralizers and normalizers, subgroups generated by a set, Cyclic groups, order of an element.	15	1, 2, 5	CO1	PSO1
2	Cosets, Lagrange's theorem, Fermat's Theorem, Euler's Theorem, Permutation group, symmetries of equilateral triangle, rectangle, circle, square, transposition and cycles, Even and Odd permutations, Alternating Groups An, Homomorphism and Isomorphism, Cayley's theorem	15	1, 2, 3, 5	CO2 CO3	PSO1, PSO2 PSO4
3	Isomorphic groups, a counting principle, Normal subgroups and quotient groups, Fundamental theorem of homomorphism, Isomorphism theorems, Definition and examples of automorphisms, Inner automorphisms, Automorphism and inner automorphism groups.	15	1, 2, 4	CO3 CO4	PSO1

Reference Books	
1.	Contemporary Abstract Algebra by Joseph A. Gallian
2.	First course in Algebra – John B. Fraleigh, Addison Wesley.
3.	"Topics in Algebra" – I. N. Herstein-Wiley Eastern Ltd

School: Science	**Program: BSc Chemistry**
Course Code: MA151	**Course Name: Numerical Methods**

Year	**II**	**Core Subject(Yes/No):**	**No**	**Lecture:**	**2**
Semester	**III**	**Elective Subject(Yes/No):**	**No**	**Tutorial**	**0**
Typology of Course	Lectures	**Foundation Subject(Yes/No):**	**Yes**	**Practical:**	**0**
		Year of Syllabus Revision:	**2018**	**Total Credit:**	**2**
		Year of Introduction	**2014**	**Prerequisites (If any)**	**FY BSc**

Course Description:
This course is a study of numerical methods. It involves the development of mathematical models and the applications using the following computational techniques: approximation, numerical differentiation, root-finding using bracketing and open methods, linear and polynomial curve fitting, solution methods for matrix equations, numerical integration and the numerical solution of differential equations.

Course Objectives:
The goal of the course is to provide the students with a strong background on numerical approximation strategies and a basic knowledge on the theory that supports numerical algorithms. Students will also learn to implement numerical methods using computer programs.

Course Outcome (CO):
CO1 Apply numerical methods to find our solution of algebraic and transedental equations using different methods under different conditions.
CO2 Apply various interpolation methods and finite difference concepts.
CO3 Work out numerical differentiation and integration whenever and wherever routine methods are not applicable.
CO4 Apply numerical solution of system of linear equations. Work numerically on the ordinary differential equations

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	***Unit 1:*** **Error analysis:** Round off error, truncation error, significant error, error in numerical computations **Solution of transcendental and algebraic equations:** Bisection, secant, Regula Falsi, Newton-Raphson methods **Interpolation:** Difference schemes, interpolation formulas using differences. Lagrange and Newton interpolation, Divided differences, spline interpolation	15	1,2,3	CO1, CO2	PSO1, PSO4
2	***Unit 2:*** **Numerical differentiation and integration:** Finite difference method, Trapezoidal, Simpson's Formulae **Solution of linear equations:** Direct methods - Gauss elimination, Iterative methods - Jacobi, Gauss-Siedel methods **Solution of Ordinary differential equations:** Euler's method, Single-step methods, Runge-Kutta's method, multi-step methods.	15	1,2,3	CO3, CO4	PSO1, PSO4

Reference books:

1.	S. S. Sastry, Introductory methods of Numerical Analysis, Prentice Hall of India.
2.	M K Jain, S R K Iyengar, and R K Jain, Numerical Methods for Scientific and Engineering Computation, 4th ed. New Delhi, India: New Age International,2012

School: Science			**Program: BSc Chemistry**		
Course Code: HR226			**Course Name: Introduction HR**		
Year	**II**	**Core Subject(Yes/No):**	**No**	**Lecture:**	**2**
Semester	**III**	**Elective Subject(Yes/No):**	**No**	**Tutorial**	**0**
Typology of Course	Lectures	**Foundation Subject(Yes/No):**	**Yes**	**Practical:**	**0**
		Year of Syllabus Revision:	**NA**	**Total Credit:**	**2**
		Year of Introduction	**2019**	**Prerequisites (If any)**	**12th science**

Unit No.	**Topic/Unit**	**Contact Hours**	**BT Level**	**CO**	**PSO**
1	Unit 1: Introduction to Business: · Manufacturing and service sectors; Small and medium enterprises · Forms of Business Organisation: Sole Proprietorship, Joint Hindu Family Firm, Partnership firm, Joint Stock Company, Cooperative society; Limited Liability Partnership; · Public Enterprises. International Business. Multinational Corporations · Technological innovations and skill development. · Social responsibility and ethics. Emerging opportunities in business; Franchising, Outsourcing	15	1, 2, 3, 4		
2	Unit 2: Introduction to HR: · Role of HRM: Nature – Scope – Objective – Importance of HRM · Job Analysis: Meaning – Uses of Job Analysis – Process of Job Analysis – Concept of Job Description & Job Specification. · Human Resource Planning: Meaning HR Planning – Objectives of HRP – Importance – process of HRP · Recruitment & Selection: Sources & Methods of Recruitment - Meaning & process of selection · The Process of Management: Planning; Decision-making · Delegation and Decentalisation of Authority · Leadership: Concept and Styles · Motivation: Concept and Importance; Maslow Need Hierarchy Theory; Herzberg Two Factors Theory. Communication: Process and Barriers; Control: Concept and Process	15	1, 2, 3, 4		

Reference Books	
1	Human Resource Management by V. S. P. Rao (Author), Excel Books
2	Gary Dessler, Human Resource Management, 11/e, Pearson Education, 2008
3	Kotler& Armstrong, Principles of Marketing, Pearson Education/PHI, New Delhi.
4	Philip Kotler, Keller, Koshy&Jha, Marketing Management, Pearson Education, New Delhi.
5	Ramaswamy&Namkumari, A Text Book of Marketing Management, Macmillan.
6	H. J. Bernardin, Human Resource Management: An Experiential Approach, TMH, 2007

SEMESTER IV

School: School of Science			**Program: BSc**		
Course Code: CH257			**Course Name: Organic Chemistry-II**		
Year	**II**	**Core Subject (Yes/No):**	**Yes**	**Lecture:**	**3**
Semester	**IV**	**Elective Subject (Yes/No):**	**No**	**Tutorial**	**0**
Typology of Course	Lectures	**Foundation Subject (Yes/No):**	**No**	**Practical:**	**0**
		Year of Syllabus Revision:	2018	**Total Credit:**	**3**
		Year of Introduction	**2014**	**Prerequisites (If any)**	***See below**

Prerequisites (If any): Students should have cleared the previous year examination; in particular, course entitled *Organic Chemistry-I* (CH255) and *Chemistry Laboratory – V* (CH204). Students should have basic concept of organic compounds (alkane, alkene, alkyne, aromatic compounds, etc.)

Course Description:
First unit describe the stereochemistry of different organic molecules. Representation of different projection and the interconversion of one form to another are included in the unit. It also includes the difference between enantiomer and diastereomer, *meso*-isomer and racemic mixtures, cis-trans and *E-Z* etc. It also describes how to separate the racemic mixture using different techniques. Second unit deals with the chemistry of alkyl and aryl halides. It includes substitution S_N1, S_N2 and S_Ni and S_NAr and elimination E1 and E2 reactions and their mechanisms. The last unit deals with chemistry of alcohols, phenol, ether and epoxides with the examples of a few well-known name reactions such as Victor Meyer test and iodoform test, Riemer–Tiemann reaction, Kolbe reaction, Fries and Claisen rearrangements.

Course Objectives:
The objective of this course is to develop abilities of student to understand the concept of stereoisomers and organic reaction mechanism and to critically interpret the diverse options regarding possible futures for the organic synthesis with different functional groups.

Course Outcome (CO):
Upon completion of the course students are expected to demonstrate knowledge, skill and abilities in the following areas:

CO1 Understand the stereochemistry of optically active compounds (chiral & achiral molecules).
CO2 Recognizing and drawing structural isomers (constitutional isomers), stereoisomers including enantiomers and diastereomers, racemic mixture, and meso compounds.
CO3 Identifying the stereocenters in a molecule and assign the configuration as R or S.
CO4 Understanding the relationship between enantiomers and their specific rotations.
CO5 learn the chemistry of functional groups of organic compounds such as Alkyl & Aryl Halides, Alcohols, Ethers, Phenol & Epoxides
CO6 learn the preparation of organic compounds of halide and oxygen based functional groups
CO7 Gain mechanistic understanding of selected organic reactions

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	**Stereochemistry** Isomerism in organic molecules- Structural and Stereoisomerism. Molecular representations: Newman, Sawhorse, Wedge & Dash, Fischer projections and their interconversions. Conformations and Conformational analysis: Ethane, *n*-butane, ethane derivatives, cyclohexane, monosubstituted and disubstituted cyclohexane and their relative stabilities. Geometrical isomerism in unsaturated and cyclic systems: cis–trans and, syn-anti isomerism, E/Z notations. Geometrical isomerism in dienes – Isolated and conjugated systems, determination of configurations. Chirality and optical isomerism: Configurational isomers. Molecules with one or two chiral centers – constitutionally symmetrical and unsymmetrical molecules; Enantiomers and	17	1.2.3.4	CO1 CO2 CO3 CO4	PSO2 PSO3 PSO4

	Diastereomers. Optical activity in absence of chiral center-with illustrative examples (Allenes and Biphenyls). *Meso* compounds, racemic modifications and methods of their resolution; stereochemical nomenclature: erythro/threo, D/L and R/S nomenclature in acyclic systems. Measurement of optical activity: specific rotation.				
2	**Alkyl Halides and Aryl Halides** *Alkyl halides*: Preparation, physical properties, nucleophilic substitution reactions – S_N1, S_N2 and S_Ni mechanism with stereochemical aspects, factors affecting nucleophilic substitution, elimination vs substitution, nucleophilicity vs basicity. *Aryl halides*: Preparation, physical properties and nucleophilic aromatic substitution: S_NAr, elimination-addition mechanism. Relative reactivity of alkyl, allyl, benzyl, vinyl and aryl halides towards nucleophilic substitution reactions. Organometallic compounds of Mg and Li: synthetic uses.	15	1,2,3,4,5	CO4 CO5 CO6	PSO2 PSO3 PSO4 PSO5
3	**Alcohols, Phenol, Ether and Epoxides** *Alcohols*: Preparation, relative reactivity of primary, secondary and tertiary alcohols. Reactions of alcohols: With hydrogen halides, phosphorus halides, thionyl chloride and ammonia. Oxidation of alcohols: Dehydrogenation and dehydration, Lucas reagent test, Victor Meyer test and Iodoform test. *Glycols*: Preparation and reactions: Oxidation, Pinacol– Pinacolone rearrangement. *Phenols*: Preparation and reactions: Acidity and factors affecting acidity of phenols. Acylation of phenol, ring substitution reactions, Riemer–Tiemann reaction, Kolbe reaction, Fries and Claisen rearrangements. *Ethers and Epoxides*: Preparation and reactions with acid. Acid and base catalyzed ring opening of epoxides.	13	1,2,3,4	CO4 CO5 CO6	PSO2 PSO3 PSO4 PSO5

Reference Books	
1.	Ernest. L. Eliel & Samuel. H. Wilen, *Stereochemistry of Organic Compounds*, John Wiley and Sons, New York, 2004.
2.	D. Nasipuri, *Stereochemistry of Organic Compounds: Principles and Applications*, New Age International Publishers, Third Edition, New Delhi, 2011.
3.	P. S. Kalsi, *Stereochemistry: Conformation and Mechanism*, 2nd Ed., Wiley Eastern Ltd, 1993.
4.	J. Clayden, N. Greeves, S. Warren, P. Wothers, *Organic Chemistry*, 1st Ed., Oxford University Press, New York, 2001.
5.	R. T. Morrison, R. N. Boyd and S. K. Bhattacharjee, *Organic Chemistry*, 7th Ed., Pearson New Delhi, 2012.
6.	T. W. Graham Solomons and Craig B. Fryhle, *Organic Chemistry*, 10th Ed., John Wiley and Sons, 2011.
7.	B. Y. Paula, *Organic Chemistry*, 3rd Ed., Pearson Education, Inc. (Singapore), New Delhi, Reprint, 2002.
8.	Arun Bahl& B. S. Bahl, *A Textbook of Organic Chemistry*, S. Chand and Sons, New Delhi, 2005.
9.	Jerry March, *Advanced Organic Chemistry*, 4th Ed., John Wiley and Sons, New York, 1992.
10.	S. H. Pine, *Organic Chemistry*, 5th Ed., McGraw Hill International Edition, Chemistry Series, New York, 1987.
11.	Francis A. Carey, *Organic Chemistry*, 3rd Ed., Tata – McGraw Hill Publications, New Delhi, 1999.

<table>
<tr><td colspan="3">School: School of Science</td><td colspan="3">Program: B.Sc. Chemistry</td></tr>
<tr><td colspan="3">Course Code: CH 258</td><td colspan="3">Course Name: Thermodynamics and Chemical Equilibrium</td></tr>
<tr><td>Year</td><td>II</td><td>Core Subject(Yes/No):</td><td>Yes</td><td>Lecture:</td><td>3</td></tr>
<tr><td>Semester</td><td>IV</td><td>Elective Subject(Yes/No):</td><td>No</td><td>Tutorial</td><td>0</td></tr>
<tr><td rowspan="3">Typology of Course</td><td rowspan="3">Lectures and Tutorials</td><td>Foundation Subject(Yes/No):</td><td>No</td><td>Practical:</td><td>0</td></tr>
<tr><td>Year of Syllabus Revision:</td><td>2019</td><td>Total Credit:</td><td>3</td></tr>
<tr><td>Year of Introduction</td><td>2014</td><td>Prerequisites (If any)</td><td>FY B.Sc. Chemistry</td></tr>
</table>

Course Description:
This course deals with all the four laws of thermodynamics along with thermochemistry and chemical equilibrium. Kirchhoff's law, application of Hess's law, Carnot cycle and heat engine, efficiency of heat engines, entropy and its significance are elaborately explained in thermodynamics. In addition, details of Gibbs-Helmholtz equation and Gibbs-Duhem equation are included in the unit. The last part deals with the details of Gibbs-Duhem equation, Van't Hoff equation and Le Chatelier's principle (qualitative treatment).

Course Objectives:
To be able to use to apply various thermodynamics laws to real system.

Course Outcome (CO):
CO1: understand the basic terms involved in thermodynamics and assess their significance in the study of the thermodynamics.
CO2: To understand and be able to use the first law of thermodynamics for open and closed systems, to set up energy balances for steady- and unsteady-state processes and to solve them for simple and classic cases.
CO3: To understand and be able to use the second law of thermodynamics, to set up entropy balances for steady- and unsteady-state processes and to solve them for simple and limiting cases to establish bounds for solutions to engineering problems.
CO4: To evaluate thermodynamic properties of pure substances with special emphasis on fluids. Be able to use various PVT equations-of-state and heat capacities to evaluate thermodynamic properties (U, H, P, V, T, etc.)
CO5: Comprehend thermochemistry and its significance for a chemical reaction
CO6: Correlate thermodynamics and chemical equilibrium. To apply the laws of thermodynamics and various methods of evaluating state properties to equipment commonly encountered in chemical engineering processes, such as turbines, pumps, engines, and refrigeration units.

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	**Unit 1: First Law and Thermochemistry** Extensive and intensive properties of a system, thermodynamic processes: cyclic, reversible, irreversible processes, isothermal and adiabatic process, Zeroth law of thermodynamics. First law of thermodynamics-statement and equation, relation between Cp and Cv, work of expansion in reversible and irreversible process, adiabatic process, relation between P, V, T.Variation in internal energy and enthalpy with temperature. Thermochemistry- Hess's law, Kirchhoff's law, Bond energy and Bond dissociation energy, calculation from thermochemical data.	16	1,2,3,4,5	CO1, CO2, CO4 CO5	PSO1, PSO3, PSO4, PSO5
2	**Unit 2: Second and Third Law** Second law of thermodynamics, Carnot's theorem, Carnot cycle, efficiency of heat engines, thermodynamic scale of temperature, concept of entropy, entropy change in acyclic, reversible, irreversible processes, calculation of entropy changes of an ideal gas with change in P,V,T, entropy change in physical transformation, entropy of mixing. Helmholtz free energy (A) and Gibb's free energy (G), variation of A and G with P,V,T, criteria for spontaneity and equilibrium, Maxwell's relationship, Gibb's –Helmholtz	17	1,2,3,4,5	CO1, CO3 CO4, CO6	PSO1, PSO3, PSO4, PSO5

	equation. Nernst heat theorem, consequence of the theorem, third law of thermodynamics, and its verification. Determination of absolute entropies of pure substance.				
3	**Unit 3: System of Variable Composition and Chemical Equilibrium** Partial molar quantities-chemical potential, Gibb's – Duhem equation, effect of temperature and pressure on chemical potential, Duhem – Margules equation, concept of activity and activity coefficient, fugacity, derivation of expression of equilibrium constant, temperature pressure and concentration dependence of equilibrium constant –Van't Hoff equation, Le chatelier principle (qualitative treatment).	12	1,2,3,4,5	CO1, CO6	PSO1, PSO3, PSO4, PSO5

Reference Books	
1.	S. H. Maron & J. B. Lando, *Fundamentals of Physical Chemistry*, Macmillan limited, New York, 1966.
2.	B. R. Puri & L. R. Sharma, *Principles of Physical Chemistry*, Shoban Lal Nagin chand and Co. 33rd Ed., 1992.
3.	P.W. Atkins, *Physical Chemistry*, 7th Ed., Oxford University Press, 2001.
4.	S. K. Dogra & S. Dogra, *Physical Chemistry Through Problems*, 4th Ed., New age international, 1996.
5.	Irving M. Klotz & Robert M. Rosenberg, *Chemical Thermodynamics*, John Wiley and sons, Inc., 1994.
6.	J. Rajaram & J. C. Kuriacose, *Thermodynamics*, Shoban Lal Nagin Chand and CO., 1986.
7.	A. Peter & J. Paula, *Physical Chemistry*, 9th Ed., Oxford University Press, 2011.
8.	N. Levine, *Physical Chemistry*, 6th Ed., Tata Mc Graw Hill 2010.

School: School of Science			**Program: B.Sc Chemistry**		
Course Code: CH 209			**Course Name: Chemistry Laboratory-VII**		
Year	**II**	**Core Subject (Yes/No):**	**Yes**	**Lecture:**	**0**
Semester	**IV**	**Elective Subject (Yes/No):**	**No**	**Tutorial**	**0**
Mode of Transaction	Laboratory	**Foundation Subject (Yes/No):**	**No**	**Practical:**	**6**
		Year of Syllabus Revision:	**2018**	**Total Credit:**	**3**
		Year of Introduction	**2014**	**Prerequisites (If any)**	**FY B.Sc. Chemistry**

Course Description:
Semi-micro qualitative analysis of inorganic compounds containing two cations and two anions, including phosphate separation scheme.

Course Outcome (CO):

CO1 Understanding basic principles of Separation
CO2 Separation of Inorganic mixture
CO3 identification of radicals in a given unknown salt mixture
CO4 phosphate separation scheme.

