GANDHI INSTITUTE OF TECHNOLOGY AND MANAGEMENT (GITAM)

(Deemed to be University, Estd. u/s 3 of UGC Act 1956)

VISAKHAPATNAM**HYDERABAD**BENGALURU

Accredited by NAAC with 'A^{+}' Grade

REGULATIONS AND SYLLABUS

of

BACHELOR OF SCIENCE
(Biotechnology, Chemistry, Microbiology)

(w.e.f. 2020-21 admitted batch)

Website: www.gitam.edu

PROGRAMME EDUCATIONAL OBJECTIVES (PEO's)

1. To train students on basic and advanced concepts, methodologies of Biotechnology, Chemistry and Microbiology

2. To educate the student on allied fields of Biotechnology which enhances the student ability to explore interdisciplinary research.

3. To educate the student understanding various concepts of Chemistry and help in enhancing their employable skills.

3. To make the student learn the protocols that are useful in designing breakthrough products.

4. To make the students useful for medical, pharma and other industrial sectors by enhancing their ability in exploring, designing and employing latest technologies.

PROGRAMME OUTCOMES

PO1	To acquire the knowledge on important classes of biological macromolecules and understand how biochemical homeostasis is regulated by metabolism
PO2	To gain fundamental knowledge on computers/ mathematics and their application in biological sciences.
PO3	To enhance the understanding of multi-disciplinary nature of environment and its impact on natural processes that sustain life.
PO4	To equipped with theoretical and practical knowledge of microbiology and microbial genetics, its significance in the onset of infectious diseases.
PO5	To understand the role of microbes in medical, fermentation, food and dairy, ecology and agriculture.
PO6	To understand the basic concepts of enzymology and immunology along with gaining practical knowledge in various techniques.
PO7	To comprehend the basic concepts and practical implications of cell biology and genetics.
PO8	To understand the basics of molecular biology and its advances in rDNA technology and its implications in in the fields of plant, animal, fermentation, marine and industrial biotechnology.
PO9	To understand the role of biosafety and intellectual properties in various fields of biotechnology.
PO10	To spread over the principles and quantifiable techniques, related to molecular diagnostics.
PO11	To improve the interaction skills and entrepreneurship abilities to promote sustainability within multi-disciplinary teams.
PO12	To identify, formulate, comprehend and analyse the theories and analytical methods in organic chemistry and chemical kinetics.
PO13	To underscore the concepts of pharmaceutical chemistry, green chemistry, instrumental methods of analysis, and the role of industrial chemicals in environment.
PO14	To introduce basic principles of clean chemical technology and to explore resultant societal and technological issues.

PROGRAM SPECIFIC OUTCOMES (PSOS)

PSO1: To conceptualize and apply the basic principles of biological sciences and chemical sciences to provides an essential platform to understand the modern biotechnological processes designed according to the current needs of the society.

PSO2: To understand and evaluate the various cellular processes and underlying mechanisms along with development of a diverse technologies.

PSO3: To provide a platform for encompassing research with proficient and ethical responsibilities towards meeting societal needs.

B.Sc. Degree with Biotechnology, Chemistry, Microbiology

REGULATIONS

(W.e.f. 2020-21 admitted batch)

1.0 ADMISSIONS

Admissions into B.Sc. Degree with Biotechnology, Chemistry, Microbiology program of GITAM (Deemed to be University) are governed by GITAM admission regulations.

ELIGIBILITYCRITERIA

A pass in Intermediate with Chemistry, Botany and Zoology or Chemistry, Mathematics, Physics with a minimum aggregate of 50% marks or any other equivalent Examination approved by GITAM (Deemed to be University).
Admissions into B.Sc. Degree with Biotechnology, Chemistry, Microbiology will be based on the marks obtained in intermediate or equivalent examination and the rule of reservation, wherever applicable.

3.0 CHOICE BASED CREDITSYSTEM

Choice based credit system (CBCS) is introduced with effect from the admitted batch of 2015-16 based on UGC guidelines in order to promote:

- Student centered learning
- Cafeteria approach
- Inter-disciplinary learning.

Learning goals/objectives and outcomes are specified leading to what a student should be able to do at the end of the program.

STRUCTURE OF THEPROGRAM

The program consists of

(i) Ability Enhancement Compulsory Core course (AECC)
(ii) Core Courses (compulsory)(CC)
(iii) Discipline Specific Electives (DSE)
(iv) Discipline Specific Core(DSC)
(v) Skill Enhancement Course (SEC)
(vi) Practical Proficiency Course (PPC): Laboratory

Each course is assigned a certain number of credits depending upon the number of contact hours (lectures/tutorials/practical) per week.

In general, credits are assigned to the courses based on the following contact hours per week per semester.

One credit for each lecture / tutorial hour.
Two credits for three hours of practicals.

The curriculum of six semesters B.Sc. Degree with Biotechnology, Chemistry, Microbiology program is designed to have a total of **124** credits for the award of B.Sc. Degree with Biotechnology, Chemistry, Microbiology.

5.0 MEDIUM OFINSTRUCTION

The medium of instruction (including examinations and case studies) shall be English.

6.0 REGISTRATION

Every student has to register himself/herself for each semester individually at the time specified by the Institute / University.

ATTENDANCEREQUIREMENTS

A student whose attendance is less than 75% in all the courses put together in any semester will not be permitted to attend the end - semester examination and he/she will not be allowed to register for subsequent semester of study. He/ She have to repeat the semester along with his/her juniors.

However, the Vice Chancellor on the recommendation of the Principal/Director of the University College/Institute may condone the shortage of attendance to the students whose attendance is between 66% and 74% on genuine medical grounds and on payment of prescribed fee.

EVALUATION

The assessment of the student's performance in a Theory course shall be based on two components: Continuous Evaluation (40 marks) and Semester-end examination (60 marks).

A student has to secure an aggregate of 40% in the course in the two components put together to be declared to have passed the course, subject to the condition that the candidate must have secured a minimum of 24 marks (i.e. 40%) in the theory component at the semester-end examination.

Practical/Viva voce/Seminar / SEC etc. courses are completely assessed under Continuous Evaluation for a maximum of 100 marks, and a student has to obtain a minimum of 40% to secure Pass Grade. Details of Assessment Procedure are furnished below in Table 1.

Table 1: Assessment Procedure

S. No.	Component of assessment	Marks allotted	Type of Assessment	Scheme of Examination
1	Theory (CC,DSE,AECC)	40	Continuous evaluation	(i) Two mid semester examinations shall be conducted for 15 marks each. (ii) 5 marks are allocated for quiz. (iii) 5marks are allocated for assignments.
		60	Semester-end examination	The semester-end examination shall be for a maximum of 60 marks.
	Total	100		
2	Theory (SEC)	100	Continuous evaluation	(i) Two mid semester examinations shall be conducted for 30 marks each. (ii) 5 marks are allocated for quiz. (iii) 5 marks are allocated for assignments. (iv) 30 marks are allocated for case study
	Total	100		
3	Practical (PPC)	40	Continuous evaluation	Forty (40) marks for continuous evaluation are distributed among the components: regularity, preparation for the practical, performance, submission of records and oral presentations in the laboratory. Weightage for each component shall be announced at the beginning of the Semester.
		60	Continuous evaluation	Sixty (60) marks for one test towards the end of the semester conducted by the concerned lab Teacher and external examiner appointed by the HoD.
	Total	100		
4	Minor project (VI semester)	100	Project work evaluation	(i) 75 marks for project work submitted by the candidate. (ii) 25 marks for the project presentation by the candidate and viva - voce The project work evaluation and the viva-voce shall be conducted by two examiners

REAPPEARANCE

A student who has secured 'F' grade in a theory course shall have to reappear atthe subsequent semester end examinations held for that course.

A student who has secured 'F' grade in a practical course shall have to attendspecial instruction classes held during summer.

10.0 SPECIALEXAMINATION

A student who has completed his/her period of study and still has “F” grade in a maximum of four theory courses is eligible to appear for special examination normally held during summer vacation.

11.0 BETTERMENT OFGRADES

A student who has secured only a pass or second class and desires to improve his/her class can appear for betterment examinations only in Theory courses of any semester of his/her choice, conducted in summer vacation along with the special examinations. Betterment of grades is permitted 'only once' immediately after completion of the program of study.

GRADINGSYSTEM

Based on the student performance during a given semester, a final letter grade will be awarded at the end of the semester in each course. The letter grades and the corresponding grade points are as given in Table-2.

Table 2: Grades & Grade Points

S.No.	Grade	Grade Points	Absolute Marks
1	O (outstanding)	10	90 and above
2	A+ (Excellent)	9	80 to 89
3	A (Very Good)	8	70 to 79
4	B+ (Good)	7	60 to 69
5	B (Above Average)	6	50 to 59
6	C (Average)	5	45 to 49
7	P (Pass)	4	40 to 44
8	F (Fail)	0	Less than 40
9	Ab. (Absent)	0	-

A student who earns a minimum of 4 grade points (P grade) in a course is declared to have successfully completed the course and is deemed to have earned the credits assigned to that course, subject to securing a GPA of 5 for a Pass in the semester.

GRADE POINTAVERAGE

A Grade Point Average (GPA) for the semester/trimester will be calculated according to the formula:

$$GPA = \frac{\Sigma [C \times G]}{\Sigma C}$$

Where

C = number of credits for the course,
G = grade points obtained by the student in the course.

To arrive at Cumulative Grade Point Average (CGPA), a similar formula is used considering the student's performance in all the courses taken, in all the semesters up to the particular point of time.

CGPA required for classification of class after the successful completion of the program is shown in Table3.

Table 3: CGPA required for award of Class

Distinction	≥ 8.0*
First Class	≥ 7.0
Second Class	≥ 6.0
Pass	≥ 5.0

* In addition to the required CGPA of 8.0, the student must have necessarily passed all the courses of every semester in **first attempt**.

ELIGIBILITY FOR AWARD OF THE B.Sc. DEGREE

Duration of the program: A student is ordinarily expected to complete B.Sc. program in six semesters of three years. However, a student may complete the
program in not more than five years including study period.
However the above regulation may be relaxed by the Vice Chancellor in individual cases for cogent and sufficient reasons.

A student shall be eligible for award of the B.Sc. Degree if he/she fulfills all the following conditions.

a) Registered and successfully completed all the courses and projects.
b) Successfully acquired the minimum required credits as specified in the curriculum corresponding to the branch of his/her study within the stipulated time.
c) Has no dues to the Institute, hostels, Libraries, NCC/NSS etc. and
d) No disciplinary action is pending against him /her.

The degree shall be awarded after approval by the Academic Council.

15.0 DISCRETIONARY POWER

Notwithstanding anything contained in the above sections, the Vice Chancellor may review all exceptional cases, and give his decision, which will be final and binding.

I SEMESTER

Course Code	Subject	Category	Instruction Hours/week		Credits	Scheme of Instruction		
			L	P		CE	SE	Total Marks
SFC 101	English for Communication-I	AECC	3	-	2	40	60	100
SBT 111	Molecules of Life	CC	4	-	4	40	60	100
SBT 127	Molecules of Life Lab	PPC	-	3	2	100	--	100
SPH 105	Atomic Structure, Bonding, General Organic Chemistry & Aliphatic Hydrocarbons	CC	4	-	4	40	60	100
SPH 125	Atomic Structure, Bonding, General Organic Chemistry & Aliphatic Hydrocarbons Lab	PPC	-	3	2	100	--	100
SMB 101	Introduction to Microbiology	CC	4	-	4	40	60	100
SMB 121	Practices in Microbiology Lab	PPC	-	3	2	100	--	100

II SEMESTER

Course Code	Subject	Category	Instruction Hours/week		Credits	Scheme of Instruction		
			L	P		CE	SE	Total Marks
SFC 102	Environmental Science	AECC	3	-	2	40	60	100
SBT 112	Cell Biology and Genetics	CC	4	-	4	40	60	100
SBT 128	Cell Biology and Genetics Lab	PPC	-	3	2	100	--	100
SPH 106	Chemical Energetics, Equilibria & Functional Organic Chemistry	CC	4	-	4	40	60	100
SPH 124	Chemical Energetics, Equilibria & Functional Organic Chemistry Lab	PPC	-	3	2	100	--	100
SMB 100	Bacteriology	CC	4	-	4	40	60	100
SMB 120	Bacteriology Lab	PPC	-	3	2	100	--	100

III SEMESTER

Course Code	Subject	Category	Instruction Hours/week		Credits	Scheme of Instruction		
			L	P		CE	SE	Total Marks
SBT 211	Enzymology and Metabolism	CC	4	-	4	40	60	100
SBT 227	Enzymology Lab	PPC	-	3	2	100	--	100
SPH 205	Solutions, phase equilibrium, conductance, electro chemistry & functional group Organic Chemistry-II	CC	4	-	4	40	60	100
SPH 225	Solutions, phase equilibrium, conductance, electro chemistry & functional group Organic Chemistry-II Lab	PPC	-	3	2	100	--	100
SMB 201	Microbial Genetics	CC	4	-	4	40	60	100
SMB 221	Microbial Genetics Lab	PPC	-	3	2	100	--	100
SFC 203	English-II	AECC	3	-	2	40	60	100
Choose any one								
SSE 287	Fundamentals of Computers	SEC	2	-	2	100	--	100
SSE 279	Mathematics for Biology	SEC	2	-	2	100	--	100

IV SEMESTER

Course Code	Subject	Category	Instruction Hours/week		Credits	Scheme of Instruction		
			L	P		CE	SE	Total Marks
SBT 212	Molecular Biology and rDNA technology	CC	4	-	4	40	60	100
SBT 228	Molecular Biology and rDNA technology Lab	PPC	-	3	2	100	--	100
SPH 206	Coordination chemistry, states of matter & chemical kinetics	CC	4	-	4	40	60	100
SPH 224	Coordination chemistry, states of matter & chemical kinetics Lab	PPC	-	3	2	100	--	100
SMB 200	Food And Dairy Microbiology	CC	4	-	4	40	60	100
SMB 220	Food And Dairy Microbiology Lab	PPC	-	3	2	100	--	100
Choose any one								
SSE 274	Chemical technology & society	SEC	2	-	2	100	--	100
SSE 286	Bioanalytical tools	SEC	2	-	2	100	--	100

V SEMESTER

Course Code	Subject	Category	Instruction Hours/week		Credits	Scheme of Instruction		
			L	P		CE	SE	Total Marks
Choose any one								
SBT 341	Plant and Animal Biotechnology	DSE	4	-	4	40	60	100
SBT 343	Industrial Biotechnology	DSE	4	-	4	40	60	100
Choose any one (*corresponding to theory course)								
SBT 325	Plant and Animal Biotechnology Lab	PPC	-	3	2	100	--	100
SBT 327	Industrial Biotechnology Lab	PPC	-	3	2	100	--	100
Choose any one								
SPH381	Analytical methods in chemistry	DSE	4	-	4	40	60	100
SPH383	Green chemistry	DSE	4	-	4	40	60	100
Choose any one ($^{\#}$corresponding to theory course)								
SPH 339	Analytical methods in chemistry Lab	PPC	-	3	2	100	--	100
SPH 341	Green chemistry Lab	PPC	-	3	2	100	--	100
Choose any one								
SMB 341	Medical Microbiology	DSE	4	-	4	40	60	100
SMB 343	Ecology and Agricultural Microbiology	DSE	4	-	4	40	60	100
Choose any one (corresponding to theory course)								
SMB 321	Medical Microbiology Lab	PPC	-	3	2	100	--	100
SMB 323	Ecology and Agricultural Microbiology Lab	PPC	-	3	2	100	--	100
Choose any one								
SSE 373	Pharmaceutical chemistry	SEC	2	-	2	100	--	100
SSE 387	Molecular Diagnostics	SEC	2	-	2	100	--	100

VI SEMESTER

Course Code	Subject	Category	Instruction Hours/week		Credits	Scheme of Instruction		
			L	P		CE	SE	Total Marks
Choose any one								
SBT 342	Marine Biotechnology	DSE	4	-	4	40	60	100
SBT 344	Bioinformatics	DSE	4	-	4	40	60	100
Choose any one (*corresponding to theory course)								
SBT 326	Marine Biotechnology Lab	PPC	-	3	2	100	--	100
SBT 328	Bioinformatics Lab	PPC	-	3	2	100	--	100
Choose any one								
SPH382	Industrial chemicals and environment	DSE	4	-	4	40	60	100
SPH384	Instrumental methods of analysis	DSE	4	-	4	40	60	100
Choose any one (#corresponding to theory course)								
SPH 340	Industrial chemicals and environment Lab	PPC	-	3	2	100	--	100
SPH 342	Instrumental methods of analysis Lab	PPC	-	3	2	100	--	100
Choose any one								
SMB 340	Microbial Physiology and Fermentation Technology	DSE	4	-	4	40	60	100
SMB 342	Immunology	DSE	4	-	4	40	60	100
Choose any one (corresponding to theory course)								
SMB 320	Microbial Physiology and Fermentation Lab	PPC	-	3	2	100	--	100
SMB 322	Immunology Lab	PPC	-	3	2	100	--	100
Choose any one								
SSE 388	Entrepreneurship Design	SEC	2	-	2	100	--	100
SSE 390	Biosafety and IPR	SEC	2	-	2	100	--	100
SBT 392	Minor Project work and Presentation	PPC	-	-	4	-	100	100

SEMESTER – I

SFC:101 - ENGLISH FOR COMMUNICATION– I

Hours per week: 3 **End Examination: 60 Marks**
Credits: 2 **Sessional: 40 Marks**

Preamble:

This course has been designed to enrich students' listening, speaking, reading, and writing, abilities so they can pursue their personal, academic and career goals through the acquisition and improvement of English language skills. Students engage with the text while reinforcing what is learnt.

Course Objectives:
1) To develop right pronunciation
2) To enable students to use English in day-to-day communication
3) To facilitate the use of language without grammatical errors
4) To expose them to prose and poetry and enable them to learn language through simple literature.
5) To build advanced vocabulary
6) To improve reading skills

UNIT- I
The eyes are not here – Ruskin Bond
Pronunciation: Consonants, **Grammar:** Nouns, **Vocabulary:** Roots forms of words**,**
Spelling: Correcting wrong spelling, **Punctuation:** Capitalisation,
Conversation and Role Play: Introducing oneself in formal or social contexts.

Learning outcomes: By the end of the course, the student will be able to
- Develop creative communication skills
- Understand and use consonant sounds in phonemic language
- Use correct spelling and capitalization.
- Introduce oneself in the appropriate diction, style and tone.

UNIT- II
Work Brings Solace – APJ Abdul Kalam

Pronunciation: Monophthongs **Grammar:** Pronouns,
Vocabulary: Prefixes & Suffixes, **Spelling:** using 'un' and 'dis' to complete antonyms**, Punctuation:** Capitalisation,
Conversation and Role Play: starting a conversation/controlling a conversation**,**

Learning outcomes: By the end of the course, the student will be able to
- perceive the content in the academic text and recognize the organization and purpose of reading a text.
- determine the meaning of words using roots, *prefixes, and suffixes*.
- engage in discussion on everyday topics
- . *open* and keep *conversations* going.
- interrupt and end *conversations* appropriately

UNIT –III

Bangle Sellers – Sarojini Naidu

Pronunciation: Diphthongs
Grammar: Helping verbs & auxiliary verbs,
Vocabulary: Homophones, Homographs, Homonyms
Punctuation: comma & full stop,
Conversation: Describing one's college and course of study,
Writing: Paragraph writing/ Descriptive Writing,

Learning outcomes: By the end of the course, the student will be able to

- Comprehend and interpret poetic diction
- define '*diphthong*'; recognize and identify *diphthongs* in speech and text
- Demonstrate the use of homophones, homographs, and homonyms in writing.
- Recognize and use comma and *full stop* in appropriate places in the text.
- Speak about his/her course of study and describe the college he/she is studying in with the right diction and tone.
- *Construct a paragraph* on familiar and academic topics using a topic sentence

UNIT -IV

The Merchant of Venice (Extract) – William Shakespeare

Pronunciation: varied pronunciation of some letters of the alphabet
Grammar: Main verbs & Tenses,
Vocabulary: Collocations,
Punctuation: Question mark and Exclamation mark,
Conversation: Leaving a message and taking an appointment

Learning outcomes: By the end of the course, the student will be able to:

- appreciate the varied uses of language in Shakespearean Play
- Use present, past and future tenses with appropriate time markers.
- Be aware of the different types of collocations and use them appropriately
- Recognize and use question mark and *exclamation mark* in appropriate places in the text.
- Leave a message and take an appointment in a professional manner

UNIT- V Vocabulary building: Synonyms, Antonyms, One Word Substitutes, Phrasal Verbs, Idiomatic Expressions, Foreign Phrases

Learning outcomes: By the end of the course, the student will be able to

- Demonstrate understanding of synonyms and antonyms in active learning
- Strengthen their vocabulary base in one word substitution
- Use phrasal verbs in their day-to-day communication
- Familiarize with commonly used idiomatic expressions and use them correctly
- Recognize frequently used foreign words and phrases related to areas of immediate relevance.

Course Outcomes: By the end of the course, the learners will be able to

- Think critically, analytically, creatively and communicate confidently in English in social and professional contexts with improved skills of fluency and accuracy.
- Write grammatically correct sentences employing appropriate vocabulary suitable to different contexts.
- Comprehend and analyse different academic texts.

Textbooks:
Part – 1 (English for Enhanced Competence (by Sumit Roy, A.Karunakar, A.Aruna Priya)

Supplementary Reading:

1. Communicative skills for Technical Students, M. Faratullah. Orient Longman

2. Rizvi,MAshraf. ***Effective Technical Communication.*** McGraw - Hill.

SEMESTER – I

SBT 111: MOLECULES OF LIFE

Hours per week: 04 **End Examination: 60 Marks**
Credits: 04 **Sessional: 40 Marks**

Preamble:
This course has been designed to enrich the students' knowledge about the classification, structure, properties, and functions of biomolecules. The course shall make the students' aware of the significance of various biomolecules necessary to maintain the living organisms

Course Objectives
The objectives of this course are to build the knowledge of undergraduate students about the classification, structure, properties, functions and interactions of different biomolecules. The course shall make the students aware of significance of various biomolecules necessary to maintain the living organisms.

UNIT-I

Structure and Properties of water, intra and intermolecular forces, non-covalent interactions- electrostatic, hydrogen bonding, Vander Waals interactions, hydrophobic and hydrophilic interactions. Disulphide bridges.

Learning Outcomes: On completion of this unit, students should be able to understand the:

- Chemical structure and properties of water
- Role of non-covalent interactions in biomolecules
- Role of pH and buffers in biological system

UNIT-II

Classification and biological functions of carbohydrates, structure and properties of monosaccharaides (Glucose and Fructose). Disaccharides (sucrose, maltose, lactose), polysaccharides (starch, cellulose and chitin). Glycosaminoglycans (chondroitin sulfate and Hyaluronic acid)

Learning Outcomes

On completion of this unit, students should be able to understand the:

- Chemical structure and properties of carbohydrates
- Biological functions of carbohydrates

UNIT-III

Classification, structure and properties of amino acids, Primary structure of protein- determination of amino acid composition and sequence. Secondary structure-α-helix, β-pleated sheet, collagen triple helix. Tertiary and quaternary structures. Solid phase peptide synthesis. Glycoproteins.

Learning Outcomes

On completion of this unit, students should be able to understand the

- Chemical structure, properties, and biological functions of amino acids
- Chemical structure, properties, and biological functions of proteins Chemical synthesis of proteins

UNIT-IV

Classification, structure, properties and functions of fatty acids, triglycerides, phospholipids, sphingolipids. Cholesterol, Eicosanoids.Structure and functions of vitamins (A,D,E,K, B complex and C).

Learning Outcomes

- On completion of this unit, students should be able to understand the:
- Chemical structure and properties of lipids
- Biological functions of lipids
- Structure and functions of vitamins

UNIT-V

Purine and pyrimidine nitrogen bases, Nucleosides and nucleotides, Structure, and properties of DNA. Alternative forms of DNA -A, B, Z. Structure and properties of RNA, different types of RNA- mRNA and non-coding RNA – tRNA, rRNA, siRNA, miRNA.

Learning Outcomes

- On completion of this unit, students should be able to understand the:
- Chemical structure and properties of DNA and RNA
- Biological functions of nucleic acids

Course outcomes: On completion of this course, students will be able to

- Understand the chemical structure, properties and biological functions of carbohydrates, amino acids, and proteins
- Identify the chemical structure, properties and biological functions of lipids, vitamins and nucleic acids

RECOMMENDED BOOKS:

1. Lehninger Principles of Biochemistry by Nelson D and Cox D –7th Edition. Mcmillan Pub.
2. Biochemistry by L.Stryer– 8th Edition. (Freeman-Tappan).
3. Biochemistry by D.Voet and J.G.Voet– 4th Edition. (John Weily).
4. Biochemistry by Garrett and Grisham – 6th Edition. (Cengage Learning).
5. Biochemistry Concepts and Connections by Mathews et.al. – Global Edition.
6. Principles of Biochemistry by David Rawn et.al. – 5th Edition (Pearson).
7. Essentials of Glycobiology, 3rd Edition (CSHL press).
8. Harper's Biochemistry by Robert K. Murray et.al. – 30thEdition (Langeman).
9. Biochemistry by U.Satyanarayana – 4th Edition.

