GANDHI INSTITUTE OF TECHNOLOGY AND MANAGEMENT (GITAM)

(Deemed to be University)

VISAKHAPATNAM * HYDERABAD * BENGALURU

Accredited by NAAC with A^{+} Grade

REGULATIONS AND SYLLABUS

OF

B.Sc. (Environmental Science, Biotechnology, Chemistry)

(for 2020-21 admitted batch)

B.Sc. Degree with Environmental Science, Biotechnology, Chemistry

REGULATIONS

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

1. ADMISSION

Admission into B.Sc. Degree with Environmental Science, Biotechnology, Chemistry program is governed by GITAM (Deemed to be University) admission regulations.

2. ELIGIBILITY CRITERIA

2.1. 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).

2.2. Admissions into B.Sc. Degree with Environmental Science, Biotechnology, Chemistry will be based on the marks obtained in intermediate or equivalent examination and the rule of reservation, wherever applicable.

3. CHOICE BASED CREDIT SYSTEM

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.

4. STRUCTURE OF THE PROGRAM

4.1 The Program Consists of

i) Foundation Courses (compulsory) which give general exposure to a Student in communication and subject related area.

ii) Core Courses (compulsory).

iii) Discipline centric electives which

a) are supportive to the discipline

b) give expanded scope of the subject

c) give their disciplinary exposure

d) nurture the student skills

iv) Open electives are of general nature either related or unrelated to the discipline.

v) Practical Proficiency Courses, Laboratory and Project work.

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

4.3 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 per week.
- One credit for two hours of Practical per week.
- Eight credits for project.

4.4 The curriculum of the Six semesters B.Sc. Degree with Environmental Science, Biotechnology, Chemistry program is designed to have a total of 131 credits for the award of B.Sc. Degree with Environmental Science, Biotechnology, Chemistry degree.

5 MEDIUM OF INSTRUCTION

The medium of instruction (including examinations and project reports) shall be in English.

6 REGISTRATION

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

7. ATTENDANCE REQUIREMENTS

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

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

8. EVALUATION

8.1 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).

8.2 A student has to secure an aggregate of 40% in the course in continuous and semester end examinations 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.

8.3 Practical/ Viva voce etc. course 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

<table>
<tr><th>S. No.</th><th>Component of assessment</th><th>Marks allotted</th><th>Type of Assessment</th><th>Scheme of Examination</th></tr>
<tr><td rowspan="3">1</td><td rowspan="2">Theory</td><td>40</td><td>Continuous evaluation</td><td>(i) Three mid semester examinations shall be conducted for 15 marks each. The performance in best two shall be taken into consideration.
(ii) 5 marks are allocated for quiz.
(iii) 5 marks are allocated for assignments.</td></tr>
<tr><td>60</td><td>Semester-end examination</td><td>The semester-end examination shall be for a maximum of 60 marks.</td></tr>
<tr><td>Total</td><td>100</td><td colspan="2"></td></tr>
<tr><td rowspan="2">2</td><td>Practicals</td><td>100</td><td>Continuous evaluation</td><td>60 marks for performance, regularity, record/ and case study. Weightage for each component shall be announced at the beginning of the semester.
40 marks (30 marks for experiment(s) and 10 marks for practical Viva-voce.) for the test conducted at the end of the Semester conducted by the concerned lab Teacher.</td></tr>
<tr><td>Total</td><td>100</td><td></td><td></td></tr>
</table>

3	Project work	200	Project evaluation	150 marks for evaluation of the project work dissertation submitted by the candidate. 50 marks are allocated for the project Viva-Voce. The project work evaluation and the Viva-Voce shall be conducted by one external examiner outside the University and the internal examiner appointed by the Head of the Department.

9. RETOTALING & REVALUATION

9.1 Retotaling of the theory answer script of the semester-end examination is permitted on request by the student by paying the prescribed fee within one week after the announcement of the results.

9.2 Revaluation of the theory answer scripts of the semester-end examination is permitted on request by the student by paying the prescribed fee within one week after the announcement of the result.

10. PROVISION FOR ANSWER BOOK VERIFICATION & CHALLENGE EVALUATION:

10.1 If a student is not satisfied with his/her grade after revaluation, the student can apply for, answer book verification on payment of prescribed fee for each course within one week after announcement of revaluation results.

10.2 After verification, if a student is not satisfied with revaluation marks/grade awarded, he/she can apply for challenge valuation within one week after announcement of answer book verification result/ two weeks after the announcement of revaluation results, which will be valued by the two examiners i.e., one Internal and one External examiner in the presence of the student on payment of prescribed fee. The challenge valuation fee will be returned, if the student is succeeded in the appeal with a change for a better grade.

11. SUPPLEMENTARY EXAMINATIONS & SPECIAL EXAMINATIONS:

11.1 The odd semester supplementary examinations will be conducted on daily basis after conducting regular even semester examinations in April/May.

11.2 The even semester supplementary examinations will be conducted on daily basis after conducting regular odd semester examinations during November/December

11.3 A student who has completed his/her period of study and still has “F” grade in final semester courses is eligible to appear for Special Examination normally held during summer vacation.

12. PROMOTION TO THE NEXT YEAR OF STUDY

12.1 A student shall be promoted to the next academic year only if he/she completes the academic requirements of 60% of the credits till the previous academic year.