No.	Experiment	Contact Hours	BT Level	CO	PSO
1	$Pb (NO_3)_2 + CuSO_4$		1,2,3,4,5	CO1, CO2, CO3,	PSO2
2	$NH_4Br + CoCl_2$		1,2,3,4,5	CO1, CO2, CO3,	PSO2
3	$FeSO_4 + Al2(PO_4)_3$		1,2,3,4,5	CO1, CO2, CO3, CO4	PSO2
4	$CaCl_2 + KBr$		1,2,3,4,5	CO1, CO2, CO3,	PSO2
5	$ZnS + MnSO_4$		1,2,3,4,5	CO1, CO2, CO3,	PSO2
6	$Na_2SO_3 + NaNO_2$		1,2,3,4,5	CO1, CO2, CO3,	PSO2
7	$Mg_2(Cr_2O_7) + CdCl_2$		1,2,3,4,5	CO1, CO2, CO3,	PSO2
8	$BaSO_4 + Ni (NO_3)_2$		1,2,3,4,5	CO1, CO2, CO3,	PSO2
9	$SrCO_3 + CdCl_2$		1,2,3,4,5	CO1, CO2, CO3,	PSO2

Reference Books

1.	J. Mendham, R. C. Denney, J. B. Barnes & M. J. K. Thomas, Vogel’s Textbook of Quantitative Chemical Analysis, 6th Ed., Pearson Education, New Delhi, 2003.
2.	R. C. Shah, Organic Qualitative Analysis, 5 th Ed., Baroda Book Depot, Vadodara, 1996

School: School of Science			**Program: B.Sc. (CPM)**		
Course Code: PH201			**Course Name: Atomic and Nuclear Physics**		
Year	**II**	**Core Subject(Yes/No):**	**No**	**Lecture:**	**2**
Semester	**IV**	**Elective Subject(Yes/No):**	**No**	**Tutorial**	**1**
Typology of Course	Lectures and Tutorials	**Foundation Subject(Yes/No):**	**Yes**	**Practical:**	**0**
		Year of Syllabus Revision:	**NA**	**Total Credit:**	**3**
		Year of Introduction	**2015**	**Prerequisites (If any)**	**FY B.Sc. Chemistry**

Course Description:

Students will be acquiring the knowledge of historical background of atomic physics. This course focuses on the concept and Structure of Nucleus. Students will be exposed to various laws of radioactivity in brief and their applications. They will be exposed to real life nuclear applications as well.

Course Objectives:

- understand various atomic models
- understand nuclear structure and various decay processes
- develop awareness of applications of nuclear physics
- understand working of nuclear detectors and accelerators

Course Outcome (CO):

CO1 To acquire knowledge and understanding about the electronic and nuclear structure of atoms.
CO2 To have an appreciation of the influence of atomic and nuclear physics on modern scientific development and everyday living.
CO3 To have the foundations for examining in more detail various aspects of experimental and theoretical physics which relate to both atomic and nuclear physics.
CO4 To understand the principle and working of various nuclear detectors and accelerators
CO5 To understand the concepts of radioactivity
CO6 To realize the applications of nuclear physics

Unit No.	**Topic/Unit**	**Contact Hours**	**BT Level**	**CO**	**PSO**
1	Unit I: **Atomic Physics** Thomson's atom model, Rutherford's atom model and their drawbacks. Bohr atom model, Sommerfeld relativistic atom model, vector atom model – LS coupling, jj coupling, Pauli's exclusion principle, selection rules, intensity rules, application of vector atom model – electronic structure in atoms, fine structure of spectral lines, Zeeman and Stark effect, experimental verification of vector atom model.	15	1,2	CO1 CO2 CO3	PSO1 PSO3 PSO4 PSO5
2	Unit II: **Structure of Nucleus** Basic nuclear properties– size, binding energy, angular momentum, parity, magnetic moment, semi-empirical mass formula and applications, magnetic moment and non central forces, meson theory of nuclear forces, salient features of nuclear forces, shell model of the nucleus – success and imitations.	12	1,2,3	CO1 CO2 CO3	PSO1 PSO3 PSO4 PSO5
3	Unit III: **Nuclear Detectors and Accelerators** Interactions of charged particles and neutrons with matter, working of nuclear detectors, GM counter proportional counter and scintillation counter, cloud chamber, survey of particle accelerators, cyclotron, synchrocyclotron, betatron, bevatron.	8	1,2,3	CO4	PSO1 PSO3 PSO4 PSO5
4	Unit IV: **Radioactivity** Natural radioactivity, artificial radioactivity, alpha decay, Geiger-Nuttal law, Fermi's theory of beta decay, continuous and discrete spectra, Gamma decay	4	1, 2, 3	CO5	PSO1 PSO3 PSO4

	and internal conversion, nuclear reactions, cross section and Q value, nuclear fission and fusion, nuclear reactors.				PSO5
5	Unit V: **Nuclear Applications** Trace element analysis, diagnostic nuclear medicine, therapeutic nuclear medicine.	6	3	CO6	PSO1 PSO3 PSO4 PSO5

Reference Books	
1.	J. B. Rajam, *Atomic Physics*, S. Chand, and Co. Ltd., 2010.
2.	Kenneth Krane, *Introductory Nuclear Physics*, 1st Ed., Wiley India Pvt. Ltd., 2008.
3.	Arthur Beiser, *Concepts of Modern Physics*, 6th Ed., Tata McGraw Hill education Pvt. Ltd., 2009.
4.	M. N. Cohen, *Concepts of Nuclear Physics*, 1st Ed., Tata Mcgraw Hill Education Pvt. Ltd., 1998.

<table>
<tr><td colspan="3">School: School of Science</td><td colspan="3">Program: B.Sc. (Chemistry)</td></tr>
<tr><td colspan="3">Course Code: PH206</td><td colspan="3">Course Name: Experimental Techniques</td></tr>
<tr><td>Year</td><td>II</td><td>Core Subject(Yes/No):</td><td>No</td><td>Lecture:</td><td>1</td></tr>
<tr><td>Semester</td><td>IV</td><td>Elective Subject(Yes/No):</td><td>No</td><td>Tutorial</td><td>1</td></tr>
<tr><td rowspan="3">Typology of Course</td><td rowspan="3">Laboratory</td><td>Foundation Subject(Yes/No):</td><td>Yes</td><td>Practical:</td><td>0</td></tr>
<tr><td>Year of Syllabus Revision:</td><td>NA</td><td>Total Credit:</td><td>2</td></tr>
<tr><td>Year of Introduction</td><td>2019</td><td>Prerequisites (If any)</td><td>FY B.Sc. Chemistry</td></tr>
</table>

Course Description:

The course will focus on the working principle of the instruments used in undergraduate physics, chemistry and biology laboratories. This is an advanced level course designed to give deep understanding of the working of various analytical instruments that are frequently required from undergraduate till Ph.D. level. Some of them are routinely used in Research and Development (R &D) in various industries. The course initially will include complete explanation of the instruments followed by demonstrations in offline or virtual platform, lab visits and hands-on experience.

Course Objectives:

Measurements of various physical parameters as well as observations are integral part of any scientific methodology.
Some of the immediate and direct objectives of this course are listed below.

1. To understand basic principle of various instruments used in undergraduate laboratory.
2. To understand applications of the instruments
3. To get awareness of some instruments used at advanced level

Course Outcome (CO):

CO1 To understand basic working principle of various instruments used in undergraduate laboratory.
CO2 To learn Physics concepts wherever necessary to understand working principle.
CO3 To learn about applicability and limitation of the instruments.
CO4 To study research literature in details where the instruments are used for measurements.
CO5 To get hands-on experience/demonstration in offline or virtual platform.

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	Spectroscopy- Raman, IR and UV-VIS	5	2,3,4	CO1 CO2 CO3 CO4 CO5	PSO1 PSO3 PSO4 PSO5
2	Optical Microscopy- Compound microscope, Stereo microscope, Polarization microscope, Fluorescence microscope, Phase contrast microscope, Confocal microscope	5	2,3,4	CO1 CO2 CO3 CO4 CO5	PSO1 PSO3 PSO4 PSO5
3	Abbe Refractometer	4	2, 3, 4	CO1 CO2 CO3 CO4 CO5	PSO1 PSO3 PSO4 PSO5
4	Polarimeter	4	2,3,4	CO1 CO2 CO3 CO4 CO5	PSO1 PSO3 PSO4 PSO5

5	Transmission and Scanning Electron Microscopy	4	2,3,4	CO1 CO2 CO3 CO4 CO5	PSO1 PSO3 PSO4 PSO5
6	Detectors- photodiode, photomultiplier tube, CCD	4	2,3,4	CO1 CO2 CO3 CO4 CO5	PSO1 PSO3 PSO4 PSO5
7	Vacuum pumps- rotary and diffusion, pirani and penning gauges	4	2,3,4	CO1 CO2 CO3 CO4 CO5	PSO1 PSO3 PSO4 PSO5

Reference Books

1.	C.N. Banwell and E.M. McCash, Fundamentals of Molecular Spectroscopy, 4th Ed., McGraw Hill Education, 2017.
2.	B. Herman and J. Lemasters, Optical Microscopy: Emerging Methods and Applications, 1st Ed., Elsevier, 2012.
3.	R. Marimuthu, Microscopy and Microtechnique, Mjp Publishers, 2008.
4.	M. Daniel, Basic Biophysics, 1st Ed., Agrobios (India), 2005.
5.	A. Roth, Vacuum Technology, 3rd Ed., North-Holland, 2012.
6.	B. R. Subramaniam and M. N. Avadhanalu, *A Text Book of Optics,* 4th Edition, S. Chand, 2008.
7.	Contemporary literature

School: School of Science			**Program: BSc Chemistry**		
Course Code: MA221			**Course Name: Linear Algebra - I**		
Year	**II**	**Core Subject(Yes/No):**	**No**	**Lecture:**	**3**
Semester	**IV**	**Elective Subject(Yes/No):**	**No**	**Tutorial**	**0**
Typology of Course	Lectures and Tutorials	**Foundation Subject(Yes/No):**	**Yes**	**Practical:**	**0**
		Year of Syllabus Revision:	**2018**	**Total Credit:**	**3**
		Year of Introduction	**2014**	**Prerequisites (If any)**	**Matrix Theory**

Course Description:
Linear algebra is a branch of mathematics that studies systems of linear equations and the properties of matrices. The concepts of linear algebra are extremely useful. Due to its broad range of applications, linear algebra is one of the most widely taught subjects in college-level mathematics (and increasingly in high school also). This course includes the concepts of vector spaces with the dimension and basis of vector spaces. It also deals with inner product spaces and the process of orthogonalization of a given set of vectors.

Course Objectives:
1. To Understand rigorous handling of various techniques in linear algebra.
2. To provide students with a good understanding of the concepts and methods of linear algebra.
3. To help the students develop the ability to solve problems using linear algebra.
4. To connect linear algebra to other fields both within and without mathematics.
5. To develop abstract and critical reasoning by studying logical proofs and the axiomatic method as applied to linear algebra.

Course Outcome (CO):

CO1	To identify various algebraic structures and its axioms
CO2	To define vector spaces, subspaces and its properties
CO3	To detect the Linearly independent vectors and understand basis
CO4	To understand the importance and requirement of the inner product space
CO5	Orthogonalize and orthornomalize the set to create basis

Unit No.	**Topic/Unit**	**Contact Hours**	**BT Level**	**CO**	**PSO**
1	Definition of a field and examples, Vector spaces over a field and elementary consequences of its axioms, Subspaces, Linear span, Quotient spaces, Internal and external direct sum of vector spaces, Linear dependence and Independence. Properties of linearly independent vectors, Basis and its existence, Dimension of a vector space.	25	1, 2, 4, 5	CO1, CO2, CO3	PSO1
2	Inner product spaces, Schwarz inequality, Orthogonal complement and Orthonormal sets, Gram Schmidt process and examples.	20	1, 2, 3, 5	CO4, CO5	PSO1, PSO4

Reference Books	
1.	N. Herstein, Topics in Algebra, Vikas Publishing House Pvt. Ltd.
2.	V. Krishnamurthy, V. P. Mainra & J. L. Arora, An Introduction to Linear Algebra, East-West Press.
3.	Vivek sahai and Vikas Bisth, Linear Algebra, Publisher: Alpha Science International, Ltd.
4.	Introduction to Linear Algebra by Gilbert Strang, Cambridge University Press.

School: Science			**Program: BSc Chemistry**		
Course Code: MA222			**Course Name: Linear Programming problem**		
Year	**II**	**Core Subject(Yes/No):**	**No**	**Lecture:**	**2**
Semester	**III**	**Elective Subject(Yes/No):**	**No**	**Tutorial**	**0**
Typology of Course	Lectures	**Foundation Subject(Yes/No):**	**Yes**	**Practical:**	**0**
		Year of Syllabus Revision:	**2018**	**Total Credit:**	**2**
		Year of Introduction	**2014**	**Prerequisites (If any)**	**FY BSc Chemistry**

Course Description:

This course deals with the formulation of linear problems, Simplex method, the geometry of Simplex method, duality in linear programming, dual simplex method and sensitivity analysis.

Course Objectives:

After completing this course, the student will be developing understanding in the following areas:

1. Able to develop an optimization model from a problem description.
2. Provide a detailed treatment of the theory of linear programming problems.
3. Learn the simplex algorithm solving for linear programming problems.
4. Develop a fundamental understanding of duality theory.

Course Outcome (CO):

CO1 Basic concept of operation research, operation research model.
CO2 Optimality and unboundedness.
CO3 Methods to solve operation research problem. Linear programming problem and methods to solve that.
CO4 Introduction and solution using duality.

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	***Unit 1:*** Introduction to linear programming problem, formation of LPP, Graphical method, Theory of simplex method, optimality and unboundedness, the simplex algorithm, simplex method in tableau format, introduction to artificial variables, two-phase method	20	1,2,3	CO1, CO2, CO3	PSO1, PSO4
2	***Unit 2:*** Big-M method and their comparison, Duality theory, Sensitivity analysis, Dual-Simplex method.	10	1,2	CO3, CO4	PSO1, PSO4

Reference books:

1.	Kanti Swarup, P. K. Gupta and Man Mohan, Operation Research, Sultanchand.
2.	H. A. Taha, Operation Research, An Introduction (9 Edition), Prentice-Hall, India

<table>
<tr><td colspan="3">School: School of Science</td><td colspan="3">Program: Bachelor of Science</td></tr>
<tr><td colspan="3">Course Code: ES201</td><td colspan="3">Course Name: Environmental Studies</td></tr>
<tr><td>Year</td><td>II</td><td>Core Subject(Yes/No):</td><td>No</td><td>Lecture:</td><td>3</td></tr>
<tr><td>Semester</td><td>IV</td><td>Elective Subject(Yes/No):</td><td>No</td><td>Tutorial</td><td>0</td></tr>
<tr><td rowspan="3">Typology of Course</td><td rowspan="3">Lectures</td><td>Foundation Subject(Yes/No):</td><td>Yes</td><td>Practical:</td><td>1</td></tr>
<tr><td>Year of Syllabus Revision:</td><td>NA</td><td>Total Credit:</td><td>4</td></tr>
<tr><td>Year of Introduction</td><td>2019</td><td>Prerequisites (If any)</td><td>FY B.Sc. Chemistry</td></tr>
</table>

Course Description:

Through interdisciplinary academic courses and co-curricular activities, the students shall become passionate stewards of the environment, scholars in sustainability and environmental management, and experts in environmental studies. The students will gain an in-depth knowledge of the different components of Environment. They will be able to recognize the components of Environment and different components of Environment. Field studies are as essential as class work and form an irreplaceable synergistic tool in the entire learning process.

Course Objectives:

- Students will be sensitized towards Environment and its concepts.
- Students will develop an understanding of environment and its types.
- To help the students develop their abilities to engage in discussions.
- To develop the logical and analytical reasoning capabilities.

Course Outcome (CO):

CO1	Gaining in-depth knowledge on natural processes that sustain life and govern economy
CO2	Recognize the physical, chemical, and biological components of the earth's systems and show how they function
CO3	Developing critical thinking for shaping strategies (scientific, social, economic and legal) for environmental protection and conservation of biodiversity, social equity and sustainable development
CO4	Understand core concepts and methods from ecological and physical sciences and their application in environmental problem-solving
CO5	Adopting sustainability as a practice in life, society and industry
CO6	Acquiring values and attitudes towards understanding complex environmental economic-social challenges, and participating actively in solving current environmental problems and preventing the future ones
CO7	Predicting the consequences of human actions on the web of life, global economy and quality of human life

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	Multidisciplinary nature of environmental studies (Definition, scope and importance) Need for public awareness. Renewable and non-renewable resources: Natural resources and associated problems. a) Forest resources: Use and over-exploitation, deforestation. Timber extraction, mining, dams and their effects on forest and tribal people. b) Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits, and problems. c) Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources. d) Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity. e) Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. f) Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification. Role of an individual in	15	1, 2	CO1 CO2	PSO1

	conservation of natural resources. Equitable use of resources for sustainable lifestyles.				
2	**Ecosystems** Concept of an ecosystem. Structure and function of an ecosystem. Producers, consumers and decomposers. Energy flow in the ecosystem. Ecological succession. Food chains, food webs and ecological pyramids. Introduction, types, characteristic features, structure and function of the following ecosystem: a. Forest ecosystem, b. Grassland ecosystem, c. Desert ecosystem, d. Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries).	10	1, 2	CO2 CO3	PSO1
3	**Biodiversity and its conservation** Introduction - Definition: genetic, species and ecosystem diversity. Biogeographical classification of India. Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values. Biodiversity at global, National, and local levels. India as a mega-diversity nation. Hot sports of biodiversity. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts. Endangered and endemic species of India. Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.	10	1, 2, 5	CO3	PSO1
4	**Environmental Pollution** Definition. Cause, effects and control measures of a. Air pollution, b. Water pollution, c. Soil pollution, d. Marine pollution, e. Noise pollution, f. Thermal pollution, g. nuclear hazards, Solid waste Management: Causes, effects and control measures of urban and industrial wastes. Role of an individual in prevention of pollution. Pollution case studies. Disaster management: floods, earthquake, cyclone and landslides.	10	1, 2, 4	CO6 CO7	PSO1
5	**Field work (on working Saturdays)** • Visit to a local area to document environmental assets: river/forest/grassland/hill/mountain • Visit to a local polluted site- Urban/Rural/Industrial/Agricultural • Floristic studies (Study of common trees, herbs, climbers, shrubs, etc.) • Faunal studies (Study of common insects, birds, butterflies, etc.) • Study of simple ecosystems- pond, river, hill slopes, etc.	30	2, 3, 4, 6	CO3 CO4 CO5	PSO1

Reference Books	
1.	Agarwal, K.C. 2001 Environmental Biology, Nidi Publ. Ltd. Bikaner.
2.	Bharucha Erach, The Biodiversity of India, Mapin Publishing Pvt. Ltd., Ahmedabad – 380 013, India.
3.	Miller T.G. Jr. Environmental Science, Wadsworth Publishing Co.
4.	Odum, E.P. 1971. Fundamentals of Ecology. W.B. Saunders Co. USA.
5.	Heywood, V.H & Waston, R.T. 1995. Global Biodiversity Assessment. Cambridge Univ.
6.	Townsend C., Harper J, and Michael Begon, Essentials of Ecology, Blackwell Science.
7.	Wanger K.D., 1998 Environmental Management. W.B. Saunders Co. Philadelphia.

SEMESTER V

School: School of Science		**Program: BSc Chemistry**			
Course Code: CH311		**Course Name: Organic Chemistry-III**			
Year	**III**	**Core Subject (Yes/No):**	**Yes**	**Lecture:**	**3**
Semester	**V**	**Elective Subject (Yes/No):**	**No**	**Tutorial**	**0**
Typology of Course	Lectures	**Foundation Subject (Yes/No):**	**No**	**Practical:**	**0**
		Year of Syllabus Revision:	2018	**Total Credit:**	**3**
		Year of Introduction	**2014**	**Prerequisites (If any)**	***See below**

Prerequisites (If any): Students should have basic concept of stereochemistry and properties of organic compounds with different functional groups.

Course Description:
This course is designed to provide a fundamental overview of organic chemistry to students interested in pursuing a career in the Chemistry. This course is an introduction to organic chemistry, focusing primarily on the basic principles to understand the structure and reactivity of organic molecules. Emphasis is on aldehydes, ketones, carboxylic acids, nitro compounds, amines and heterocyclic compounds. The course also introduces the chemistry of Pericyclic Reactions. Also, this course is helpful to students to understand better about these compounds while performing practical experiments.

Course Objectives:
The objective of this course is to develop abilities of student to understand the organic reaction mechanism and to critically interpret the diverse options regarding possible futures for the organic synthesis with different functional groups.