SEMESTER – I

SBT 127: MOLECULES OF LIFE LAB

Hours per week: 03 **End Examination: 00 Marks**
Credits: 02 **Sessional: 100 Marks**

Preamble:
This course has been designed to provide the hands on experience to the students and enrich the students' knowledge about the qualitative and quantitative analysis and separation of biomolecules.

Course Objectives:
The objective of this course is to provide hands on experience to under graduate students on qualitative and quantitative analysis and separation of biomolecules by chromatography techniques and analysis of biomolecules by spectroscopy.

1. Qualitative analysis of amino acids

2. Qualitative analysis of carbohydrates

3. Determination of isoelectric point of glycine

4. Estimation of protein by Lowry's method

5. Separation of amino acids by paper chromatography

6. Ultraviolet absorption spectra of protein and nucleic acids

Course Outcomes: On completion of this course, students should be able to

- Identify and quantify the biomolecules.
- Understand the principle, procedure, and application of various biochemical separation techniques.
- Understand the principle and biochemical analysis by spectroscopy.

RECOMMENDED BOOKS:

1. Modern experimental Biochemistry by Rodney Boyer – 3rdEdition (Benjamin Cummings)

2. Biochemical methods By Sadasivam and Manikam – 3rdEdition (New Age International Pvt. Ltd., Publishers)

3. An introduction to practical biochemistry by D.T.Plummer – 2nd Edition (McGraw Hill)

4. Biochemistry - a laboratory courses by J.M.Beckar – 2nd Edition (Academic Press)

5. Introductory practical Biochemistry by S.K.Sawhney and Randhir Singh – 2ndEdition (Narosa)

SEMESTER – I

SPH 105: ATOMIC STRUCTURE, BONDING, GENERAL ORGANIC CHEMISTRY & ALIPHATIC HYDROCARBONS

Hours per week	**: 04**	**End examination**	**: 60 Marks**
Credits	**: 04**	**Sessional**	**: 40 Marks**

Section A: Inorganic Chemistry-1

Preamble: The students of undergraduate program in science in Chemistry need to be conversant with the various fields off chemistry. Therefore, one module each on in general, physical and organic chemistry is introduced which helps the student familiarize with the concepts of chemistry essential for allied and interdisciplinary fields of science.

Course objective: To introduce the concepts of general chemistry. The students will be conversant with the chemistry of all the elements that is closely knitted with analytical chemistry, physical chemistry, and organic chemistry.

UNIT-I

Atomic Structure: Review of: Bohr's theory and its limitations, dual behaviour of matterand radiation, de Broglie's relation, Heisenberg Uncertainty principle.

What is Quantum mechanics? Time independent Schrodinger equation and meaning of various terms in it.Significance of ψ and ψ^2, Schrödinger equation for hydrogen atom.Graphical representation of 1*s*, 2*s*, 2*p*, 3*s*, 3*p* and 3*d* orbitals. Significance of quantum numbers, orbital angular momentum and quantum numbers *ml* and *ms*. Shapes of *s*, *p* and *d* atomic orbitals, nodal planes.

Rules for filling electrons in various orbitals, Electronic configurations of the atoms.Stability of half-filled and completely filled orbitals, concept of exchange energy.Relative energies of atomic orbitals, Anomalous electronic configurations.

Learning Outcomes

The student will learn about the fundamental assumptions of atomic theory and explain the composition of atoms including electronic configuration.

UNIT-II

Chemical Bonding and Molecular Structure

Ionic Bonding: General characteristics of ionic bonding. Energy considerations in ionicbonding, lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds.Statement of Born-Landé equation for calculation of lattice energy, Born-Haber cycle and its applications, polarizing power and polarizability. Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment and percentage ionic character.

Covalent bonding: VB Approach: Shapes of some inorganic molecules and ions on the basisof VSEPR and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements.

MO Approach: Rules for the LCAO method, bonding and antibonding MOs and their characteristics for *s-s*, *s-p* and *p-p* combinations of atomic orbitals, nonbonding combination of orbitals, MO treatment of homonuclear diatomic molecules of 1st and 2nd periods (including idea of *s- p* mixing) and heteronuclear diatomic molecules such as CO, NO and NO^+.

Learning Outcomes

The students will learn about ionic, covalent bonding in molecules. compare/contrast the properties of molecular and ionic compounds.

UNIT-III

Section B: Organic Chemistry-1

Fundamentals of Organic Chemistry

Physical Effects, Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation. Cleavage of Bonds: Homolysis and Heterolysis.

Structure, shape and reactivity of organic molecules: Nucleophiles and electrophiles. Reactive Intermediates: Carbocations, Carbanions and free radicals.

Strength of organic acids and bases: Comparative study with emphasis on factors affecting pK values. Aromaticity: Benzenoids and Hückel's rule.

Learning Outcomes

The students learn about the fundamental concepts of reaction mechanism, reactive species in organic chemistry and concept of aromaticity

UNIT-IV

Stereochemistry

Conformations with respect to ethane, butane and cyclohexane.Interconversion of Wedge Formula, Newmann, Sawhorse and Fischer representations.Concept of chirality (upto two carbon atoms). Configuration: Geometrical and Optical isomerism; Enantiomerism, Diastereomerism and Meso compounds). Threo and erythro; D and L; *cis - trans* nomenclature; CIP Rules: R/ S (for upto 2 chiral carbon atoms) and E / Z Nomenclature (for upto two C=C systems).

Aliphatic Hydrocarbons

Functional group approach for the following reactions (preparations & reactions) to be studied.

Alkanes: (Upto 5 Carbons).*Preparation:*Catalytic hydrogenation, Wurtz reaction, Kolbe'ssynthesis, from Grignard reagent. *Reactions:* Free radical Substitution: Halogenation.

Learning Outcomes

- The student shall learn the essential concepts of chirality, configuration, isomerism in organic chemistry and nomenclature of isomers.
- Students will familiarize with the elementary concept of saturated aliphatic hydrocarbons an reactions.

UNIT-V

Alkenes: (Upto 5 Carbons)*Preparation:*Elimination reactions: Dehydration of alkenes anddehydrohalogenation of alkyl halides (Saytzeff's rule); cis alkenes (Partial catalytic hydrogenation) and trans alkenes (Birch reduction). *Reactions:* cis-addition (alk. KMnO4) and trans-addition (bromine),

Addition of HX (Markownikoff's and anti-Markownikoff's addition), Hydration, Ozonolysis.

Alkynes: (Upto 5 Carbons)*Preparation:*Acetylene from CaC2and conversion into higheralkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinal-dihalides.
Reactions: formation of metal acetylides, addition of bromine and alkaline KMnO4,ozonolysis and oxidation with hot alk. KMnO4.

Learning Outcomes
The students will learn synthetic reactions, mechanism and properties of aromatic alcohol, aromatic and aliphatic ether, aldehydes, and ketones.

Course outcomes: By the end of the course, the student will be able to

- learn about the fundamental assumptions of atomic theory and explain the composition of atoms including electronic configuration.
- learn about the fundamental concepts of reaction mechanism, reactive species in organic chemistry and concept of aromaticity
- learn synthetic reactions, mechanism and properties of aromatic alcohol, aromatic and aliphatic ether, aldehydes and ketones.

RECOMMENDED BOOKS:

1. Lee, J.D. *Concise Inorganic Chemistry* ELBS, 1991.
2. Cotton, F.A., Wilkinson, G. & Gaus, P.L. *Basic Inorganic Chemistry*, 3rdEd., Wiley.
3. Huheey, J.E., Keiter, E.A., Keiter, R.L. & Medhi, O.K. *Inorganic Chemistry:Principles of Structure and Reactivity*, Pearson Education India, 2006.
4. McMurry, J.E. *Fundamentals of Organic Chemistry*, 7th Ed. Cengage Learning India Edition, 2013.
5. Sykes, P. *A Guidebook to Mechanism in Organic Chemistry*, Orient Longman, New Delhi (1988).
6. Eliel, E.L. *Stereochemistry of Carbon Compounds*, Tata McGraw Hill education, 2000.
7. Finar, I.L. *Organic Chemistry* (Vol. I & II), E.L.B.S.
8. Morrison, R.T. & Boyd, R.N. *Organic Chemistry*, Pearson, 2010.
9. Bahl, A. & Bahl, B.S. *Advanced Organic Chemistry*, S. Chand, 2010.

SEMESTER –I

SPH 125: ATOMIC STRUCTURE, BONDING, GENERAL ORGANIC CHEMISTRY & ALIPHATIC HYDROCARBONS LAB

Hours per week: 03 **End Examination: 00 Marks**
Credits: 02 **Sessional: 100 Marks**

Preamble: The students of undergraduate program in science in Chemistry need to be conversant with the various basic methodologies of chemistry. Therefore, one module each on in inorganic , physical and organic chemistry is introduced which helps the student familiarize with the techniques essential for developing the foundation of practical chemistry

Course objective: To make student develop the fundamental skill required for quantitative and qualitative analysis in inorganic and organic chemistry.

Section A: Inorganic Chemistry - Volumetric Analysis

1. Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture.
2. Estimation of oxalic acid by titrating it with KMnO4.
3. Estimation of water of crystallization in Mohr's salt by titrating with KMnO4.
4. Estimation of Fe (II) ions by titrating it with K2Cr2O7 using internal indicator.
5. Estimation of Cu (II) ions iodometrically using Na2S2O3.

Learning outcomes:

- The student will learn about the quantitative analysis concepts of redox chemistry

Section B: Organic Chemistry

1. Detection of extra elements (N, S, Cl, Br, I) in organic compounds (containing upto two extra elements)
2. Separation of mixtures by Chromatography: Measure the Rf value in each case (combination of two compounds to be given)
   (a) Identify and separate the components of a given mixture of 2 amino acids (glycine, aspartic acid, glutamic acid, tyrosine or any other amino acid) by paper chromatography

   (b) Identify and separate the sugars present in the given mixture by paper chromatography.

Learning outcomes:

- The students will familiarize the concept of qualitative element detection in organic chemistry essential for functional group analysis.
- The students will also have the elementary idea of the techniques of planar chromatography

Course outcomes: By the end of the course the student will be able to

- learn about the quantitative analysis concepts of redox chemistry
- familiarize with the concept of qualitative element detection in organic chemistry essential for functional group analysis.
- have an elementary idea of the techniques of planar chromatography

RECOMMENDED BOOKS:

1. Svehla, G. *Vogel's Qualitative Inorganic Analysis*, Pearson Education, 2012.
2. Mendham, J. *Vogel's Quantitative Chemical Analysis*, Pearson, 2009.
3. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., *Textbookof Practical Organic Chemistry*, Prentice-Hall, 5th Edition, 1996.
4. Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry* Orient-Longman, 1960.

SEMESTER –I

SMB 101: INTRODUCTION TO MICROBIOLOGY

Hours per week	**: 04**	**End examination**	**: 60 Marks**
Credits	**: 04**	**Sessional**	**: 40 Marks**

Preamble:
This paper provides a base line understanding of Microbiology and has been designed to enrich students an insight in acquiring the fundamental knowledge on various microorganisms and their importance and applicability in different fields of industry.

Course Objectives:
The objective of this course is to introduce field of microbiology with special emphasis on microbial diversity, morphology, physiology, and nutrition; methods for control of microbes and host-microbe interactions.

UNIT- I
History of microbiology, Spontaneous generation theory.Contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming, Beijerinck, Winogradsky,EdwardJenner,Ivanowski.Germtheoryofdisease,goldeneraofmicrobiology.

Learning outcomes:
By the end of the course, the student will be able to:
- Develop a detailed knowledge on history of Microbiology and golden age of Microbiology
- Learn the contribution of prominent Scientists to the development of Microbiology

UNIT-II
Classification: Whittaker's and Carl Woese's three kingdom classification systems and introduction to Bergey's manual. Prokaryotic and eukaryotic cell organization.Acellular microorganisms (Viruses,Viroids,Prions)andCellularmicroorganisms(bacteria,algae,fungiandprotozoa).

Learning outcomes:
By the end of the course, the student will be able to:
- Understand the classification systems and Bergey' manual
- Learn cell organization of Prokaryotes and eukaryotes
- Develop knowledge on Acellular microorganisms

UNIT-III
General characteristics of algae, occurrence, thallus organization, algal cell ultra-structure, pigments, flagella, eyespot food reserves.Vegetative, asexual and sexual reproductions.Economic importance of algae.

Learning outcomes:
By the end of the course, the student will be able to:
- Acquire knowledge about mode of reproduction, general characteristics, occurrence, and importance of Algae.

UNIT-IV

General characteristics of fungi including habitat, distribution, nutritional requirements, fungal cell ultra-structure, thallus organization, types of septa, asexual reproduction, types of spores (asexual and sexual), sexual reproduction, heterokaryosis, heterothallism and parasexual mechanism. Economic importance of fungi.

Learning outcomes:

By the end of the course, the student will be able to:

- Acquire knowledge about mode of reproduction, general characteristics, occurrence, and importance of Fungi.

UNIT-V

General characteristics with special reference to *Amoeba, Euglena*, and *Paramecium.*

Virus taxonomy, ICTV, Baltimore, virus structure, and cultivation of virus-Embryonated egg, tissue culture; TMV, lytic and lysogenic cycle (T4 and λ phages).

Learning outcomes:

By the end of the course, the student will be able to:

- Acquire knowledge regarding individual microbes
- Develop a detailed knowledge on taxonomy, structure, and cultivation of viruses
- Learn the concepts of viral replication.

Course Outcomes: On completion of this course, students should be able to

- Describe the main steps and processes used to classify microorganisms
- Discover new useful microorganisms and store them reliably for later use
- Evaluate which molecular techniques are applicable to isolate, identify and culture different types of microbes

RECOMMENDED BOOKS:

1.Microbiology: An Introduction (2016) by Tortora *et al.,* 12th Edition Pearson publishers

2.Prescott's Microbiology (2016) by Joanne Willey *et al.,* 10th Edition McGraw-Hill Education

3.Sherris Medical Microbiology, (2018) by Kenneth J. Ryan *et al.,*7th EditionMcGraw-Hill Education

4.Brock Biology of Microorganisms (2015) by Michael T. Madigan (15th Edition), Pearson publishers

5.Algae (2008) by James E. Graham (2nd Edition), Benjamin Cummings

6.The Fungi by Sarah C. Watkinson, Academic Press; 3rdEdition (2016)

7.Fungi: Experimental Methods in Biology (2019) by Ramesh Maheshwari, 2ndEdition, CRC Press

SEMESTER – I

SMB 121: PRACTICES IN MICROBIOLOGY LAB

Hours per week: 03 **End Examination: 00 Marks**
Credits: 02 **Sessional: 100 Marks**

Preamble:
This paper has been designed to enrich students in learning the good laboratory practices and understand the principle and applications of important instruments used in Microbiology laboratory.

Course Objectives:
The objective of this laboratory course is to develop a detailed knowledge on instruments used in Microbiology laboratory and also provide practical skills in operation of basic microbiological instruments and learn the basic techniques of staining and preparation of temporary mounts.

1. Microbiology Good Laboratory Practices and Biosafety.

2. Principle and applications of important instruments used in microbiology lab (biological safety cabinets,autoclave,bacteriologicalincubator,BODincubator,hotairoven,lightmicroscope,pHmeter and colony counter) used in the microbiology laboratory.

3. Studyof*Rhizopus*,*Penicillium*,*Aspergillus*usingtemporarymounts

4. Studyof*Spirogyra*and*Chlamydomonas*,*Volvox*usingtemporaryMounts

5. Study of the following protozoans using permanent mounts/photographs: *Amoeba*, *Entamoeba*, *Paramecium* and *Plasmodium*

Course outcomes: By the end of the course, the student will be able to:

- Learn good laboratory practices and biosafety aspects
- Acquire a detailed knowledge on instruments used in Microbiology laboratory
- Perform basic experiments in staining and specimen mount preparation

RECOMMENDED BOOKS:

1. Laboratory Exercises in Microbiology (2016) by John Harley 8th Edition, McGraw-Hill Education
2. Microbiology: A Laboratory Manual (2016) by James G. Cappuccino 11th Edition Pearson publishers
3. Microbiology: Laboratory Theory and Application (2015) 4th Edition by Michael J. Leboffe, Morton Publishing Company

SEMESTER – II

SFC 102: ENVIRONMENTAL SCIENCE

Hours per week: 02 **End examination: 00 Marks**
Credits: 02 **Sessional: 100 Marks**

Preamble:
The dynamic changes in the Environment require as precise understanding to adjust to the changes. This paper provides a base line understanding of Environmental changes problems.

Objectives:
To enable student, understand importance of environmental science
To introduce student to ecosystem and its process, sources, and effects of Environmental Pollution.
To Sensitize student regarding day to day social & environmental issues.

UNIT-I
The Multidisciplinary nature of environmental studies–Definition, Scope and Importance, Need for Public awareness. Natural Resources: Classification – Renewable and Non Renewable Resources. Renewable Resources: Forest, Water and Energy Resources Non Renewable Resources: Mineral, Food and Land resources (Uses, reasons for over-utilization and effects)
Learning Outcome: By the end of the unit the student
- Will understand importance of Environmental Science & Natural Resources

UNIT-II
Eco-system: Structure of an Ecosystem, Producers, consumers and de-composers. Structure of Terrestrial Ecosystems (Forest ecosystem, Grassland ecosystem and Desert ecosystem) and Aquatic Ecosystems (Pond ecosystem and ocean ecosystem). Function of an ecosystem -food chains, food web and ecological pyramids - energy flow in the ecosystem. Environmental Pollution: Causes, effects and control measures of Air, Water,
soil pollution, Thermal pollution, and nuclear hazards. Municipal solid waste management.
Learning Outcome: By the end of the unit the student
- Will appreciate ecosystems and its process

UNIT-III
Environmental problems: Global Environmental Problems, Green house effect, Ozone layer depletion, acid rains and Climate change. National Environmental Problems: Deforestation – Causes and Effects, Environmental Problems associated with dams. Mining and Environmental effects.
Learning Outcome: By the end of the unit the student
- Will gain knowledge as sources and effects of Environmental Pollution

UNIT-IV
Social Issues and the Environment: Environmental ethics, Issues and possible solutions. Waste land reclamation, Consumerism and waste products. Environmental Legislation: Environment Protection Act, Air Act, Water Act, Wildlife Protection act and Forest conservation act.
Learning Outcome: By the end of the unit the student.
- Will get exposure towards social problems and gain understand on environmental legislation.

UNIT-V

Human Population and the Environment: Population growth, variation among nations, Population explosion-Family welfare programme. Environment and human health. Human rights, Value education, HIV/AIDS, Women and Child welfare, Role of information technology in environment and human health.

Learning Outcome: By the end of the unit the student

- Will be to explain patterns of population growth and problems associated with it.

Course Outcomes: On completion of this course, students will be able to

- Stay updated in environmental science and technologies by applying information resources and industrial contacts
- Explain the role of information technology in environment and human health
- Hypothesize different environmental legislation acts and issues involved in enforcement of legislation

RECOMMENDED BOOKS:

1. Text Book of Environmental studies for Undergraduate courses by Bharucha Erach Published byV.G.C
2. Environmental Science: A Global Concern by William P.Cunningham and BarabaWoodworth Saigo.
3. A text book of Environmental Science byP.C.Joshi
4. A text book of Environmental Science by ArvindKumar
5. A text book of Environmental Science byS.C.Santra
6. Ecology & Environment byP.D.Sharma

SEMESTER – II

SBT 112: CELL BIOLOGY AND GENETICS

Hours per week	**: 04**	**End examination**	**: 60 Marks**
Credits	**: 04**	**Sessional**	**: 40 Marks**

Preamble:
The aim of this course is to provide an introduction to Cell Biology and Genetics from the basic organization of cell and its components to the functions it performs. It also covers the basic principles of genetics and inheritance.

Course Objectives:

1. To explain the Morphology and chemical composition of the cell and function of each organelle present in the cell.
2. To make students understand the basics of genetics and classical concepts of Mendelian
3. genetics across life-forms.
4. To empower students to concepts of population genetics, quantitative genetics and
5. genetics of evolution.

UNIT-I
Cell: Introduction and classification of organisms by cell structure. Cell Division: Mitosis and Meiosis: Role of meiosis in life cycles of organisms. Cell cycle and its regulation.
Learning outcomes: By the end of the unit, the student will be able to:
- Understand the transmission of genetic material in cell division by mitosis or meiosis.
- Comprehend the processes that control cell division.

UNIT-II
Chemical components of biological membranes, organization and Fluid Mosaic Model, membrane as a dynamic entity, cell recognition and membrane transport. Structure and function of Endoplasmic reticulum, Golgi complex, Lysosomes: Ribosomes, Mitochondria, Chloroplasts and Nucleus.

Learning outcomes: By the end of the unit, the student will be able to:
- Comprehend and describe the features of prokaryote and eukaryote cells, the composition and spatial organization of the cell.

UNIT-III
Cytoskeleton and cell motility: Structure and function of microtubules, Microfilaments, Intermediate filaments.
Extracellular Matrix: Composition, molecules that mediate cell adhesion, Endocytosis, Exocytosis membrane receptors for extra cellular matrix.

Learning outcomes: By the end of the unit, the student will be able to:

- Understand the mechanisms of transport into and out of the cell.
- Explain the cytoskeleton and its role in the cell.

UNIT-IV

Mendelian genetics: Mendel's experimental design, Law of segregation & Principle of independent assortment. Test and back crosses. Pedigree analysis.

Dominance relationships, Pleiotropy, Multiple alleles, pseudo-allele, essential and lethal genes, Penetrance and Expressivity. Non allelic interactions: epistasis (dominant & recessive). Extra chromosomal inheritance and sex linkage.

Learning outcomes: By the end of the unit, the student will be able to:

- Understand fundamental principles of genetics.
- Understand the concepts of various factors that influence phenotype and genotype.

UNIT-V

Genetic linkage, crossing over and chromosome mapping. Population genetics: Gene pool, Gene Frequency, Hardy Weinberg law and its limitations. Evolution: Origin of life, theories of organic evolution, Lamarckism and Darwinism, modern synthetic theory. Evolution above species level – micro, macro, and mega evolution. Evolutionary genetics.

Learning outcomes:

By the end of the unit, the student will be able to:

- Learn the concept of linkage.
- Understand Genome evolution, population variation and speciation.

Course Outcomes: On completion of this course, students should be able to

- Acquire basic knowledge on cell structure and function, transport in a cell, protein trafficking in the cell
- Understand the cell-cell communication, cell division, and cell death.
- Appreciate the basic concepts of classical genetics and developmental genetics

RECOMMENDED BOOKS:

1. iGenetics: A Molecular Approach by peter J. Russell (2016), Pearson Education
2. The Cell: A Molecular Approach by Geoffery M Cooper, (2013), 6th Edition, Sinauer Associates Inc.
3. Karp's Cell and Molecular Biology: Concepts and Experiments by Janet Iwasa (2016), John Wiley & Sons Inc; 8 edition
4. Cell Biology by Thomas D Pollard (2017), 3rd Revised edition, Elsevier - Health Sciences Division.
5. Principles of Genetics by Peter Snausted (2011), 6th Edition, John Wiley & Sons Inc.
6. Principles of Genetic by Tamarin, (2017), 7th Edition, McGraw Hill Education.
7. Genetics: Analysis and Principles by Robert J Brooker, (2017), 6th Edition, McGraw Hill Education.
8. Genetics: A Conceptual Approach by Benjamin Pierce, (2017), 6th Edition, WH Freeman
9. Concepts of Genetics by William S. Klug, (2013), 10th edition, Pearson Publishers.
10. De Robertis, E.D.P. and De Robertis, E.M.F. 2011.Cell and Molecular Biology.8th Ed. Lippincott, Williams and Wilkins, Philadelphia.

SEMESTER – II

SBT 128: CELL BIOLOGY AND GENETICS LAB

Hours per week: 03 **End Examination: 00 Marks**
Credits: 02 **Sessional: 100 Marks**

Preamble:
This course has been designed to train students with basic techniques of cell biology and genetics. Imparts training in karyotype and pedigree analysis and also to learn inheritance patterns of genes.

Course Objectives:

- To introduce students to experiments of cell biology – different stages of cell division, organelle fractionation and diffusion and osmosis phenomena.
- To make understand what a karyotype is and how it is performed.
- To make students lean inheritance patterns of genes with the help of pedigree charts.