Course Outcome (CO):
Upon completion of the course students are expected to demonstrate knowledge, skill and abilities in the following areas:

CO1 A range of organic reactions with Aldehydes, Ketones, Carboxylic Acids, Nitro Compounds, Amines, pericyclic reactions.
CO2 open-ended problems related to different organic compounds with functional group (mentioned above) and produce tangible outcomes.
CO3 Preparing to design a reaction mechanism through to completion, encompassing the organic concept.
CO4 Gain mechanistic understanding of selected organic transformations and variety of name reaction in organic chemistry
CO5 Basic concept of pericyclic reactions

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	**Aldehydes, Ketones and Carboxylic Acids** *Aldehydes and Ketones*: Structure and Nomenclature, preparation of aldehydes: oxidation of primary alcohols and methylbenzenes, reduction of acid chlorides, Reimer-Tiemann reaction, preparation of ketones: oxidation of secondary alcohols, Friedel–Crafts acylation, use of lithium dialkylcuprates. Reactions: nucleophilic addition reactions (addition of CN^-, ammonia and its derivatives, alcohol, Grignard reagents), oxidation, reduction, Cannizzaro reaction, haloform reaction, Beckmann Rearrangement. nucleophilic addition of carbanion (Mechanisms of Aldol, Claisen Schmidt and Benzoin condensations, Perkin's reaction, Knoevenagel reaction), Wittig reaction, Beckmann and Benzil – Benzilic acid rearrangements. Oxidation (including Baeyer Villiger oxidation) and Reduction. □,□-Unsaturated carbonyl compounds (nucleophilic and electrophilic addition in brief), Michael addition. *Carboxylic acids*: Introduction, acidity of carboxylic acid, Preparation of carboxylic acids: oxidation of primary alcohols and alkylbenzenes, carbonation of Grignard reagents, hydrolysis of nitriles. Reactions of carboxylic acids: Hell-Volhard-Zelinsky reaction, ring	27	1,2,3,4	CO1 CO2 C03 C04	PSO2 PSO3 PSO4 PSO5

	substitution in aromatic acids, reduction. *Functional derivative of carboxylic acids*: introduction, nucleophilic acyl substitution (alkyl *vs*. acyl), preparation and reactions of acid chlorides, esters and amides, mechanism of esterification and decarboxylation. Preparation and reactions of dicarboxylic acids, conversion to anhydrides and imides. Reformatsky reaction				
2	**Amines and aromatic nitro compounds** Introduction, physical properties, stereochemistry of nitrogen, Aliphatic and aromatic amines preparation: reduction of nitro compounds, ammonolysis of halides, reductive amination, reduction of nitriles and amides, rearrangement reactions (Lossen, Curtius, Schmidt and Hofmann), Gabriel phthalimide synthesis. Reactions: salt formation, alkylation, conversion to amide, ring substitution in aromatic amines, Hofmann elimination, Cope elimination. Structure and basicity of amines: Effects of substituents on basicity of aromatic amines. Separation of 1°, 2° and 3° amines (Hofmann method and Hinsberg method). Diazonium salts: Preparation and reactions (replacement of nitrogen, coupling and reduction)	12	1,2,3,4,5	CO1 CO2 C03 C04	PSO2 PSO3 PSO4 PSO5
3	**Pericyclic Reactions** *Pericyclic Reactions*: Molecular orbitals of ethylene and 1,3-butadiene, and 1,3,5- hexatriene, cycloaddition reactions ([2+2] and [4+2] (Diels-Alder reaction)), electrocyclic reactions, Woodward-Hoffmann rules for electrocyclic reactions, Claisen rearrangement as a sigmatropic reaction, *Photochemical reactions*: Norrish type-I and type-II reactions of carbonyl compounds.	6	1,2,3,4	CO4 CO5	PSO3 PSO4 PSO5

Reference Books	
1.	R. T. Morrison, R. N. Boyd and S. K. Bhattacharjee, *Organic Chemistry*, 7th Ed., Pearson New Delhi, 2012.
2.	M. K. Jain and S. C. Sharma, *Modern Organic Chemistry*, Vishal Publishing Co., New Delhi, 2018.
3.	J. Clayden, N. Greeves, S. Warren, P. Wothers, *Organic Chemistry*, 1st Ed., Oxford University Press, New York, 2001.
4.	T. W. Graham Solomons and Craig B. Fryhle, *Organic Chemistry*, 10th Ed., John Wiley and Sons, 2011.
5.	B. Y. Paula, *Organic Chemistry*, 3rd Ed., Pearson Education, Inc. (Singapore), New Delhi, Reprint, 2002.
6.	ArunBahl& B. S. Bahl, *A Textbook of Organic Chemistry*, S. Chand and Sons, New Delhi, 2005.
7.	Jerry March, *Advanced Organic Chemistry*, 4th Ed., John Wiley and Sons, New York, 1992.
8.	S. H. Pine, *Organic Chemistry*, 5th Ed., McGraw Hill International Edition, Chemistry Series, New York, 1987.

<table>
<tr><td colspan="3">School: School of Science</td><td colspan="3">Program: B.Sc. Chemistry</td></tr>
<tr><td colspan="3">Course Code: CH 302</td><td colspan="3">Course Name: Phase Equilibria, Chemical Kinetics and Catalysis</td></tr>
<tr><td>Year</td><td>III</td><td>Core Subject(Yes/No):</td><td>Yes</td><td>Lecture:</td><td>3</td></tr>
<tr><td>Semester</td><td>V</td><td>Elective Subject(Yes/No):</td><td>No</td><td>Tutorial</td><td>0</td></tr>
<tr><td rowspan="3">Typology of Course</td><td rowspan="3">Lectures and Tutorials</td><td>Foundation Subject(Yes/No):</td><td>No</td><td>Practical:</td><td>0</td></tr>
<tr><td>Year of Syllabus Revision:</td><td>2018</td><td>Total Credit:</td><td>3</td></tr>
<tr><td>Year of Introduction</td><td>2014</td><td>Prerequisites (If any)</td><td>SY B.Sc. Chemistry</td></tr>
</table>

Course Description:
This course deals with phase equilibria of variable systems and chemical kinetics. In the first part, the definitions along with some examples of different terms involved in phase equilibria are discussed. Phase diagram of one component (water, sulphur, carbon dioxide) and two component systems involving eutectic, congruent and incongruent melting points and solid solutions are involved in the chapter. In the latter part, basics of chemical kinetics and the detailed study of zero order, first order and second order kinetics with problems are discussed. In addition, kinetics of complex reactions and theory of catalysis with applications are involved therein.

Course Objectives:
Will acquire basic understanding regarding phase transitions and be able to construct and interpret phase diagrams. Student will be able to learn the fundamentals of chemical reactions, rates of reactions, factors affecting rate of reactions. Will be able to distinguish between order and molecularity of a reaction. Students will comprehend different types of adsorptions, applications of adsorption and significance of adsorption for the process of catalysis.

Course Outcome (CO):
CO1 Acquire comprehensive knowledge about phase equilibrium. Able to construct phase diagram, interpret phase diagram and understand phase transitions.
CO2 Utilization of phase diagrams for industrial applications
CO3 understand the rates of reactions and correlation between rate of a reaction and rate constant, factors affecting rates of reactions, mechanism of reaction
CO4 comprehend different types of reactions, theories of reaction rates, effect of catalyst on reaction rates, classification of catalysts and theories of catalysis
CO5 understanding different types of adsorptions and their significance with respect to different industrial applications and catalysis.

Unit No.	**Topic/Unit**	**Contact Hours**	**BT Level**	**CO**	**PSO**
1	**Unit 1: Phase Equilibria** Concept of phases, components and degrees of freedom, Gibbs Phase Rule; phase diagram for one component systems (water, sulphur, carbon dioxide), with applications. Phase diagrams for two component systems involving eutectic, congruent and incongruent melting points and solid solutions. Solid solutions. Hume-Rothery rules for alloy/solid solution formation. Ideal/non – ideal liquids, Raoult’s Law, Henry’s Law, Steam Distillation. Fractional distillation. Azeotropes, breaking of azeotrope, partial miscibility of liquids, lower and upper critical solution temperature, Immiscible liquid pairs.	16	1,2,3,4,5	CO1 CO2	PSO1 PSO3 PSO4
2	**Unit 2: Chemical Kinetics** Order and molecularity of a reaction. Differential and integrated form of rate expressions up to second order reactions. Experimental methods of the determination of the order of a reaction, kinetics of complex reactions	16	1,2,3,4,5	CO2	PSO1 PSO3 PSO4

	(integrated rate expressions upto first order): Examples of (i) Opposing reactions (ii) parallel reactions and (iii) consecutive reactions and their differential rate equations (steady – state approximation in reaction mechanisms) (iv) chain reactions. Temperature dependence of reaction rates; Arrhenius equation; activation energy. Collision theory and transition state				
3	**Unit 3: Adsorption and Catalysis** Adsorption: Physisorption and Chemisorption and factors affecting adsorption, Freundlich and Langmuir Adsorption Isotherms. BET isotherm (No derivation). Applications. Catalysis: Catalyst, inhibitor, autocatalysis. Homogeneous and heterogeneous catalysis, General characteristics of catalytic reactions. Theories of catalysis. Applications of catalysts in industries. Turn over number. Enzyme catalysis. Applications of catalysts in industries.	13	1,2,3,4,5	CO3	PSO1 PSO3 PSO4 PSO5

Reference Books	
1.	S. H. Maron& J. B. Lando, *Fundamentals of Physical Chemistry*, Macmillan limited, New York, 1966.
2.	B. R. Puri& L. R. Sharma, *Principles of Physical Chemistry*, Shoban Lal Nagin chand and Co. 33rd Ed., 1992.
3.	P.W. Atkins, *Physical Chemistry*, 7th Ed., Oxford UniversityPress, 2001.
4.	S. K. Dogra & S. Dogra, *Physical Chemistry Through Problems*, 4th Ed., New age International, 1996.
5.	Irving M. Klotz & Robert M. Rosenberg, *Chemical Thermodynamics*, John Wiley and sons, Inc., 1994.
6.	Gilbert. W. Castellan, *Physical chemistry*, 3rd Ed., Narosa Publishing House, 1985.
7.	K. L. Kapoor, *A textbook of Physical chemistry*, Vol. – 2 & 3, Macmillan, India Ltd, 1994.

<table>
<tr><td colspan="3">School: School of Science</td><td colspan="3">Program: B.Sc. in Chemistry</td></tr>
<tr><td colspan="3">Course Code: CH 303</td><td colspan="3">Course Name: Spectroscopy and Separation Techniques</td></tr>
<tr><td>Year</td><td>III</td><td>Core Subject(Yes/No):</td><td>Yes</td><td>Lecture:</td><td>3</td></tr>
<tr><td>Semester</td><td>V</td><td>Elective Subject(Yes/No):</td><td>No</td><td>Tutorial</td><td>0</td></tr>
<tr><td rowspan="3">Typology of Course</td><td rowspan="3">Lectures and Tutorials</td><td>Foundation Subject(Yes/No):</td><td>No</td><td>Practical:</td><td>0</td></tr>
<tr><td>Year of Syllabus Revision:</td><td>2018</td><td>Total Credit:</td><td>3</td></tr>
<tr><td>Year of Introduction</td><td>2014</td><td>Prerequisites (If any)</td><td>SY B.Sc. Chemistry</td></tr>
</table>

Course Description:

It gives the basic idea of organic spectroscopy and its application to detect the organic compound having different functional groups. The first unit describes the basic principle of UV-visible and IR spectroscopy, their instrumentation, range etc. The types of electronic transitions and the method to find-out the λ_{max} is well discussed. In addition, fundamental, overtone, combination and coupled bands, fingerprint region, characteristic absorptions of various functional groups are also included in the chapter. The second unit deals with the basic principle of NMR and mass spectroscopy and their application to analyze the unknown compound. In the last unit principle of adsorption and partition chromatography and their applications are included.

Course Objectives:

The students will learn the basics principle of UV-visible, IR spectroscopy, Mass spectroscopy, and NMR their instrumentation, and basics of diverse types of chromatographic techniques like paper chromatography, column chromatography, TLC, Gas Chromatography, Ion Exchange Chromatography, etc.

Course Outcome (CO):

CO1: understand the interaction between UV and Visible radiation with organic compounds and its consequences in elucidation of the structure of organic compounds
CO2: appreciate the concept of IR spectroscopy in detecting some common functional groups during structural elucidation
CO3: investigate the basic principles, Instrumentation, Interpretation of mass spectroscopy and NMR and their application
CO4: learn the basic analytical methods and appreciate what is involved in an analysis like (paper chromatography, column chromatography, TLC, Gas Chromatography, Ion Exchange Chromatography, etc.)

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	**Ultra – Violet and InfraRed Spectroscopy** Electromagnetic spectrum, interaction of electromagnetic radiation with matter, atomic and molecular spectroscopy, absorption and emission spectroscopy. *Ultraviolet – Visible (UV – Vis) Spectroscopy*: Absorption laws, instrumentation, UV – Vis spectrum, types of electronic transitions, concept of chromophore and auxochrome, UV spectra of alkenes, conjugated enes, enones and aromatic compounds. *Infrared (IR) Spectroscopy:* Molecular vibrations, Hooke's Law, selection rules, instrumentation, and measurement of IR spectrum, Fundamental, overtone, combination and coupled bands, fingerprint region, characteristic absorptions of various functional groups.	15	1, 2, 3, 4, 5	CO1, CO2	PSO1, PSO3, PSO4
2	**Mass and Nuclear magnetic resonance (NMR) spectroscopy** Mass Spectrometry: Principle and instrumentation. Fragmentation of simple organic molecules. Nitrogen Rule. McLafferty rearrangement. Relevance of M+1 and M+2 peaks in mass spectra. Determination of molecular formula and structure of compound based on mass spectral data. Nuclear Magnetic Resonance (NMR) Spectroscopy: Nuclear magnetic resonance, instrumentation, proton NMR, nuclear shielding and deshielding, chemical shift, spin-spin splitting, interpretation of NMR spectra of simple organic molecules. Problems based on structure determination using NMR spectra.	15	1, 2, 3, 4, 5	CO3	PSO1, PSO3, PSO4

3	**Separation Techniques** Principle of adsorption and partition chromatography. *Column chromatography*: adsorbents, classification of adsorbents, solvents, preparation of column, adsorption and applications. *Thin Layer Chromatography*: choice of adsorbent, choice of solvent, R_f value and its applications. *Paper chromatography*: solvent used, R_f value, factors which affect R_f value. Ion exchange chromatography, resins used, experimental techniques, applications. *Gas Chromatography*: Principle, instrumentation Applications.	15	1, 2, 3, 4, 5	CO4	PSO1, PSO3, PSO4

Reference Books	
1.	D. A. Skoog, D. M. West & F.J. Holler, *Analytical Chemistry: An Introduction*, 5th Ed., Saunders college publishing, Philadelphia, 1990.
2.	S. M. Khopkar, *Basic concept of Analytical Chemistry*, 2nd Ed., New Age International, Publishers, New Delhi, 1998.
3.	P. S. Kalsi. Spectroscopy of Organic Compounds. New Age International Publishers, New Delhi. 6th Edition. 2005.

School: Science		**Program: B.Sc (Chemistry)**			
Course Code: CH 304		**Course Name: Chemistry laboratory-IX**			
Year	**III**	**Core Subject(Yes/No):**	**Yes**	**Lecture:**	**0**
Semester	**V**	**Elective Subject(Yes/No):**	**No**	**Tutorial**	**0**
Mode of Transaction	Laboratory	**Foundation Subject(Yes/No):**	**No**	**Practical:**	**8**
		Year of Syllabus Revision:	**2018**	**Total Credit:**	**4**
		Year of Introduction	**2014**	**Prerequisites (If any)**	**SY B.Sc. Chemistry**

Course Description:

An essential element of experimental organic chemistry is the identification of unknown organic compounds from the given mixture. This course covers the following topics: separation and purification of organic molecules; synthesis using diverse techniques; and functional group identification using various organic methods.

Physical chemistry practicals make up the second half of this course. Physical Chemistry is a branch of science that combines physics and chemistry to study the physical properties of molecules and the relationships between those properties and their composition. This course introduces students to the fundamental concepts of physical chemistry, chemical thermodynamics, Electrochemistry, Spectroscopy, Chemical kinetics, First and second-order reactions, Integrated rate laws, Reaction rate theories, solutions of electrolytes, Faraday's law of electrolysis, molar conductivity, Arrhenius theory, Ostwald's dilution law, thermodynamics of electrochemical cells, applications of emf measurements, surface chemistry, Langmuir Adsorption Isotherm, Chemical reactions on surfaces. The laboratory portion of the course teaches a variety of theoretical and applied physical chemistry techniques that are useful in both industrial and research contexts.

Course Outcome (CO):

CO1: Gain knowledge on organic qualitative analysis for a binary organic compound using various separation techniques like distillation, separation, crystallization derivatization and function group detection for both solid as well as liquid compounds.

CO2: Lastly identify given unknown organic compound by taking melting/boiling point depending on the state of the compounds and carry out crystallization and prepare derivative for purification of an organic compound.

CO3: To conduct the experiment on various instrumental techniques and to describe the principles behind the experiment performed in the laboratory.

CO4: understand the instrumentation techniques like conductometric titration, potentiometric titration, pHmetry, chemical kinetics, hydrolysis of sucrose using polarimetry, decomposition of H2O2 using gasometer, COD, etc.

CO5: Understanding the UV- spectroscopy and its theoretical aspect of the instrument that is been used for colored compounds. Lastly, to interpret the experimental results obtained by refractometer, spectrophotometer, Ph meter, potentiometer.

No.	**Experiment**	**Contact Hours**	**BT Level**	**CO**	**PSO**
	Identification of given Unknown Organic Compounds (Organic Spotting)				
1	Acid + Neutral (Benzoic Acid + Naphthalene)	4	1,2,3,4,5	CO1, CO2	PSO1, PSO2, PSO3 PSO4 PSO5
2	Acid + Neutral (Phthalic acid + Acetanilide)	4	1,2,3,4,5	CO1, CO2	PSO1, PSO2, PSO3 PSO4 PSO5
3	Phenol + Neutral (B-Naphthol + P-Toluidine)	4	1,2,3,4,5	CO1, CO2	PSO1, PSO2, PSO3 PSO4 PSO5

4	Acid + Base (Cinnamic acid + P-nitroaniline)	4	1,2,3,4,5	CO1, CO2	PSO1, PSO2, PSO3 PSO4 PSO5
5	Base+ Neutral (m-nitroaniline + Anthracene)	4	1,2,3,4,5	CO1, CO2	PSO1, PSO2, PSO3 PSO4 PSO5
6	Acid + Phenol (Salicylic acid + Resorcinol)	4	1,2,3,4,5	CO1, CO2	PSO1, PSO2, PSO3 PSO4 PSO5
7	Base+ Neutral (Aniline+ Toluene)	4	1,2,3,4,5	CO1, CO2	PSO1, PSO2, PSO3 PSO4 PSO5
8	Neutral+ Neutral (Ethyl acetate + Nitrobenzene)	4	1,2,3,4,5	CO1, CO2	PSO1, PSO2, PSO3 PSO4 PSO5
9	Neutral + Neutral (Benzaldehyde+ Benzophenone)	4	1,2,3,4,5	CO1, CO2	PSO1, PSO2, PSO3 PSO4 PSO5
10	Acid + Neutral (Salicylic acid + Acetamide)	4	1,2,3,4,5	CO1, CO2	PSO1, PSO2, PSO3 PSO4 PSO5
	Physical Chemistry Experiments				
11	To study the adsorption of oxalic acid on charcoal.	4	1,2,3,4,5	CO3, CO4, CO5	PSO1, PSO2, PSO3 PSO4 PSO5
12	To determine equivalent conductance, degree of dissociation and the dissociation constant of weak acid conductometrically.	4	1,2,3,4,5	CO3, CO4, CO5	PSO1, PSO2, PSO3 PSO4 PSO5
13	To determine the rate constant of acid catalyzed hydrolysis of sucrose	4	1,2,3,4,5	CO3, CO4, CO5	PSO1, PSO2, PSO3 PSO4 PSO5
14	To determine the Relative strength of two acids.	4	1,2,3,4,5	CO3, CO4, CO5	PSO1, PSO2, PSO3 PSO4 PSO5
15	To determine the Chemical oxygen demand (COD) for the given polluted sample.	4	1,2,3,4,5	CO3, CO4, CO5	PSO1, PSO2, PSO3 PSO4 PSO5

16	To determine the normality of acetic acid potentiometrically.	4	1,2,3,4,5	CO3, CO4, CO5	PSO1, PSO2, PSO3 PSO4 PSO5
17	To determine the λ_{max} and concentration of given unknown Potassium permanganate (KMnO4) using Visible Spectroscopy technique.	4	1,2,3,4,5	CO3, CO4, CO5	PSO1, PSO2, PSO3 PSO4 PSO5
18	To determine the strength of acetic acid and NaOH solution conductometrically	4	1,2,3,4,5	CO3, CO4, CO5	PSO1, PSO2, PSO3 PSO4 PSO5
19	Catalytic decomposition of hydrogen peroxide using metal ions as a catalyst.	4	1,2,3,4,5	CO3, CO4, CO5	PSO1, PSO2, PSO3 PSO4 PSO5
20	To find out surface tension of given liquid by drop number method at room temperature and calculate the Parachor.	4	1,2,3,4,5	CO3, CO4, CO5	PSO1, PSO2, PSO3 PSO4 PSO5
21	To determine the equilibrium constant of a reaction with the help of a spectrophotometer	4	1,2,3,4,5	CO3, CO4, CO5	PSO1, PSO2, PSO3 PSO4 PSO5
22	To find out the composition and viscosity of unknown liquid mixture by viscometer method.	4	1,2,3,4,5	CO3, CO4, CO5	PSO1, PSO2, PSO3 PSO4 PSO5

Reference Books	
1.	A. I. Vogel, A textbook of Practical Organic Chemistry, Fourth Edition.
2.	R.C. Shah's Organic Spotting, Edited by P. Samnani, Ria Publishing House, Gujarat.
3.	A. Silbey, Physical Chemistry, Fourth Edition, Wiley, 2002.
4.	Puri, Sharma and Pathania, Principles of Physical Chemistry, 47th Edition. 1962-2016.

School: Science			**Program: B.Sc Chemistry**		
Course Code: CH 305			**Course Name: Chemistry Laboratory-X**		
Year	**III**	**Core Subject(Yes/No):**	**Yes**	**Lecture:**	**0**
Semester	**V**	**Elective Subject(Yes/No):**	**No**	**Tutorial**	**0**
Mode of Transaction	Laboratory	**Foundation Subject(Yes/No):**	**No**	**Practical:**	**8**
		Year of Syllabus Revision:	**2018**	**Total Credit:**	**4**
		Year of Introduction	**2014**	**Prerequisites (If any)**	**SY B.Sc. Chemistry**

Course Description:
Inorganic Quantitative Analysis (Gravimetric Analysis) is a branch of chemistry that is concerned with determining the amount and concentration of one or more constituents in a sample. Quantitative analyses are carried out using several methodologies, which can be classed as chemical or physical depending on which properties are used. Precipitation, neutralization, oxidation, and, in general, the production of a new compound is all used in chemical processes. Gravimetric analysis and volumetric, or titrimetric, analysis are the two most common forms of exclusively chemical procedures. In most cases, an analysis will involve a combination of methods: qualitative for isolating desirable constituents from a sample and quantitative for determining the amounts present. The analytical balance is the most important tool in all quantitative tests since it allows for the precise weighing of materials and precipitates.

Course Outcome (CO):
CO1 Gain knowledge on volumetric and gravimetric analysis, wherein gravimetric analysis and volumetric titration works on the idea of determining the mass of an ion in a pure compound and then using that information to calculate the mass percentage of that same ion in a known quantity of an impure compound.
CO2 The student will get in-hand experience of separating the element from the given sample and will calculate the amount and the concentration of elements.
CO3 Facilitate the students to make solutions of various molar concentrations. This may include: The concept of the mole; Converting moles to grams; Converting grams to moles; Defining concentration; Dilution of Solutions; Making different molar concentrations.
CO4 Students will explore the concept of Inorganic quantitative analysis to find out the concentrations of cations and anions.
CO5 Practical training in the field of Inorganic chemical analysis.

No.	Experiment	Contact Hours	BT Level	CO	PSO
	Quantitative separation and determination of the following pairs of metal ions using gravimetric and volumetric methods.				
1	Cu^{2+} (Volumetrically) and Fe^{3+}(Gravimetrically)	4	1,2,3,4,5	CO1, CO2, CO3, CO4, CO5	PSO1, PSO2, PSO3, PSO4, PSO5
2	Cu^{2+} (gravimetrically) and Ni^{2+}(Volumetrically)	4	1,2,3,4,5	CO1, CO2, CO3, CO4, CO5	PSO1, PSO2, PSO3, PSO4, PSO5
3	$^{Ni2+}$ (gravimetrically) and Cu^{2+}(Volumetrically)	4	1,2,3,4,5	CO1, CO2, CO3, CO4, CO5	PSO1, PSO2, PSO3, PSO4, PSO5
4	Cu^{2+} (gravimetrically) and Fe^{3+}(Volumetrically)	4	1,2,3,4,5	CO1, CO2,	PSO1, PSO2, PSO3,

				CO3, CO4, CO5	PSO4, PSO5
5	Al^{3+} (gravimetrically) and Cu^{2+}(Volumetrically)	4	1,2,3,4,5	CO1, CO2, CO3, CO4, CO5	PSO1, PSO2, PSO3, PSO4, PSO5
6	$^{Mg2+}$ (gravimetrically) and Ca^{2+}(Volumetrically)	4	1,2,3,4,5	CO1, CO2, CO3, CO4, CO5	PSO1, PSO2, PSO3, PSO4, PSO5
7	Ba^{2+} (gravimetrically) and Ca^{2+}(Volumetrically)	4	1,2,3,4,5	CO1, CO2, CO3, CO4, CO5	PSO1, PSO2, PSO3, PSO4, PSO5
8	Al^{3+} (gravimetrically) and Ba^{2+} (gravimetrically)	4	1,2,3,4,5	CO1, CO2, CO3, CO4, CO5	PSO1, PSO2, PSO3, PSO4, PSO5
9	Cl^- Volumetrically (Mohr's, Volhard, Fajan's method)	4	1,2,3,4,5	CO1, CO2, CO3, CO4, CO5	PSO1, PSO2, PSO3, PSO4, PSO
10	Ca^{2+} (gravimetrically) and Mg^{2+}(Volumetrically)	4	1,2,3,4,5	CO1, CO2, CO3, CO4, CO5	PSO1, PSO2, PSO3, PSO4, PSO5

Reference Books	
1.	A. I. Vogel, *Fundamentals of Quantitative Analysis*, 5th Ed., Addison Wesley longman., 1989.
2.	G. Suehla, *Vogel's Qualitative Inorganic Analysis*, 6th Ed., Orient Longman, 1989 J. Mendham, R. C. Denney, J. B. Barnes & M. J. K. Thomas, *Vogel's Textbook of Quantitative Chemical Analysis*, 6th Ed., Pearson Education, New Delhi, 2003.
3.	P. Samnani, *Experiments in Chemistry*, Anmol Publications, New Delhi 2007

<table>
<tr><td colspan="3">School: School of Science</td><td colspan="3">Program: BSc. Chemistry</td></tr>
<tr><td colspan="3">Course Code: SE201</td><td colspan="3">Course Name: Essential Laboratory Practices</td></tr>
<tr><td>Year</td><td>III</td><td>Core Subject(Yes/No):</td><td>No</td><td>Lecture:</td><td>2</td></tr>
<tr><td>Semester</td><td>V</td><td>Elective Subject(Yes/No):</td><td>Yes</td><td>Tutorial</td><td>0</td></tr>
<tr><td rowspan="3">Typology of Course</td><td rowspan="3">Lectures</td><td>Foundation Subject(Yes/No):</td><td>No</td><td>Practical:</td><td>0</td></tr>
<tr><td>Year of Syllabus Revision:</td><td>NA</td><td>Total Credit:</td><td>2</td></tr>
<tr><td>Year of Introduction</td><td>2016</td><td>Prerequisites (If any)</td><td>Basic knowledge about lab apparatus handling and SOPs
which students
have learned in their previous year laboratory sessions.</td></tr>
</table>

Course Description:
This Essential Laboratory Practice course provides an essential grounding in the way all types of non-clinical health and environmental safety studies should be planned, performed, monitored, recorded, archived and reported.

Course Objectives:
To provide students with good laboratory practice
To prepare student for Quality control training
To prepare students for Clinical Studies

Course Outcome (CO):
CO1: the role of Essential Laboratory Practices in the Biotechnology industry
CO2: the regulatory aspects of laboratories
CO3: importance of quality control
CO4: Food and Drug Regulations
CO5: In-vitro and In Vivo techniques principle and application

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	**Unit I** In vivo studies, In vitro studies, regulatory affairs, drug development, preclinical studies, clinical studies	15	1,2,3,5	CO1, CO5,	PSO1, PSO3, PSO5
2	**Unit II** Quality System Regulations (QSR), Good Clinical Practice (GCP), Good Laboratory Practices (GLP), Good Manufacturing Practice (GMP), FDA inspections	15	1,2,3,4	CO1, CO2, CO3, CO4	PSO1 PSO3, PSO5

Reference Books	
1.	Weinberg, S. (Ed.). (2003). Good laboratory practice regulations. Marcel Dekker.
2.	Seiler, J. P. (2006). Good Laboratory Practice: The why and the how. Springer Science & Business Media.
3.	McPherson, R. A., & Pincus, M. R. (2017). Henry's Clinical Diagnosis and Management by Laboratory Methods E-Book. Elsevier Health Sciences.
4.	Ezzelle, J., Rodriguez-Chavez, I. R., Darden, J. M., Stirewalt, M., Kunwar, N., Hitchcock, R., ... & D'souza, M. P. (2008). Guidelines on good clinical laboratory practice: bridging operations between research and clinical research laboratories. Journal of pharmaceutical and biomedical analysis, 46(1), 18-29.

School: School of Science			**Program: BSc Chemistry**		
Course Code: SE202			**Course Name: Food and Nutrition**		
Year	**III**	**Core Subject(Yes/No):**	No	**Lecture:**	2
Semester	**V**	**Elective Subject(Yes/No):**	Yes	**Tutorial**	0
Typology of Course	Lectures	**Foundation Subject(Yes/No):**	**No**	**Practical:**	0
		Year of Syllabus Revision:	**NA**	**Total Credit:**	**2**
		Year of Introduction	**2016**	**Prerequisites (If any)**	**FY BSc Chemistry**

Course Description:

Nutrition refers to the science which deals with the role of nutrients and other substances in health, growth, physiology and disease of an individual. A proper diet is determined by the proper proportions, requisite quantities, availability, method of cooking and palatability of the food.

Course Objectives:

To prepare students for successful career in industry and research institutes.
To enable students to work in a team with multidisciplinary approach.
To provide students with fundamental strength in analyzing, designing and solving health related problems.

Course Outcome (CO):

CO1 Identify nutrition and health problems associated with diet
CO2 Importance of eating patterns and dietary needs both for people of different ages and for different groups within society
CO3 Understand the basis for different methods of cooking

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	An understanding of the terms used in nutrition and the concept of diet and nutrition Balanced diet, My plate, Nutrition and dietetics. Nutritive value of foods - The sources and functions of: proteins, carbohydrates, fats, vitamins, Mineral elements, water, Sources and uses of food energy, Sources and functions of dietary fibre. Dietary guidelines - Factors affecting food requirements, Planning and serving of family meals. Meals for all ages and occupations. Special needs of pregnant and lactating women, convalescents, Vegetarians, Use of herbs, spices and garnishes. Composition and value of the main foods in the diet - Milk, meat, fish, cheese, eggs, margarine and Butter, Cereals, fruits and vegetables.	15	1,2	CO1	PSO1
2	Cooking of food Transfer of heat by conduction, convection and radiation. Principles involved in the different methods of cooking – boiling, stewing, grilling, baking, roasting, frying, steaming, pressure cooking, Preparation and cooking of food to preserve nutritional value and flavour. Traditional methods of cooking. Economical use of food, equipment, fuel and labour. Food spoilage, and hygiene in the handling and storage of food, Food preservation.	15	1,2	CO2,3	PSO1

Reference Books

1	N.W. Desrosier & J. N. Desrosier, The Technology of Food Preservation, Westport: Connecticut, Publishing Company, 1997. 2. Deaton, A., & Drèze, J. (2009).
2	Food and nutrition in India: facts and interpretations. Economic and political weekly, 42-65. 3. Duyff, R. L. (2012).
3	American dietetic association complete food and nutrition guide. Houghton Mifflin Harcourt. 4. Curry, K. R. (2000).
4	Multicultural competence in dietetics and nutrition. Journal of the Academy of Nutrition and Dietetics, 100(10), 1142.
5	E. Whitney, E. Hamiliton & S. Rolfes, Understanding Nutrition, St. Paul, MN: West Publishing Company, 1990. 6. Mahan, L. K. (2004).
6	Krause's food, nutrition, & diet therapy (Vol. 11). S. Escott-Stump (Ed.). Philadelphia: Saunders.

<table>
<tr><td colspan="3">School: School of Science</td><td colspan="3">Program: B.Sc. Chemistry</td></tr>
<tr><td colspan="3">Course Code: SE204</td><td colspan="3">Course Name: Intellectual Property Rights and Patents Law</td></tr>
<tr><td>Year</td><td>III</td><td>Core Subject(Yes/No):</td><td>No</td><td>Lecture:</td><td>2</td></tr>
<tr><td>Semester</td><td>V</td><td>Elective Subject(Yes/No):</td><td>Yes</td><td>Tutorial</td><td>0</td></tr>
<tr><td rowspan="3">Typology of Course</td><td rowspan="3">Lectures and Tutorials</td><td>Foundation Subject(Yes/No):</td><td>No</td><td>Practical:</td><td>0</td></tr>
<tr><td>Year of Syllabus Revision:</td><td>2018</td><td>Total Credit:</td><td>2</td></tr>
<tr><td>Year of Introduction</td><td>2014</td><td>Prerequisites (If any)</td><td>FY BSc Chemistry</td></tr>
</table>

Course Description:
This course deals with study of history of Intellectual Property system (International as well as India), introduction of various types of Intellectual Property Rights and laws governing them. It also deals with comprehensive understanding of patents law, its use during patent drafting and procedures underlying patent filing.

Course Objectives:
Comprehend the importance of intellectual property rights, intellectual property protection and significance with respect to economy and Scientific innovation. Distinguish between different intellectual property rights and utilization of intellectual property rights for leveraging financial benefits and seeking rights for intellectual creations.

Course Outcome (CO):
CO1 acquire basic understanding of intellectual property rights, historical perspective and evolution of Intellectual Property Rights at global level and in India
CO2 acquire knowledge on basic concepts of different intellectual properties, viz. copyrights, trademarks, geographical indications, Industrial Design Protection and Trade secrets. Protection of Plan Varieties and Farmers Rights Act etc.
CO3 gain insights into laws governing Intellectual Property Rights, especially Patents law
CO4 develop thorough understanding of Patents law, patentable inventions
CO5 use of patents law during patent drafting and procedures underlying patent filing

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	**Unit 1: Introduction to IPR** Understanding Intellectual Property Rights (IPRs), history of Intellectual Property (IP) system, development of IP law in India, evolution of IPR regime. Introduction to IP laws in India and an overview on Patents, Copyright, Trademarks, Geographical Indicators, Industrial Design Protection and Trade secrets. Protection of Plan Varieties and Farmers Rights Act.	13	1,2,3,4	CO1 CO2 CO3	PSO1 PSO4
2	**Unit 2: Patents Laws** Patenting: Important of Patent Policy, Patents Act 1970, Patents Amendment Act 1999, Patents Amendment Act, 2002. Patent Act 2005. Procedure for Patent Application. Patent Drafting and details therein, viz. Specifications, Claims. Grant of Patents, Opposition to Patents, Patent Licensing, Patent Search	17	1,2,3,4,5	CO3 CO4 CO5	PSO1 PSO4

Reference Books

1.	E. F. Charles Rickett & W. Austin Graeme, International intellectual property and the common law, World Ed., Hart Publishing, 2000.
2.	Robert P Merges, Peter S Menell & Mark A Lemley, Intellectual property in the new technological age, 2nd Ed., Aspen Law and Business, 2000.
3.	Prabudhha Ganguli, Gearing up for patents: The Indian Scenario, Universities Press (India) Ltd. 1998.
4.	T. Ramappa, Intellectual Property Rights under WTO: Tasks before India, Wheeler Publishing, 2000.
5.	Patent Office Manual, Department of Industrial Policy and Policy Protection, Government of India, New Delhi.

School: School of Science	**Program: BSc Chemistry**
Course Code: SE213	**Course Name:** Introduction to Neuroscience and Cognition

Year	**III**	**Core Subject (Yes/No):**	**No**	**Lecture:**	**2**
Semester	**V**	**Elective Subject (Yes/No):**	**Yes**	**Tutorial**	**0**
Typology of Course	Lectures	**Foundation Subject (Yes/No):**	**No**	**Practical:**	**0**
		Year of Syllabus Revision:	**NA**	**Total Credit:**	**2**
		Year of Introduction	**2019**	**Prerequisites (If any)**	**SY BSc Chemistry**

Course Description:
This course introduces basic neuroanatomy, neurophysiology, neural plasticity, functional imaging techniques. It also explains cognitive and neural processes that support attention, vision, language, motor control, navigation, and memory. Course explores behavioral measures of cognition and discusses methods by which inferences about the brain bases of cognition are made along with various neurological disorders.

Course Objectives:
Development and organization of nervous system, types of cells in CNS and PNS, understanding concept of neurophysiology, electric firing of neurons, and types of synapses- chemical and electrical. The course also describes neurobiology of sleep, memory and attention along with the various neurological disorders.

Course Outcome (CO):

CO1. Concepts of neuroanatomy, neurophysiology, development, and sensation/ perception
CO2. Principle of cognitive science, cognitive control, plasticity
CO3. Modes of learning and memory, attention and action, sleep, emotion and language
CO4. Various neurological disorders

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	**Unit I:** Nervous Physiology and Functions: Introduction to neuroscience, History of neuroscience and Introduction to Neurons, Neurology of biological cycle and techniques to study neurology, Types of Neurons, Circadian rhythm, Action Potential, Evolution of Neurons, Evolution of nervous system, Neuroanatomy- Structure of brain, spinal cord, medulla oblongata, Neurophysiology, Neurotransmitters	15	1,2,3	CO1	PSO1
2	**Unit II:** Cognition and Defects Sleep cycle and disorders, Neurology of Learning, Neurology of Memory, Neurology of Attention and Action, Neurology of Emotions and Language, Development of neurons, Plasticity of Neurons, Methods in Cognitive Science, Sensation and perception, Cognitive control, Object recognition, Neurological Disorder.	15	1,2,3	CO2, CO3, CO4	PSO1

Reference Books

1.	Bear, Connors, Paradiso-Neuroscience '16 58
2.	Development of the nervous system second edition dan h. Sanes thomas a. Reh, william a. Harris amsterdam, Academic Press is an imprint of Elsevier 3
3.	Basic Neurochemistry: Principles of Molecular, Cellular, and Medical Neurobiology (2011) Scott Brady. Elsevier Science & Technology
4.	Basic Neurochemistry: Molecular, Cellular and Medical Aspects (1994) George J. Siegel, Bernard W. Agranoff, R. Wayne Albers, Perry B. Molinoff. Raven Press
5.	Handbook of Neurochemistry (1969) A. Lajtha. Plenum Press
6.	Selected Topics from Neurochemistry (1985) N. N. Osborne. Elsevier Science Limited.

School: School of Science			**Program: B. Sc. Chemistry**		
Course Code: SE 302			**Course Name: Medicinal Chemistry-I**		
Year	**III**	**Core Subject(Yes/No):**	**No**	**Lecture:**	**2**
Semester	**V**	**Elective Subject(Yes/No):**	**Yes**	**Tutorial**	**0**
Typology of Course	Lectures	**Foundation Subject(Yes/No):**	**No**	**Practical:**	**0**
		Year of Syllabus Revision:	**2018**	**Total Credit:**	**2**
		Year of Introduction	**2014**	**Prerequisites (If any)**	**SY B.Sc. Chemistry**

Course Description:

This course is designed to introduce factors that play important roles in effect of drug in the body. Active principles in drug, excipients and other important constituents that go in drug making will be introduced. The journey of thousands of drug candidates screened for potential candidates that actually reach the market after numerous tests will be explained. Important antibiotics will be introduced with respect to their structures, activities and applications.

Course Objectives:

the student will have knowledge of: General structural features of agents belonging to the therapeutic class, Relevant physicochemical properties of active pharmacophores, their Relevant chemical reactions/synthetic pathways for selected drugs, moreover their Structural influences on mechanism of pharmacologic action (structure-activity relationship) and their toxicological profile.

Course Outcome (CO):

CO1: Knowledge of the connection between the structural features of the drugs and their physico-chemical characteristics, mechanism of action and use.