1. Cell division in onion root tip/ insect gonads
2. Permanent and temporary mount of mitosis.
3. Permanent and temporary mount of meiosis
4. Sub cellular fractionation of cell organelles.
5. Study of plasmolysis /deplasmolysis
6. Demonstration of - Barr Body.
7. Karyotyping with the help of photographs
8. Pedigree charts of some common characters like blood group, color blindness and PTC testing.
9. Study of polyploidy in onion root tip by colchicine treatment

Course Outcomes: By the end of this course, the students will be able to

- Learn different stages of cell division and cell organelle separation.
- Understand arrangement of human chromosomes and how to identify genetic defects by karyotype analysis.
- Do pedigree analysis that helps students appreciate inheritance patterns of genes.

RECOMMENDED BOOKS:

1. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons.Inc.

2. Essential Cell Biology Vol 1: Cell Structure (Practical Approach Series). John Davey and Michael Lord, Oxford University Press.

3. Rediscovering Genetics A Laboratory Manual**:** Sunita Joshi and Neeru Dhamija: I.K International Publishing House Pvt. Limited

4. Genetics A Laboratory Manual 2nd edition Gregore Koliantz & Daniel B. Szymanski: Published by: American Society of Agronomy, Crop Science Society of America, 2nd Edition.

SEMESTER –II

SPH 106: CHEMICAL ENERGETICS, EQUILIBRIA &FUNCTIONAL ORGANIC CHEMISTRY

Hours per week	**: 04**	**End examination**	**: 60 Marks**
Credits	**: 04**	**Sessional**	**: 40 Marks**

Preamble: The students of undergraduate program in science need to be conversant with the various aspects of energetic and chemical equilibria. Functional group chemistry forms the foundation for training a undergraduate students as organic chemist.

Course objective:
To introduce the concept of chemical reaction equilibrium and reaction energetics in general and physical chemistry to the undergraduate students.
The students will learn the essential functional groups in organic chemistry, their reactions, and properties.

UNIT-I

Section A: Physical Chemistry-1
Chemical Energetics
Review of thermodynamics and the Laws of Thermodynamics.
Important principles and definitions of thermochemistry. Concept of standard state and standard enthalpies of formations, integral and differential enthalpies of solution and dilution. Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data. Variation of enthalpy of a reaction with temperature – Kirchhoff's equation. Statement of Third Law of thermodynamics.

Chemical Equilibrium:
Free energy change in a chemical reaction.Thermodynamic derivation of the law of chemical equilibrium. Le Chatelier's principle. Relationship between *Kp*, and *Kc*

Learning Outcomes:

- The student will learn about the essential concepts of thermo-chemistry and chemical thermodynamics The student will learn the calculation of bond energy, bond dissociation energy and resonance energy from thermo-chemical data.
- The students will learn Le Chatelier's principle and applications.

UNIT-II
Ionic Equilibria:
Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect.Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts.Buffer solutions. Solubility and solubility product of sparingly soluble salts
Learning Outcomes:

- The students will learn the elementary concepts of ionic chemical equilibrium with respect to acid – base, salt hydrolysis and solubility of ionic substances.

Section B: Organic Chemistry-2

UNIT-III

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

Aromatic hydrocarbons

Preparation (Case benzene): from phenol, by decarboxylation, from acetylene, from benzenesulphonic acid.

Reactions: (Case benzene): Electrophilic substitution: nitration, halogenation andsulphonation. Friedel-Craft's reaction (alkylation and acylation) (upto 4 carbons on benzene).Side chain oxidation of alkyl benzenes (upto 4 carbons on benzene).

Alkyl Halides

Preparation: from alkenes *and* alcohols.

Reactions: hydrolysis, nitrite & nitro formation, nitrile & isonitrile formation. Williamson'sether synthesis: Elimination vs substitution.

Learning Outcomes:

- The students will learn the concept of Functional group approach for aromatic hydrocarbon and alkyl halide.

UNIT-IV

Aryl Halides *Preparation:*(Chloro, bromo and iodo-benzene case): from phenol, Sandmeyer& Gattermann reactions.

Reactions (Chlorobenzene): Aromatic nucleophilic substitution (replacement by –OH group)and effect of nitro substituent. Benzyne Mechanism: KNH2/NH3 (or NaNH2/NH3).

Alcohols: *Preparation:*Preparation of 1º, 2ºand 3ºalcohols: using Grignard reagent, Esterhydrolysis, Reduction of aldehydes, ketones, carboxylic acid and esters.

Reactions: With sodium, HX (Lucas test), esterification, oxidation (with PCC, alk. KMnO4,acidic dichromate, conc. HNO3). Oppeneauer oxidation *Diols:* (Upto 6 Carbons) oxidation of diols. Pinacol-Pinacolone rearrangement.

Learning Outcomes:

- The student shall learn the elementary reactions and properties , mechanism of aryl halides and alcohol . The students will learn differentiation between, primary, secondary and tertiary alcohol.

UNIT-V

Phenols: (Phenol case)*Preparation:*Cumene hydroperoxide method, from diazonium salts.*Reactions:* Electrophilic substitution: Nitration, halogenation and sulphonation. Reimer-

Tiemann Reaction, Gattermann-Koch Reaction, Houben–Hoesch Condensation, Schotten – Baumann Reaction.

Ethers (aliphatic and aromatic): Cleavage of ethers with HI.

Aldehydes and ketones (aliphatic and aromatic): (Formaldehye, acetaldehyde, acetone andbenzaldehyde)

Preparation: from acid chlorides and from nitriles.
Reactions – Reaction with HCN, ROH, NaHSO3, NH2-G derivatives. Iodoform test.AldolCondensation, Cannizzaro's reaction, Wittig reaction, Benzoin condensation.Clemensen reduction and Wolff Kishner reduction.Meerwein-Pondorff Verley reduction.

Learning Outcomes:

- The students will learn about reactions and properties of aromatic alcohols, ethers, aldehydes and ketones

Course Outcomes: By the end of the course the student will be able to

- learn the elementary reactions and properties, mechanism of aryl halides and alcohol
- learn about reactions and properties of aromatic alcohols, ethers, aldehydes and ketones
- learn the concept of Functional group approach for aromatic hydrocarbon and alkyl halide.
- learn the elementary concepts of ionic chemical equilibrium with respect to acid – base, salt hydrolysis and solubility of ionic substances

RECOMMENDED BOOKS:

1. Graham Solomon, T.W., Fryhle, C.B. & Dnyder, S.A. *Organic Chemistry*, John Wiley & Sons (2014).

2. McMurry, J.E. *Fundamentals of Organic Chemistry*, 7th Ed. Cengage Learning India Edition, 2013.

3. Sykes, P. *A Guidebook to Mechanism in Organic Chemistry*, Orient Longman, New Delhi (1988).

4. Finar, I.L. *Organic Chemistry* (Vol. I & II), E.L.B.S.
5. Morrison, R.T. & Boyd, R.N. *Organic Chemistry*, Pearson, 2010.
6. Bahl, A. & Bahl, B.S. *Advanced Organic Chemistry*, S. Chand, 2010.
7. Barrow, G.M. *Physical Chemistry* Tata McGraw-Hill (2007).

SEMESTER –II

SPH 124: CHEMICAL ENERGETICS, EQUILIBRIA & FUNCTIONAL ORGANIC CHEMISTRY LAB

Hours per week: 03 **End Examination: 00 Marks**
Credits: 02 **Sessional: 100 Marks**

Preamble: The students of undergraduate program in science in Chemistry need to be conversant with the various basic methodologies of chemistry. Therefore, one module each on in inorganic, physical and organic chemistry is introduced which helps the student familiarize with the techniques essential for developing the foundation of practical chemistry

Course objective: student will be familiarized with the practical applications of thermo-chemistry and ionic equilibrium.

Section A: Physical Chemistry

Thermochemistry

1. Determination of heat capacity of calorimeter for different volumes.
2. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
3. Determination of enthalpy of ionization of acetic acid.
4. Determination of integral enthalpy of solution of salts (KNO3, NH4Cl).
5. Determination of enthalpy of hydration of copper sulphate.
6. Study of the solubility of benzoic acid in water and determination of *H*.

Ionic equilibria pH

measurements

a) Measurement of pH of different solutions like aerated drinks, fruit juices, shampoos and soaps (use dilute solutions of soaps and shampoos to prevent damage to the glass electrode) using pH-meter.

b) Preparation of buffer solutions:
   (i) Sodium acetate-acetic acid
   (ii) Ammonium chloride-ammonium hydroxide

Measurement of the pH of buffer solutions and comparison of the values with theoretical values.

Learning Outcomes:

The student will learn determination of heat of neutralization and enthalpy. The students will also lear to apply concept of ionic equilibrium for determination of pH. The students will also learn to prepare the solution of buffer and determination of its pH.

Section B: Organic Chemistry

1. Purification of organic compounds by crystallization (from water and alcohol) and distillation.
2. Criteria of Purity: Determination of melting and boiling points.
3. Preparations: Mechanism of various reactions involved to be discussed. Recrystallisation, determination of melting point and calculation of quantitative yields to be done.

(a) Bromination of Phenol/Aniline
(b) Benzoylation of amines/phenols

(c) Oxime and 2,4-dinitrophenylhydrazone of aldehyde/ketone

Course outcomes: By the end of the practical course the students will be able to

- familiarize the concept of qualitative element detection in organic chemistry essential for functional group analysis.
- learn about the quantitative analysis concepts of redox chemistry

RECOMMENDED BOOKS:

1. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., *Textbookof Practical Organic Chemistry*, Prentice-Hall, 5th edition, 1996.

2. Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry* Orient-Longman, 1960.

3. Khosla, B. D.; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry*, R. Chand & Co.: New Delhi (2011).

SEMESTER – II

SMB 100: BACTERIOLOGY

Hours per week	**: 04**	**End examination**	**: 60 Marks**
Credits	**: 04**	**Sessional**	**: 40 Marks**

Preamble:
This course has been designed to introduce field of bacteriology with special emphasis on bacterial diversity, morphology, physiology, and nutrition; methods for control of bacteria and its culture techniques with precise methods of how to characterize the organisms.

Course Objectives:
1. To study morphological diversity of bacteria using microscopy techniques.
2. To identify and demonstrate how to control microbial growth.
3. To learn about different methods of culturing of bacteria on an animate media.

UNIT-I
Microscopy: Bright field microscope, dark field microscope, phase contrast microscope, fluorescence microscope, confocal microscopy, scanning and transmission electron microscope. Staining techniques: simple and differential staining, Gram and acid fast, spore, capsular, flagellar staining.

Learning outcomes:

By the end of the course, the student will be able to:
- Learn microscopic techniques to study ultrastructure of bacteria
- Understand the application of stains or dyes, in examining the morphology of bacteria by microscopy.

UNIT-II
Cell size, shape and arrangement, morphology and ultrastructure of bacteria, actinomycetes and mycoplasma. Endospore: structure, formation, stages of sporulation**.** Bacterial growth, binary fission, growth curve, phases of growth, generation time and specific growth rate. Growth measurement: optical density, colony forming units, batch, synchronous and continuous cultures. Chemostat and turbidostat.

Learning outcomes:
By the end of the course, the student will be able to:
- Learn the shape, morphological variations in arrangement of cells and to understand the ultrastructure of bacterial cell
- Study the bacterial growth kinetics and will be able to learn the techniques used in measuring the bacterial growth

UNIT-III
Physical methods: Dryheat-hot air oven, incineration; moist heat: boiling water, tyndallization, autoclaving, pasteurization, radiation: ionizing and non ionizing radiations; filtration.
Chemical methods: alcohols, phenols, halogens, quaternary ammonium compounds, aldehydes, and gases. Antiseptics and disinfectants.

Learning outcomes:

By the end of the course, the student will be able to:
1. Learn about different kinds of methods to control microorganisms
2. Learn the mechanism of sterilizing agents and their applications in day today life.

UNIT-IV

Nutritional requirement of bacteria, microbiological media- natural and synthetic media, chemically defined media, complex media, selective, differential, indicator, enriched and enrichment media. Pure culture techniques: pour plate, streak plate, and spread plate; preservation and maintenance of pure cultures; cultivation of anaerobic bacteria.

Learning outcomes:

By the end of the course, the student will be able to:

- Learn about the nutrients which enhance the growth of microorganisms
- Learn various culture techniques to cultivate bacteria in lab conditions

UNIT-V

Identification and characterization of bacterial cultures, and archaea morphological, biochemical, (IMViC, catalase, oxidase, urease, nitrate reductase; sugar fermentations, amylase, protease) metabolic, genetic, ecological, and molecular characteristics.

Learning outcomes:

By the end of the course, the student will be able to:

- Learn how to classify the microorganisms based on biochemical parameters
- Identify the taxon of bacteria based on various characteristic features.

Course Outcomes: By the end of this course, the students will be able to

- Identify the taxon of bacteria based on various characteristic features
- Learn various culture techniques to cultivate bacteria in lab conditions
- Understand the bacterial growth kinetics and will be able to learn the techniques used in measuring the bacterial growth

RECOMMENDED BOOKS:

1.Microbiology: An Introduction (2016) by Tortora et al., 12th Edition Pearson publishers

2.Microbiology: A Systems Approach (2017) by Kelly Cowan 5th Edition McGraw-Hill Education

3.Prescott's Microbiology (2016) by Joanne Willey et al., 10th Edition McGraw-Hill Education

4.Sherris Medical Microbiology, (2018) by Kenneth J. Ryan et al.,7th Edition McGraw-Hill Education

5.Microbiology: Principles and Explorations (2015) by Black et al.,9th Edition, Wiley Pulishers

6.Brock Biology of Microorganisms (2015) by Michael T. Madigan (15th Edition), Pearson publishers.

7. Microbiology: Laboratory Theory and Application (2015) 4th Edition by Michael J. Leboffe, Morton Publishing Company.

SEMESTER – II

SMB 120: BACTERIOLOGY LAB

Hours per week: 03 **End Examination: 00 Marks**
Credits: 02 **Sessional: 100 Marks**

Preamble:
This course has been designed to train students with basic techniques of microbiology and the role of microbes in the daily life as well as in the various fields of science, Imparts advanced training in Microbiology for the students and also how the microbes can be controlled is also dealt with.

Course Objectives:

- Is to provide practical skills on basic microbiological techniques.
- Is to isolate, characterize and identify common bacterial organisms.
- Is to preserve bacterial cultures.

1. SterilizationofglasswareusingHotAirOvenandassessmentforsterility
2. PreparationandsterilizationofmediumusingAutoclaveandassessmentforsterility
3. Sterilizationofheatsensitivematerialbymembranefiltrationandassessmentforsterility
4. Preparation of different media: synthetic media, Complex media-Nutrient agar, McConkey agar, EMB agar.
5. Simple staining, Negative staining
6. Gram's staining
7. Acid fast staining-permanent slide only.
8. Capsule staining
9. Endospore staining.
10. Isolation of pure cultures of bacteria by streaking method.
11. Estimation of CFU count by spread plate method/pour plate method.
12. Motility by hanging drop method.
13. Preservation of bacterial cultures by various techniques.

Course outcomes: By the end of the course, the student will be able to

- Learn how to make slides for microbial examinations and will equip themselves with the basic staining aspects to be performed in the laboratory.
- Isolate and characterize the microorganisms based on morphology
- Enumerate the microbes by different plating methods.
- Learn all aspects of microbiology as it is required for Biotechnology course.

RECOMMENDED BOOKS:

1. Laboratory Exercises in Microbiology (2016) by John Harley 8th Edition, McGraw-Hill Education
2. Microbiology: A Laboratory Manual (2016) by James G. Cappuccino 11th Edition Pearson publishers
3. Microbiology: Laboratory Theory and Application (2015) 4th Edition by Michael J. Leboffe, Morton Publishing Company

SEMESTER – III

SBT 211: ENZYMOLOGY AND METABOLISM

Hours per week	**: 04**	**End examination**	**: 60 Marks**
Credits	**: 04**	**Sessional**	**: 40 Marks**

Preamble: This course enables a learner to makes an insight into the enzymes, known as macromolecular biological catalysts that enhances the basic biochemical reactions and fine-tunes the metabolism with high accuracy. Understanding the basic process of biochemistry and are very much crucial for many applications of biological research with specific emphasis on enzyme kinetics, inhibition and regulation. The course shall make the students aware of various functions of enzymes within the context of each topic. The course shall make the students aware of significance of metabolism and its regulation and disorders of metabolic pathways.

Course Objectives:

- To educate students about the fundamental concepts of Enzymology&Metabolism and its related applications, thus preparing them to meet the challenges in medicine and industry.
- To improve the basic knowledge and to bring awareness on enzyme inhibition and regulatory processes.
- To enhance the knowledge about the key biochemical pathways in metabolism and their regulations

UNIT –I

Nomenclature and classification of enzymes, Factors effecting enzyme activity: enzyme concentration, substrate concentration, pH, temperature and metal ions. Enzyme assay, units of enzyme activity and specific activity. Michaelis - Menten equation, significance of Km, Vmax.

Learning outcomes: By the end of the unit, the student will be able to:

- Gain fundamental knowledge on basic concepts of enzymes
- Understand the molecular basis of enzyme kinetics and various types of inhibitions from the perspective of biochemical pathways occur in biological cellular environments, which are very important in understanding the life processes.

UNIT-II

Cofactors, coenzymes, metalloenzymes. Enzyme inhibition: Irreversible inhibition and Reversible inhibition - competitive, non- competitive and uncompetitive. Enzyme regulation: allosteric enzymes, zymogen activation, covalent modification, and isoenzymes. Overview of Abzyme, ribozyme and enzyme immobilization.

Learning outcomes: By the end of the unit, the student will be able to:

- Gain knowledge about the fine-tuning of metabolism by means of enzyme regulation.
- Be familiar with various types of enzyme immobilization.
- Understand the abzymes and ribozymes with respect to their mechanism and functions.

UNIT-III

Glycolysis and its regulation. TCA cycle and its regulation. Electron transport chain and oxidative phosphorylation. Significance of gluconeogenesis, HMP shunt and glyoxylate cycle. Glycogen synthesis and degradation, Glycogen storage diseases.

Learning outcomes: By the end of the unit, the student will be able to:

- Gain knowledge about the carbohydrate metabolism.
- Understand the diseases related to carbohydrate metabolism

UNIT-IV

Synthesis and degradation of Saturated and Unsaturated Fatty acids, Ketone bodies, Synthesis of Triacyl glycerides, Phospholipids and Cholesterol.

Learning outcomes: By the end of the unit, the student will be able to:

- Give account on lipid metabolism.
- Understand the synthesis of saturated, unsaturated fatty acids and triacyl glycerides

UNIT-V

Transamination and oxidative deamination and Urea cycle. Biosynthesis and degradation of phenylalanine and valine. Inborn errors of amino acid metabolism. Synthesis and degradation of purine and pyrimidine nucleotides. Formation of deoxyribonucleotides.

Learning outcomes: By the end of the unit, the student will be able to:

- Gain knowledge on urea cycle and its importance.
- Understand the nucleotide metabolism
- Know the inborn errors associated with amino acid metabolism

Course Outcomes: By the end of this course, the student will be able to

- Understand the molecular basis of enzyme kinetics and various types of inhibitions from the perspective of biochemical pathways
- Gain knowledge about the fine-tuning of metabolism by means of enzyme regulation
- Gain knowledge about the carbohydrate, lipid and nucleotide metabolism

RECOMMENDED BOOKS:

1. Enzymes: Biochemistry, Biotechnology, Clinical Chemistry by Palmer, 2nd edition, East West publishers
2. Lehninger Principles of Biochemistry by Nelson, D and Cox, D. –7th Edition. Mcmillan Pub.
3. Biochemistry by L.Stryer– 8th Edition. (Freeman-Tappan).
4. Biochemistry by D.Voet and J.G.Voet– 4th Edition. (John weily).
5. Biochemistry by Garrett and Grisham 6th Edition. (Cengage Learning)
6. Biochemistry Concepts and Connections by Mathews et. al.,Global Edition.
7. Principles of Biochemistry by David Rawn etal., 5th Edition (Pearson)
8. Essentials of Glycobiology. 3rd Edition. (CSHL press)
9. Harper's Biochemistry by Robert K. Murray et al., – 30thEdition. (Langeman).
10. Biochemistry by U.Satyanarayana—4thEdition.

SEMESTER – III

SBT 227: ENZYMOLOGY LAB

Hours per week: 03 **End Examination: 00 Marks**
Credits: 02 **Sessional: 100 Marks**

Preamble: Enzymology is the study of enzymes, their structure and function. Enzymes are highly specific towards their substrates. Their specificity is due to their sequence and structural conformation. Sensitive to various physical and biochemical factors. This course enables the learner to be acquainted with laboratory skills in assaying, quantifying various enzymes. Further, enhances the ability to understand the kinetics aspects of enzymes.

Course objectives:

- To train students in the practical aspects of enzymology so that they can perform quantification and assay procedures.
- To conduct the experiments on enzymes to study their kinetic behavior at various temperatures, pH etc. with respect to the kinetic parameters such as Km and Vmax

1. Assay of salivary amylase
2. Assay of potato acid-phosphatase
3. Effect of pH on enzyme activity
4. Effect of temperature on enzyme activity
5. Effect of incubation time on enzyme activity
6. Effect of substrate concentration on enzyme activity

Course Outcomes: By the end of this practical course, the student will be able to

- Gain hands-on experience in conducting various enzyme assays and analysis
- Perform experiments related to various factors influence the enzyme the enzyme activity

RECOMMENDED BOOKS:

1. Modern experimental Biochemistry by Rodney Boyer – 3rd Edition (Benjamin Cummings).
2. Biochemical methods By Sadasivam and Manikam – 3nd Edition (New Age International Pvt. Ltd. Publishers).
3. An introduction to practical biochemistry by D.T.Plummer – 2nd Edition (McGraw Hill).
4. Laboratory manual in Biochemistry by J.Jayaraman (Wilety Eastern limited).
5. Biochemistry - a laboratory courses by J.M.Beckar – 2nd Edition (Academic Press).

6. Introductory practical Biochemistry by S.K.Sawhney and Randhir Singh – 2nd Edition (Narosa).

SEMESTER –III

SPH 205: SOLUTIONS, PHASE EQUILIBRIUM, CONDUCTANCE, ELECTROCHEMISTRY & FUNCTIONAL GROUP ORGANIC CHEMISTRY-II

Hours per week	**: 04**	**End examination**	**: 60 Marks**
Credits	**: 04**	**Sessional**	**: 40 Marks**

Preamble: The students of undergraduate program in science need to be conversant with the various aspects of solution chemistry, phase equilibrium, electrochemistry and Functional group chemistry forms the foundation for training a undergraduate students as analytical and synthetic chemist.

Course objective: To introduce the concept of solution phase chemistry in physical chemistry and functional group chemistry in organic chemistry to the undergraduate students. The students will learn the essential functional groups in organic chemistry, their reactions, and properties.

UNIT-I

Section A: Physical Chemistry-2

Solutions

Thermodynamics of ideal solutions: Ideal solutions and Raoult's law, deviations from Raoult's law – non-ideal solutions. Vapour pressure-composition and temperature-composition curves of ideal and non-ideal solutions. Distillation of solutions.Lever rule.Azeotropes.

Phase Equilibrium

Phases, components and degrees of freedom of a system, criteria of phase equilibrium.Gibbs Phase Rule and its thermodynamic derivation. Derivation of Clausius – Clapeyron equation and its importance in phase equilibria. Phase diagrams of one-component systems (water) and two component systems involving eutectics, congruent and incongruent melting points (lead-silver only).

Learning Outcomes:

- The student will learn about the essential concepts impotent principle and terms of phase rule. The students will be apple to apply phase rule to one component and two component systems

UNIT-II

Conductance

Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes.Kohlrausch law of independent migration of ions.

Transference number and its experimental determination using Hittorf and Moving boundary methods.Ionic mobility. Applications of conductance measurements: determination of degree of ionization of weak electrolyte, solubility and solubility products of sparingly soluble salts, ionic product of water, hydrolysis constant of a salt. Conductometric titrations (only acid-base).

Electrochemistry

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 thermodynamic properties: G, H and S from EMF data.

Calculation of equilibrium constant from EMF data. Concentration cells with transference and without transference. Liquid junction potential and salt bridge.

Learning Outcomes:

- The students will learn the elementary concepts of conductance and electrochemistry.
- The students will learn the applications of Kolhlrausch law. They will be able to calculate
- thermodynamic properties: *G*, *H* and *S* from EMF data.

UNIT-III

Section B: Organic Chemistry-3

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

Carboxylic acids and their derivatives

Carboxylic acids (aliphatic and aromatic)

Preparation: Acidic and Alkaline hydrolysis of esters.