CO2: Application the gained knowledge about the therapeutic classes of drugs.

CO3: Describe the basics to understand active pharmacophore, mechanism of action, use and mode of application of the selected drugs on the basis of their structure.

CO4: Describe and perform synthesis of the drugs and determine its pharmacologic action (structure-activity relationship) and their toxicological profile

Unit No.	**Topic/Unit**	**Contact Hours**	**BT Level**	**CO**	**PSO**
1	Concept of drug, lead compound and lead modification, prodrugs and soft drugs; Structure activity relationship (SAR), quantitative structure-activity relationship (QSAR); Factors affecting bioactivity-resonance, inductive effect, isosterism, bio-isosterism, spatial considerations; Theories of drug activity – occupancy theory, rate theory, induced fit theory Concept of drug receptors – elementary treatment of drug –receptor interactions; Physicochemical parameters lipophilicity, partition coefficient, electronic ionization constants, steric, Shelton and surface activity parameters and redox potentials; Factors affecting modes of drug administration, absorption, metabolism and elimination; Significance of drug metabolism in medicinal chemistry.	15	1, 2, 3, 4, 5	CO1, CO2, CO3	PSO1, PSO3, PSO5
2	**Antibiotics** Cell wall biosynthesis, inhibitors of β-lactam rings, antibiotics inhibiting protein synthesis; Isolation, structure elucidation, synthesis, SAR and mode of action of penicillins; Synthesis of penicillin G, penicillin V, ampicillin, amoxicillin and cephalosporin. Isolation, structure elucidation, synthesis,	15	1, 2, 3, 4, 5	CO1, CO2, CO3, CO4	PSO1, PSO3, PSO5

	SAR and mode of action of following antibiotics: streptomycin, tetracyclines and chloramphanicol.				

Reference Books	
1.	Burger, *Medicinal Chemistry and Drug Discovery*, Vol. – 1, Ed., M. E. Wolff, John Wiley, 1994.
2.	Goodman & Gilman, *Pharmacological Basis of Therapeutics*, Mc Graw – Hill, 2005.
3.	S. S. Pandeya & J. R. Dimmock. *Introduction to Drug Design*, New Age International, 2000.
4.	D. Lednicer, *Strategies for Organic Drug Synthesis and Design*, John Wiley, 1998.
5.	Graham & Patrick. *Introduction to Medicinal Chemistry*, 3rd Ed., OUP, 2005.

<table>
<tr><td colspan="3">School: School of Science</td><td colspan="3">Program: BSc Chemistry</td></tr>
<tr><td colspan="3">Course Code: SE305</td><td colspan="3">Course Name: Introduction to Cell and Tissue Culture</td></tr>
<tr><td>Year</td><td>III</td><td>Core Subject (Yes/No):</td><td>No</td><td>Lecture:</td><td>2</td></tr>
<tr><td>Semester</td><td>V</td><td>Elective Subject (Yes/No):</td><td>Yes</td><td>Tutorial</td><td>0</td></tr>
<tr><td rowspan="3">Typology of Course</td><td rowspan="3">Lectures</td><td>Foundation Subject (Yes/No):</td><td>No</td><td>Practical:</td><td>0</td></tr>
<tr><td>Year of Syllabus Revision:</td><td>NA</td><td>Total Credit:</td><td>2</td></tr>
<tr><td>Year of Introduction</td><td>2019</td><td>Prerequisites (If any)</td><td>SY B.Sc. Chemistry</td></tr>
</table>

Course Description:
This course provides an expertise in animal and plant tissue culture theory and practice. It introduces the student to the theory and practice of plant tissue culture and their role from modifying plants in plant biotechnology to the propagation of endangered plants and from modifying cell lines to the propagation of all lines for use in medical, microbiological, and biochemical research. It also emphasizes on the importance and applications of stem cells.

Course Objectives:
To understand the concept of cell and tissue culture. The course describes various methods and aspects of plant tissue culture such as sterilization and media preparation, the composition of media for different cultures, types of tissue cultures and the creation of hybrid plants through micropropagation. The course also highlights the basics of animal cell culture, media sterilization, biology of cells in culture and various assays done to test compounds as a method of drug development studies.

Course Outcome (CO):

CO1.	Understand the methods for plant and animal tissue culture and characterization.
CO2.	Study the applications of plant and animal tissue cultures
CO3.	Understand different types and methods of cell culture.
CO4.	To study the culture and characterization of animal cell lines.

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	**Unit I:** Plant Tissue Culture History and scope of plant tissue culture. Laboratory requirements and organization. Sterilization methods. Media preparation-inorganic nutrients, organic supplements, carbon source, vitamins, gelling agents, phytohormones and growth regulators; composition of commonly used culture media. Types of tissue culture-plantlets, seedlings, callus, somatic embryogenesis. Micropropagation: Factors affecting morphogenesis and proliferation rate; technical problems in micropropagation. Organogenesis: formation of shoots and roots, production of virus free plants by meristem and shoot tip culture Hybrid plants: protoplast isolation, culture and fusion, selection of hybrid cells and regeneration of hybrid plants, symmetric and asymmetric hybrid, cybrid. Production of haploid plants: anther, pollen, and ovary cultures for production of haploid plants and homozygous lines.	15	1,2,3	CO1, CO2	PSO1
2	**Unit II:** Animal Cell Culture Introduction to Mammalian Cell Culture and its history, Application of cell culture, Equipments and materials for animal cell culture technology, Media composition for cell culture (Basal media and supplements), Characteristics of cells in culture: Contact inhibition, anchorage dependence (adherent and non-adherent, way to passage it), cell-cell communication (cell junction basics, co-culture), Cell senescence (telomerase and ageing), Types of culture (cell/tissue/organ).	15	1,2,3	CO3, CO4	PSO1

	Various systems of tissue culture, their distinguishing features, advantages and limitations, applications, measurement of viability and cytotoxicity, various cell cultures: primary, cell lines immortalized, transformed, haploid and diploid cell lines and Stem cells (based on potency- totiptent, multipotent, pleuripotent, oligopotent and based on their origin-embryonic, hematopoietic, somatic), iPSC (mechanism of its generation with eg. Human fibroblast to pluripotent-beta cell of pancrease), transfection methods (lipofection, calcium mediated, electroporation), Tissue engineering				

Reference Books	
1.	Introduction to plant tissue culture (1993) M. K. Razdan. Science Publishers Inc.
2.	Plant Cell and Tissue Culture (1994), Indra K. Vasil, Trevor A. Thorpe. Springer
3.	R. Ian Freshney -Culture of Animal Cells_ A Manual of Basic Technique and Specialized Applications, Sixth Edition-Wiley-Blackwell (2010)
4.	Masters, J. R. W. (Ed): Animal Cell Culture – Practical Approach, Oxford Univ. Press.
5.	Basega, R. (Ed): Cell Growth and Division: A Practical Approach. IRL Press.
6.	Clynes, M. (Ed.). (2012). Animal cell culture techniques. Springer Science & Business Media.
7.	Knoepfler, P. (2013). Stem cells: an insider's guide. World Scientific.
8.	Turksen, K. (Ed.). (2012). Adult and Embryonic Stem Cells. Springer Science & Business Media.
9.	Lanza, R., Gearhart, J., Hogan, B., Melton, D., Pedersen, R., Thomas, E. D., & West, M. (Eds.). (2005). Essentials of stem cell biology. Elsevier.

School: School of Science	**Program: B.Sc (Chemistry)**
Course Code:SE307	**Course Name: Number Theory**

Year	**III**	**Core Subject(Yes/No):**	**No**	**Lecture:**	**2**
Semester	**V**	**Elective Subject(Yes/No):**	**Yes**	**Tutorial**	**0**
Typology of Course	Lectures and Discussions	**Foundation Subject(Yes/No):**	**No**	**Practical:**	**0**
		Year of Syllabus Revision:	**NA**	**Total Credit:**	**2**
		Year of Introduction	**2019**	**Prerequisites (If any)**	**SY B.Sc. Chemistry**

Course Description: This course is about the study of the fundamental properties of the Number systems and their application to the real-world problems

Course Objectives: The objective of this course is to

- Understand some of the important theorems in Number Theory which helps them in solving some of the real-world problems with their applications.
- Learn the basic properties of the number system such as the Euclid's Algorithm, congruences, residue classes and solve linear congruences

Course Outcome (CO):

CO1: Learn the properties of numbers and properties of numbers, prime numbers
CO2: Find greatest common divisors of numbers, solve linear Diophantine equations
CO3: Learn about linear congruences and Chinese remainder theorem
CO4: Learn about Wilson's theorem, Fermat's little theorem and their applications
CO5: Learn about the multiplicative functions and their applications
CO6: Find the primitive roots

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	Numbers and Sequences: Sums and Products, Mathematical Induction, The Fibonacci Numbers. Primes and Greatest Common Divisors: Prime Numbers, distribution of Primes	5	1,2,5	CO1	PSO1
2	Greatest Common Divisors, Euclidean Algorithm, Fundamental Theorem of Arithmetic, Factorization Methods and Fermat Numbers, Linear Diophantine Equations.	5	1,2,3,5	CO2	PSO1
3	Congruences: Introduction to Congruences, Linear Congruences, Chinese Remainder Theorem. Applications of Congruences: Divisibility Tests, Check Digits	5	1,2,3,4,5	CO3	PSO1
4	Some Special Congruences, Wilson's Theorem and Fermat's Little Theorem, Pseudoprimes, Euler's Theorem	5	2,3,5	CO4	PSO1
5	Multiplicative functions: The Euler Phi-Function, The Sum and Number of Divisors, Perfect Numbers and Mersenne Primes, Mobius Inversion	5	2,3,4,5	CO5	PSO1
6	Primitive Roots: Order of an Integer and Primitive Roots, Primitive Roots for Primes.	5	1,2,3,4,5	CO6	PSO1

Reference Books

1.	T. Koshy, Elementary Number Theory with Applications, Harcourt/Academic Press (2002)
2.	G. Andrews, Number Theory, Dover Publications (1994)
3.	O. Ore, Number Theory and Its History, Dover Publications (1988)
4.	J. Havil, F. Dyson, Gamma: Exploring Euler's Constant, Princeton University Press (2003)
5.	Euler: The Master of Us All, The Mathematical Association of America (1999)
6.	G. Dunnungton, J. Gray, Carl Friedrich Gauss: Titan of Science, The Mathematical Association of America (2004)
7.	K. Rosen, Elementary Number Theory and its Applications (5th Edition), Addison-Wesley (2005).

School: School of Science	**Program: B.Sc. Chemistry**
Course Code: PS322	**Course Name: Scientific Inquiry and Research Methodology**

Year	**III**	**Core Subject(Yes/No):**	**Yes**	**Lecture:**	**3**
Semester	**VI**	**Elective Subject(Yes/No):**	**No**	**Tutorial**	**0**
Typology of Course	Lectures	**Foundation Subject(Yes/No):**	**No**	**Practical:**	**0**
		Year of Syllabus Revision:	**NA**	**Total Credit:**	**3**
		Year of Introduction	**2021**	**Prerequisites (If any)**	**SY B.Sc. Chemistry**

Course Description:

This course is designed to orient students to Research Methodology and develop a research aptitude in them. Topics included are an understanding of basic research methodology - problem identification; importance of literature review; types of research designs; tool and techniques of data collection; techniques of data analysis; reporting of findings; scientific and research writing. Section on review of different types of research provides the understanding to carry out the research work independently. Once equipped with this knowledge, students would have the requisite knowledge and understanding to conduct research in an area of their choosing

Course Objectives:

- Read, interpret and critically evaluate ‘research’.
- Explain and apply research terminologies; describe the research process and the principle activities, skills and ethics associated with the research process.
- Identify and explain the difference between quantitative, qualitative & mixed methods research.
- Explain components of a research study and justify the theory as well as the methodological decisions, including sampling, measurement and analysis.
- Critically review a research study including an abstract, introduction, literature review, objectives of the study, research design and ethical considerations.

Course Outcome (CO):

CO1 Explain key research concepts and issues
CO2 Explain the difference between quantitative, qualitative & mixed methods research.
CO3 Relate the type of Study with methodology to be adopted – research design, tools / techniques of data collection and analysis.
CO4 Evaluate critically a research study and its various components
CO5 Read, comprehend, and explain research articles in their academic discipline
CO6 Explain the ethical issues that need to be addressed in the conducting of research

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	Definition of research and its importance. Steps in the process of research Identifying research problem. Discussion on importance, feasibility… Quantitative & Qualitative research characteristics	8	1,2,3,4,5	**CO1** **CO2**	PSO1, PSO2, PSO3, PSO6
2	Reviewing related literature Understanding Concepts, Variables. Understanding Research questions Understanding Hypothesis, types of hypotheses; Framing of Objectives.	8	2,3,4,5	**CO1** **CO4**	PSO1, PSO2, PSO3, PSO6

3	Research design – Experimental, Correlational Research design – Survey, Field study Research design – Mixed method Research design - Action research	9	2, 3, 4,5	**CO2** **CO3** **CO4**	PSO1, PSO2, PSO3, PSO6
4	Understanding Population, Sample, Sampling techniques Tools and techniques of data collection Designing tools with Reliability, Validity, Objectivity, Sensitivity Understanding Normal Probability curve; Implications.	10	2,3,4,5	**CO3**	PSO1, PSO2, PSO3, PSO6
5	Data Analysis - Qualitative Research. Data Analysis – Quantitative Research (Central Tendency – calculating Mean, Median, Mode)	4	1,2,3,4,5	**CO3**	PSO1, PSO2, PSO3, PSO6
6	Critically review a research proposal - including an abstract, introduction, literature review, objectives of the study, research design and ethical considerations. Ethical issues in conducting research Skills needed to design and conduct research	6	2,3,4,5	**CO4** **CO5** **CO6**	PSO1, PSO2, PSO3, PSO6

Reference Books	
1.	Anthony, M., Graziano, A.M. and Raulin, M.L., 2009. Research Methods: A Process of Inquiry, Allyn and Bacon.
2.	Best J.W., and Kahn J.V., (2003) Research in education Ninth edition, New Delhi: Prentice Hall of India
3.	Cresswell J.W. (2011) Educational Research New Delhi: PHI learning Pvt. Ltd.
4.	Day, R.A., 1992.How to Write and Publish a Scientific Paper, Cambridge University Press.
5.	Fink, A., 2009. Conducting Research Literature Reviews: From the Internet to Paper. Sage Publications.
6.	Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers
7.	Kothari C.R., (2008), Research Methodology- Methods and Techniques, Wiley and Eastern Ltd., New Delhi.
8	Koul Lokesh., (2009) Methodology of educational research fourth edition., New Delhi: Vikas publishing
9	Leedy, P.D. and Ormrod, J.E., 2004 Practical Research: Planning and Design, Prentice Hall.
10	Marshall Stephen D, Nick Green (2010) Your Ph.D companion New Delhi: Viva books
11	Mc Burney H. Donald., (2001) “Research Methodology “fifth edition., Australia: Thomson - Wadsworth
12	Pandya Shefali., (2010) Educational Research New Delhi: APH Publishing corporation
13	Panneerselvam R., (2010) Research Methodology New Delhi: Anmol Publication
14	Satarkar, S.V., 2000. Intellectual property rights and Copy right. Ess Ess Publications.
15	Sharma R. N., (2008) Statistical techniques in educational research Delhi: Surjeet publication.

SEMESTER VI

School: Science			**Program: B.Sc. (Chemistry)**		
Course Code: CH 312			**Course Name: Inorganic chemistry III**		
Year	**III**	**Core Subject(Yes/No):**	**Yes**	**Lecture:**	**3**
Semester	**VI**	**Elective Subject(Yes/No):**	**No**	**Tutorial**	**0**
Typology of Course	Lectures	**Foundation Subject(Yes/No):**	**No**	**Practical:**	**0**
		Year of Syllabus Revision:	**2019**	**Total Credit:**	**3**
		Year of Introduction	**2014**	**Prerequisites (If any)**	**SY B.Sc. Chemistry**

Course Description:
The first part elaborately explains the chemistry of boron, carbon, nitrogen, oxygen, halogen families as well as the chemistry of noble gases. It includes the preparation and properties of oxides, halides, oxyhalides of all p block elements as well as noble gases. In addition, the detailed study of boranes, borohydrides, carboranes, boron nitride, borazine, carbides, graphitic compounds, silicates, etc. are also included in the course. The course also deals with inorganic solids in research and day-to-day life which includes solid electrolytes, inorganic pigments, molecular material and fullerides, silicones, glass, ceramics, refractories, and rubber. It also deals with the metal-ligand equilibrium in the solution.

Course Objectives:
Understand the concept of Boron, Carbon, Nitrogen, Oxygen and Halogen Family. Understand the applications of inorganic solids in various field of chemistry. Detail understanding on metal complexation and effect of ligand on stability of metal ions.

Course Outcome (CO):

CO1	Detail understanding on periodic table elements.
CO2	Application of inorganic materials like zeolites, clays, feldspar, and ultramarines.
CO3	Understanding on Nobel gas, halogen elements and about the pseudohalogens and polyhalides,
CO4	Application of inorganic materials in the field of paint, separation, and catalysis.
CO5	Detail knowledge on stability of metal complexes and effect of ligand on the stability of metal complexes.

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	Unit 1: Boron and Carbon Family Chemistry of Boron family: Electron deficiency and acceptor behavior, Oxides, hydroxides and halides, boron nitride and borazole. Structure, bonding and important applications. Boranes, borohydrides and carboranes. Chemistry of Carbon family: Allotropy, trends in metallic properties and conduction, structure, bonding and properties of oxides. Carbides, graphitic compounds, silicates, zeolites, feldspars, ultramarines and clay minerals. Synthetic zeolites and clays. Ceramics, refractories and rubber.	15	1,2,3,4,5,	CO1 CO2 CO3	PSO1 PSO3 PSO4
2	Unit 2: Nitrogen, Oxygen, Halogen Family and Nobel Gases Nitrogen family: hydrazine, hydroxylamine and hydrazoic acid, hydrides of other elements, Oxides and halides, Oxyacids of nitrogen and phosphorous. Chemistry of Oxygen family : Ozone, oxides, peroxides and superoxides. Oxyacids and halides of sulphur, peracids and persalts of sulphur, Chemistry and applications of lead compounds, Chemistry of Halogens: Oxides and oxyacids of halogens, peracids and persalts, interhalogen compounds, pseudohalogens and polyhalides, basic properties of Iodine, Chemistry of Astatine. Chemistry of Noble Gases: Oxides, fluorides and oxyfluorides of xenon.	10	1,2,3,4,5,	CO3	PSO1 PSO3 PSO4
3	Unit 3: Inorganic Solids and Application Solid electrolytes-Cationic, anionic, mixed Inorganic pigments-coloured solids, white andblack pigments	5	1,2,3,4,5,	CO4	PSO1 PSO3 PSO4

	Molecular material and fullerides, molecular magnets, inorganic liquid crystal.				
4	Unit 4: Metal-ligand equilibria in solution, stepwise and overall formation constants and their interpretation, trends in stepwise formation constants. Factors affecting the stability of metal complexes with reference to the nature of central metal ion, Nature of the coordinating group (ligand), and the presence of ring structure (chelate effect and number of chelate rings and their size. Determination of stoichiometry of complex formation. Determination of binary formation constants of complexes by pH–metry. Stability of mixed ligand complexes, ring-size effect, inter ligand electron delocalization, intramolecular inter ligand interactions and their effect on the stability of ternary complexes.	15	1,2,3,4,5,	CO5	PSO1 PSO3 PSO4

Reference Books	
1.	J. D. Lee, Concise Inorganic Chemistry, 5th Ed., Blackwell Science, London, 1996.
2.	D. F. Shriver & P. W. Atkins, Inorganic Chemistry, 3rd Ed., W. H. Freeman and Co., London, 1999.
3.	B. R. Puri, L. R. Sharma & K. C. Kalia, Principles of Inorganic Chemistry, Shoban Lal Nagin Chand and Co., Delhi, 1996.
4.	G.Chatwal and M.S. yadav, Coordination Chemistry, Himalaya Publishing House. 1992.
5.	J. E. Huheey, E. A. Kieter& R. L. Keiter, Inorganic Chemistry, 4th Ed., Harper Collins, 1993.
6.	F. A. Cotton, G. Wilkinson, C. Murillo & M. Bochman, Advanced Inorganic Chemistry, 6th Ed., John Wiley, New York, 1999.
7.	T. Moeller, Inorganic Chemistry: A Modern Introduction, Wiley, New York, 1990.

School: Science	**Program: B.Sc. (Chemistry)**
Course Code: CH 313	**Course Name: Electrochemistry and Photochemistry**

Year	**III**	**Core Subject(Yes/No):**	**Core**	**Lecture:**	**3**
Semester	**VI**	**Elective Subject(Yes/No):**	**No**	**Tutorial**	**0**
Typology of Course	Lectures and Tutorials	**Foundation Subject(Yes/No):**	**No**	**Practical:**	**0**
		Year of Syllabus Revision:	**2018**	**Total Credit:**	**3**
		Year of Introduction	**2014**	**Prerequisites (If any)**	**CH258, Thermodynamics and chemical equilibrium**

Course Description:
This course mainly explains the basics and details of electro chemistry and photochemistry. The first part elaborately explains the different terms used in electrochemistry. Details of Kohlrausch's law, Debye – Hückel – Onsager equation, Wien effect, Debye – Falkenhagen effect, Grotthuss conductance, Hittorf and Moving Boundary methods are included in the chapter. In the last part, laws of photochemistry and different photochemical processes are included. Details of luminescence phenomenon, Frank – Condon principle, Stern – Volmer equation are included therein. Some practical applications such as photochemistry of stratospheric ozone, harvesting of light during plant photosynthesis, photochemistry of vision, solar energy conversion is included in the unit.

Course Objectives: Gain thorough understanding about electrical conductivity of solutions, distinguish between different types of electrical conductance, applications of electrical conductance for quantitative analysis. Acquire insights regarding photochemical processes, laws of photochemistry, quantum yield of photochemical reaction, photochemical smog and photosynthesis.

Course Outcome (CO):
CO1 gain the knowledge of photochemistry and comprehend photochemical reactions
CO2 understand the different photo – physical processes responsible for phenomena like fluorescence and phosphorescence
CO3 gain insights pertaining to electrical conductance in solution, factors affecting electrical conductance, distinguish between molar, equivalent, specific conductance. Applications of electrical conductance for quantitative analysis.
CO4 construct various electrochemical cells based on electrochemical series displayed by the redox couples and the types of electrodes used
CO5 establish a correlation between thermodynamics and electrochemical cell reactions

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	**Unit 1: Electrolytic Conductance** Electrolytic and metallic conductance. Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. Molar conductivity at infinite dilution. Kohlrausch law of independent migration of ions. Grotthus conductance, transference numbers and their relation to ionic mobilities, determination of transference numbers using Hittorf and Moving Boundary methods. Ionic velocities, mobilities and their determinations. Debye – Hückel – Onsager equation, Wien effect, Debye – Flakenhagen effect. Walden's rule.	14	1,2,3,4,5	CO3	PSO1 PSO3 PSO4
2	**Unit 2: Chemical Cells** Chemical cells, reversible and irreversible cells with examples. Electromotive force of a cell and its measurement, Nernst equation; Standard electrode (reduction) potential and its application to different types of half-cells. Determination of exact value of half – cell potential, dissociation constant of weak acid, ionic product of water by graphical	16	1,2,3,4,5,6	CO4 CO5	PSO1 PSO3 PSO4 PSO5

	method. Application of EMF measurements in determining (i) Gibbs energy, enthalpy and entropy of a cell reaction, (ii) equilibrium constants, and (iii) pH values, using hydrogen, quinone hydroquinone and glass electrodes. Concentration cells with and without transference, liquid junction. Batteries as power storage devices.				
3	**Unit 3: Photochemistry** Photophysical and photochemical processes, Grothus -Draper law, Stark – Einstein's law of photochemical equivalence and quantum yield. Electronic excitation of molecules, Frank – Condon principle. Examples of low and high quantum yields. Photosensitization, Photochemical formation of HCl, HBr and HI and rate of photochemical reactions. Actinometry. Luminescence phenomenon: Timescales of photophysical processes, phosphorescence, fluorescence, chemiluminescence. Quenching of fluorescence, Stern – Volmer equation. Photochemistry of stratospheric ozone, harvesting of light during plant photosynthesis, photochemistry of vision. Solar energy conversion.	15	1,2,3,4,5	CO1 CO2	PSO1 PSO3 PSO4 PSO5

Reference Books	
1.	K. K.Rohatgi Mukherjee, *Fundamentals of photochemistry*, Revised Ed., Wiley Eastern Ltd., 1996.
2.	S. H. Maron & J.B. Lando, *Fundamentals of physical chemistry*, Macmillan limited, New York, 1966.
3.	Gilbert. W. Castellan, *Physical chemistry*, 3rd Ed., Narosa publishing house, 1985.
4.	P.W. Atkins, *Physical chemistry*, Oxford University Press, 1978.

School: School of Science	**Program: BSc Chemistry**
Course Code: CH314	**Course Name: Organic Chemistry-IV**

Year	**III**	**Core Subject (Yes/No):**	**Yes**	**Lecture:**	**3**
Semester	**VI**	**Elective Subject (Yes/No):**	**No**	**Tutorial**	**0**
Typology of Course	Lectures	**Foundation Subject (Yes/No):**	**No**	**Practical:**	**0**
		Year of Syllabus Revision:	2018	**Total Credit:**	**3**
		Year of Introduction	**2014**	**Prerequisites (If any)**	***See below**

Prerequisites (If any): Students should have cleared the previous year examination; in particular, course entitled *Organic Chemistry-III* (CH311). Students should have some prior knowledge and understanding of techniques and methodologies for the isolation and purification methods of organic compounds.

Course Description:
This course gives the information of naturally occurring organic compounds and macromolecules, drugs and dyes and their applications in day-to-day life. The first unit deals with the natural occurrence, classifications, method of isolation of terpenoids and alkaloids. Second unit describes various heterocyclic compounds and their chemistry. The last unit deals with the introduction, classification of carbohydrate and amino acids. In the first part of Unit 3 mutarotation and its mechanism, epimers, chain shortening and chain lengthening of aldose etc. discussed in detail, whereas in second part Gabriel phthalimide synthesis, details of peptides and proteins are discussed.

Course Objectives:
The objective of this course is to make the students aware of the many pharmaceutically active products of natural origin and about the richness and diversity of plants and animal around them.

Course Outcome (CO):
Upon completion of the course students are expected to demonstrate knowledge, skill and abilities in the following areas:

CO1 Gain the knowledge of naturally occurring organic compounds
CO2 Identify and characterize various classes of natural products by their structures.
CO3 Have acquired the skills to isolate and purify simple products that are derived from plants.
CO4 Understand the chemistry and importance of heterocyclic compounds
CO5 Describe/recognize Carbohydrate, Amino Acid and Nucleic Acid structures; describe their physical and chemical properties.

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	**Terpenoids and Alkaloids** Terpenoids: Natural occurrence, classification. Structure and specific uses of citral, limonene and α – terpineol. Alkaloids: Natural occurrence, general methods of Isolation and structural features. Medicinal importance of nicotine, quinine, morphine and reserpine.	12	1,2,3,4	CO1 CO2 CO3	PSO2 PSO3 PSO5
2	**Heterocyclic Compounds:** Classification: Five membered ring compounds: Preparation of Furan, pyrrole and thiophene. Reactions: electrophilic and nucleophilic substitutions, oxidation and reduction reactions. Six membered rings: Pyridine, Quinoline and isoquinoline: Preparation by ring closing reactions. Reactions: Mechanism of electrophilic and nucleophilic substitutions, oxidation and reduction reactions.	12	1,2,3,4,5	CO1 CO2 CO4	PSO2 PSO3 PSO5
3	**Carbohydrates and Amino Acids** **Carbohydrates:** Classification and nomenclature, open chain and cyclic structure of glucose, determination of ring size, mutarotation and its mechanism, epimers, formation of glycosides, ethers and esters, erythro and threo diastereoisomers. Disaccharides and polysaccharides: Introduction to maltose, sucrose and lactose, starch and	21	1,2,3,4	CO1 CO2 CO4 CO5	PSO2 PSO3 PSO5

	cellulose. **Amino Acids:** Introduction, Classification, Isoelectric point, Preparation: malonic acid synthesis, Gabrial phthalimide synthesis. Peptides and proteins: Structure of peptides and proteins, classification of proteins, peptide structure determination, end group analysis, selective hydrolysis of peptides, classical peptide synthesis, solid phase peptide synthesis, protein denaturation. **Nucleic acids:** Introduction, nucleoproteins, structure of nucleic acids, ribonucleosides and ribonucleotides, the double helical structure of DNA, genetic code.				

Reference Books	
1.	I. L. Finar, *Organic Chemistry, Volume 2: Stereochemistry and the Chemistry of Natural Products*, 5th Ed., Pearson Education, New Delhi, 1975.
2.	R. T. Morrison, R. N. Boyd and S. K. Bhattacharjee, *Organic Chemistry*, 7th Ed., Pearson New Delhi, 2012.
3.	M. K. Jain and S. C. Sharma, *Modern Organic Chemistry*, Vishal Publishing Co., New Delhi, 2018.
4.	U. Satyanarayana, *Biochemistry*, 2nd Edition, Books and Allied (P) Ltd., Kolkata, 2002.
5.	V. K. Ahluwalia, *Chemistry of Natural Products*, 2nd Edition, Vishal Publishing Co., New Delhi, 2013.
6.	O. P. Agarwal, *Chemistry of Natural Products*, Volume 1, Krishna Prakashan, 2015.
7.	Gurdeep Chatwal & Anand, *Chemistry of Natural Products*, Himalayan Publishing Co, 2001.

School: Science			**Program: B.Sc Chemistry**		
Course Code: CH 309			**Course Name: Chemistry Laboratory-XI**		
Year	**III**	**Core Subject(Yes/No):**	**Yes**	**Lecture:**	**0**
Semester	**VI**	**Elective Subject(Yes/No):**	**No**	**Tutorial**	**0**
Mode of Transaction	Laboratory	**Foundation Subject(Yes/No):**	**No**	**Practical:**	**8**
		Year of Syllabus Revision:	**2018**	**Total Credit:**	**4**
		Year of Introduction	**2014**	**Prerequisites (If any)**	**SY B.Sc. Chemistry**

Course Description:

It involves a systematic qualitative inorganic analysis where the identification of the cation and anion of inorganic salt is carried out. This is done by conducting a series of tests in a systematic manner and using observations to confirm the absence or presence of specific cations and anions. The segregation of different anions and cations and identification of the same in inorganic salts is known as salt analysis. This process is known via different names like qualitative analysis of inorganic salts or systematic qualitative analysis. Inorganic salts are separated into different ions with the help of different sorts of experiments done under laboratory conditions and putting the compounds under different distinct tests which confirm whether certain ions are present or not in the solution.

Course Outcome (CO):

CO1 Students will explore the concept of Inorganic qualitative analysis for the identification of cations and anions.
CO2 Hand-in Training on detection of rare earth elements.
CO3 Students will explore the experiments with semimicro qualitative analysis of inorganic mixture following the test in a sequential manner.
CO4 Gain knowledge to identify acid and basic radicals from the mixture.
CO5 Students will learn the separation and estimation of amount of metal ions in trinary or quaternary metal ion mixture

No.	**Experiment**	**Contact Hours**	**BT Level**	**CO**	**PSO**
	Inorganic Spotting (Identification of the cation and Anion in the given salt mixture)				
1	NH4Cl+ FeSO4+ NaCl	4	1,2,3,4,5	CO1, CO2, CO3, CO4, CO5	PSO1, PSO2, PSO3, PSO4, PSO5
2	CuSO4+ PB(NO3)2+ BaCl2	4	1,2,3,4,5	CO1, CO2, CO3, CO4, CO5	PSO1, PSO2, PSO3, PSO4, PSO5
3	Al2SO4+ CoCO3+ LiCO3	4	1,2,3,4,5	CO1, CO2, CO3, CO4, CO5	PSO1, PSO2, PSO3, PSO4, PSO5
4	WCl+ Na2CO3+ NH4Br	4	1,2,3,4,5	CO1, CO2, CO3, CO4, CO5	PSO1, PSO2, PSO3, PSO4, PSO5
5	MgCl2+ NaBr+ KI	4	1,2,3,4,5	CO1, CO2, CO3, CO4, CO5	PSO1, PSO2, PSO3, PSO4,

					PSO5
6	Al2(PO4)3+ CuCl2+ CaCO3	4	1,2,3,4,5	CO1, CO2, CO3, CO4, CO5	PSO1, PSO2, PSO3, PSO4, PSO5
7	MnPO4+ ZnCl2+ NaNO3+ NH4Cl	4	1,2,3,4,5	CO1, CO2, CO3, CO4, CO	PSO1, PSO2, PSO3, PSO4, PSO5
8	CaCO3+ Mg(Cr2O7)+ NH4SO4	4	1,2,3,4,5	CO1, CO2, CO3, CO4, CO5	PSO1 PSO7 PSO8
9	NH4Ce(NO3)+ Al2SO4+ FeCl3	4	1,2,3,4,5	CO1, CO2, CO3, CO4, CO5	PSO1, PSO2, PSO3, PSO4, PSO5
10	KBr+ ZnS+ NH4V	4	1,2,3,4,5	CO1, CO2, CO3, CO4, CO5	PSO1, PSO2, PSO3, PSO4, PSO5
11	ThNO3+ ZrCl2+ LiCO3+ NH4V	4	1,2,3,4,5	CO1, CO2, CO3, CO4, CO5	PSO1, PSO2, PSO3, PSO4, PSO5
12	NaNO3+ NaNO2+ NH4Cl	4	1,2,3,4,5	CO1, CO2, CO3, CO4, CO5	PSO1, PSO2, PSO3, PSO4, PSO5
13	CdCl2+ MnCl2+ WCl+ Sr(NO3)2	4	1,2,3,4,5	CO1, CO2, CO3, CO4, CO5	PSO1, PSO2, PSO3, PSO4, PSO5
14	NH4V+ KCl+ KBr+KI	4	1,2,3,4,5	CO1, CO2, CO3, CO4, CO5	PSO1, PSO2, PSO3, PSO4, PSO5

Reference Books	
1.	G. Svehla, Vogel’s Qualitative Inorganic Analysis, 6th Ed., Orient Longman, 1989
2.	R. C. Shah, Inorganic Qualitative Analysis, Fifth edition, 2000

School: Science			**Program: B.Sc chemistry**		
Course Code: CH 310			**Course Name: Chemistry Laboratory-XII**		
Year	**III**	**Core Subject(Yes/No):**	**Yes**	**Lecture:**	**0**
Semester	**VI**	**Elective Subject(Yes/No):**	**No**	**Tutorial**	**0**
Mode of Transaction	Laboratory	**Foundation Subject(Yes/No):**	**No**	**Practical:**	**8**
		Year of Syllabus Revision:	**2018**	**Total Credit:**	**4**
		Year of Introduction	**2014**	**Prerequisites (If any)**	**SY B.Sc. Chemistry**

Course Description:

Handle organic chemicals in a safe and competent manner. Perform the standard techniques used in practical organic chemistry. Carry out organic preparation following a prescribed procedure. Read and explain the information labels on chemical bottles. Students will learn about the various preparations of the name reaction. Also, the % yield has been calculated to relate the product with the amount of the reagent that has been utilized.

Course Outcome (CO):

CO1 How to calculate a limiting reagent, yield, and percent yield by applying the preparation methods for useful compounds.

CO2 To perform the stoichiometry of various substrates required to carry named reactions and rearrangement. Also, to use the techniques involved in purification and identification of final product.

CO3 How to critically evaluate data collected to determine the identity, purity, and yield of products. And how to summarize findings in writing in a clear and concise manner.

CO4 How to use the scientific method to create, test, and evaluate a hypothesis andto engage in safe laboratory practices handling laboratory glassware, equipment, and chemical reagents.

CO5 How to perform common laboratory techniques, including reflux, distillation, steam distillation, recrystallization, vacuum filtration, aqueous extraction etc.

CO6 How to predict the outcome and mechanism of some simple organic reactions, using a basic understanding of the relative reactivity of functional groups

No.	Experiment	Contact Hours	BT Level	CO	PSO
	Organic Preparation				
1	Acetanilide to P-nitro acetanilide	4	1, 2, 3, 4, 5, 6	CO1, CO2, CO3, CO4, CO5, CO6	PSO1, PSO2, PSO3, PSO4, PSO5
2	Aniline to Benzene azo- B-Naphthol	4	1, 2, 3, 4, 5, 6	CO1, CO2, CO3, CO4, CO5, CO6	PSO1, PSO2, PSO3, PSO4, PSO5
3	Phthalic anhydride to Phthalimide	4	1, 2, 3, 4, 5, 6	CO1, CO2, CO3, CO4, CO5, CO6	PSO1, PSO2, PSO3, PSO4, PSO5
4	Aniline to 2, 4, 6 tribromo aniline	4	1, 2, 3, 4, 5, 6	CO1, CO2, CO3, CO4, CO5, CO6	PSO1, PSO2, PSO3, PSO4, PSO5
5	2, 4, 6 tribromo aniline to 1, 3, 5 tribromo benzene	4	1, 2, 3, 4, 5, 6	CO1, CO2, CO3,	PSO1, PSO2, PSO3,

				CO4, CO5, CO6	PSO4, PSO5
6	P- nitrotoluene to P- nitrobenzoic acid	4	1, 2, 3, 4, 5, 6	CO1, CO2, CO3, CO4, CO5, CO6	PSO1, PSO2, PSO3, PSO4, PSO5
7	P- nitrobenzoic acid to P- aminobenzoic acid	4	1, 2, 3, 4, 5, 6	CO1, CO2, CO3, CO4, CO5, CO6	PSO1, PSO2, PSO3, PSO4, PSO5
8	Malonic acid to Cinnamic acid	4	1, 2, 3, 4, 5, 6	CO1, CO2, CO3, CO4, CO5, CO6	PSO1, PSO2, PSO3, PSO4, PSO5

Reference Books	
1.	Named Organic Reactions 2nd Ed by Thomas Laue; Andreas Plagens
2.	J. Leonard,B. Lygo, G. procter, ‘ Advanced Practical Organic Chemistry;, Third edition, 2017.

School: Science			**Program: BSc Chemistry**		
Course Code: SE 208			**Course Name: Herbal Cosmetics**		
Year	**III**	**Core Subject(Yes/No):**	**No**	**Lecture:**	**2**
Semester	**VI**	**Elective Subject(Yes/No):**	**Yes**	**Tutorial**	**0**
Typology of Course	Lectures	**Foundation Subject(Yes/No):**	**No**	**Practical:**	**0**
		Year of Syllabus Revision:	**NA**	**Total Credit:**	**2**
		Year of Introduction	**2014**	**Prerequisites (If any)**	**SY B.Sc. Chemistry**

Course Description:
Students will learn to use scientific method to combine the cosmetic properties of plants with cosmetic making techniques to achieve health benefits and balance in the body. Plants of medicinal value will be introduced and how to process them will be shown. Safe use of herbs to make beauty products will be discussed.

Course Objectives:
The course will enhance knowledge regarding herbal products, their medicinal application, preparations, encourage students to prepare original, unadulterated good quality beauty products at home. Enterprising students may see ways to become entrepreneurs and develop signature products.

Course Outcome (CO):
CO1: illustrate the Fundamental knowledge on cosmetic and cosmeceuticals
CO2: Learn various skin problems and how to overcome through skin preparations
CO3: Learn about the formulation design, formulation, and evaluations of herbal cosmetics
CO4: Understand basics of Perfumery, and Aromatherapy. Moreover, sound knowledge of plants with aromatic compounds and herbal formulation for perfumery.