Reactions: Hell – Vohlard - Zelinsky Reaction.

Carboxylic acid derivatives (aliphatic): (Upto 5 carbons)

Preparation: Acid chlorides, Anhydrides, Esters and Amides from acids and the irinterconversion.

Reactions: Comparative study of nucleophilicity of acyl derivatives. Reformatsky Reaction, Perkin condensation.

Amines and Diazonium Salts

Amines (Aliphatic and Aromatic): (Upto 5 carbons)

Preparation: from alkyl halides, Gabriel's Phthalimide synthesis, Hofmann Bromamidereaction.

Reactions: Hofmann vs. Saytzeff elimination, Carbylamine test, Hinsberg test, with HNO2,Schotten – Baumann Reaction. Electrophilic substitution (case aniline): nitration, bromination, sulphonation.

Diazonium salts:*Preparation:*from aromatic amines

Reactions: conversion to benzene, phenol, dyes.

Learning Outcomes:

- The students will learn the concept of synthesis nd reactions carboxyl Functional group and derivatives.

UNIT-IV

Amino Acids, Peptides and Proteins:

Preparation of Amino Acids: Strecker synthesis using Gabriel's phthalimide synthesis.Zwitterion, Isoelectric point and Electrophoresis.

Reactions of Amino acids: ester of –COOH group, acetylation of –NH2group, complexationwith Cu^{2+} ions, ninhydrin test.

Overview of Primary, Secondary, Tertiary and Quaternary Structure of proteins.

Determination of Primary structure of Peptides by degradation Edmann degradation (N-terminal) and C–terminal (thiohydantoin and with carboxypeptidase enzyme).Synthesis of simple peptides (upto dipeptides) by N-protection (t-butyloxycarbonyl and phthaloyl) & C-activating groups and Merrifield solid-phase synthesis.

Learning Outcomes: The student shall learn

- the elementary reactions and properties, mechanism of amines and diazonium salts . The students will learn the concept of applications of diazonium salts in synthetic organic chemistry.
- The students will also familiarize with syntheticapproaces to simple amono acids and concept of proteins.

UNIT-V

Carbohydrates: Classification, and General Properties, Glucose and Fructose (open chain and cyclic structure), Determination of configuration of monosaccharides, absolute configuration of Glucose and Fructose, Mutarotation, ascending and descending in monosaccharides. Structure of disaccharides (sucrose, cellobiose, maltose, lactose) and polysaccharides (starch and cellulose) excluding their structure elucidation.

Learning Outcomes:

- The students will learn about the classification of carbohydrates. The students will familiarize the reactions and properties of mono, di and polysaccharides.

Course Outcomes: By the end of this course, the student will be able to

- Learn the concept of synthesis and reactions carboxyl Functional group and derivatives.
- Understand the elementary concepts of conductance and electrochemistry
- Describe the classification of carbohydrates

RECOMMENDED BOOKS:

1. Barrow, G.M. *Physical Chemistry* Tata McGraw-Hill (2007).
2. Morrison, R. T. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Finar, I. L. *Organic Chemistry* (*Volume 1*), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
4. Finar, I. L. *Organic Chemistry* (*Volume 2)*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
5. Nelson, D. L. & Cox, M. M. *Lehninger's Principles of Bioch*emistry *7th Ed.*, W. H. Freeman.
6. Berg, J.M., Tymoczko, J.L. & Stryer, L. *Biochemistry*, W.H. Freeman, 2002.

SEMESTER –III

SPH 225: SOLUTIONS, PHASE EQUILIBRIUM, CONDUCTANCE, ELECTROCHEMISTRY & FUNCTIONAL ORGANIC CHEMISTRY-II LAB

Hours per week: 03 **End Examination: 00 Marks**
Credits: 02 **Sessional: 100 Marks**

Preamble: The students of undergraduate program in science in Chemistry need to be conversant with the various basic methodologies of chemistry. Therefore, one module each on in inorganic, physical and organic chemistry is introduced which helps the student familiarize with the techniques essential for developing the foundation of practical chemistry

Course objective: To make student learn the practical application of solution, phase and electrochemistry for quantitative analysis. Students also learn to differentiate between reducing and non-reducing sugars by qualitative analysis.

Section A: Physical Chemistry

Distribution
Study of the equilibrium of one of the following reactions by the distribution method:

$I_2(aq) + I^-(aq)$ $I_3^-(aq)$
$Cu^{2+}(aq) + x\text{NH2}(aq)$ $[Cu(NH3)x]^{2+}$

Phase equilibria

a) Construction of the phase diagram of a binary system (simple eutectic) using cooling curves.
b) Determination of the critical solution temperature and composition of the phenol water system and study of the effect of impurities on it.
c) Study of the variation of mutual solubility temperature with concentration for the phenol water system and determination of the critical solubility temperature.

Conductance
1. Determination of cell constant
2. Determination of equivalent conductance, degree of dissociation and dissociation constant of a weakacid.
3. Perform the following conductometric titrations:
   i. Strong acid vs. strong base
   ii. Weak acid vs. strong base

Potentiometry
Perform the following potentiometric titrations:
i. Strong acid vs. strong base
ii. Weak acid vs. strong base
iii. Potassium dichromate vs. Mohr's salt

Section B: Organic Chemistry

I Systematic Qualitative Organic Analysis of Organic Compounds possessing monofunctional

groups (-COOH, phenolic, aldehydic, ketonic, amide, nitro, amines) and preparation of one derivative.

II

1. Separation of amino acids by paper chromatography
2. Determination of the concentration of glycine solution by formylation method.
3. Titration curve of glycine
4. Action of salivary amylase on starch
5. Effect of temperature on the action of salivary amylase on starch.
6. Differentiation between a reducing and a nonreducing sugar.

Course Outcomes: By the end of the practical course, the students will be able to

- Learn determination of conductance, cell constant.
- Apply the concepts of electrochemistry for redox titrations by instrumental methods of analysis.

RECOMMENDED BOOKS:

1. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., *Textbookof Practical Organic Chemistry*, Prentice-Hall, 5th edition, 1996.
2. Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry* Orient-Longman, 1960.
3. Khosla, B. D.; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry,* R. Chand & Co.: New Delhi (2011).
4. Ahluwalia, V.K. & Aggarwal, R. *Comprehensive Practical Organic Chemistry,* Universities Press.

SEMESTER – III
SMB 201: MICROBIAL GENETICS

Hours per week	**: 04**	**End examination**	**: 60 Marks**
Credits	**: 04**	**Sessional**	**: 40 Marks**

Preamble
Understanding microbial genes, genomes, and gene expression is essential for understanding the biology and evolution of microorganisms and their interactions with the environment. Moreover, microbial genetics is essential for understanding molecular biological studies and for practical applications in diverse areas of biotechnology.

Course Objectives:
1. To make student understand Microbial growth and metabolism.
2. To enable students learn concepts of microbial genetic structure; maintenance, expression, and exchange of genetic materials in microbial cells.
3. To make students learn mutation and mutagenesis and their detection methods.

UNIT-I
Organization of genetic material in prokaryotes.Genome organization: *E.coli*, *Saccharomyces, Tetrahymena.*Structure of genes, types of genes.
Features of T4 phage.Genetic basis of Lytic vs Lysogenic switch of phage λ.
Learning outcomes: By the end of the unit, the student will be able to:

- Understand the genetic makeup of bacterial cells.
- Comprehend the basics of lytic and lysogenic cycles of bacteriophages

UNIT-II
Types of plasmids – F plasmid, R Plasmids, colicinogenic plasmids, Ti plasmids, linear plasmids, yeast-2 μ plasmid, plasmid-incompatibility, plasmid replication, plasmid amplification, regulation of copy number, curing of plasmids.
Learning outcomes: By the end of the unit, the student will be able to:
- Describe the roles of plasmids in bacterial cells and the various genetic elements in natural and synthetic plasmid.
- Describe the process of DNA replication of plasmids in a bacterial cell.
- Understand the molecular basis of plasmid incompatibility and how plasmid copy
- number is regulated in a bacterial cell.

UNIT-III
Discovery and mechanism of transformation, conjugation- Hfr and F`strains, interrupted mating technique. Transduction-generalized transduction, specialized transduction, mapping by recombination.
Learning outcomes: By the end of the unit, the student will be able to:

- Describe the molecular mechanisms of gene transfer by conjugation (including Hfr strains), transformation and transduction

UNIT-IV

Discovery of transposons. Prokaryotic transposable elements – insertion sequences, composite and non-composite transposons, replicative and non-replicative transposition, uses of transposons and transposition.

Learning outcomes: By the end of the unit, the student will be able to:

- Identify the key characteristics of various types of transposons.
- Describe how transposition occurs at the molecular level.

UNIT-V

Mutations and mutagenesis: definition and types of mutations; physical and chemical mutagens; molecular basis of mutations; functional mutants (loss and gain of function mutants); uses of mutations. Ames test; mutator genes

Learning outcomes: By the end of the unit, the student will be able to:

- Understand the difference between DNA lesions and mutation.
- Describe the various mechanisms of how mutations can arise spontaneously within a cell or can be induced.
- Identify the various kinds of DNA mutation detection methods

Course Outcomes: By the end of the course, the student will be able to

- Understand the genetic makeup of bacterial cells
- Describe the process of DNA replication of plasmids in a bacterial cell
- Describe how transposition occurs at the molecular level
- Identify the various kinds of DNA mutation detection methods

RECOMMENDED BOOKS:

1. Molecular Biology: Principles and Practice (2015) by Michael M. Cox 2nd Edition, W. H. Freeman publishers

2.Molecular Genetics of Bacteria, (2013) by by Larry Snyder 4th Edition, ASM Press

3.Molecular Cell Biology (2016) by Lodish *et al.*, 8th Edition, W. H. Freeman publishers

4.Genetics: A Molecular Approach (2009) by Peter J Russell (3rd Edition), Pearson

5.Genetics: A Conceptual Approach (2016) 6th Edition W. H. Freeman publishers

6.Microbiology: An Introduction (2016) by Tortora et al., 12th Edition Pearson publishers

7.Microbiology: A Systems Approach (2017) by Kelly Cowan 5th Edition McGraw-Hill Education

8.Prescott's Microbiology (2016) by Joanne Willey et al., 10th Edition McGraw-Hill Education

9.Microbiology: Principles and Explorations (2015) by Black et al.,9th Edition, Wiley Pulishers

10.Brock Biology of Microorganisms (2015) by Michael T. Madigan (15th Edition), Pearson publishers

SEMESTER – III

SMB 221: MICROBIAL GENETICS LAB

Hours per week: 03 **End Examination: 00 Marks**
Credits: 02 **Sessional: 100 Marks**

Preamble:
This course has been designed to train students with basic techniques of Microbiology. Imparts training in growth curve analysis and preparation of replica plates and isolate bacteriophages from sewage.

Course Objectives:
- To introduce students to experiments of microbial analysis – Growth curve.
- To make understand mechanism of conjugation and transduction along with AMES test; what it is and how it is performed.
- To make students learn mechanism of mutagenesis using chemical (HNO_2) and physical (UV) mutagens on bacterial cells.

1. Preparation of Master and Replica Plates
2. Growth curve of *E. coli*.
3. Mutagenesis using chemical (HNO_2) and physical (UV)mutagens on bacterial cells
4. Survival curve of bacteria after exposure to ultraviolet (UV)light
5. Demonstration of Bacterial Conjugation
6. Demonstration of bacterial transformation and transduction
7. Demonstration of Ames test
8. Isolation and enumeration of bacteriophages (PFU)from water/sewage sample using double agar layer technique

Course outcomes: By the end of the course, the student will be able to
- Learn preparation of replica and master plates
- Perform and analyze growth curve of bacteria.
- Understand the mechanism of bacterial conjugation and transduction.
- Analysis of PFU from water/sewage sample helps students learnt to purify a clonal population of virus to know the amount of virus used to infect cells.

RECOMMENDED BOOKS:
1. Laboratory Exercises in Microbiology (2016) by John Harley 8thEdition, McGraw-Hill Education

2.Microbiology: A Laboratory Manual (2016) by James G. Cappuccino 11thEdition Pearson publishers

3.Microbiology: Laboratory Theory and Application (2015) 4th Edition by Michael J. Leboffe, Morton Publishing Company

4.Cell and Molecular Biology Lab Manual (2011) by Dr. David A Thompson, CreateSpace Independent Publishing Platform

5.Cell and Molecular Biology: A Lab Manual (2013) by K. V. Chaitanya, PHI

SFC 203: ENGLISH FOR COMMUNICATION– II

Hours per week: 3 **End Examination: 60 Marks**

Credits: 02 **Sessional: 40 Marks**

Preamble:

This course has been designed to help students acquire English language skills for professional development. The students will be exposed to aspects of English language through some very interesting texts. Each unit of the book carries a very extensive and relevant explanation on pronunciation, grammar, vocabulary, spelling, punctuation, spoken dialogues, writing, and reading.

Course Objectives:

1) To introduce students to Prosodic features for right speech
2) To enable students to use English in day-to-day communication
3) To build up their confidence in the usage of English
4) To expose them to Group Discussion sessions
5) To develop their written communicative competence
6) To make them interview ready

UNIT- I

The Open Window: Saki (H.H.Munro)
Pronunciation: Syllabi fiction**, Grammar:** Non-infinite verbs, **Vocabulary:** Simile & Metaphor**,**
Spelling: using 'ie' or 'ei', **Punctuation:** semi-colon, **Conversation:** Asking for advice/information,

Learning outcomes: By the end of the course, the student will be able to

- Improve their speaking ability in English both in terms of fluency and comprehensibility.
- Heighten their awareness of correct usage of English grammar in writing and speaking.
- Attain and enhance competence in the four modes of literacy: LSRW.
- Utilize phonetic dictionary symbols to continue to improve pronunciation.
- Punctuate quoted statements, sentences and questions correctly.

UNIT- II

The Voice of Humanity – Rabindranath Tagore
Pronunciation: Word Stress, **Grammar:** Adjectives, **Vocabulary:** Oxymoron & Hyperbole**,**
Spelling: using 'able' and 'ible', **Punctuation:** Colon & dash, **Group Discussion**

Learning outcomes: By the end of the course, the student will be able to

- To use newly acquired vocabulary in classroom activities.
- Develop independent learning strategies and study skills.
- Have the ability to communicate effectively with others.
- understand the rules of word stress
- acquire the skills needed for a G.D and participate efficiently

UNIT –III

If – Rudyard Kipling

Pronunciation: Sentence Stress**, Grammar:** Articles, **Vocabulary:** Portmanteau and loan words**, Spelling:** using suffixes, **Punctuation:**Hyphen & dash, **Oral Presentation**

Learning outcomes: By the end of the course, the student will be able to

- Demonstrate command of the conventions of Standard English punctuation, and spelling when writing.
- Enable to discuss literary texts from various theoretical and critical perspectives.
- Formulate ideas and connections between literary concepts and themes.
- Establish a deeper appreciation of cultural diversity by introducing them to poetry.
- acquire effective presentation skills

UNIT -IV

Riders to the Sea – JM Synge

Pronunciation – Intonation**, Grammar:** Adverbs, **Vocabulary:** Palindromes**, Spelling:** completing tables with nouns, verbs, adjectives, adverbs **Punctuation:** Inverted comma, **Conversation/Role play:** Appearing for a job interview/conducting a job interview

Learning outcomes: By the end of the course, the student will be able to:

- Collaborate with peers for role-playing, story analysis, and presentation planning.
- Use comparative forms of high frequency adjectives and adverbs.
- Apply sentence mechanics and master spelling of high frequency words.
- Demonstrate increased understanding of English syntax and grammatical elements for effective writing.
- Understand and use intonation in spoken language.
- Develop the skills needed for attending an interview

UNIT- V

Academic Writing: Letter Writing, Paragraph Writing, Essay Writing, Resume Preparation, Dialogue Writing, Precis

Learning outcomes: By the end of the course, the student will be able to:

- Develop outlines, clusters, lists, or other graphic organizers to organize ideas for writing
- Format various types of writing such summaries, personal letters, formal letters and narrative, descriptive, and expository paragraphs on a variety of topics
- Develop own creativity and enhance their writing skills
- Paraphrase text appropriately.
- Write effective introductions and conclusions for paragraphs.
- Prepare a persuasive resume

Course Outcomes: By the end of the course, the students will be able to

- Improve their speaking ability in English both in terms of fluency and comprehensibility
- Formulate ideas and connections between literary concepts and themes

- Demonstrate increased understanding of English syntax and grammatical elements for effective writing
- Develop own creativity and enhance their writing skills

Textbooks:

Part – 2 (English for Enhanced Competence (by Sumit Roy, A.Karunakar, A.Aruna Priya)

Supplementary Reading:

- Communicative skills for Technical Students, M. Faratullah. Orient Longman
- Rizvi,MAshraf. ***Effective Technical Communication.*** McGraw - Hill.

SEMESTER –III

SSE 287: FUNDAMENTALS OF COMPUTERS

Hours per week: 02 **End Examination: 00 Marks**
Credits: 02 **Sessional: 100 Marks**

Preamble :

The course gives an understanding about the characteristics and classification of computers, various components of computer along with different operating systems and computer networks that are available. It gives a hands-on training on the packages MS-Word, MS-Power Point and MS-Excel.

Course Objective:

- To make the student to learn Computer basics.
- Student train to acquaint about Basic computer organization.
- Students learn about computer Networks and data communication.
- To make to write shell script programs

Introduction: Characteristics of Computers, Classification of Computers,Binary Number System .Computer Software, Computer languages, Concept of assembler, interpreter, linker and compiler.

Basic computer organization, Processor and Memory, Algorithm, Flow Charts.

Operating Systems: What is an Operating System, Main functions of an Operating system, Some Popular Operating Systems

Data Communications and Computer Networks: Basic Elements of a Communication System, **The Internet:** Brief History, Its basic Services, WWW &browsers, internet search engines, uses of internet.

Learning Outcomes: By the end of this course, the student will be able to

- Describe Characteristics of Computers and Classification of Computers.
- Illustrate the Basic computer organization
- Explain the need of the Data Communications and Computer Networks.
- Describe The internet
- Use WWW & browsers

TEXTBOOK

Computer Fundamentals – Pradeep K.Sinha: BPB Publications, 6th Edition

RECOMMENDED BOOKS:

1. Computer Fundamentals- Rajaraman V.

2. Introduction to Computers -Peter Norton.

3. Fundamentals Of Information technology Alexis Leon, Methew Leon, Vikas publications.

SEMESTER –III

SSE 279: MATHEMATICS FOR BIOLOGY

Hours per week: 02 **End Examination: 00 Marks**
Credits: 02 **Sessional: 100 Marks**

Preamble :

Mathematics of biology aims at the mathematical representation and modelling of biological processes, using techniques of applied mathematics**.** This course is introduced to learn fundamental topics such as limits, differentiation, matrices and differential equations

Course Objectives:

- To understand limits, continuity, differentiation and integration and their use in biological problems
- To formulate differential equation for biological problem
- To learn the basic concepts and applications of differential equations
- To learn the basic concepts and applications of differential equations for biochemistry

UNIT-I

Functions, limits and continuity, differentiation and integration, maxima and minima and their use in biological problems.

UNIT-II

Differential equation, separable variables, homogeneous, exact and linear equations of second order, applications of differential equations of Biochemistry. Matrices and determinants, characteristic roots and characteristic equation.

Course Outcomes: By the end of this course, the student will be able to
- Able to evaluate problems on limits, continuity, differentiability and integration
- Explain various methods to solve differential equations
- Able to describe the basic concepts of matrices
- Able to explain biological applications of differential equations and matrices

RECOMMENDED BOOKS:

1. John .E Frenund's mathematical statistics with application by Irwin Miller and Marylees Miller, Ed. 7^{th}, Pearson -2006.

2. Essential mathematical biology by Nicholas F. Britton; Ed.1^{st} –Springer -2004.

3. Differential calculus by Shanti Narayan, Ed. 30^{th}, S.Chand & Co. Ltd. 2005.

SEMESTER – IV

SBT 212: MOLECULAR BIOLOGY AND rDNA TECHNOLOGY

Hours per week	**: 04**	**End examination**	**: 60 Marks**
Credits	**: 04**	**Sessional**	**: 40 Marks**

Preamble: Molecular Biology and rDNA technology course brings together the diverse areas of biology and engineering, giving you an interdisciplinary perspective on this fast-moving area.

Course Objectives: Cells are fundamental units of body, and this course aims at providing an introduction to experimental methods that scientists have used to discover mechanisms by which cells, at molecular level, control their specific functions, growth and differentiation into specialized tissues. Further, this course teaches various approaches to genetic engineering that students can apply in their future career in biological research as well as in biotechnology industry. Genetic engineering is a technology that has been developed based on our fundamental understanding of the principles of molecular biology and this is reflected in the contents of this course.

UNIT-I

Features of DNA Replication, mechanism of DNA replication in prokaryotes and eukaryotes, enzymes and proteins involved in DNA replication, DNA damage and repair

Learning Outcomes:

- Students should be able to learn various molecular events that leadtoduplication of DNA, recombination and repair of genes

UNIT-II

Transcription mechanism in prokaryotes and eukaryotes, Types of RNA polymerases and promoter-polymerase interactions, DNA-dependent RNA polymerase, RNA transport and editing, inhibitors of transcription and applications of antibiotics.

Learning Outcomes:

- Students should be able to learn various molecular events that leadto gene expression in both prokaryotes and eukaryotes.

UNIT-III

Mechanism of translation in prokaryotes and euakryotes, Co-and post translational modifications**,** protein targeting, regulation of gene expression-operon concept, cis-trans elements, DNA methylation, RNAi and gene silencing

Learning Outcomes:

- Students should be able to learn expressed genes or transcripts can be translated into proteins following a central dogma.

UNIT-IV

Genetic engineering molecular tools: Restriction enzymes, DNA ligases, Polymerases, Alkaline phosphatase, Poly nucleotide kinase, Terminal deoxy nucleotide transferase. Cloning vectors: Plasmids, Bacteriophage-derived vectors and artificial chromosomes. Gene Recombination and Gene transfer: Transformation and screening of recombinants.

Learning Outcomes:

- Understand the fundamental molecular tools and their applications in DNA modification and manipulation.

UNIT-V

Hybridization techniques: Southern and Northern hybridization. Principle and applications of Polymerase Chain Reaction (PCR) and Reverse transcription (RT) PCR.Preparation of Genomic and cDNA libraries, DNA sequencing by chemical, enzymatic and Next Generation Sequencing (NGS) methods, DNA fingerprinting.

Learning Outcomes:

- Students should be able to understand various facets of molecular procedures and basics of genomics.

Course Outcomes: By the end of the course, the student will be able to

- Learn the impact of genetic engineering in modern society,
- endowed with strong theoretical knowledge of this technology.
- gain working knowledge of gene silencing and editing tools and methods and appreciate their relevance for investigating specific contemporary biological questions.
- In conjunction with the practical's in molecular biology & genetic engineering, the students should be able to take up biological research as well as find placement in the relevant biotech industry.

RECOMMENDED BOOKS:

1. Recombinant DNA: Genes and Genomes - a Short Course by James D. Watson, (2006) WH Freeman & Co; 3rd edition
2. Lewin's Genes-XII by Jocelyn E. Krebs et al., (2017) Jones and Bartlett Publishers, Inc; 12th edition
3. Principles of Gene Manipulation and Genomics by Primrose & Twyman (2006) 7thed (Oxford).
4. Molecular Biotechnology: Principles and Applications of Recombinant DNA by Glick et al., (2017) 5th ed ASM Press.
5. Gene Cloning and DNA Analysis: An Introduction by T.A. Brown (2016) 7thed (Wiley-Blackwell).
6. Molecular Biology of the Cell by Bruce Alberts (2014), 6th edition, Garland Science
7. Genomes by T.A. Brown (2017) 4th ed Garland Science Publishers.
8. Molecular Biology of the Gene by Watson et al., (2013) Person Publishers
9. Molecular Cell Biology by Lodish et al., (2016) 8th Edition, WH Freeman publishers
10. Karp's Cell and Molecular Biology: Concepts and Experiments by Janet Iwasa (2016), John Wiley & Sons Inc; 8 edition

SEMESTER – IV

SBT 228: MOLECULAR BIOLOGY AND rDNA TECHNOLOGY LAB

Hours per week: 03 **End Examination: 00 Marks**
Credits: 02 **Sessional: 100 Marks**

Preamble: Develop an understanding of appropriate and relevant fundamental and applied scientific knowledge with the ability to use and apply that knowledge in a wide range of situations, including new situations within the professional discipline. You will gain laboratory skills in molecular biology techniques such as micropipetting, PCR and electrophoresis.

Course Objectives: The objectives of this course are to provide students with the experimental knowledge of molecular biology and genetic engineering.