Unit No.	**Topic/Unit**	**Contact Hours**	**BT Level**	**CO**	**PSO**
1	Unit 1: Creams and Lotions: Cosmetics, definition, Structure of skin, various forms of cosmetics, main ingredients, preservatives, quality control measures, instrumentation for extraction and manufacture. Cosmetic creams: base cream, cleansing creams, Emollient creams, Finishing creams, cold cream, Preparation of creams. Cosmetic emulsions, properties of emulsions, emulsifiers, Creams: Cleansing creams (Cold creams, Quick liquifying creams, liquid cleaners), Emollient creams, finishing creams (Vanishing creams), Special creams (Astringent creams, Bleaching creams, Acne creams, All-purpose creams, Estrogenic creams, Industrial or protective creams) etc. Commercially available ingredients, retinoids, hydroxy acids, antioxidants etc., antimicrobial compounds from plants, Plants improving blood circulation etc.	15	1, 2, 3, 4, 5	CO1, CO2, CO3	PSO1, PSO3, PSO4
2	Unit 2: Perfumery and Aromatherapy: Perfumes, Flower perfumes, leaf perfumes, Fruit perfumes, root perfumes etc. Different perfumes from rose, jasmine, tuberose, sandalwood, kewda, Lavender, peppermint, Neroli, petit grain oils etc. constituent compounds, monoterpenes, methods of extraction, preparation of perfumes. Perfumes for soaps, detergents, incense, candles, household products, creams, powders, aerosols, industrial perfumes. Aromatherapy: Principles and practice.	15	1, 2, 3, 4, 5	CO1, CO3, CO4	PSO1, PSO3, PSO4

Reference Books	
1.	André O. Barel, Handbook of Cosmetic Science and Technology, 3rd Ed., Maibach, University of Calirfornia, San Francisco, CA, 2009
2.	P. K. Chattopadhyay, Herbal Cosmetics & Ayurvedic Medicines, (EOU), 1999.
3.	H. Panda, Herbal Cosmetics Handbook, 2004
4.	NIIR Board, Handbook on Herbal Products, (Medicines, Cosmetics, Toiletries, Perfumes)

School: School of Science			**Program: BSc Chemistry**		
Course Code: SE210			**Course Name: Food and Nutrition II**		
Year	**III**	**Core Subject(Yes/No):**	**No**	**Lecture:**	2
Semester	**VI**	**Elective Subject(Yes/No):**	Yes	**Tutorial**	0
Typology of Course	Lectures	**Foundation Subject(Yes/No):**	**No**	**Practical:**	0
		Year of Syllabus Revision:	**NA**	**Total Credit:**	**2**
		Year of Introduction	**2016**	**Prerequisites (If any)**	**SY B.Sc. Chemistry**

Course Description: This course emphasizes on importance of nutrition in health. It also focuses on importance of diet in preventing diseases, especially lifestyle disorders. It emphasizes on role of nutrition policies and programmes in boosting health.

Course Objectives:

1. To prepare students for successful career in clinical nutrition and dietetics
2. To help the students understand the importance of food safety
3. To enable students to apply the knowledge gained through the subject to improve their own lifestyle

Course Outcome (CO):

CO1: To understand the essentials of diet and health
CO2: To apply the knowledge on management of health

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	Social, population and environmental influences on nutrition, the food chain, types of nutritional studies; Food Selection and meal Planning- Factors to be considered, Dietary Guidelines Normal Clinical Nutrition- malnutrition, obesity, inflammatory response, enteral and parenteral nutrition. Dietetics & Therapeutic Aspects of Clinical Nutrition	15	1,2	1	PSO1
2	Nutrition Policies & Programmes; Nutrigenetics- personalized nutrition, Nutrient Requirements Based on Genotype; Nutrition in Special Conditions: chronic diseases- diabetes, cardiovascular diseases. Health Promotion & Nutritional Education. Food Safety in Practice.	15	1,2	2	PSO1

Reference Books

1.	Desrosier, N.W. and Desrosier, J.N. (1997) *The Technology of Food Preservation*, Westport: Connecticut Publishing Company.
2.	Whitney, E., Hamilton, E., and Rolfes, S. (1990) *Understanding Nutrition*, St. Paul, MN: West Publishing Company.
3.	Sunetra Roday, (2012) *Food Science and Nutrition*, Oxford Publishing Company.

School: Science					**Program: B.Sc. (Chemistry)**
Course Code: SE 218					**Course Name: Introduction to Polymer Science**

Year	**III**	**Core Subject(Yes/No):**	**-No**	**Lecture:**	**2**
Semester	**VI**	**Elective Subject(Yes/No):**	**Yes**	**Tutorial**	0
Typology of Course	Lectures	**Foundation Subject(Yes/No):**	**-No**	**Practical:**	0
		Year of Syllabus Revision:	NA	**Total Credit:**	**2**
		Year of Introduction	**2016**	**Prerequisites (If any)**	**SY B.Sc. Chemistry**

Course Description:
This course deals with history of macromolecular science, basic concepts of polymerization, classification of polymers and various polymerization techniques. It also deals with physical properties of polymers, concept of molecular weight averages, polydispersity and their practical significance. The nuances of molecular weight determination by various method are also dealt with.

Course Objectives:
After completing this course students will be able to: Understand polymerization mechanisms, molecular weight, crystallinity affecting various properties they will also know about glass transition temperature and its role structure-property correlation in polymers/polymer blends.

Course Outcome (CO):
CO1 Different kind of polymers and their properties.
CO2 Concept of Molecular Weight and distribution.
CO3 Variation of properties of polymer by crystallinity and glass transition temperature.
CO4 Various Process to know the molecular weight of different polymers.

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	**Unit-1 Introduction to Polymer:** History of macromolecular science. Basic concept of polymers (monomer, oligomers, degree of polymerization), Classification of polymers based on structure, repeating units, source, nature and processing. Polymerization: Free radical, cationic, anionic, condensation and coordination polymerization. Techniques of polymerization: Bulk solution, suspension, emulsion, interfacial and ring opening polymerization. CRP techniques. Controlled Radical Polymerization techniques.	15	1,2,3,4,5	CO1 CO2	PSO1 PSO3 PSO4
2	Unit-2 Physical Properties of The Polymers and Average Molecular Weight Concepts and Measurement of Molecular Weights: Physical Properties of Polymers The amorphous state, the glass transition, factors affecting glass transition temperature. Concept of molecular weight averages: number average, weight and viscosity average molecular weight, molecular weight distribution, Polydispersity, Molecular weight distribution curves. Practical significance of molecular weight, Determination of molecular weight: End group analysis, viscosity; vapour pressure osmometry, light scattering, sedimentation and size exclusion chromatography. Blends, alloys and composites.	15	1,2,3,4,5	CO3 CO4	PSO1 PSO3 PSO4

Reference Books	
1.	Joel R Fried, *Polymer Science & Technology*, 2nd Ed., PHI learning Pvt. Ltd.,2009.
2.	J. Brydson, *Plastic Materials*, 7th Ed., CBS publishers and Distributors, 2005.
3.	G. Odien, *Principles of Polymerization*, 3rd Ed., Wiley Interscience Publications,1991.
4.	F. W. Billmeyer, *Textbook of Polymer Science*, 1st Ed., Wiley – India Pvt. Ltd., 2012
5.	G. Pritchard, *Plastics Additives*, *An A – Z reference*, Springer – Verlag Gmbh, 1997
6.	L. A. Utracki (Ed.), *Polymer Blends Handbook* (Part – 1 & 2), Springer, 2003.

School: School of Science				Program: Bachelor of Science	
Course Code: SE310				**Course Name: Introduction to Pharmacognosy**	
Year	**II**	**Core Subject(Yes/No):**	**No**	**Lecture:**	**2**
Semester	**III**	**Elective Subject(Yes/No):**	**Yes**	**Tutorial**	**0**
Typology of Course	Lectures	**Foundation Subject(Yes/No):**	**No**	**Practical:**	**0**
		Year of Syllabus Revision:	**NA**	**Total Credit:**	**2**
		Year of Introduction	**2019**	**Prerequisites (If any)**	**SY B.Sc. Chemistry**

Course Description:

This course is designed for study of medicinally important plants with their cultivation, collection and adulteration of crude drugs, and the role of these plants in national economy.

Course Objectives:

Introduction to medicinal compounds and raw materials of natural origin including biosynthesis, chemical structures and qualitative and quantitative analysis. Understanding the role of natural products in research and development of drugs as well as in disease prevention and treatment. Acquisition of basic knowledge and skills in quality control of herbal drugs and products.

Course Outcome (CO):

CO1 Recognize and define medicinal natural compounds according to their chemical structure and biosynthetic pathway
CO2 Associate medicinal compounds with their natural sources
CO3 Use basic pharmacognostical terminology in Latin
CO4 Understanding the quality control of herbal drugs with their effectiveness and safe use
CO5 Introduction to the Indian Pharmacopoeia and its usage in the area of herbal drug analysis

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	• Course Introduction: History, Scope and Development of Pharmacognosy • Classification of crude drugs • Sources of crude drugs: Crude drugs of Plant, Animal and Mineral origin • Different types of plant tissues and their functions • Morphological and Microscopical study: Leaf, root, stem, bark, wood, flower, fruit and seed • Modifications of leaf, root and stem	15	1, 2	CO1 CO2 CO5	PSO1
2	• Study of medicinally important plants belonging to the families with special reference to: Solanaceae, Umbelliferae, Leguminosae, Liliaceae • Cultivation, collection and adulteration of crude drugs: Methods of cultivation, Factors influencing cultivation of medicinal plants, methods of collection and different types of adulteration • Role of medicinal plants in national economy	15	1, 2	CO3 CO4	PSO1

Reference Books

1.	Text book of Pharmacognosy: T. E. Wallis; CBS publishers, New Delhi.
2.	The Ayurvedic Pharmacopoeia of India: Government of India, Ministry of Health & Family Welfare, 1st edition, Part-I, Vol. III, 2001.
3.	Quality Control Methods for Medicinal Plant Materials: 2002, WHO, Geneva.
4.	Trease and Evan’s Pharmacognosy: W. C. Evans, 14th edition, 1997, W. B. Saunders Company, Singapore.
5.	Cultivation of medicinal plants, C. K. Kokate, 4th edition, 2007, Nirali Prakashan, Pune
6.	Botany for Degree Student: A. C. Dutta; Oxford University Press, New Delhi.
7.	Pharmacognosy: C. K. Kokate; Nirali Prakashan, Pune

School: Science				**Program: B.Sc.(Chemistry)**	
Course Code: SE 311				**Course Name: Introduction to Paint Technology**	
Year	**III**	**Core Subject(Yes/No):**	No	**Lecture:**	**2**
Semester	**VI**	**Elective Subject(Yes/No):**	Yes	**Tutorial**	0
Typology of Course	Lectures	**Foundation Subject(Yes/No):**	No	**Practical:**	0
		Year of Syllabus Revision:	NA	**Total Credit:**	**2**
		Year of Introduction	**2016**	**Prerequisites (If any)**	**SY B.Sc. Chemistry**

Course Description:
This course deals basic concepts of Polymer Science, different components of coating formulation (Introductory ideas of emulsion polymerization and polymer dispersion). It also deals with various additives of coating. Finally, it focuses on paint formulations and their applications

Course Objectives:
The course offers a preliminary survey of Polymer chemistry as applicable to Paint Technology especially its components like resins, their method of preparation and properties, choice of pigments and their effect on film formation, and additional components like wetting agents, thickeners, dispersing agents etc. The overreaching objective is to give an idea about paint making process and testing.

Course Outcome (CO):
CO1 Develop basic understanding of polymer science especially applicable to Paint Technology
CO2 Correlate the properties of the additives with their function
CO3 Understanding of water and oil-based paint formulation and additives
CO4 Stages of making a paint and testing methods

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	**Unit 1: Introductory Polymer Science** Definition of Polymer, Polymer types and Polymerization mechanisms, Glass transition temperature, Factors affecting glass transition temperature, Film formation, Minimum film formation temperature (MFFT), Rheology of polymer solutions, Viscometers, Mechanical properties of polymer film	7	1,2,3,4,5	CO1	PSO1
2	**Unit 2: Components of coating formulation** Different components of coating formulation. Resin, Pigments, Extenders, Solvents, Additives and their scope. Introductory ideas of emulsion polymerization and polymer dispersion especially for water borne coatings, Hiding, Refractive index of pigments, Effect of pigments on coating properties, Pigment volume concentration (PVC), Critical pigment volume concentration (CPVC), Relationship between film properties and PVC, Pigment dispersion, Extenders	8	1,2,3,4,5	CO1 CO2	
3	**Unit –III: Additives for coatings** Wetting and dispersing agents, Pigment wetting, Polymeric dispersing agents, Surfactants, types of surfactants, Angle of contact, HLB rating, Fluoro surfactants, Foam formation in paints, Defoamers, Thickeners-inorganic and organic thickeners, Sagging and leveling, Coalescing agents, Different stages of film formation, Driers, Biocides, Adhesion promoters, Problems encountered with additives content.	8	1,2,3,4,5	CO1 CO2 CO3	
4	**Unit-IV: Paint formulation and colour** Stages of making paint: Grind and let down. Components to be added in grind and letdown. Formulation of Exterior/Interior water borne paints. Properties of paint for various applications, Sheen and gloss, Industrial standards, Testing standards, Primers and colour basics.	7	1,2,3,4,5	CO1 CO2 CO3 CO4	

Reference Books	
1.	Zeno W. Wicks, Douglas A. Wicks, Frank N. Jones & S. Peter Pappas, *Organic Coatings Science and Technology*, 3rd Ed., John Wiley and Sons Inc.
2.	Johan Bieleman, *Additives for coatings*, Wiley –vch Verlag Gmbh, 2000.
3.	V. C. Malshe & Meenal Sikchi, *Basics of Paint Technology*, Part – 2, Antar Prakash Centre for Yoga, 2008.
4.	Bodo M. Ller and Ulrich Poth, *Coatings Formulation*, Vincentz Network, 2006.
5.	W. M. Morgans, *Outlines of Paint Technology*, 3rd Ed., CBS publishers, 2000.

School: School of Science			**Program: B.Sc. Chemistry**		
Course Code: SE 312			**Course Name: Medicinal Chemistry-II**		
Year	**III**	**Core Subject(Yes/No):**	**No**	**Lecture:**	**2**
Semester	**VI**	**Elective Subject(Yes/No):**	**Yes**	**Tutorial**	**0**
Typology of Course	Lectures	**Foundation Subject(Yes/No):**	**No**	**Practical:**	**0**
		Year of Syllabus Revision:	**2019**	**Total Credit:**	**2**
		Year of Introduction	**2014**	**Prerequisites (If any)**	**SY B.Sc. Chemistry**

Course Description:
This course introduces synthetic strategies used to manufacture important drugs. Types of drugs used to treat fever, pain, anxiety, cancer, malaria etc. will be introduced in this course. Structures and synthesis of these naturally occurring and synthetic drugs form an important aspect of this course.

Course Objectives:
After completing this course students will be able to gain the knowledge of drugs/ pharmaceuticals as well as gain the knowledge about synthetic routes to form different group of drug molecules.

Course Outcome (CO):

CO1: To understand causes of different diseases
CO2: To study various synthetic routes of drug molecules
CO3: To study mode of action of various drugs
CO4: To study SAR of different drug molecules

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	**Sulpha Drugs:** Introduction. Synthesis of sulphapyridine, sulphathaizole, phthalyl sulphathiazole, succinyl sulphathiazole, sulphadiazine, sulphamerazine, sulphamethazine and sulphasalazine. Mode of action of sulpha drugs. **Antipyretics and analgesics:** Introduction. *Aniline derivatives:* synthesis of paracetamol. *Salicylic acid derivatives*: Synthesis and mode of action of aspirin. Salol Principle (true and partial salol). Salsalate. *Aryl acetic acid derivatives:* Synthesis of ibuprofen, ibufenac, diclofenac. *Quinoline derivatives:* cinchophen and neocinchophen (only structures). *Pyrazolone derivatives:* Phenazone and aminophenazone (only structures). **Anaesthetics:** General classification of anaesthetics (general, local and regional). Spinal and epidural anaesthetics. Stages of anaesthesia. *Inhalation anaesthetics:* Synthesis of nitrous oxide, diethyl ether, divinyl ether, cyclopropane, chloroform, haloethane. *Injection anaesthetics:* Synthesis of thiopental sodium, thiamylal sodium, tribromoethanol, paraldehyde. *Local anaesthetics:* Synthesis of α- eucaine, β-eucaine, benzocaine, procaine, and tetracaine.	15	1,2,3,4,5	CO1, CO2, CO3, CO4	PSO1, PSO2, PSO3, PSO4, PSO5
2	**Sedatives and hypnotics:** Difference between sedatives and hypnotics. Classification of barbiturates. *Long acting barbiturates:* Synthesis of veronal, phenobarbital, methylphenobarbital. *Intermediate acting barbiturates:* Synthesis of butobarbital, allobarbital and amobarbital. *Short acting barbiturates:* Synthesis of pentobarbital and cyclobarbital. *Ultrashort acting barbiturates:* Synthesis of thiopental. Mode of action of barbiturates. *Non-barbiturates:* Synthesis of paraldehyde, chloral hydrate, glutethimide and nitrazepam. **Antimalarials:** Types of plasmodium. Malarial cycle. *Quinine derivatives:* Structure and properties of quinine. *4-Aminoquinolines:* Structures of chloroquine, nivaquine, hydroxychloroquine and amodiaquine. Synthesis of	15	1,2,3,4,5	CO1, CO2, CO3, CO4, CO5	PSO1, PSO2, PSO3, PSO4, PSO5

	chloroquine and amodiaquine. *8-Aminoquinolines:* Structures of pentaquine, isopentaquine and primaquine. SAR of aminoquinoline derivatives. *Guanidine derivatives:* Synthesis of chloroguanil and bromoguanil. *Sulphones:* Preparation of dapsone. *Pyrimidine derivatives:* Synthesis of pyrimethamine and trimethoprim. **Anticancer drugs:** Types of cancers. Incidence of tumours. Types of cancer treatment therapies: Radiation, chemotherapy, hormone therapy and gene therapy. Synthesis of nitrogen mustards: mechlorethamine, mepJhalan, cyclophosphamide and chlorambucil. Synthesis of busulfan (methansulphonate derivative), triethylenemelamine (ethylimine derivative), Mercaptopurine and Azathiopurine (purine derivatives).				

Reference Books	
1.	Ashutosh Kar, *Medicinal Chemistry*. New Age International Publishers, New Delhi. 4th Edition, 2007.
2.	Burger, *Medicinal Chemistry and Drug Discovery*, Vol. – 1, Ed., M. E. Wolff, John Wiley
3.	Graham & Patrick. *Introduction to Medicinal Chemistry*, 3rd Ed., OUP, 2005.

School: Science			**Program: B.Sc Chemistry**		
Course Code: SE 313			**Course Name: Green Chemistry**		
Year	**III**	**Core Subject(Yes/No):**	**No**	**Lecture:**	**2**
Semester	**VI**	**Elective Subject(Yes/No):**	**Yes**	**Tutorial**	**0**
Typology of Course	Lectures and Tutorials	**Foundation Subject(Yes/No):**	**No**	**Practical:**	**0**
		Year of Syllabus Revision:	**NA**	**Total Credit:**	**2**
		Year of Introduction	**2015**	**Prerequisites (If any)**	**FY B.Sc. Chemistry**

Course Description:
Green Chemistry is the design of chemical products and processes that reduce or eliminate the use and generation of hazardous substances. This course will present the fundamentals of the 12 principles of green chemistry, and explore relevant examples of their practical use in commercial applications mainly in the area of chemical and pharmaceutical synthesis, catalysis, alternative energy sources and solvents

Course Objectives:
Students learn the basic principles of green and sustainable chemistry. They must be able to do and understand stoichiometric calculations and relate them to green process metrics. The course is designed to familiarize them to alternative solvent media and energy sources for chemical processes & renewable feedstocks for the chemical industry, present and under development. The course reviews the principles of catalysis, photochemistry and other interesting processes from the viewpoint of green chemistry

Course Outcome (CO):
CO1: The students are expected to be familiar with different types of green metrices and related calculations.
CO2: Designing and planning atom economical synthetic reactions.
CO3: Gain understanding of environmentally friendly solvents and reaction systems.
CO4: Renewable feed stocks in chemical Industry novel catalytic systems and alternative chemical systems.