1. Isolation of DNA from Eukaryotic cells.
2. Isolation of Plasmid DNA by alkaline Lysis method
3. Separation of DNA by Agarose gel electrophoresis
4. Purity of isolated DNA by A260/A280 Ratio
5. Isolation of RNA by Trizol method
6. DNA denaturation and Hyperchromic effect
7. Estimation of DNA by DPA method
8. Estimation of RNA by Orcinol method
9. Restriction digestion of DNA
10. Ligation of DNA
11. Polymerase Chain Reaction (PCR)

Course Outcomes: By the end of practical course, students should be able to

- Gain hands-on experience on conventional and molecular methods for gene manipulation in microbial and other systems

RECOMMENDED BOOKS:

1. Biotechnology: A laboratory course by Becker J.M.
2. Molecular Cloning: A laboratory manual Vals. 1-3, Sambrook, J.
3. Biochemistry - a lab course by J.M.Becker (Academic Press).
4. Molecular Cloning: A laboratory manual Vals. 1-3, Sambrook, J.

SEMESTER –IV

SPH 206: COORDINATION CHEMISTRY, STATES OF MATTER & CHEMICAL KINETICS

Hours per week	**: 04**	**End examination**	**: 60 Marks**
Credits	**: 04**	**Sessional**	**: 40 Marks**

Preamble: The students of undergraduate program in science need to be conversant with the various aspects of coordination chemistry, chemical kinetics and states of matter for training a undergraduate students as synthetic chemist.

Course objective: To introduce the concept of coordination chemistry and the essentials of inorganic chemistry. Students will also learn reactions kinetics, and chemical concepts of states of matter.

UNIT-I

Transition Elements (3d series)

General group trends with special reference to electronic configuration, variable valency, colour, magnetic and catalytic properties, ability to form complexes and stability of various oxidation states (Latimer diagrams) for Mn, Fe and Cu.

Lanthanoids and actinoids: Electronic configurations, oxidation states, colour, magnetic properties, lanthanide contraction, separation of lanthanides (ion exchange method only).

Learning Outcomes: The students will learn the properties of transition elements , Lanthanides and Actinides.

UNIT-II

Coordination Chemistry

Valence Bond Theory (VBT): Inner and outer orbital complexes of Cr, Fe, Co, Ni and Cu (coordination numbers 4 and 6). Structural and stereoisomerism in complexes with coordination numbers 4 and 6.

Drawbacks of VBT.IUPAC system of nomenclature.

Crystal Field Theory

Crystal field effect, octahedral symmetry. Crystal field stabilization energy (CFSE), Crystal field effects for weak and strong fields. Tetrahedral symmetry.

Learning Outcomes: The students will know about Inner and outer orbital complexes Structural and stereoisomerism in complexes and Crystal Field Theory.

UNIT-III

Section B: Physical Chemistry-3 **(30 Lectures)**

Kinetic Theory of Gases

Postulates of Kinetic Theory of Gases and derivation of the kinetic gas equation.

Deviation of real gases from ideal behaviour, compressibility factor, causes of deviation. van der Waals

equation of state for real gases. Boyle temperature (derivation not required). Critical phenomena, critical constants and their calculation from van der Waals equation.
Maxwell Boltzmann distribution laws of molecular velocities and molecular energies (graphic representation – derivation not required) and their importance.

Temperature dependence of these distributions.Most probable, average and root mean square velocities (no derivation). Collision cross section, collision number, collision frequency, collision diameter and mean free path of molecules. Viscosity of gases and effect of temperature and pressure on coefficient of viscosity (qualitative treatment only).

Learning Outcomes: The student will learn about ideal gases , deviation from ideal behavior. van der Waals equation of state for real gases. The student will learn to calculate critical constants from Vander Waals equation.

UNIT-IV

Liquids
Surface tension and its determination using stalagmometer.Viscosity of a liquid and determination of coefficient of viscosity using Ostwald viscometer.Effect of temperature on surface tension and coefficient of viscosity of a liquid (qualitative treatment only).
Solids
Forms of solids. Symmetry elements, unit cells, crystal systems, Bravais lattice types. Miller indices. X–Ray diffraction by crystals, Bragg's law. Structures of NaCl, KCl and CsCl (qualitative treatment only).Defects in crystals.

Learning Outcomes: The student will learn about Surface tension & viscosity and their determination. The students will also be familiar with effect of temperature on viscosity.

UNIT-V

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, first and second order reactions (both for equal and unequal concentrations of reactants).Half–life of a reaction.General methods for determination of order of a reaction.Concept of activation energy and its calculation from Arrhenius equation.
Theories of Reaction Rates: Collision theory and Activated Complex theory of bimolecular reactions.

Learning Outcomes: The student will learn concept of reaction rates, factors affecting reaction rates. Order and molecularity of a reaction. The student will also learn derivation of integrated rate equations for zero, first and second order reactions and theories of reaction rates

Course Outcomes: By the end of course, students should be able to

- learn the properties of transition elements, Lanthanides and Actinides.
- learn about ideal gases, deviation from ideal behavior. van der Waals equation of state for real gases
- learn about Surface tension & viscosity and their determination
- learn derivation of integrated rate equations for zero, first and second order reactions and theories of reaction rates

RECOMMENDED BOOKS:

1. Barrow, G.M. *Physical Chemistry* Tata McGraw-Hill (2007).

2. Castellan, G.W. *Physical Chemistry* 4th Ed. Narosa (2004).
3. Kotz, J.C., Treichel, P.M. & Townsend, J.R. *General Chemistry* Cengage Learning India Pvt. Ltd., New Delhi (2009).
4. Mahan, B.H. *University Chemistry* 3rd Ed. Narosa (1998).
5. Petrucci, R.H. *General Chemistry* 5th Ed. Macmillan Publishing Co.: New York (1985).
6. Cotton, F.A. & Wilkinson, G. *Basic Inorganic Chemistry,* Wiley.
7. Shriver, D.F. & Atkins, P.W. *Inorganic Chemistry*, Oxford University Press.
8. Wulfsberg, G. *Inorganic Chemistry,* Viva Books Pvt. Ltd.
9. Rodgers, G.E. *Inorganic & Solid State Chemistry,* Cengage Learning India Ltd., 2008.

SEMESTER –IV

SPH 224: COORDINATION CHEMISTRY, STATES OF MATTER & CHEMICAL KINETICS LAB

Hours per week: 03 **End Examination: 00 Marks**
Credits: 02 **Sessional: 100 Marks**

Preamble: The students of undergraduate program in science in Chemistry need to be conversant with the various basic methodologies of chemistry. Therefore, one module each on in inorganic, physical and organic chemistry is introduced which helps the student familiarize with the techniques essential for developing the foundation of practical chemistry

Course objective: To make student learn the practical application of Coordination Chemistry, States of Matter & Chemical Kinetics for quantitative analysis

Section A: Inorganic Chemistry

Semi-micro qualitative analysis using H2S of mixtures - not more than four ionic species (two anions and two cations and excluding insoluble salts) out of the following:

Cations : $NH4^{+}$, Pb^{2+}, Ag^{+}, Bi^{3+}, Cu^{2+}, Cd^{2+}, Sn^{2+}, Fe^{3+}, Al^{3+}, Co^{2+}, Cr^{3+}, Ni^{2+}, Mn^{2+}, Zn^{2+}, Ba^{2+}, Sr^{2+}, Ca^{2+}, K^{+}

Anions : $CO3^{2-}$, S^{2-}, SO^{2-}, $S2O3^{2-}$, $NO3^{-}$, $CH3COO^{-}$, Cl^{-}, Br^{-}, I^{-}, $NO3^{-}$,$SO4^{2-}$, $PO4^{3-}$, $BO3^{3-}$, $C2O4^{2-}$, F^{-}

(Spot tests should be carried out wherever feasible)

1. Estimate the amount of nickel present in a given solution as bis(dimethylglyoximato) nickel(II) or aluminium as oximate in a given solution gravimetrically.
2. Draw calibration curve (absorbance at λmax vs. concentration) for various concentrations of a given coloured compound (KMnO4/ CuSO4) and estimate the concentration of the same in a given solution.
3. Determine the composition of the Fe^{3+}-salicylic acid complex solution by Job's method.
4. Estimation of (i) Mg^{2+} or (ii) Zn^{2+} by complexometric titrations using EDTA.
5. Estimation of total hardness of a given sample of water by complexometric titration.

Section B: Physical Chemistry

(I) Surface tension measurement (use of organic solvents excluded).

Determination of the surface tension of a liquid or a dilute solution using a stalagmometer.

(II) Viscosity measurement (use of organic solvents excluded).

Determination of the relative and absolute viscosity of a liquid or dilute solution using an Ostwald's viscometer.

(III) Chemical Kinetics

Study the kinetics of the following reactions.

Integrated rate method:

a. Acid hydrolysis of methyl acetate with hydrochloric acid.
b. Compare the strengths of HCl and H2SO4 by studying kinetics of hydrolysis of methyl acetate

Course Outcomes: By the end of the practical course, the students will be able to

- Learn to apply the principles of chemical kinetics for ester hydrolysis
- Understand to apply the concepts of coordination chemistry Job's method by instrumental methods of analysis
- Learn the concept of complexometric titration

RECOMMENDED BOOKS:

1. Svehla, G. *Vogel's Qualitative Inorganic Analysis*, Pearson Education, 2012.
2. Mendham, J. *Vogel's Quantitative Chemical Analysis*, Pearson, 2009.
3. Khosla, B. D.; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry*, R. Chand & Co.: New Delhi (2011).

SEMESTER –IV

SMB 200: FOOD AND DAIRY MICROBIOLOGY

Hours per week	**: 04**	**End examination**	**: 60 Marks**
Credits	**: 04**	**Sessional**	**: 40 Marks**

Preamble:
This course has been designed to offer students a good command on basic principles of food microbiology and gain knowledge on the microbes associated with food spoilage, food borne illness and rapid detection of pathogens and learn regulatory aspects in food and dairy microbiology.

Course Objectives:

- To make the students understand the importance of microorganisms and their products in foods.
- To envisage the causes of food spoilage and predict the microorganisms that can spoil a given food, when prepared, processed, and stored under given conditions.

UNIT-I

Intrinsic and extrinsic factors. Source of contamination-fruits, vegetable, grains, poultry, meat and fish. Prevention and control measures. Spoilage of vegetables, fruits, meat, eggs, milk,butter, bread and canned foods. Factors affecting spoilage.

Learning outcomes:

By the end of the course, the student will be able to:
1. Learn factors affecting the spoilage of fruits, vegetables and canned foods
2. Gain knowledge about prevention and control measures of food spoilage.

UNIT-II

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, SO_2, nitrite and nitrates, ethylene oxide, antibiotics and bacteriocins.

Learning outcomes:

By the end of the course, the student will be able to:
- Learn different physical methods of food preservation and aseptic methods of packing
- Learn the use of chemicals and enzymes for preserving foods.

UNIT-III

Milk composition. Dairy starter cultures fermented dairy products: yogurt, acidophilus milk, dahi and cheese, other fermented foods, Probiotics: Health benefits, types of microorganisms used, probiotic foods available in market.

Learning outcomes:

By the end of the course, the student will be able to:

1. Learn the composition of milk and process of fermentation to prepare value added fermented dairy foods.
2. Learn about microorganisms that are used as probiotics and health benefits of probiotics.

UNIT-IV

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. Microorganisms in food spoilage.

Learning outcomes:

By the end of the course, the student will be able to:

- Understand the causes of food-borne microbial diseases and predict pathogens that can grow in a given food, when prepared, processed and stored under given conditions.
- Learn necessary measures to control the spoilage and pathogenic microorganisms in food.

UNIT-V

Hazard Analysis Critical Control Points (HACCP), indices of food sanitary quality and sanitizers, cultural and rapid detection methods of food borne pathogens in foods and introduction to predictive microbiology.

Learning outcomes:

By the end of the course, the student will be able to:

- Learn conventional and rapid methods for detection of food borne pathogens
- Learn importance of food safety and analysis indices in food and dairy industries

Course Outcomes: By the end of this course, the students will be able to

- Apprehend the importance of microorganisms and their products in foods.
- Understand the causes of food spoilage and predict the microorganisms that can spoil a given food, when prepared, processed, and stored under given conditions

RECOMMENDED BOOKS:

1.Food Microbiology: An Introduction (2017) by Thomas J. Montville *et al.*, 4th Edition, ASM Press

2.Food Microbiology (2015) by Martin R Adams, Royal Society of Chemistry; 4th Edition

3.Food Microbiology: Fundamentals and Frontiers (2012) by Michael P. Doyle 4thEdition, ASM Press

4.Fundamental Food Microbiology (2013) by Bibek Ray, 5thEdition, CRC Press;

5.Food-Borne Infections and Intoxications (Food Science and Technology) (2005), by Riemann *et al.*,Academic Press Inc.

SEMESTER –IV

SMB 220: FOOD AND DAIRY MICROBIOLOGY LAB

Hours per week: 03 **Credits: 02**

Preamble:

This course has been designed to train students with basic hands-on information of food microbial analysis that will give practical experience of how to apply them in food industry.

Course Objectives:

- Is to isolate and identify common food spoilage microorganisms
- Is to determine the quality of milk and dairy products for microbial analysis.

1. MBRT of milk samples and their standard platecount.
2. Alkalinephosphatasetesttochecktheefficiencyofpasteurizationofmilk.
3. Isolation of food bornebacteria
4. Isolation of microorganisms from spoiledvegetables/fruits.
5. Isolation of breadmold
6. Preparation ofYogurt/Dahi.
7. Isolation of yeast fromgrapes
8. Platform tests forMilk: organoleptic evaluation- Odor / Smell, GeneralAppearance, Colour, Consistency, Temperature
9. Platform tests forMilk: Clot on boiling test, Alcohol test, Sediment test and Resazurin test.

Course outcomes: By the end of the practical course, the student will be able to

- Learn to analyze quality of different processed and raw food
- Co-relate enzymes used in various branches of food and dairy industry
- Explain mechanism of action of enzymes used in specific processes

RECOMMENDED BOOKS:

1. Food Microbiology Laboratory (Contemporary Food Science) (2003) by Lynne McLandsborough 1st Edition, CRC Press

2. Food Microbiology: A Laboratory Manual (2002) by Ahmed E. Yousef, 1st Edition, Wiley-Interscience

SEMESTER –IV

SSE 274: CHEMICAL TECHNOLOGY & SOCIETY

Hours per week: 02 **End Examination: 00 Marks**
Credits: 02 **Sessional: 100 Marks**

Course objective: To make student learn role of chemistry in day-to-day life and for safeguarding the environment and society.

Chemical Technology

Basic principles of distillation, solvent extraction, solid-liquid leaching and liquid-liquid extraction, separation by absorption and adsorption. An introduction into the scope of different types of equipment needed in chemical technology, including reactors, distillation columns, extruders, pumps, mills, emulgators. Scaling up operations in chemical industry.Introduction to clean technology.

Society

Exploration of societal and technological issues from a chemical perspective. Chemical and scientific literacy as a means to better understand topics like air and water (and the trace materials found in them that are referred to as pollutants); energy from natural sources (i.e. solar and renewable forms), from fossil fuels and from nuclear fission; materials like plastics and polymers and their natural analogues, proteins and nucleic acids, and molecular reactivity and interconversions from simple examples like combustion to complex instances like genetic engineering and the manufacture of drugs.

Course Outcomes: By the end of the course, the student will be able to

- Understand the scope of different types of equipment needed in chemical technology, Scaling up operations in chemical industry and concept of clean technology.
- Learn exploration of societal and technological issues from a chemical perspective

RECOMMENDED BOOKS:

John W. Hill, Terry W. McCreary & Doris K. Kolb, *Chemistry for changing times* 13th Edition.

SEMESTER –IV

SSE 286: BIOANALYTICAL TOOLS

Hours per week: 02 **End Examination: 00 Marks**
Credits: 02 **Sessional: 100 Marks**

Preamble: The bioanalytical methods predominately embrace a broad cross-section of modern analytical techniques and latest sophisticated instruments like HPLC, GC-MS, PFGE…etc. The course will help to build the knowledge about the bioanalytical techniques used to analyze various biomolecules and the use of radio tracer techniques in biology.

Course Objectives

- To make the students aware of the principle, operation and applications of various techniques used to analyze biomolecules.
- To understand the separation of biomolecules by means of various centrifugation methods.

Chromatographic techniques

Principles and applications of chromatographic techniques- Paper chromatography, thin layer chromatography, gel filtration, ion-exchange chromatography, affinity chromatography, GC, HPLC and GC-MS.

Electrophoretic techniques

Principles and concepts of electrophoretic techniques- native PAGE, SDS-PAGE, Agarose gel electrophoresis, capillary electrophoresis, isoelectric focusing (IEF), two dimensional, pulse field and diagonal electrophoresis.

Centrifugation

Principles and applications of preparative centrifugation: Differential centrifugation, density gradient centrifugation, rate zonal centrifugation and isopycnic centrifugation. Types of rotors. Analytical centrifugation: sedimentation coefficient, boundary sedimentation, band sedimentation.

Course Outcomes: By the end of this course, the student will be able to

- Explain the principle, operation, and applications of various centrifuges.
- Understand the separation of biomolecules based on centrifugation techniques.

RECOMMENDED BOOKS:

1. Physical Biochemistry: Principles and Applications by David Sheehan (2009)
2. Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology by Andreas Hofmann and Samuel Clokie (8th edition, 2018)Practical Biochemistry by Keith Wilson and Walker. 5th ed. Cambridge University Press.
3. Biophysical chemistry principles and techniques by Upadyay, Upadyay and Nath (Himalaya publishing).
4. Instrumental methods of chemical analysis by Chatwal and Anand. Ed 5, Himalaya Publishers.
5. Atkin's Physical Chemistry (10th edition). 2014. Peter Atkins and Julio de Paula, Oxford University Press;.

SEMESTER – V

SBT 341: PLANT AND ANIMAL BIOTECHNOLOGY

Hours per week	**: 04**	**End examination**	**: 60 Marks**
Credits	**: 04**	**Sessional**	**: 40 Marks**

Preamble: This course will develop the graduate capabilities of knowledge ability, comprehension and applications of plants in cell and tissue culture systems, and how cell and tissue culture contribute to global sustainability. It will also develop the practical skills and confidence of students to successfully culture plant cells and tissues.

Course Objectives: The objectives of this course are to introduce students to the principles, practices and application of animal biotechnology, plant tissue culture, plant and animal genomics, genetic transformation and molecular breeding of plants and animals.

UNIT-I

Phytohormones, types of culture: Seed, Embryo, Callus, Organs, Cell and Protoplast culture. Micropropagation: advantages and disadvantages. Organogenesis and somatic embryogenesis. In vitro haploid production: Androgenic and Gynogenic methods. Transgenic plants: Production methods and its applications.

Learning Outcomes:

- Learn plant tissue culture methods and usage purposes, Have knowledge about tissue culture methods used in plant breeding.

UNIT-II

Protoplast Isolation and fusion methods somatichybridization, identification and selection of hybrid cells and its limitations. Cybrids, Somaclonal variation.Plant growth promoting bacteria, Nitrogen fixation.

Learning Outcomes:

- Learn plant tissue culture methods and usage purposes, Have knowledge about tissue culture methods used in plant breeding.

UNIT-III

Basic techniques of animal cell and tissue culture.Different types of animal cell culture media- Natural, synthetic media, cryopreservation of cells, applications of cell culture. Stem cells: Properties, types, and applications.

Learning Outcomes:

- Students should be able to successfully maintain cultures of animal cells and established cell lines with good viability, minimal contamination and appropriate documentation.

UNIT-IV

Causes of infertility in male and females. super ovulation, embryo transfer. In vitro Fertilization methodology, Artificial insemination, Immuno-contraception.

Learning Outcomes:

- Students should be able to gain greater appreciation of the biological processes of mammalian reproduction that are relevant to the manipulation of fertility and the treatment of reproductive disease.

UNIT-V

Production of transgenic animals -by microinjection, retroviral, vector method and embryonic stem cell method. Animal cloning – methodologies and its applications. Gene Therapy-Ex vivo and In vivo gene therapy.

Learning Outcomes:

- Gain knowledge about recent advances in animal reproduction and acquire exposure to application of reproductive biotechniques and technologies in livestock.

Course Outcomes: On completion of this course, students should be able to

- Benefit with fundamental knowledge in plant and animal biotechnology and their applications
- Utilize the principles, practices and application of plant and animal biotechnology, plant tissue culture, plant and animal genomics, genetic transformation, and molecular breeding of plants and animals in numerous areas.

RECOMMENDED BOOKS:

1. Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications by R. Ian Freshney
2. Molecular Biotechnology by Glick.
3. Gene cloning and DNA analysis an introduction by T.A. Brown (Blackwell).
4. Biotechnology by U.Satyanarayana.
5. Biotechnology by B.D.Singh (Kalyani).
6. Plant Tissue Culture and Practice.by Bhojwani, S.S. and Razdan
7. Plant Biotechnology: The Genetic Manipulation of Plants, by Slater, A., Scott, N.W. & Fowler, M.R.
8. In Vitro Fertilization: The A.R.T. of Making Babies (Assisted Reproductive Technology) (2013) by Geoffrey Sher, Virginia Marriage Davis, Jean Stoess
9. In-Vitro Fertilization 3rd Edition (2011), by Kay Elder, Yves Ménézo, Joyce Harper, John Huntriss

SEMESTER – V

SBT 343: INDUSTRIAL BIOTECHNOLOGY

Hours per week	**: 04**	**End examination**	**: 60 Marks**
Credits	**: 04**	**Sessional**	**: 40 Marks**

Preamble: The significance of this course is to provide students with sound theoretical knowledge and principles relevant to Industrial Biotechnology. As per the course content, one can understand the diversity of microorganisms and search for strains from the natural environment, which are able to produce novel or unusual products of high commercial value. The main task of the industrial biotechnologist is to develop procedures for obtaining new microbial metabolites by rapid and reliable isolation and screening procedures and metabolic engineering. Understanding various principles of reactor designs, scale-up and downstream processing is primary and essential in large-scale production of various biologically active principles or products. This course also provides the knowledge about the importance of immobilization of enzymes/ cells and their applications.

Course Objectives:

1. To educate students about the fundamental concepts of industrial biotechnology and its related applications, thus preparing them to meet the challenges of the new and emerging areas of biotechnology industry.
2. To develop skills about the screening and maintenance of industrially useful microorganisms, the sterilization kinetics, fermentation processes, reactor design, product development and recovery.
3. To improve the base knowledge and to bring awareness on various industrial processes.

UNIT- I

Screening, isolation and maintenance of microbes, preservation of isolated pure cultures. Sterilization of media: Batch and Continuous sterilization. Strain selection, Strain improvement: physical and chemical methods

Learning outcomes:

- Isolate and screen the microorganisms from the soil, air or water and preserve the selected strains.
- Improve the wild strains at genetic level to make industrial applications
- Understand the concept of sterilization

UNIT – II

Bioreactor: design and parts of bioreactor, types of bioreactor, Batch reactor, Continuous reactor, fixed bed reactor, fluidized bed reactor, trickle fermenter. single stage CSTR; mass transfer in aerobic fermentation; resistances encountered; overall mass transfer co-efficient (Ka) determination, factors depending on scale up principle and different methods of scaling up.

Learning outcomes:

- Be familiar with various types of bioreactors.
- Carry out stoichiometric calculations and specify models for growth.
- Understand mass transfer and scale up processes.
- Gain knowledge about the design parameters and operations of the bioreactors.

UNIT – III

Downstream processing: solids and liquid handling. Distribution of microbial cells, centrifugation, filtration of fermentation broth, ultra-centrifugation, liquid extraction, ion-exchange recovery of biological products. Isolation and Purification of proteins.

Learning outcomes:

- Be familiar with different methodologies involved in the downstream processing in removing the microbial cells and solid matter from the fermentation broth and finishing of product purification.
- Be acquainted with the protein purification process.

UNIT- IV

Production of industrial chemicals, biochemicals and chemotherapeutic products. Propionic acid, butyric acid, 2-3 butanediol, gluconic acid, itaconic acid, Ethanol, hydrogen, microbial electricity, starch conversion processes; Microbialpolysaccharides; Microbial insecticides; anti-cancer agents.

Learning outcomes:

- Give an account of important microbial / industrial processes in industrial chemicals, solvents, insecticides etc.
- Understand the production of therapeutic agents

UNIT – V

Microbial products of pharmacological interest, steroid fermentations, and transformations. Secondary metabolism, its significance and products. Metabolic engineering of secondary metabolism for highest productivity. Enzyme and cell immobilization techniques in industrial processing. Application of immobilized enzymes in medicine and industry.

Learning outcomes:

- Be familiar with industrial processes and applications in pharma, medicine etc
- Understand the transformations and metabolic engineering of biologically active molecules.
- Know the immobilization techniques.

Course Outcomes: On completion of this course the students will be able to

- Appreciate relevance of microorganisms from industrial context
- Carry out stoichiometric calculations and specify models of their growth
- Give an account of design and operations of various fermenters
- Calculate yield and production rates in a biological production process, and also interpret data
- Critically analyze any bioprocess from market point of view
- Give an account of important microbial/enzymatic industrial processes in food and fuel industry.

RECOMMENDED BOOKS:

1. Modern Industrial Microbiology and Biotechnology, Second Edition **2nd Edition (2017)** byNduka Okafor, Benedict C. Okeke

2. Casida LE. (2016). Industrial Microbiology.2nd edition.New Age International Private Limited.

3. Crueger W and Crueger A. (2017). Cruegers Biotechnology: A Textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi.

4. Patel AH. (2015). Industrial Microbiology.2nd edition, LAXMI PUBLICATIONS-NEW DELHI.

5. Stanbury PF, Whitaker A and Hall SJ.(2016). Principles of Fermentation Technology.3rded, Butterworth-HeinemannLtd.

SEMESTER – V

SBT 325: PLANT AND ANIMAL BIOTECHNOLOGY LAB

Hours per week: 03 **End Examination: 00 Marks**
Credits: 02 **Sessional: 100 Marks**

Preamble: The science of plant and animal biotechnology has tremendous potential for application in agriculture and medicine. The linkage between basic and applied research and new discoveries and innovations can find direct applications in agriculture and human health

Course Objectives: The objectives of this course are to providehands-on training in basic experiments of plant and animal biotechnology.

1. Preparation of simple growth nutrient (Knop's medium), full strength, half strength, solid and liquid.

2. Preparation of complex nutrient medium (Murashige & Skoog's medium)

3. Sterilization and preparation of various explants for plant tissue culture.

4. To demonstrate various steps of Micropropagation.

5. Isolation of protoplasts from Leaf.

6. Preparation of animal cell culture media

7. Preparation of single cell suspension cultures from spleen

8. Enumeration of cells in culture by haemocytometer

9. Preparation of glycerol stocks

Course Outcomes: On completion of this course, students will be able to

- Carry out basic experiments on plant biotechnology and help them to take up plant biological research as well as placement in relevant biotech industry.
- Work basic experiments on animal biotechnology and help them to take up animal biological research

RECOMMENDED BOOKS:

1. Plant cell culture - A practical approach by Dixion RA.

2. Plant tissue culture - Theory and practice by Bhojwani, S.S.

3. Biotechnology: A laboratory course by Becker, J.M.

4. Animal cell culture - A practical approach Ed. By John R.W. Masters (IRL Press).

5. Animal cell culture techniques, Ed. Martin Clyenes (Springer).

6. Culture of Animal cells; A manual of Basic techniques by R. Ian Freshney

SEMESTER – V

SBT 327: INDUSTRIAL BIOTECHNOLOGY LAB

Hours per week: 03 **End Examination: 00 Marks**
Credits: 02 **Sessional: 100 Marks**

Preamble : Industrial Biotechnology is an applied area where microorganisms are cultivated in bioreactors to produce enzymes, materials for industry, organic acids, solvents, bioplastics, food, agricultural and pharmaceutical products.Use cheaper raw materials and waste from agriculture and forestry for the manufacture of industrial goods. This course enables the learner to develop laboratory skills towards the isolation and screening of various useful microorganisms and to enhance the fermentation skills to produce various enzymes, alcoholic beverages, amino acids etc. Further, the course provides the insights and tools for the design of biotechnological process for producing various important products of commercial value.

Course Objectives:

- To train the students in isolation and screening of useful microorganisms from their native habitats.
- To make students gain expertise in industrial methods such as batch fermentation, production and estimation of enzymes and alcoholic beverages.
- To improve the base knowledge and to bring awareness on various industrial processes.

1. Isolation of antibiotic producing strain from soil samples.

2. Isolation and analysis of actinomycetes from soil samples.

3. Solvent extraction & analysis of a metabolite from a bacterial culture.

4. Fermentative production of protease by shake flask method.

5. Fermentative production of amylase by shake flask method.

6. Production of wine / alcohol.

7. Immobilization of bacterial cells.

8. Immobilization of enzyme trypsin.

Course Outcomes: By the end of the practical course, the students will be able to

- Gain knowledge to investigate, design and conduct experiments and apply the laboratory skills to isolate a potent production strain.
- Be familiar with immobilization skills
- Perform wine production and distillation.

RECOMMENDED BOOKS:

1. A manual of Industrial Microbiology and Biotechnology by Demain A.L.
2. Immobilization of enzymes and cells: Methods in Biotechnology vol.1 by Bickerstaff G.F.
3. Principle of fermentation technology by Stanbury. 2nd ed. Elsevier.
4. Biotechnology: A laboratory course by Becker J.M.
5. Lab manual in Biochemistry by J.Jayaraman (Wiley Eastern limited).
6. Biochemistry - A lab course by J.M.Becker (Academic Press).

SEMESTER – V

SPH 381: ANALYTICAL METHODS IN CHEMISTRY

Hours per week	**: 04**	**End examination**	**: 60 Marks**
Credits	**: 04**	**Sessional**	**: 40 Marks**

Preamble: The students of undergraduate program in science need to be conversant with the various instrumental and analytical techniques in analytical chemistry for training a undergraduate students as analytical chemist.

Course objective:

The concept of qualitative and quantitative methods in analytical chemistry will be introduced to undergraduate students. Students will also learn the fundamental concepts of various instrumental methods for quantitative analysis, separation methods and solvent extraction.

UNIT –I

Qualitative and quantitative aspects of analysis:
Evaluation of analytical data, errors, accuracy and precision, methods of their expression,, statistical test of data; F, Q and t test, rejection of data, and confidence intervals.
Optical methods of analysis:
Origin of spectra, interaction of radiation with matter, fundamental laws of spectroscopy and selection rules, validity of Beer-Lambert's law.
Learning Outcomes: The students will learn evaluation of analytical data and fundamental laws of spectroscopy.

UNIT –II
UV-Visible Spectrometry: Basic principles of instrumentation (choice of source, monochromator and detector) for single and double beam instrument.
Infrared Spectrometry: Basic principles of instrumentation (choice of source, monochromator& detector) for single and double beam instrument.
Learning Outcomes: The students will learn the concept and applications of UV Visible& Infra-red spectrometry for quantitative analysis.

UNIT-III
Flame Atomic Absorption and Emission Spectrometry: Basic principles of instrumentation (choice of source, monochromator, detector, choice of flame and Burner designs. Techniques of atomization and sample introduction; sources of chemical interferences. Techniques for the quantitative estimation of trace level of metal ions from water samples.
Learning Outcomes: The student will learn the concept of atomic spectrometry for quantitative analysis.

UNIT-IV
Thermal methods of analysis:
Theory of thermogravimetry (TG), basic principle of instrumentation.
Electroanalytical methods:

Classification of electroanalytical methods, basic principle of pH metric, potentiometric and conductometric titrations.

Learning Outcomes: The student will familiarize with basic thermo and electro-analytical methods for chemical analysis.

UNIT-V

Separation techniques:

Solvent extraction: Classification, principle and efficiency of the technique.
Mechanism of extraction: extraction by solvation and chelation.
Technique of extraction: batch, continuous and counter current extractions.
Chromatography: Classification, principle and efficiency of the technique.
Mechanism of separation: adsorption, partition & ion exchange.
Development of chromatograms: frontal, elution and displacement methods.

Learning Outcomes: The student will learn concept of separation methods in chemical analysis.

Course Outcomes: By the end of the course, the students will be able to

- Learn evaluation of analytical data and fundamental laws of various spectroscopic techniques
- Familiarize with the basic thermo and electro-analytical methods for chemical analysis
- Understand the concept of separation methods in chemical analysis

RECOMMENDED BOOKS:

1. Mendham, J., *A. I. Vogel's Quantitative Chemical Analysis 6thEd.*, Pearson, 2009.
2. Willard, H.H. *et al.*: *Instrumental Methods of Analysis*, 7th Ed. Wardsworth Publishing Company, Belmont, California, USA, 1988.
3. Christian, G.D. *Analytical Chemistry*, 6th Ed. John Wiley & Sons, New York, 2004.
4. Harris, D.C.: *Exploring Chemical Analysis*, 9th Ed. New York, W.H. Freeman, 2016.
5. Khopkar, S.M. *Basic Concepts of Analytical Chemistry*. New Age International Publisher, 2009.
6. Skoog, D.A. Holler F.J. & Nieman, T.A. *Principles of Instrumental Analysis*, Cengage Learning India Ed.
7. Mikes, O. *Laboratory Hand Book of Chromatographic & Allied Methods*, Elles Harwood Series on Analytical Chemistry, John Wiley & Sons, 1979.
8. Ditts, R.V. Analytical Chemistry; Methods of separation, van Nostrand, 1974

SEMESTER – V

SPH 383: GREEN CHEMISTRY

Hours per week	**: 04**	**End examination**	**: 60 Marks**
Credits	**: 04**	**Sessional**	**: 40 Marks**

Preamble: The students of undergraduate program in science need to be conversant with the various green techniques in synthetic and analytical chemistry. This course will lay the foundation for the student to be able to appreciate eco-friendly methods in chemistry and develop as a responsible chemist forth benefit of the society and environment.

Course objective:

The concept of green chemistry encompassing green chemistry strategies, concepts and practices will be introduced to the undergraduate students. Students will also learn the fundamental concepts of various green synthetic methods and techniques for quantitative analysis. The student will also Green separation and extraction for sample preparation

UNIT –I

Introduction to Green Chemistry

Green chemistry - Introduction - need for green chemistry - goals of green chemistry - Anastas' twelve principles of green chemistry - Designing a green synthesis (tools) - choice of starting materials, solvents, catalysts, reagents, processes with suitable examples.

Learning Outcomes: The students will learn the goals and principles of green chemistry.

UNIT –II

Ionic liquids - synthesis, physical properties of ionic liquids - applications in alkylation, epoxidation, Friedal-Crafts reaction - Diels-Alder reactions – Knoevengal condensations and Wittig reactions.
Phase Transfer Catalyst (PTC) - Definition - advantages, types of PTC reactions - synthesis of PTC, applications of PTC in organic synthesis - Michael reaction - alkylation of aldehydes and ketones. Wittig, generation of dihalocarbene, elimination reaction

Learning Outcomes: The students will learn the properties of ionic liquids and synthesis of molecules using the green solvents- ionic liquids.

UNIT –III

Supercritical CO_2- phase diagram - uses in extracting natural products, dry cleaning, bromination, Kolbe-Schmidt synthesis - Friedel-crafts reaction. Dimethyl carbonate as a methylating agent in green synthesis

Learning Outcomes: The student will learn the concept of supercritical CO_2.

UNIT –IV

Microwave and Ultrasound Assisted Reactions

Microwave activation - advantages of microwave exposure - Microwave assisted reactions, condensation reactions - oxidation, reduction reactions, multicomponent reactions.
Sonochemistry - use of ultrasound in organic synthesis (alternate source of energy) - saponification - substitution, addition, oxidation reactions, reductions.

Learning Outcomes: The student will familiarize with basic thermo and electro-analytical methods for chemical analysis.

UNIT –V

Green Analytical Techniques
Micelle mediated extraction- Cloud point extraction and adsorptive miceller flocculation methods.
Solid Phase Micro Extraction (SPME)

Learning Outcomes: The student will learn concept of separation methods in chemical analysis.

Course Outcomes: By the end of the course, the students will be able to

- Learn the goals and principles of green chemistry and green analytical techniques
- Understand the properties of ionic liquids and synthesis of molecules using the green solvents-ionic liquids

RECOMMENDED BOOKS:

1. Paul T. Anastas and John C. Warner, "Green Chemistry", Oxford UniversityPress, Indian Ed., 2008.
2. V. K. Ahluwalia and M. Kidwai, "New Trends in Chemistry", Anamaya Publishers, 2nd Ed. 2007.

3. V. Kumar, "An Introduction to Green Chemistry", Vishal Publishers, 1st Edition,2007.

4. V. K. Ahluwalia and R. S. Varma, "Green Solvents", Narosa Publishing, 1st Edition, 2009.

5. V.K.Ahluwalia and Renu Aggarwal, "Organic Synthetic Special Techniques",Narosa,2nd Ed., 2009.

6. V. K. Ahluwalia, "Green Chemistry - Environmentally Benign Reactions", Ane books,India, 2006.

7. Matlack, A.S. *Introduction to Green Chemistry*, Marcel Dekker (2001).

SEMESTER – V

SPH 339: ANALYTICAL METHODS IN CHEMISTRY LAB

Hours per week: 03 **End Examination: 00 Marks**
Credits: 02 **Sessional: 100 Marks**

Preamble: The students of undergraduate program in science in Chemistry need to be conversant with the various basic methodologies of chemistry. Therefore, one module each on in inorganic , physical and organic chemistry is introduced which helps the student familiarize with the techniques essential for developing the foundation of practical chemistry

Course objective: To make student learn the practical application of analytical techniques and Instrumental methods for quantitative analysis.

I. Separation Techniques

1. Chromatography:
(i) Separation of mixtures
2. Paper chromatographic separation of Fe^{3+}, Al^{3+}, and Cr^{3+}.
3. Separation and identification of the monosaccharides present in the given mixture (glucose & fructose) by paper chromatography. Reporting the Rf values.
(i) Separate a mixture of Sudan yellow and Sudan Red by TLC technique and identify them on the basis of their Rf values.
(ii) Chromatographic separation of the active ingredients of plants, flowers and juices by TLC

II Solvent Extractions:

(i) To separate a mixture of Ni^{2+}& Fe^{2+} by complexation with DMG and extracting the Ni^{2+}-DMGcomplex in chloroform, and determine its concentration by spectrophotometry.

(ii) Solvent extraction of zisconium with amberliti LA-1, separation from a mixture of irons and gallium.

1. Determine the pH of the given aerated drinks fruit juices, shampoos and soaps.
2. Determination of Na, Ca, Li in cola drinks and fruit juices using fame photometric techniques.
3. Analysis of soil:

(i) Determination of pH of soil.
(ii) Total soluble salt
(iii) Estimation of calcium, magnesium, phosphate, nitrate

4. Ion exchange:
(i) Determination of exchange capacity of cation exchange resins and anion exchange resins.
(ii) Separation of metal ions from their binary mixture.
(iii) Separation of amino acids from organic acids by ion exchange chromatography.

III Spectrophotometry

1. Determination of pKa values of indicator using spectrophotometry.
2. Structural characterization of compounds by infrared spectroscopy.

3. Determination of dissolved oxygen in water.
4. Determination of chemical oxygen demand (COD).
5. Determination of Biological oxygen demand (BOD).
6. Determine the composition of the Ferric-salicylate/ ferric-thiocyanate complex byJob's method.

Course Outcomes: By the end of the practical course, the students will be able to

- Understand the practical application of analytical techniques for quantitative analysis
- Study the practical application of instrumental methods for quantitative analysis

RECOMMENDED BOOKS:

1. Mendham, J., *A. I. Vogel's Quantitative Chemical Analysis 6thEd.,* Pearson, 2009.
2. Willard, H.H. *et al.*: *Instrumental Methods of Analysis,* 7th Ed. Wardsworth Publishing Company, Belmont, California, USA, 1988.
3. Christian, G.D. *Analytical Chemistry,* 6th Ed. John Wiley & Sons, New York, 2004.
4. Harris, D.C. *Exploring Chemical Analysis,* 9th Ed. New York, W.H. Freeman, 2016.
5. Khopkar, S.M. *Basic Concepts of Analytical Chemistry*. New Age Int. Publisher, 2009.

SEMESTER – V

SPH 341: GREEN CHEMISTRY LAB

Hours per week: 03 **Credits: 02**

Preamble: The students of undergraduate program in science in Chemistry need to be conversant with the various basic methodologies of green chemistry. Therefore, green chemistry is introduced which helps the student familiarize with the techniques essential for green chemistry.

Course objective: To make student learn the practical application of green analytical and synthetic techniques for waste utilization.

1. Safer starting materials

Preparation and characterization of nanoparticles of gold using tea leaves.

2. Using renewable resources

Preparation of biodiesel from vegetable waste cooking oil.

3. Avoiding waste

Principle of atom economy.

Use of molecular model kit to stimulate the reaction to investigate how the atom economy can illustrate Green Chemistry.

Preparation of propene by two methods can be studied

(I) Triethylamine ion + OH^- → propene + trimethylpropene + water

(II) 1-propanol $\xrightarrow{H_2SO_4/\square}$ propene + water

Other types of reactions, like addition, elimination, substitution and rearrangement should also bestudied for the calculation of atom economy.

4. Use of enzymes as catalysts

Benzoin condensation using Thiamine Hydrochloride as a catalyst instead of cyanide.

5. Alternative Green solvents

Extraction of D-limonene from orange peel using liquid CO2 prepared form dry ice.
Mechanochemical solvent free synthesis of azomethines

6. Alternative sources of energy

1. Solvent free, microwave assisted one pot synthesis of phthalocyanine complex of copper (II).
2. Photoreduction of benzophenone to benzopinacol in the presence of sunlight.

Course outcomes: By the end of the practical course, the students will be able to

- Learn synthesis of nano material, biodiesel, and simple organic molecules
- Learn alternate green solvents and sources of energy

RECOMMENDED BOOKS:

1. Anastas, P.T & Warner, J.C. *Green Chemistry: Theory and Practice*, Oxford University Press (1998).
2. Kirchoff, M. & Ryan, M.A. *Greener approaches to undergraduate chemistryexperiment*. American Chemical Society, Washington DC (2002).
3. Ryan, M.A. *Introduction to Green Chemistry*, Tinnesand; (Ed), American Chemical Society, Washington DC (2002).
4. Sharma, R.K.; Sidhwani, I.T. & Chaudhari, M.K. I.K. *Green Chemistry Experiment:A monographInternational Publishing House Pvt Ltd. New Delhi*. Bangalore CISBN978-93- 81141-55-7 (2013).
5. Cann, M.C. & Connelly, M. E. *Real world cases in Green Chemistry*, American Chemical Society (2008).

SEMESTER – V

SMB 341: MEDICAL MICROBIOLOGY

Hours per week	**: 04**	**End examination**	**: 60 Marks**
Credits	**: 04**	**Sessional**	**: 40 Marks**

Preamble: The Medical Microbiology course has been formulated to impart basic and medically relevant information on the microbes. The microbial structure, growth and development, methods, and role of sterilization in the context of study of microbes are included. The pathogenic microbes and the diseases caused by them are included to broaden the perspective of the subject. This course will also focus on mechanisms of microbial pathogenesis and the host response, and the scientific approaches that are used to investigate these processes. Lastly the course deals with the problem of emerging antimicrobial resistance with reference to known pathogens

Course objective: To make student learn the basic principles of medical microbiology, host-pathogen interactions, different forms of pathogens (bacterial, fungal, viral), their life cycles, diagnostic techniques, and modes of treatment.

UNIT -I

Normalmicrofloraofthehumanbody-skin,throat,gastrointestinaltract,urogenitaltract.Host pathogen interaction: infection, invasion, pathogen, pathogenicity, virulence, toxigenicity, carriers and their types, opportunistic infections, nosocomial infections.Vertical and horizontal transmission.

Learning outcome:

By the end of the unit, students would be able to

- understand the normal microflora of the human body
- describe host-pathogen interaction
- distinguish different forms of infections and transmission

UNIT -II

Symptoms, mode of transmission, prophylaxis, diagnosis and control of – respiratory diseases: *Streptococcus pyogenes, Mycobacterium tuberculosis,* gastrointestinal diseases: *Escherichia coli, Salmonella typhi, Vibrio cholerae, Helicobacter pylori,* disease caused by: *Staphylococcus aureus, Bacillus anthracis, Clostridium tetani*.

Learning outcome:

By the end of the unit, students would

- have an overview of infections caused by different species
- have an overview about the diagnosis and control of respiratory diseases

UNIT –III

Symptoms, mode of transmission, prophylaxis, diagnosis and control of-Polio, Herpes, hepatitis, HIV, Influenza, emerging and reemerging viruses-Ebola, Zika virus.
Disease cycle, mode of transmission, treatment of Plasmodium, Leishmania and Giardia.

Learning outcome:

By the end of the unit, students would be able to

- detail the symptoms of several diseases caused by viruses
- get an overview about the disease cycle and mode of transmission of plasmodium and Leishmania
- understand about new emerging viruses and their diseases

UNIT –IV

Mycoses and types. Symptoms, mode of transmission, prophylaxis, diagnosis and control of- Cutaneous mycoses: Tinea pedis (Athlete's foot) Systemic mycoses: Histoplasmosis, Opportunistic mycoses: Candidiasis.

Learning outcome:

By the end of the unit, students would be able to

- describe fungal infections
- understand the mode of transmission of fungal pathogens
- explain treatment options available for mycoses

UNIT –V

Collection, transport, and culturing of clinical samples. Antimicrobial agents: mode of action: Inhibitors of nucleic acid synthesis; cell wall synthesis; cell membrane function; protein synthesis; metabolism. Antibiotic resistance, MDR, MRSA.

Learning outcome:

By the end of the unit, students would be able to

- gain expertise over collection and culturing of clinical samples
- get a holistic view of different forms of antimicrobial agents
- understand the concept of antibiotic resistance

Course Outcomes: On completion of this course, students will be able to

- Compare and contrast different microbial diseases, including properties of different types of pathogens, and mechanisms of pathogenesis
- Compare and contrast experimental approaches for identifying virulence genes and advantages/disadvantages of each approach for specific pathogens.
- Gain a holistic view of different forms of antimicrobial agents

RECOMMENDED BOOKS:

1.Microbiology: An Introduction (2016) by Tortora *et al.,* 12th Edition Pearson publishers

2.Prescott's Microbiology (2016) by Joanne Willey *et al.,* 10th Edition McGraw-Hill Education

3.Sherris Medical Microbiology, (2018) by Kenneth J. Ryan *et al.,*7th Edition McGraw-Hill Education

4.Microbiology: Principles and Explorations (2015) by Black *et al.,*9th Edition, Wiley Pulishers

5.Algae (2008) by James E. Graham (2nd Edition), Benjamin Cummings

6.The Fungi by Sarah C. Watkinson, Academic Press; 3 edition (2016)

7.Fungi: Experimental Methods in Biology by Ramesh Maheshwari, Second Edition, CRC Press

8.Understanding viruses (2016) by Teri shors, Jones and Bartlet Publishers

SEMESTER – V

SMB 343: ECOLOGY AND AGRICULTURAL MICROBIOLOGY

Hours per week	**: 04**	**End examination**	**: 60 Marks**
Credits	**: 04**	**Sessional**	**: 40 Marks**

Preamble:
This paper provides a base line understanding of Ecology and Agricultural Microbiology and has been designed to enrich students an insight in acquiring the fundamental knowledge on Microbial ecology and various microorganisms and their importance and applicability in different fields of Agricultural industry.

Course Objectives:
The objectives of this course are to introduce field of Agricultural microbiology with special emphasis on microbial diversity, host-microbe interactions. Also provide technological aspects related to the concept of ecosystem and its management, soil environment, Plant pathogens and biofertilizers.

UNIT –I
Microbial ecology-scope, positive microbial interactions- mutualism, protocooperation, commensalism. Negative microbial interactions – competition, antagonism, parasitism, predation, Microbial community development, r and k strategies.
Learning outcomes:
By the end of the course, the student will be able to:
- Learn and understand microbial ecology
- Acquire knowledge about various microbial interactions

UNIT –II
Air-borne transmission of microbes, air sampling principles and techniques. Aquatic microbiology- fresh water, marine habitats. Zonation of water ecosystems, eutrophication. Potability of water- Microbial assessment of water quality, water purification, major water-borne diseases, and their control measures.
Learning outcomes:
By the end of the course, the student will be able to:
- Gain basic knowledge of Airborne transmission of microbes and sampling techniques and water ecosystem.
- Understand procedures involved in Microbial assessment of water quality and purification
- Learn the methods of water borne diseases, and control measures.

UNIT –III
Soil environment soil profile. Physico-chemical conditions, sampling techniques, role of microorganisms in organic matter decomposition, biogeochemical cycles – nitrogen cycle, sulfur and phosphorous cycles. Rhizosphere, bio-chelators, siderophores.
Learning outcomes:
By the end of the course, the student will be able to:
- Acquire the knowledge on soil environment and learn the sampling techniques.
- Learn the concepts of various biogeochemical cycles.

UNIT –IV
Plant pathogens-fungal (white rusts of crucifers, early and late light of potato, Fusarium wilt, powdery

mildew), bacterial (Citrus canker) and viral (Tobacco mosaic virus, CaMV) disease symptoms, disease cycle, prevention, and management.