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	**Green Chemistry** **Unit 1: I**ntroduction**:** Principles and concepts of Green Chemistry: need for green chemistry, Definition and twelve guiding principles of Green Chemistry, Prospects and future of Green Chemistry, Green synthesis – Real world cases (Traditional Vs. Green processes) Synthesis of Ibuprofen, Adipic acid. Green Chemistry Metrics, Green solvents: Enhancement of selectivity, efficiency, and industrial applicability of green solvents Supercritical fluids, Aqueous medium, Ionic liquids, Solvent free neat reactions in liquid phase, Solvent free neat reactions, Flourous phase reactions.	15	1,2,3,4,5	CO1 CO2 CO3	PSO1 PSO5
2	**Unit II: Green catalysis, alternative energy resources and future trend in Green Chemistry** **Green Catalysis:** Introduction to catalysis, heterogeneous and homogeneous catalysis, Heterogeneous catalysis: Use of zeolites, catalytic cracking, commercial use of ZSM-5, catalytic convertors. Homogeneous catalysis: transition metal catalysts, lewis acid catalyst, asymmetric catalyst Phase-transfer catalysis (micellar/ surfactant), Biocatalysis: enzymes, microbes. Photocatalysis. **Alternative energy sources:** photochemical reactions, Microwave assisted reactions, Sonochemistry, Electrochemical synthesis. **Future trends in Green Chemistry:** Biomimetic, multifunctional reagents; Combinatorial green chemistry; Non–covalent derivatization, Biomass conversion, emission control. Bio – catalysis	15	1,2,3,4,5	CO1 CO4	PSO1 PSO5

Reference Books	
1.	P.T. Anastas & J.C. Warner, *Green Chemistry: Theory and Practice*, Oxford University Press, 1998.
2.	M. Kirchoff & M. A. Ryan, *Greener approaches to undergraduate chemistry experiment*, American Chemical Society, Washington DC, 2002
3.	M. Lancaster, *Green Chemistry an Introductory text*, Royal Chemical Society, TJ International Ltd, Padstow, Cornwall, UK.

School: School of Science			**Program: BSC - Chemistry**		
Course Code: SE-314			**Course Name:** Conservation Biology		
Year	**III**	**Core Subject (Yes/No):**	**No**	**Lecture:**	**2**
Semester	**VI**	**Elective Subject (Yes/No):**	**Yes**	**Tutorial**	**0**
Typology of Course	Lectures	**Foundation Subject (Yes/No):**	**No**	**Practical:**	**0**
		Year of Syllabus Revision:	**NA**	**Total Credit:**	**2**
		Year of Introduction	**2019**	**Prerequisites (If any)**	**FY B.Sc. Chemistry**

Course Description:
This course will demonstrate the basics of ecological understanding as well as teaches the basic nature of conservation biology pertaining to protection and restoration of biodiversity. The course will also teach loss of biodiversity due to anthropogenic activities and the ways to control the devastating effect pollution on biodiversity.

Course Objectives:
The students will enable the use of various unique ideas in order to conserve the biodiversity of the planet. Students will also be able to understand the role of ex-situ and in-situ conservation methods in protecting the wildlife.

Course Outcome (CO):
CO1: Demonstrate critical analysis skills through the analysis and interpretation of conservation case studies.
CO2: Understand and respond to issues of local, national, and global significance through the knowledge that the causes of and solutions to the loss of biodiversity have a cultural and societal context
CO3: The role of conservation biologist in making ethical policies
CO4: Demonstrate the role of in-situ and ex-situ conservation strategies

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	**Introduction of Conservation biology** ➢ Role of Conservation biologist ➢ Brief idea on Conservation ethics **Understanding Biodiversity** ➢ Introduction to biodiversity ➢ Biodiversity distribution ➢ Value of Biodiversity **Biodiversity Crisis** ➢ Brief idea on cause of biodiversity loss ■ Case studies: 5 major extinctions ➢ IUCN and Red Data list ➢ Ecological consequences of Biodiversity loss ■ Case study: Ecological service of crow.	15	1,2,3	CO1, CO2	PSO1
2	**Maintaining and Restoring Biodiversity** ➢ In-Situ conservation: Reserve Selection, Design & Management ➢ Brief idea on restoration ecology ■ Case study: Turtle ➢ Ex-Situ conservation ■ Case Studies	15	1,2,3	CO3, CO4	PSO1

Reference Books

1.	Hunter Jr, M. L., & Gibbs, J. P. (2006). Fundamentals of conservation biology. John Wiley & Sons.
2.	Primack, R. B. (2012). A primer of conservation biology. Sinauer Associates.
3.	Conservation Biology for All (2010) N. S. Sodhi. Oxford University Press
4.	Fiedler, P. L. (Ed.). (2012). Conservation biology: the theory and practice of nature conservation preservation and management. Springer Science & Business Media.

School: School of Science				**Program: BSc Chemistry**	
Course Code: SE316				**Course Name:** Bioinformatics	
Year	**III**	**Core Subject (Yes/No):**	**No**	**Lecture:**	**2**
Semester	**VI**	**Elective Subject (Yes/No):**	**Yes**	**Tutorial**	**0**
Typology of Course	Lectures	**Foundation Subject (Yes/No):**	**No**	**Practical:**	**0**
		Year of Syllabus Revision:	**NA**	**Total Credit:**	**2**
		Year of Introduction	**2019**	**Prerequisites (If any)**	**SY B.Sc. Chemistry**

Course Description:

The course focuses on algorithmic aspects of modern bioinformatics and covers the following topics: computational gene sequencing, DNA arrays, sequence comparison, pattern discovery in DNA, genome rearrangements, molecular evolution, computational proteomics, and others. It encompasses the multidisciplinary approach which makes this subject a dynamic entity. It involves analysis of various factors which affects the movement in our biological systems.

Course Objectives:

The students will use the role of software in deciphering the sequence of nucleotides using various databases online. Students will also learn the approaches from various discipline like computer science, chemistry and biology.

Course Outcome (CO):

CO1.	Concepts of fundamental concepts of bioinformatics.
CO2.	Gain the knowledge of gene sequences and molecular evolution.
CO3.	Introduction to database
CO4.	Softwares to use for sequence alignment

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	**Introduction to Bioinformatics** - Historical perspectives, Scope and importance, Commercial potential. Introduction to biological Databases (Accession codes & identifications). Examples of Biological. Database (A) Nucleotide sequence Databases (B) Protein sequence databases (EMBL, SWISS Port). cord, medulla oblongata, Neurophysiology, Neurotransmitters	15	1,2,3	CO1, CO2	PSO1
2	Primary Nucleotide sequence, databases. Molecular phylogenetics, Phylogenetics tree constructing methods. Introduction to NCBI Software. Elucidating the functions of NCBI (BLAST, Primer designing, FASTA alignment, DNA Homology, studying of exons and introns). BOLD nucleotide sequence database, Gene bank (DNA and mRNA sequence, protein Sequence).	15	1,2,3	CO3, CO4	PSO1

Reference Books	
1.	Essentials of Bioinformatics by Jin Xiong
2.	The Ten Most Wanted Solutions in Protein Bioinformatics by Anna Tramontano
3.	Bioinformatics Basics by Hooman Rashidi, Lukas K. Buehler
4.	Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins by Andreas D. Baxevanis, B. F. Francis Ouellette jones

<table>
<tr><td colspan="3">School: School of Science</td><td colspan="3">Program: B. Sc. Chemistry</td></tr>
<tr><td colspan="3">Course Code: SE 318</td><td colspan="3">Course Name: Introduction to Forensic Science</td></tr>
<tr><td>Year</td><td>III</td><td>Core Subject(Yes/No):</td><td>No</td><td>Lecture:</td><td>2</td></tr>
<tr><td>Semester</td><td>VI</td><td>Elective Subject(Yes/No):</td><td>Yes</td><td>Tutorial</td><td>0</td></tr>
<tr><td rowspan="3">Typology of Course</td><td rowspan="3">Lectures and Tutorials</td><td>Foundation Subject(Yes/No):</td><td>No</td><td>Practical:</td><td>0</td></tr>
<tr><td>Year of Syllabus Revision:</td><td>NA</td><td>Total Credit:</td><td>2</td></tr>
<tr><td>Year of Introduction</td><td>2018</td><td>Prerequisites (If any)</td><td>SY B.Sc. Chemistry</td></tr>
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Course Description:
This course is an applicative course and gives an insight to the working in a forensic laboratory. Through this course students shall gain exposure to different techniques and methods used in forensics as well as its several levels of applications in crime detection and analysis.

Course Objectives:
This course focusses on the steps of collection of evidence in Crime Scene Investigation. It also deals with collection and analysis of fingerprints, biological samples and various signs to observe in a dead body. High end instrumental techniques involved in forensic analysis has also been discussed.

Course Outcome (CO):
CO1: explain the importance of forensic analysis.
CO2: understand the application of analytical techniques in forensic analysis.
CO3: to understand how to analyze samples in forensic laboratory
CO4: to understand changes in body post death

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	Introduction: Basis of forensic sciences. Types of forensic scientists. Role of Forensic Scientists. Sub-specialties of forensic science- forensic pathology, forensic toxicology, forensic psychology, forensic odontology, digital forensics and criminology. Crime-scene investigation: Locard's Principle. Steps to be followed in CSI. Fingerprint analysis: Fingerprint ridges and their analysis. Loops (radial and ulnar), whorls (plain, central pocket loop, double loop, accidental loop) and arches (plain and tented). Latent and patent prints. Methods of visualizing and collecting fingerprints. Calculation of fingerprint classification ratio. Forensic pathology: Introduction and relation to postmortem study. Types of trauma- mechanical, electrical, thermal and chemical. Changes in body after death- Rigor mortis, Algor mortis, lividity. Internal examination and dissection. Determination of time of death. Decomposition of the body. Exhumations. Drug analysis: Postmortem redistribution of drug in body. Specificity and selectivity of method. Use of GC, HPLC, IR, MS, electrophoresis in analysis. Determination of alcohol in breath and blood.	15	1,2,3,4,5	CO1, CO2, CO3, CO4	PSO1, PSO2, PSO3, PSO4, PSO5
2	Biological material – collection, characterization, and storage: Evaluation of blood strain in patterns: identification and characterization of fluids and examination of trace evidence. The Microscope and Its Forensic Applications, Evidentiary Value of Hair and Fibers. Serology: Presumptive and confirmatory tests for blood, saliva and semen samples. Forensic genetics Introduction to Forensic genetics, A brief history of forensic genetics Role of DNA structure and the genome in analysis, Polymerase chain reaction, The analysis of short tandem repeats, Assessment of STR profiles, Statistical interpretation of STR profiles, Kinship testing	15	1,2,3,4,5	CO1, CO2, CO3, CO4	PSO1, PSO2, PSO3, PSO4, PSO5

	Single nucleotide polymorphisms, Lineage markers, Non-human DNA typing DNA analysis: Overview of nuclear DNA. Tandem repeats. Mitochondrial DNA. DNA databases. Anthropology: Basis, determination of bone sample. Difference between male and female skeletons. Age determination by skeleton study. Importance of odontology in identification of individual. Drug Abuse and Drug Evidence: Determination of drugs traces in unconventional samples such as hair and oral fluids with respect to cocaine, opioids, amphetamines, cannabis, benzodiazepines etc.				

Reference Books	
1.	W.J. Welcher (Ed.), Scott's Standard Methods of Chemical Analysis, Vol. III A, 6th Edition (1966), and vol. III B, 5th Edition (1975), Van Nostrand Reinhold Co. London.
2.	Peter Fordham, Non-destructive Testing Techniques, 1st edition (1968), London Business Publications Ltd., London
3.	W. Horwitz, Official Methods of Analysis, 11th Edition (1970), Association of Official Analytical Chemists, Washington DC.
4.	K. Simpson and B. Knight, Forensic Medicine, 9th Edition (1985), Edward Arnold Publishers Ltd., London.

School: Science	**Program:** BSc (Chemistry)
Course Code: SE319	**Course Name:** Fuzzy Logic

Year	**III**	**Core Subject(Yes/No):**	**No**	**Lecture:**	**2**
Semester	**VI**	**Elective Subject(Yes/No):**	**Yes**	**Tutorial**	**0**
Typology of Course	Lectures and Tutorials	**Foundation Subject(Yes/No):**	**No**	**Practical:**	**0**
		Year of Syllabus Revision:	**NA**	**Total Credit:**	**2**
		Year of Introduction	**2018**	**Prerequisites (If any)**	**SY B.Sc. Chemistry**

Course Description:
This course aims at introducing the fundamental theory and concepts of fuzzy set theory. Student will learn basic set operations on fuzzy sets and elementary properties of them. Fuzzy numbers and arithmetic operations on fuzzy numbers will also be studied in the course. Fuzzy relation and properties will be discussed in detail.

Course Objectives:
1. Understand the importance of fuzzy theory
2. Learn basics of fuzzy sets and operations
3. Learn and apply concepts of fuzzy numbers and fuzzy relation to solve problems

Course Outcome (CO):

CO1	Understand the concept of fuzzy sets
CO2	Learn crisp and fuzzy set theory
CO3	Decide the difference between crisp set and fuzzy set theory.
CO4	Able to solve problems on fuzy set theory, fuzzy numbers and fuzzy relation

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	**Fuzzy sets** From crisp sets to fuzzy sets: a paradigm shift: Introduction-crisp sets: an overview-fuzzy sets: basic types and basic concepts of fuzzy sets, Fuzzy sets versus crisp sets, Additional properties of cuts, Representation of fuzzy sets.	14	1	CO1, CO2, CO3	PSO1
2	**Operations on fuzzy sets and Fuzzy Arithmetic** Operations on fuzzy sets-types of operations, fuzzy complements, fuzzy intersections, Fuzzy numbers, Linguistic variables, Arithmetic operations on intervals, Arithmetic operations on fuzzy numbers	10	2	CO4	PSO1
3	**Fuzzy relations** Crisp versus fuzzy relations, projections and cylindric extensions, Binary fuzzy relations, Binary relations on a single set, Fuzzy equivalence relations	6	3	CO4	PSO1 PSO2

Reference Books	
1.	Fuzzy sets, Fuzzy Logic and Applications by George Klir and Be Yaun
2.	First Course in Fuzzy Theory and Applications by Kwang H. Lee

School: School of Science	**Program: B.Sc. Chemistry**
Course Code: CH262	**Course Name: Industrial Hygiene and Safety**

Year	III	**Core Subject (Yes/No):**	No	**Lecture:**	2
Semester	VI	**Elective Subject (Yes/No):**	Yes	**Tutorial**	0
Typology of Course	Lectures and Tutorials	**Foundation Subject (Yes/No):**	No	**Practical:**	0
		Year of Syllabus Revision:	**NA**	**Total Credit:**	2
		Year of Introduction	**2021**	**Prerequisites (If any)**	**SY B.Sc. Chemistry**

Course Description:

The course will help students to gain knowledge of carious hazards related to fire, mechanical, electrical, chemical and pharmaceutical field. It will also provide the knowledge of industrial safety and preventions from various accidents and toxin eliminations.

Course Outcome (CO):

CO1: Get an insight into the area of hazards and safety
CO2: learn the basic of monitoring and prevention during lab and industrial accidents

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	**Hazards:** Classification Hazardous chemical, transportation of Hazardous chemicals, Storage, Handling and control measures for hazardous chemicals. Hazards and controls in Unit process and Unit Operations. **Hazards -** fire, mechanical, electrical, chemical and pharmaceutical, Monitoring & prevention systems, industrial effluent testing & treatment. Control of environmental pollution. **Fire and Safety:** Fire: Chemistry of fire, Personal protective equipment, Fire extinguishers, type of fire extinguishers, and use of fire extinguishers. **Safety:** Safety work permits, safety of pipelines, safety industrial equipment, safe start up and shut down procedures, emergency shutdown.	15	1,2,3,4,5	CO1, CO2	PSO1, PSO2, PSO3,
2	**Concept of Industrial Safety:** Accident's investigation and Analysis, Statutory provisions, Types of chemical hazards and control, control techniques, process flow chart and its importance for safety inspection, interpretation, use and training of MSDS, UN, HAZCHEM. **Safety in chemical industry:** General introduction, type of chemical hazards, Safety and risk phrases, Storage hazards and control, Prevention of overflow pressure-temperature and process flow, Types of guards and valves for the vessel, its inlet and outlet, need of remote and auto control valves, Process hazards and controls. **Housekeeping and First aid:** Housekeeping and toxicology First aid training, First aid measures.	15	1,2,3,4,5	CO1, CO2	PSO3. PSO4, PSO5

Reference Books	
1.	Deshmukh, L.M., Industrial Safety Management, Tata McGraw-Hill Education, 2005.
2.	Gupta, A., Industrial Safety and Environment, Firewall Media, 2006.
3.	King, R. W., Magid, J., Industrial hazard and safety handbook, Elsevier, 2013.
4.	Dalton, A. J. P., Safety, Health and Environmental Hazards at the Workplace, Cengage Learning EMEA, 1998.
5.	Shearer P., Freedman, J., Good Housekeeping Family First Aid, Hearst Books, 2004.
6.	DK, First Aid Manual, Dorling Kindersley Ltd, 2016.

School: Science			**Program: BSc Chemistry**		
Course Code: MG321			**Course Name: Entrepreneurship**		
Year	**II**	**Core Subject(Yes/No):**	**No**	**Lecture:**	**3**
Semester	**IV**	**Elective Subject(Yes/No):**	**No**	**Tutorial**	**0**
Typology of Course	Lectures	**Foundation Subject(Yes/No):**	**Yes**	**Practical:**	**0**
		Year of Syllabus Revision:	**NA**	**Total Credit:**	**3**
		Year of Introduction	**2015**	**Prerequisites (If any)**	**SY B.Sc. Chemistry**

Course Description:
Introductory course on Entrepreneurship aims at sensitizing students to the spirit of entrepreneurship. The course includes discussion on the entrepreneurial journeys of various entrepreneurs in diverse fields so as to help students understand different aspects of an entrepreneur as well as entrepreneurial venture. Further it aims at systematically identifying opportunities and developing new business ideas. The course also deals with the issues concerning entrepreneurial ventures at a broad level like entrepreneurial ecosystem in India, marketing of a new venture, sources of finance etc.

Course Objectives:
The objective of the course is to :

- Introduce students to the idea of entrepreneurship and exposing learners to take entrepreneurship as a career choice.
- To help students develop better understanding about the various stages of entrepreneurial process.
- Develop creativity, problem solving and opportunity recognition skills.
- Provide students with first-hand experience of entrepreneurship
- To help them introspect about their own entrepreneurial capabilities

Course Outcome (CO):
Upon completion of the course students are expected to demonstrate knowledge, skill and abilities in the following areas:

CO 1: Foresee Entrepreneurship as one of the possible career paths for themselves
CO 2: Recognize the innate entrepreneurial potential within themselves
CO 3: Recognize and assess opportunities in their environments
CO 4: Evaluate the feasibility of any innovative idea
CO 5: Conduct Concept Test and Buying Intention Survey
CO 6: Identify appropriate sources of finance for their business
CO 7: Determine appropriate legal form of business for establishing their venture
CO 8: Select and apply for required intellectual property right
CO 9: Prepare Business Model Canvas
CO 10: Present Elevator Pitch

Unit No.	Topic/Unit	Contact Hours	BT Level	CO	PSO
1	**Introduction to Entrepreneurship**	10	2,3,4	CO1 CO2	PSO1 PSO5
2	**Creativity and Innovation**	10	4,5,6	CO1 CO2 CO3 CO4 CO5	PSO1 PSO5
3	**Marketing, Financial and Legal aspects of new venture**	12	2,3,4,5	CO1 CO6 CO7 CO8	PSO1 PSO5
4	**Business Plan and Pitching**	8	2,3,4,5,6	CO1 CO2 CO9 CO10	PSO1 PSO5

Reference Books	
1.	Bansal, R. (2011). *Connect The Dots*. Westland
2.	Bansal, R. (2011). *I have a dream*. *Westland*
3.	Barringer, B. R., Ireland,R.D. (2015). *Entrepreneurship: Successfully launching new ventures*. Pearson Education India
4.	Bygrave , W. D., & Zacharakis , A. (2011). *Entrepreneurship.* John Wiley & Sons, Inc
5.	Hisrich, R. D., Peters, M. P., & Shepherd, D. A. (2018). *Entrepreneurship*. McGraw Hill Education
6.	Kawasaki, G. (2004). *The art of the start: The time-tested, battle-hardened guide for anyone starting anything*. Penguin.
7.	Kuratko, D. F., & Rao, T. V. (2012). *Entrepreneurship: A South-Asian Perspective*. Cengage Learning
8.	Mauborgne, R., & Kim, W. C. (2005). *Blue Ocean Strategy- How to Create Uncontested Market Space and Make the Competition Irrelevant.* Harvard Business School Publishing Corporation. Boston, Massachusetts.
9.	Harvard Business Publishing Articles – Class readings