Learning outcomes:

By the end of the course, the student will be able to:

- Develop knowledge on various Plant pathogens
- Acquire knowledge on various plant diseases affecting agricultural crops
- Understand the pathogenesis, prevention and management.

UNIT –V

PGPR Biofertilizers- nitrogen fixing microbes- Rhizobium, Azotobacter, blue green algae, Phosphate solubilizing microorganisms. Mycorrhiza. Biopesticides – Bacillus thuringiensis, Pseudomonas syringe and Beauveria bassiana, NPV. Mycophagy.

Learning outcomes:

By the end of the course, the student will be able to:

- Develop knowledge in Plant growth promoting microbes
- Learn the concepts of Nitrogen fixation using microbes
- Understand the role of various microbes as biofertilizers

Course Outcomes: On completion of this course, students will be able to

- Acquire knowledge about various microbial interactions
- Gain basic knowledge of Airborne transmission of microbes and sampling techniques and water ecosystem
- Appreciate the pathogenesis, prevention and management techniques
- Improve knowledge in Plant growth promoting microbes

RECOMMENDED BOOKS:

1.Microbiology: An Introduction (2016) by Tortora et al., 12thEdition Pearson publishers

2.Microbiology: A Systems Approach (2017) by Kelly Cowan 5thEdition McGraw-Hill Education

3.Prescott's Microbiology (2016) by Joanne Willey et al., 10thEdition McGraw-Hill Education

4.Brock Biology of Microorganisms (2015) by Michael T. Madigan (15thEdition), Pearson publishers

5.Handbook of Microbial Biofertilizers (2006) by Mahendra Rai 1stEdition, CRC Press

6.Algae: An Introduction to Phycology (1996) by Christiaan van den Hoek, 1st Edition, Cambridge University press

7.The Fungi by Sarah C. Watkinson, Academic Press; 3rd Edition (2016).

SEMESTER – V

SMB 321: MEDICAL MICROBIOLOGY LAB

Hours per week: 03 **End Examination: 00 Marks**
Credits: 02 **Sessional: 100 Marks**

Course objectives:

The Medical Microbiology Lab is designed to give students an exposure to various laboratory techniques dealing with microbial infections. Students would get an overall experience in identifying microbes, culturing them and understand their sensitivity to drugs

1. Identification of bacteria (E. coli, Pseudomonas, Staphylococcus, Bacillus) using laboratory strains based on cultural, morphological, and biochemical characteristics: IMViC, TSI, nitrate reduction, urease production and catalase tests.

2. Studyofcompositionanduseofimportantdifferentialmediaforidentificationofbacteria:

EMB Agar, McConkey agar, Mannitol salt agar, Deoxycholate citrate agar, TCBS

3. Study of bacterial flora of skin by swabmethod.

4. Perform antibacterial sensitivity by Kirby-Bauermethod.

5. Determination of minimal inhibitory concentration (MIC) of an antibiotic.

Course outcomes: By the end of the practical exercises, students would gain

- hands-on experience in identifying microbial pathogens, culturing them in laboratory and assay their sensitivity to various available drugs.

RECOMMENDED BOOKS:

1.Laboratory Exercises in Microbiology (2016) by John Harley 8th Edition, McGraw-Hill Education

2.Microbiology: A Laboratory Manual (2016) by James G. Cappuccino 11th Edition Pearson publishers

3.Microbiology: Laboratory Theory and Application (2015) 4th Edition by Michael J. Leboffe, Morton Publishing Company

SEMESTER – V

SMB 323: ECOLOGY AND AGRICULTURAL MICROBIOLOGY LAB

Hours per week: 03 **End Examination: 00 Marks**
Credits: 02 **Sessional: 100 Marks**

Preamble:
This paper has been designed to enrich students in learning the good laboratory practices used in Microbiology laboratory and provide practical skills in basic ecology and agricultural microbiology laboratory.

Course Objectives:
The objective of this laboratory course is to develop a detailed knowledge and practical skills in Ecology and Agricultural Microbiology. Students acquire sufficient level of knowledge and aptitude in all aspects of agricultural microbiology.

1. Isolation of bacteria and fungi from soil using serial dilution method
2. Isolation of Rhizobium from root nodules
3. MPN test
4. DO and BOD
5. Observation of rust spots from local leafy vegetables
6. Observation of viral symptoms
7. VAM fungal observation
8. Observation and comparison of different Biofertilizers

Course outcomes: By the end of the course, the student will be able to
- Learn the methods of isolation of bacteria and fungi from soil
- Acquire knowledge regarding water quality tests
- Understand the pathogenesis of fungal and viral diseases on agricultural crops
- Develop a detailed knowledge on use of biofertilizers

RECOMMENDED BOOKS:

1. Laboratory Exercises in Microbiology (2016) by John Harley 8th Edition, McGraw-Hill Education
2. Microbiology: A Laboratory Manual (2016) by James G. Cappuccino 11th Edition Pearson publishers
3. Microbiology: Laboratory Theory and Application (2015) 4th Edition by Michael J. Leboffe, Morton Publishing Company
4. Handbook of Microbial Biofertilizers (2006) by Mahendra Rai 1st Edition, CRC Press
5. Fungi: Experimental Methods in Biology (2019) by Ramesh Maheshwari, Second Edition, CRC Press

SEMESTER – V

SSE 373: PHARMACEUTICAL CHEMISTRY

Hours per week: 02 **End Examination: 00 Marks**
Credits: 02 **Sessional: 100 Marks**

Drugs & Pharmaceuticals

Preamble: The students of undergraduate program in Chemistry need to be conversant with the various basic methodologies of pharmaceutical chemistry. Pharmaceutical Chemistry is a multifaceted field that deals with the principles and applications of natural, synthetic, computational, and analytical chemistry in the discovery of chemical moieties for the prevention and cure of life-threatening diseases.

Course objective: To make student learn the basic principles of pharmaceutical chemistry with respect to Drug discovery, design, and development. The idea of basic retrosynthetic approach for the synthesis of representative drugs of the different classes.

Drugs & Pharmaceuticals

Drug discovery, design and development; Basic Retrosynthetic approach. Synthesis of the representative drugs of the following classes: analgesics agents, antipyretic agents, anti- inflammatory agents (Aspirin, Paracetamol, Ibuprofen); antibiotics (Chloramphenicol); antibacterial and antifungal agents (Sulphonamides; Sulphanethoxazol, Sulphacetamide, Trimethoprim); antiviral agents (Acyclovir), Central Nervous System agents (Phenobarbital, Diazepam), Cardiovascular (Glyceryl trinitrate), antilaprosy (Dapsone), HIV-AIDS related drugs (AZT-Zidovudine).

Fermentation

Aerobic and anaerobic fermentation. Production of (i) Ethyl alcohol and citric acid, (ii) Antibiotics; Penicillin, Cephalosporin, Chloromycetin and Streptomycin, (iii) Lysine, Glutamic acid, Vitamin B2, Vitamin B12 and Vitamin C.

Course outcomes: By the end of the course the students will be able to

- Learn synthetic route via retrosynthesis
- Gain knowledge on fermentation methods to representative drugs and vitamins.

RECOMMENDED BOOKS:

1. The organic chemistry of drug design and drug action. Richard B Silverman
2. Pharmaceutical biotechnology, concepts and applications. Gary Walsh. Wiley publications.
3. Drug metabolism in drug design and development. Wiley publications.
4. Design of controlled release drug delivery systems. Xiaoling Li. McGraw-Hill publications
5. Applied biopharmaceutics and pharmacokinetics. Leon shargel, Susanna Wu-Pong, Andrew Yo.

SEMESTER – V

SSE 387: MOLECULAR DIAGNOSTICS

Hours per week: 02 **End Examination: 00 Marks**
Credits: 02 **Sessional: 100 Marks**

Preamble:
This course is designed to get view about the critical role of molecular diagnostics in forensic analysis and deals with the methods to identify them and recent advancements in learning about different markers. Gives a comprehensive review about genomic instability and enlightens about different molecular approaches in the diagnosis of diseases.

Course objectives:
The objective of this course is to introduce the student about molecular diagnostics and methods for identifying disease markers and make the student aware of genomic instability. The objective also includes to introduce about chromosomal aberrations and molecular approaches in the diagnosis of diseases.

Molecular Diagnostics-Scope and importance. Genetic Markers commonly used for forensic analysis. Methods for identification of disease markers, predictive value, diagnostic value. Emerging blood markers for sepsis, cancer and inflammation.

Genomic instability-Mechanism and factors involved. Common fragile sites and methods of induction. Heritable fragile sites. Trinucleotide Repeats. Mechanism of expansion and triplet repeats and related disorders. Genetic linkage maps. Diseases resulting from Chromosomal Aberrations.

Molecular approaches in the is of diseases. DNA Extraction Methodologies, DNA Quantitation, Capillary Electrophoresis. DNA based Techniques in the diagnosis of diseases-Hybridization, PCR and RT PCR. RNA signature-based methods in detection of different diseases. Protein and DNA microarrays in diagnosis. ELISA in the detection of diseases. Immunodiagnostic methods for detection of microbial infections-WIDAL and VDRL

Course outcomes: By the end of the course the students will be able to

- Understand basics about Molecular Diagnostics and learn about various diagnostic markers
- Be able explain genomic instability and about diseases of chromosomal aberrations
- Be able to enumerate and explain various DNA based methodologies in the diagnosis of different diseases.

RECOMMENDED BOOKS:

1. Medical Biotechnology by Bernard Glick, Terry L delovitch, Cheryl L Patten
2. Molecular biology of the cell. Bruce Alberts, 6th Edition
3. Molecular Cell Biology: Darnell J, Lodish H and Baltimore D
4. An introduction to Human Molecular Genetics by Pasternak et al., Wiley Pubs
5. Human Chromosomes by Miller & Tharman, Springer Publishing Company
6. Genes XII, by Lewin B, Pearson India
7. Elements of medical Genetics by Turnpenny and Ellard, Churchill Livingstone

SEMESTER – VI

SBT 342: MARINE BIOTECHNOLOGY

Hours per week	**: 04**	**End examination**	**: 60 Marks**
Credits	**: 04**	**Sessional**	**: 40 Marks**

Preamble: The course will give a comprehensive view on the composition of sea water and marine environment. It gives an overall view of aqua culture practices adapted for the culture of Fish, shrimps, crabs, oysters, sea weeds and artificial breeding techniques. This course also covers post harvesting methodologies, marine pollution and role of government agencies in managing and preventing marine pollution.

Course objectives:
The objective of this course is to introduce students about marine environment, culture practices of Fish, shrimp, oysters, sea weeds. This course also gives a detailed view on post harvesting methodologies, preservation technologies and management of marine pollution.

UNIT –I

Chemical Composition of sea water. Biological features of the marine environment, Estuaries, Tropical shores, and brackish water. Biogeochemical cycles in marine ecosystem.

Learning outcomes: Student will be able to
- Know the composition of sea water
- Understand the components of marine environment
- Explain biogeochemical cycles of marine ecosystem

UNIT –II

General aquaculture practices - fish, shrimp and crab culture practices, induced breeding techniques - Hypophysation and Eyestalk oblation. Management of aquaculture farms – Feeding schedules, feed formulations, wet feeds and dry feeds.Fish byproducts.Economically important aquatic resources.

Learning outcomes: Student will
- Learn culture practices of fish, shrimp, and crab
- Be able to explain induced breeding techniques
- Understand management of aquaculture farms
- Be able to enumerate Fish byproducts and economically important aquatic resources.

UNIT-III

Mariculture: Culture of Lobsters, Mussel, Pearls, Oysters and Sea-weeds. Biology of estuaries – Estuarine adaptations, Coral reef communities and conservation methods.

Learning outcomes: Student will
- Understand about culture of lobsters, mussel, perals, oysters and sea weeds
- Be able to explain Biology of estuaries
- Be able to enumerate Fish byproducts and economically important aquatic resources.

UNIT-IV

Post harvesting and preservation technologies – on board handling, drying and dehydration, salt curing, smoking, marinades, freezing, freeze drying, modified atmosphere packaging. Quality assurance.

Learning outcomes: Student will

- Be able to explain post harvesting technologies
- Understand about various preservation technologies

UNIT-V

Marine pollution- Causes and preventive measures, Role of government agencies – Role of NABARD and other central government agencies in the upliftment of fisher folk. The Marine Products Exports Development Authority (MPEDA), Integrated coastal zone management, ocean policy and Coastal regulatory zone (CRZ)

Learning outcomes: Student will

- Understand about marine pollution
- Be able to identify different agencies and understand their role in managing marine pollution

Course Outcomes: On completion of this course, students should be able to

- Explain fundamental principles of aquaculture biotechnology
- Identify role of aquaculture biotechnology in society.
- Report inexpensively valuable products from marine natural resources

RECOMMENDED BOOKS:

1. Elements of Marine Ecology Fourth Edition R.V. Tait F. A. Dipper 1998
2. Marine fisheries ecology by Simon Jennings, Michel J. Kaiser, 2001 by Blackwell Science Ltd, a Blackwell Publishing company
3. Aquaculture: Farming Aquatic Animals and Plants edited by John S. Lucas, Paul C. Southgate (2012), second edition; (Wiley Blackwell)
4. Post-harvest Technology of Fish and Fish Products by K. K. Balachandran, Daya publishinghouse.
5. Marine Fish Culture (1998) By John W. Tucker Jr. Springer publishers
6. Fish and Fisheries (2006) by By B. N. Yadav, DAYA publishing house
7. Induced Fish Breeding: A Practical Guide for Hatcheries (2017) By Nihar Ranjan Chattopadhyay, Acdemic Press.

SEMESTER – VI

SBT 344: BIOINFORMATICS

Hours per week	**: 04**	**End examination**	**: 60 Marks**
Credits	**: 04**	**Sessional**	**: 40 Marks**

Preamble:

Bioinformatics is an information technology applied to the management and analysis of biological data with the aid of computers. It is the science of using information to understand biology. It is a field in which biological information collected, compared, studied and analyses to find the interrelation between them for solving structural, functional and evolutionary problems using computational technologies.

Course Objectives:

1. The objective of this course is to provide theoretical and practical knowledge of the usage of computational tools and databases
2. This course enables investigation of molecular biology and evolution-related ideas by using various tools and databases.

UNIT -I

Scope of computers in biological research. Anatomy of computers and its accessories, types of computers. Introduction to networks (internet) and its applications. Introduction to Bioinformatics, history of Bioinformatics, branches of Bioinformatics, scope and research areas of Bioinformatics

Learning Outcomes: By the end of this Unit, the student will be able to

- Learn about the salient features of computers and internet.
- Acquire basic knowledge about the bioinformatics and its scope in biology and allied fields that are useful in biological research

UNIT -II

Introduction to Biological Databases, Classification of Biological Databases, National Center for Biotechnology Information (NCBI), EMBL Nucleotide Sequence Database (EMBL-Bank), DNA Data Bank of Japan (DDBJ). Protein Information Resource (PIR), UniProt, TREMBL, Protein Data Bank (PDB), Human genome data base.

Learning Outcomes: By the end of this Unit, the student will be able to

- Gain knowledge of various biological databases and their uses in research.
- Know about the database searching using various Insilco tools.

UNIT -III

Concept of Alignment, Pairwise Alignment, Multiple Sequence Alignment (MSA), MSA by CLUSTALW, Scoring Matrices, Point Accepted Mutation (PAM), Blocks of Amino Acid Substitution Matrix (BLOSUM).

Learning Outcomes: By the end of this Unit, the student will be able to

- Be acquainted with the sequence alignment and its variants and its role in constructing phylogenetic trees.

- Acquire knowledge on different scoring methods used in the process of sequence alignment.

UNIT -IV

Methods of Phylogeny- Distance based and character based methods.Software for Phylogenetic Analyses, Consistency of Molecular Phylogenetic Prediction.

Learning Outcomes: By the end of this Unit, the student will be able to
- Comprehend various methods in phylogenetic tree construction and their importance
- Analyze the phylogenetic tree construction methods which gives a clear picture of molecular evolution

UNIT -V

Searching Databases: SRS, Entrez, Sequence Similarity Searches-BLAST, FASTA, Introduction to genomics, Genome Annotation: Pattern and repeat finding, Gene identification tools. Introduction to proteomics.

Learning Outcomes: By the end of this Unit, the student will be able to

- Know about the similarity searching of biomolecules using various *insilico* tools.
- Be acquainted with the genome annotation and gene identification using dry-lab techniques

Course Outcomes: On completion of this course, students should be able to

- Develop an understanding of the basic theory of these computational tools
- Gain working knowledge of these computational tools and methods
- Appreciate their relevance for investigating specific contemporary biological questions
- Critically analyze and interpret the results of their study.

RECOMMENDED BOOKS:

1. Essential Bioinformatics by Jin Xiong, Reprint 2011(Cambridge University Press).
2. Biological Sequence Analysis by Richard Durbin, Sean R. Eddy, Anders Krogh, Graeme Mitchison, Indian Reprint (Cambridge University Press).
3. An Introduction to Bioinformatics by T. K. Attwood and D. J. Parry-Smith Addison, Reprint 2011 (Wesley Longman, Harlow).
4. Introduction to Bioinformatics by Arthur M. Lesk, 3rd Edition (Oxford University Press).
5. Bioinformatics: Sequence and Genome Analysis by David W. Mount, 2nd Edition (Cold Spring Harbor Laboratory Press).
6. Bioinformatics and Functional Genomics by Pevsner J. (2009). II Edition. Wiley-Blackwell.
7. Discovering Genomics, Proteomics and Bioinformatics by Campbell A. M., Heyer L. J. (2006). II Edition. Benjamin Cummings.

SEMESTER – VI

SBT 326: MARINE BIOTECHNOLOGY LAB

Hours per week: 03 **End Examination: 00 Marks**
Credits: 02 **Sessional: 100 Marks**

Preamble:

This course is about the methodology related to collection and analysis of sea water and determine physical and chemical parameters of sea water. An industrial visit is included to make the student aware of fish farming methods.

Course objectives:

This course main objective is to learn to collect sea water and determine physical parameters and chemical parameters of sea water and expose the students to the fish farming industry.

1. Identification of marine fish
2. Collection and identification of marine seaweeds
3. Analysis of sea water: Turbidity, pH., temperature
4. Determination of Dissolved oxygen in sea water
5. Determination of salinity of sea water.
6. Spotters: Cultivable species of finfish and shellfish based on the theory
7. Visit to aquaculture farms, finfish and shrimp hatcheries and processing units
8. Identification of marine zones by photograph / Google earth

Course outcomes: By the end of the practical course, the student will be able to

- Analyze sea water and determine physical and chemical parameters.
- Learn and understand the process of fish farming by visiting aqua farms.

RECOMMENDED BOOKS:

1. Seaweeds of India (2009) by By Bhavanath Jha, C.R.K. Reddy, Mukund C. Thakur, M. Umamaheswara Rao Springer Publishers
2. Common Seaweeds of India (2010) By Dinabandhu Sahoo, IK International
3. The Diversity of Fishes: Biology, Evolution, and Ecology (2009) By Gene Helfman, Bruce B. Collette, Douglas E. Facey, Brian W. Bowen, 2nd edition, (Wiley Blackwell).
4. The Larvae of Indo-Pacific Coastal Fishes: An Identification Guide to Marine fish larvae (2000) by edited by Jeffrey Martin Leis, Brooke M. Carson-Ewat; Brill Publishers
5. Encyclopedia of Fishes (1998) by John R. Paxton, William N. Eschmeyer, 2ndEdition (Natural World Series) Academic Press
6. Analysis of Seawater (1989) By Crompton; Butterworths Publishing house
7. Analysis of Seawater: A Guide for the Analytical and Environmental Chemist (2006) by T.R. Crompton
8. Practical Guidelines for the Analysis of Seawater (2009) by Oliver Wurl; CRC Press

SEMESTER – VI

SBT 328: BIOINFORMATICS LAB

Hours per week: 03 **End Examination: 00 Marks**
Credits: 02 **Sessional: 100 Marks**

Preamble: Bioinformatics is an interdisciplinary field that develops methods and software tools for understanding biological data. As an interdisciplinary field of science, bioinformatics combines biology, computer science, information engineering, mathematics and statistics to analyze and interpret biological data. This has been used for *in silico* analyses of biological queries using mathematical and statistical techniques.

Course Objectives:

- The aim of this course is to provide practical training in bioinformatics methods including accessing major public sequence databases.
- The usage of different computational tools to find sequences, analysis of protein and nucleic acid sequences by various software packages.
- Construct phylogenetic trees using various methods

1. Internet Search Engines
2. Understanding and use of various web resources: EMBL, Genbank, Entrez, Unigene
3. Understanding and using: PIR, PDB, Swissprot, TREMBL
4. Searching for homologous sequences using BLASTn and interpretation of results.
5. Searching for homologous sequences using BLASTp and interpretation of results.
6. Searching for homologous sequences using FASTAx and interpretation of results
7. Aligning two sequences using Genbank.
8. Multiple sequence alignment using Clustal W
9. Phylogenetic tree construction using NJ and UPGMA methods
10. Phylogenetic tree construction using MP and ML methods

Course Outcomes: On completion of this course, students should be able to

- Describe contents and properties of most important bioinformatics databases.
- Perform text- and sequence-based searches and analyze & discuss results in perspective of biological knowledge.
- Compute phylogenetic trees using both character-based and distance-based methods.

RECOMMENDED BOOKS:

1. Bioinformatics - D.Mount
2. C programming by BalaguruSwamy.
3. Introduction to Bioinformatics by Arthur M.Lesk, Oxford.
4. Programming in C- Yashwant kanitkar

SEMESTER – VI

SPH 382: INDUSTRIAL CHEMICALS AND ENVIRONMENT

Hours per week	**: 04**	**End examination**	**: 60 Marks**
Credits	**: 04**	**Sessional**	**: 40 Marks**

Preamble: With industrial development in gigantic proportions, the onus of safeguarding the environment from the hazard of the chemical synthesis, usage and disposal lies a great deal on every individual. It becomes imperative to inculcate the education related to safe use of handling of chemicals. An understanding of the potential hazards and precautions required in handling of chemicals is of utmost importance in preventing exposure to chemicals and mishaps.

Course objective:

- Individual and material safety is of utmost importance in any organization. Many a times accidents take place due to unsafe working in environment. Wide ranges of chemicals are used in universities, national laboratories, and industries, each with its own inherent hazards.
- The course is designed to impart basic knowledge of production, uses, storage and hazards in handling industrial gases and chemicals.
- Essential knowledge of the components of the environment, sources of pollution and pollutants shall be imparted to the students

UNIT-I

Industrial Gases and Inorganic Chemicals

Industrial Gases: Large scale production, uses, storage and hazards in handling of thefollowing gases: oxygen, nitrogen, argon, neon, helium, hydrogen, acetylene, carbon monoxide, chlorine, fluorine, sulphur dioxide and phosgene.

Inorganic Chemicals: Manufacture, application, analysis, and hazards in handling thefollowing chemicals: hydrochloric acid, nitric acid, sulphuric acid, caustic soda, common salt, borax, bleaching powder, sodium thiosulphate, hydrogen peroxide, potash alum, chrome alum, potassium dichromate and potassium permanganate.

Learning Outcomes: The students will learn about the production, uses, storage and hazards in handling industrial gases and chemicals.

UNIT-II

Environment and its segments

Ecosystems. Biogeochemical cycles of carbon, nitrogen, and sulfur.

Air Pollution: Major regions of atmosphere. Chemical and photochemical reactions in atmosphere. Air pollutants: types, sources, particle size and chemical nature; Photochemical smog: its constituents and photochemistry. Environmental effects of ozone, Major sources of air pollution. Pollution by SO_2, CO_2, CO, NO_x, H_2S. Methods of estimation of CO, NOx, SO_x and control procedures.

Learning Outcomes: The students will learn about the biogeochemical cycles in environment and air pollution: sources and pollutants

UNIT-III

Greenhouse effect and Global warming, Ozone depletion by oxides of nitrogen, chlorofluorocarbons and

Halogens, removal of sulphur from coal.Control of particulates.

Water Pollution : Hydrological cycle, water resources, aquatic ecosystems, Sources andnature of water pollutants, Techniques for measuring water pollution, Impacts of water pollution on hydrological and ecosystems.

Learning Outcomes: The student will learn the concept of global warming. The students will also learn about water pollution.

UNIT -IV

Water purification methods. Effluent treatment plants (primary, secondary and tertiary treatment). Industrial effluents from the following industries and their treatment: textile, tannery, dairy, petroleum, and petrochemicals.

Industrial waste management, incineration of waste. Water treatment and purification (reverse osmosis, electro dialysis, ion exchange). Water quality parameters for wastewater, industrial water and domestic water.

UNIT –V

Energy & Environment

Sources of energy: Coal, petrol and natural gas. Nuclear Fusion / Fission, Solar energy, Hydrogen, geothermal, Tidal and Hydel, etc., Nuclear Pollution: Disposal of nuclear waste, nuclear disaster, and its management.

Learning Outcomes: The student will learn about sources of energy. The students will also learn about nuclear pollution and waste management.

Course Outcomes: On completion of this course, students should be able to

- Learn about the production, uses, storage and hazards in handling industrial gases and chemicals
- Understand about the biogeochemical cycles in environment and air pollution: sources and pollutants
- Study the concept of global warming
- Learn about nuclear pollution and waste management.

REFERENCE BOOKS:

1. E. Stocchi: *Industrial Chemistry,* Vol-I, Ellis Horwood Ltd. UK.
2. R.M. Felder, R.W. Rousseau: *Elementary Principles of Chemical Processes*, Wiley Publishers,New Delhi.
3. J. A. Kent: Riegel's *Handbook of Industrial Chemistry*, CBS Publishers, New Delhi.
4. S. S. Dara: *A Textbook of Engineering Chemistry*, S. Chand & Company Ltd. New Delhi.
5. K. De, *Environmental Chemistry*: New Age International Pvt., Ltd, New Delhi.
6. S. M. Khopkar, *Environmental Pollution Analysis*: Wiley Eastern Ltd, New Delhi.
7. S.E. Manahan, *Environmental Chemistry*, CRC Press (2005).
8. G.T. Miller, *Environmental Science* 11th edition. Brooks/ Cole (2006).
9. A. Mishra, *Environmental Studies*. Selective and Scientific Books, New Delhi (2005).

SEMESTER – VI

SPH 384: INSTRUMENTAL METHODS OF ANALYSIS

Hours per week	**: 04**	**End examination**	**: 60 Marks**
Credits	**: 04**	**Sessional**	**: 40 Marks**

Preamble: The students of undergraduate program in science need to be conversant with the various instrumental and analytical techniques in analytical chemistry for training a undergraduate students as analytical chemist.

Course objective:

The concept of qualitative and quantitative methods in analytical chemistry will be introduced to undergraduate students. Students will also learn the fundamental concepts of various instrumental methods for quantitative analysis, separation methods and solvent extraction.

UNIT- I

Thermal methods of analysis: Thermo gravimetry - theory, in-strumentation, applications with special reference to CuSO4. 5H2O, CaC2O4.H2O and CaCO3. Basic idea of differential thermal analysis: principle and instrumentation. Difference between TGA and DTA. Differential scanning calorimetry: principle and instrumentation.

Learning Outcomes: The students will learn the fundamentals of thermo analytical technique.

UNIT -II

Flame photometry: Theory and instrumentation. Analyses of Na, K, Ca, and Mg.
Atomic Absorption Spectrometer: Theory, instrumentation, chemical and spectral interferences, Applications
Induced couple plasma spectroscopy: Theory, Instrumentation and applications of ICP-OES

Learning Outcomes: The student will learn the concept of atomic spectrometry for quantitative analysis.

UNIT –III

Principles of chromatography: Classification of different chromatographic methods, adsorption and partition isotherms, column capacity, retardation factor, retention time and retention volume, gradient elution, height equivalent theoretical plate (HETP)
High performance liquid chromatography: Theory and instrumentation: pumps, column, detectors-UV detector, refractive index detector, Fluorescence detector, photo diode array detector and applications.
Gas liquid chromatography: Theory and instrumentation: columns (packed and capillary columns), detector: thermal conductivity detector, flame ionization detector, electron capture detector, nitrogen-phosphorus detector, photo ionization detector, and applications.

Learning Outcomes: The students will learn about the details of a gas chromatograph and applications of gas chromatography.

UNIT IV

Voltametry: Principle of polarography residual current, migration current, diffusion current, half-wave potential, Ilkovic equation. Instrumentation: Dropping mercury electrode (DME), advantages and disadvantages of DME, qualitative and quantitative analysis of inorganic ions - Cu, Pb Cd and Zn. Anode Stripping Voltametry: Principle and instrumentation. Hanging drop mercury electrode, application in the analysis of some selected metals

Learning Outcomes: The student will familiarize electro-analytical methods for chemical analysis with reference to voltametry.

UNIT V

X-ray Spectroscopy: X-ray spectrometers, energy dispersive and wavelength dispersive techniques, instrumentation, matrix effects and applications.

Learning Outcomes: The student will learn applications and details of the X-ray spectrometer in chemical analysis.

Course Outcomes: On completion of this course, students should be able to

- Learn applications and details of the X-ray spectrometer in chemical analysis
- Familiarize with thermo-analytical and electro-analytical methods for chemical analysis
- Understand about the details of a gas chromatograph and applications of gas chromatography

REFERENCE BOOKS:

1. Instrumental methods of analysis - H.H. Willard, Meritt Jr. and J.A. Dean,CBS Publishers and distributors, 6th edition, 1986.
2. Principles of instrumental analysis – Douglas A. Skoog, F. James Holler and R. Crouch, Cengage Learning, 6th edition, 2006.
3. Vogel's textbook of Quantitative Inorganic analysis - J. Basset, R.C. Denney, G.H. Jeffery and J. Mendham, Prentice Hall, 6th edition, 2000
4. Instrumental methods of Analysis – G.R. Chatwal and S. Anand, Himalaya publishing House, 13th reprint, 1999.
5. Analytical Chemistry – S.Usha Rani, Macmillan India Limited, 2001
6. Instrumental methods of Analysis – Galen S. Ewing, Mcgraw Hill Higher Education, 5th ed., 1985
7. Handbook of Instrumental techniques for Analytical Chemistry, Frank Settle, Prentice Hall, 1997.

SEMESTER – VI

SPH 340: INDUSTRIAL CHEMICALS & ENVIRONMENT LAB

Hours per week: 03 **End Examination: 00 Marks**
Credits: 02 **Sessional: 100 Marks**

Preamble: Application of basic chemistry and chemical calculations to measure chemical, parameters of water and wastewater. Laboratory methods and interpretation of results with regard to environmental analysis are important for studying the pollution trend.

Course objective: To introduce students to how the common environmental experiments relating to water and wastewater quality are performed. This course will help students know which tests are appropriate for given environmental problems and apply the laboratorial results to problem identification, quantification, and basic solutions.

1. Determination of dissolved oxygen in water.
2. Determination of Chemical Oxygen Demand (COD)
3. Determination of Biological Oxygen Demand (BOD)
4. Percentage of available chlorine in bleaching powder.
5. Measurement of chloride, sulphate, and salinity of water samples by simple titration method (AgNO3 and potassium chromate).
6. Estimation of total alkalinity of water samples ($CO3^{2-}$, $HCO3^{-}$) using double titrationmethod.
7. Measurement of dissolved CO2.
8. Study of some of the common bio-indicators of pollution.
9. Estimation of SPM in air samples.
10. Preparation of borax/ boric acid.

Course outcomes: By the end of the practical course, the students will be able to

- perform environmental experiments relating to water and wastewater quality, and know which tests are appropriate for given environmental problems.

REFERENCE BOOKS:

1. E. Stocchi: *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK.
2. R.M. Felder, R.W. Rousseau: *Elementary Principles of Chemical Processes*, Wiley Publishers, New Delhi.
3. J. A. Kent: Riegel's *Handbook of Industrial Chemistry*, CBS Publishers, New Delhi.
4. S. S. Dara: *A Textbook of Engineering Chemistry*, S. Chand & Company Ltd. New Delhi.
5. K. De, *Environmental Chemistry*: New Age International Pvt., Ltd, New Delhi.
6. S. M. Khopkar, *Environmental Pollution Analysis*: Wiley Eastern Ltd, New Delhi.

SEMESTER – VI

SPH 342: INSTRUMENTAL METHODS OF ANALYSIS LAB

Hours per week: 03 **Credits: 02**

Preamble: The students of undergraduate program in science in Chemistry need to be conversant with the various instrumental method of analysis in chemistry. Therefore, It helps the student familiarize with the techniques essential for developing the foundation of Instrumental methods in analytical chemistry.

Course objective:

To make student learn the practical application of Instrumental methods for quantitative analysis.
To make the students learn separation methods of analysis including planar, gas and liquid chromatography.

1. Safety Practices in the Chemistry Laboratory
2. Titration curve of an amino acid.
3. Determination of a Mixture of Cobalt and Nickel (UV/Vis spec.)
4. IR Absorption Spectra (Study of Aldehydes and Ketones)
5. Determination of Calcium, Iron, and Copper in Food by Atomic Absorption
6. Quantitative Analysis of Mixtures by Gas Chromatography (i.e., chloroform and carbon tetrachloride)
7. Separation of Carbohydrates by HPLC
8. Potentiometric Titration of a Chloride-Iodide Mixture
9. Laboratory analysis to confirm anthrax or cocaine
10. Detection in the field and confirmation in the laboratory of flammable accelerants or explosives.
11. Detection of illegal drugs or steroids in athletes
12. Detection of pollutants or illegal dumping

Course outcomes: By the end of the practical course, the students will be able to

- Learn quantitative analysis using atomic absorption spectroscopy, HPLC and Gas chromatography
- Identify the explosives, illegal drugs and pollutants

REFERENCE BOOKS:

1. Skoog, D.A. Holler F.J. & Nieman, T.A. *Principles of Instrumental Analysis*, Cengage Learning India Ed.
2. Willard, H.H., Merritt, L.L., Dean, J. & Settoe, F.A. *Instrumental Methods of Analysis*, 7th Ed. Wadsworth Publishing Company Ltd., Belmont, California, USA, 1988.

SEMESTER – VI

SMB 340: MICROBIAL PHYSIOLOGY AND FERMENTATION TECHNOLOGY

Hours per week	**: 04**	**End examination**	**: 60 Marks**
Credits	**: 04**	**Sessional**	**: 40 Marks**

Preamble: This course provides insights to the principles relevant to Microbial Physiology and Fermentation Technology. As per the course content, one can understand the basic principles of important physiological processes in microorganisms. Development of procedures for obtaining new microbial metabolites by rapid and reliable isolation and screening procedures. Understanding various principles of fermentation processes, selection of media, reactor designs, scale-up and downstream processing is primary and essential in large-scale production of various biologically active principles or products.

Course Objectives:

1. To study physiology of transportation of biomolecules and microbial growth in response to nutrition and energy.
2. To develop skills about the fermentation processes with respect to growth kinetics and fermenter design
3. To understand the production of various growth factors, organic solvents, nutraceuticals and therapeutic agents

UNIT –I

Passive and facilitated diffusion, Primary and secondary active transport, concept of uniport, symport and antiport, Group translocation, Iron uptake. Microbial growth in response to nutrition and energy, EMP pathway and EDP pathway.

Learning outcomes: By the end of the unit, the student will be able to:

- Gain the knowledge about the concepts of physiological processes.
- Know the microbial growth response to nutrition and energey

UNIT-II

Fermenter design - basic functions of a fermenter for microbial cell culture – alternative vessel design, common measurements and control systems. aeration and agitation antifoaming reagents in fermentation. Fermentation - Alcohol fermentation and Pasteur effect; Lactate fermentation (homo fermentative and hetero fermentative pathways), concept of linear and branched fermentation pathways.

Learning outcomes: By the end of the unit, the student will be able to:

- Understand the basic functions and designs of fermenter for microbial cell cultures
- Gain knowledge on concepts of fermentative pathways

UNIT-III

Fermentation process: Definitions of growth, growth kinetics - measurement of microbial growth - generation time and specific growth rate, synchronous growth, diauxic growth curve. Batch culture, Continuous Culture, Fed -Batch culture. Major types of organisms used in fermentation.

Learning outcomes: By the end of the unit, the student will be able to:

- Differentiate the various types of fermentation processes
- Gain knowledge on concept of growth kinetics

UNIT -IV

Media for industrial fermentation, types of media. Product recovery: *In-situ* recovery of products, *ex-situ* recovery of products: Production of enzymes used in food technology by microbial fermentation – amylase, proteases, lipases, glucose isomerase.

Learning outcomes: By the end of the unit, the student will be able to:

- Differentiate the various types of fermentation media
- Understand the product recovery or purification from culture broth
- Give account on production of enzymes used in food technology

UNIT –V

Production of single cell proteins, organic acids - citric acid, vinegar, amino acids – glutamic acid and lysine. Vitamins - riboflavin, Vitamin B12. Antibiotics – penicillin and tetracycline. Acetone and butanol.

Learning outcomes: By the end of the unit, the student will be able to:

- Gain knowledge on single cell proteins, organic acids & solvents production.
- Give account on vitamins and antibiotics production

Course outcomes: By the end of the course, the students will be able to

- Be familiar with different methodologies involved in the downstream processing in removing the microbial cells and solid matter from the fermentation broth and finishing of product purification.
- Give an account of important microbial / industrial processes in industrial chemicals, solvents, insecticides etc
- Understand the production of therapeutic agents
- Be familiar with industrial processes and applications in pharma, medicine etc
- Understand the transformations and metabolic engineering of biologically active molecules.

REFERENCE BOOKS:

1. Principles of Fermentation Technology (2016) by Peter F Stanbury, 3rd Edition, Butterworth-Heinemann
2. Microbiology and Technology of Fermented Foods (Ift Press) (2006) by Robert W. Hutkins, 1st Edition, Wiley-Blackwell
3. Industrial Microbiology (2016) by KL Benson, CBS Publishers
4. Industrial microbiology (2016) by Casida, New Age International Private Limited
5. Cruegers Biotechnology: A Textbook of Industrial Microbiology (2017) by Wulf Crueger, Medtech Publishers

SEMESTER – VI

SMB 342: IMMUNOLOGY

Hours per week	**: 04**	**End examination**	**: 60 Marks**
Credits	**: 04**	**Sessional**	**: 40 Marks**

Preamble: This course deals about the structure and organization of cells and organs of the immune system and gives an idea about activation of different types of immune responses. The course explain how the immune system responds against transplantation. This course also helps in analyzing the response of the system against cancer. This course gives an comprehensive view on the tolerance, Autoimmunity and hypersensitivity. The course also helps to understand the principles and significance of various immunological techniques and various diagnostic assays.

Course objectives:

1. Course helps students to get knowledge about different cells, organs, and other components of the immune system
2. Student will understand the immune response manifested by different components.
3. Students will learn about the response of immune system in different pathological conditions and learns about different techniques based on antigen and antibody interactions

UNIT-I

Immune System-Characteristics of Innate and Adaptive immune systems. Anatomical and Physiological barriers. Cells and Organs of the Immune System.Toll like receptors. Immunogen, Antigen, Hapten, adjuvants, Epitopes.

Learning Outcomes: Student will learn about

- Different cells of the immune system
- Various lymphoid organs
- Different types of antigens

Unit-II

B cells-Types. B cell receptor. General structure of antibodies. Structure and functions of different classes of antibodies. Genetic basis of antibody diversity, Affinity maturation. Complement system-Classical, alternate and MBL pathways. Functions of complement system and their regulation.

Learning Outcomes: Student will learn about

- Types of B cells, functions of different classes of antibodies and antibody diversity
- Biological function and regulation of complement system

Unit III

T cells-Types.T cell receptor.MHC restriction.General structure and types of MHC. Role of MHC in the Immune Response and antigen presentation, Cell mediated responses of different T cells.

Learning Outcomes: Student will learn about

- Types of T cell
- Significance of MHC in antigen processing and presentation cell mediated responses

Unit-IV

Immunological tolerance.Types, characteristics and examples of Hypersensitivity, Autoimmunity, Transplantation-Types of rejection, Graft versus host disease. Disorders of the Immune System, Basic immune response to cancer, Modern Antibody Therapy

Learning Outcomes: Student will

- Get an idea of types of T cell
- Understand the significance and physiology of tolerance, autoimmunity and hypersensitivity
- Learn about different disorders of immune system and immune response against cancer

Unit-V

Antigen-Antibody Interactions. Double immunodiffusion and single immunodiffusion. Principles of Western blotting and ELISA Principles of Diagnostic tests-VDRL, WIDAL, Pregnancy detection. Diagnostic methodologies and limitations in identifying HIV, Salmonella, and other infections.

Learning Outcomes: Student will

- Understand antigen and antibody interactions
- Analyze and critically examine various immunological techniques
- Learn about different Diagnostic assays.

Course Outcomes: On completion of this course, students will be able to

• Provide sequential and conceptual thinking and paradigms of cellular and molecular basis of immune system and their applications

• Evaluate the usefulness of immunology in different fields like medicine, industry…etc.,

• Apply their knowledge and design molecular diagnostic kits for detection of diseases

REFERENCE BOOKS:

1.Immunology a short course byBenjamin E and Leskowitz S (Wiley Liss NY)

2.Fundamental Immunology by William E. Paul, Paul, 4th ed. (Garland Science publishers).

3.Immunology by Roit et.al (Harper Row).

4.Kuby Immunology by Judy Owen *et al.,* 7th edition (NY: WH Freeman and Co)

5.Principles of Microbiology and Immunology byDavis et.al.,(Harper).

6.Immunology-understanding of immune system by KlansD.Elgret (.Wiley-Liss.NY,)

7.Cellular and Molecular Immunology by Abul K. Abbas and Andrew H. Lichtman,, 5th ed. (W B. Saunders).

SEMESTER – VI

SMB 320: MICROBIAL PHYSIOLOGY AND FERMENTATION TECHNOLOGY LAB

Hours per week: 03 **End Examination: 00 Marks**
Credits: 02 **Sessional: 100 Marks**

Preamble: This course enables the learner to develop laboratory skills towards fermentation technology and microbial growth physiology. Able to demonstrate the effect of various physical and biochemical factors on growth rate and survival of microorganisms.

Course Objectives:

1. To train the students to demonstrate the production of organic solvents and enzymes through fermentation.
2. To show the enzyme producing capability of microorganisms
3. To understand the effects of various physical and biochemical factors on growth rate of bacteria.

1. Study and plot the growth curve of *E. coli* by standard plate count methods.

2. Calculations of generation time and specific growth rate of bacteria from the graph plotted with the given data.

3. Effect of temperature on growth of *E. coli.*

4. Effect of pH on growth of *E. coli.*

5. Effect of carbon and nitrogen sources on growth of *E. coli.*

6. Effect of salt on growth of *E. coli.*

7. Demonstration of alcoholic fermentation.

8. Demonstration of the thermal death time and decimal reduction time of *E. coli.*

9. Extracellular activities of microorganisms- amylase, lipase, caseinase.

10. Isolation of Antibiotic producing organism.

Course Outcomes: By the end of this practical course, the student will be able to

- Gain knowledge to investigate and analyze the effect of various factors on growth rate of bacteria.
- Calculate the generation time and specific growth rate of bacteria
- Be familiar with extracellular activities of microorganisms
- Demonstrate alcohol production

REFERENCE BOOKS:

1.Laboratory Exercises in Microbiology (2016) by John Harley 8th Edition, McGraw-HillEducation
2.Microbiology: A Laboratory Manual (2016) by James G. Cappuccino 11th Edition Pearson publishers.
3.Microbiology: Laboratory Theory and Application (2015) 4th Edition by Michael J. Leboffe, Morton Publishing Company
4. Industrial microbiology (2016) by Casida, New Age International Private Limited
5.Practical Manual on Fermentation Technology (2012) by S. Kulandaivelu, I K International Publishing House
6.Practical Fermentation Technology (2008) by Brian McNeil, Wiley Publishers

SEMESTER – VI

SMB 322: IMMUNOLOGY LAB

Hours per week: 03 **End Examination: 00 Marks**
Credits: 02 **Sessional: 100 Marks**

Preamble: This course is about different laboratory experiments designed basing on the antigen and antibody interactions. Experiments are helpful for identifying specificity between antigens and antibodies and qualitative and quantitative estimation of antigens or antibodies.

Course objectives:
This course objective is to make the student aware of the techniques, instrumentation, methods available with regard to the estimation of antigens and antibodies. Methods include both qualitative and quantitative estimations and limitations of certain diagnostic assays.

1. Identification of human blood groups.
2. Total Leukocyte Count of the given blood sample.
3. Differential Leukocyte Count of the given blood sample.
4. Separation of serum from the blood sample(demonstration).
5. VDRL and WIDAL
6. Immunodiffusion by Ouchterlony method.
7. ELISA
8. Immunoelectrophoresis

Course outcomes: By the end of this practical course, the student will be able to

- Identify blood group of the given sample
- Understand antigen and antibody reactions
- Perform various experiments to determine concentrations of antigens or antibodies
- Can perform diagnostic test for some infections

REFERENCE BOOKS:

1. Immunology methods manual - The comprehensive source book by Lefkovits. I 6.Manual of clinical laboratory immunology by Rose NR.

2. The experimental foundations of modern immunology by Clark W.R.

SEMESTER – VI

SSE 388: ENTREPRENEURSHIP DESIGN

Hours per week: 02 **End Examination: 00 Marks**

Credits: 02 **Sessional: 100 Marks**

Preamble: This course gives a glimpse of the characteristics of entrepreneurship and reviews about the requirements of project formulations and appraisals. This course gives information about different institutions that support small scale business.

Course Objectives:

The objectives of this course are to introduce students the concept of entrepreneurship and its characteristics and enlighten students about different forms of business organizations. This course us also helps students to learn about project formulation and make aware of various institutions which support small business enterprises.

Entrepreneur characteristics – Classification of Entrepreneurships – Incorporation of Business – Forms of Business organizations –Role of Entrepreneurship in economic development –Start-ups.

Project Formulation and Appraisal: Preparation of Project Report –Content; Guidelines for Report preparation – Project Appraisal techniques –economic – Steps Analysis; Financial Analysis; Market Analysis; Technical Feasibility.

Institutions Supporting Small Business Enterprises**:** Central level Institutions: NABARD; SIDBI, NIC, KVIC; SIDIO; NSIC Ltd; etc. – state level Institutions –DICs- SFC- SSIDC- Other financial assistance.

Course outcomes: By the end of this course, the student will be able to

- Gain entrepreneurial skills, understand the various forms of business organizations
- Get knowledge about project formulations and appraisals and know about various institutions which support small business enterprises.

REFERENCE BOOKS:

1. Arya Kumar, Entrepreneurship, Pearson, Delhi,2012.
2. Poornima M.CH., Entrepreneurship Development –Small Business Enterprises, Pearson, Delhi,2009
3. Michael H. Morris, ET. al., Entrepreneurship and Innovation, Cen gage Learning, New Delhi,2011

SEMESTER – VI

SSE 390: BIOSAFETY AND IPR

Hours per week: 02 **End Examination: 00 Marks**

Credits: 02 **Sessional: 100 Marks**

Preamble:

This course explains about different safety measures adopted in research laboratories. This course also gives an idea and understanding on Intellectual property rights.

The course objectives:

The objective also includes to make the student understand about biosafety and risk assessment in the industry related to the biological products.

The objective of this course is to provide basic knowledge on intellectual property rights and their role in research.

Biosafety: Definition of bio-safety, Biotechnology and bio-safety with special emphasis on Indian concerns. Introduction to the concept of containment level and Good Laboratory Practices (GLP) and Good Manufacturing Practices (GMP). Bio safety regulation: handling of recombinant DNA products and process in industry and in institutions

Introduction to IPR: IPR, forms of IPR, Copy right, Trademarks, Geographical indications, Industrial designs and Intellectual property protection. WIPO, EPO. Type of patents. Indian patent act and foreign patents. Infringement of intellectual property rights.

Concept related to patents novelty, non-obviousness, utility, anticipation, prior art etc. Searching a patent, Drafting of a patent, Filing of a patent, Revocation of patent, Infringement and Litigation with case studies on patent, Commercialization and Licensing, Moral Issues in Patenting Biotechnological inventions, Case studies : Basmati, Haldi..

Course outcomes: By the end of this course, the student will be able to

- Understand risk assessment and enumerate different biosafety measures with particular reference to Indian concerns.
- Know about IPR and various forms of IPR
- Get knowledge about filing a patent

RECOMMENDED BOOKS:

1. Principles of Intellectual Property : N.S. Gopalakrishnan & T.G. Agitha, (2009) Eastern BookCo., Lucknow.
2. Kerly's Law of Trade Marks and Trade Names (14th Edition) Thomson, Sweet &Maxweel.
3. Indian Patents Law – Legal &BusinessImplications; AjitParulekar and Sarita D' Souza, (2006) Macmillan India Ltd.
4. Law Relating to Patents, Trade Marks, Copyright, Designs & Geographical Indications; B.L.Wadehra (2000) Universal law Publishing Pvt. Ltd., India.
5. Law of Copyright and Industrial Designs; P. Narayanan (2010) Eastern law House, Delhi.

SEMESTER – VI

SBT 392: MINOR PROJECT WORK

Credits: 04 **End examination: 100 Marks**

The student shall submit a minor project report by the end of the VI semester based on the survey of existing scientific literature involving research articles, review articles, monographs etc., on the topic relevant to Biotechnology and should give a presentation on the work.