12.2 Whenever there is a change in syllabus or curriculum he/she has to continue the course with new regulations after detention as per the equivalency established by the BoS to continue his/her further studies.

13. BETTERMENT OF GRADES

13.1 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 ‘n’ (where ‘n’ is no.of semesters of the program) theory courses of any semester of his/her choice, conducted in summer vacation along with the Special Examinations.

13.2 Betterment of Grades is permitted ‘only once’, immediately after completion of the program of study.

14. REPEAT CONTINUOUS EVALUATION:

14.1 A student who has secured ‘F’ grade in a theory course shall have to reappear at the subsequent examination held in that course. A student who has secured ‘F’ grade can improve continuous evaluation marks upto a maximum of 50% by attending special instruction classes held during summer.

14.2 A student who has secured ‘F’ grade in a practical course shall have to attend Special Instruction classes held during summer.

14.3 A student who has secured ‘F’ grade in a combined (theory and practical) course shall have to reappear for theory component at the subsequent examination held in that course. A student who has secured ‘F’ grade can improve continuous evaluation marks upto a maximum of 50% by attending special instruction classes held during summer.

14.4 The RCE will be conducted during summer vacation for both odd and even semester students. Student can register a maximum of 4 courses. Biometric attendance of these RCE classes has to be maintained. The maximum marks in RCE be limited to 50% of Continuous Evaluation marks. The RCE marks are considered for the examination held after RCE except for final semester students.

14.5 RCE for the students who completed course work can be conducted during the academic semester. The student can register a maximum of 4 courses at a time in slot of 4 weeks. Additional 4 courses can be registered in the next slot.

14.6 A student is allowed to Special Instruction Classes (RCE) 'only once' per course.

15. GRADING SYSTEM

15.1 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 sin Table 2.

Table 2: Grades & Grade Points

Sl.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	-

15.2 A student who earns a minimum of 4 grade points (P grade) in a course is declared to have successfully completed the course, subject to securing an average GPA (average of all GPAs in all the semesters) of 5 at the end of the Program to declare pass in the program.

Candidates who could not secure an average GPA of 5 at the end of the program shall be permitted to reappear for a course(s) of their choice to secure the same.

16. GRADE POINT AVERAGE

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

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

Where

C = number of credits for the course,

G = grade points obtained by the student in the course.

16.2 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.

16.3 CGPA required for classification of class after the successful completion of the program is shown in Table 3.

Table 3: CGPA required for award of Class

Class	CGPA Required
First Class with Distinction	≥ 8.0*
First Class	≥ 6.5
Second Class	≥ 5.5
Pass Class	≥ 5.0

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

17. ELIGIBILITY FOR AWARD OF THE B.Sc. DEGREE WITH ENVIRONMENTAL SCIENCE, BIOTECHNOLOGY, CHEMISTRY DEGREE

17.1 Duration of the program: A student is ordinarily expected to complete B.Sc. Degree with Environmental Science, Biotechnology, Chemistry program in six semesters of two years. However a student may complete the program in not more than four years including study period.

17.1 However the above regulation may be relaxed by the Vice Chancellor in individual cases for cogent and sufficient reasons.

17.2 A student shall be eligible for award of the B.Sc. Degree with Environmental Science, Biotechnology, Chemistry 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.

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

18. DISCRETIONARY POWER:

Not with standing anything contained in the above sections, the Vice Chancellor may review all exceptional cases, and give his decision, which will be final and binding.

Program Educational Objectives (PEOs)

B.Sc Environmental Science, Biotechnology, Chemistry graduates, within two – three years of graduation should:

1. Exhibit their proficiency for solving contemporary environmental issues through measurement, modelling, monitoring and management.
2. Engross in environmental science profession at local and global levels through ethical contribution in terms of professional and skilled practice of science and allied professions.
3. Acclimatize to the dynamically changing world through sustained learning and professional development.
4. Present skills of entrepreneurship and leadership through incorporating goals of the organization and through providing facilities for peer associates with defined objectives.
5. Acquire communication skills and exhibit commitment towards teamwork which is necessary for functioning productively and professionally on multidisciplinary teams.

Programme Outcomes

1. To gain understanding on relationships among natural and man-made systems.
2. Integrate principles of biology, physical, chemical and social sciences and apply them to resource conservation.
3. Understand ecological principles and management of resources, communities and ecosystems.
4. To gain understanding in chemistry and biotechnology.
5. Comprehend consequences of human actions atmospheric pollution and realize the importance of microorganisms in environment and pollution abatement.
6. Cognize concepts of chemistry and biotechnology.
7. Develop core concepts and methods from environmental science, biotechnology and chemistry their applications in solving environmental issues
8. Appreciate the pollution control techniques for air and water towards reducing their effects on natural environment. Apprehend the techniques of molecular biology and rDNA.
9. Appreciate the management of solid waste and grasp the concepts of soil pollution. Empathise the effects of human activities on global warming.
10. Understand and comprehend industrial biotechnology and green chemistry.

11. Develop expertise in quantifiable techniques, qualitative investigation, critical thinking, inscribed and verbal communication required to monitor, measure and report an environmental issue.
12. Ability to design, execute a scientific project, write scientific reports, develop research and communication skills

Program Specific Outcomes (PSOs)

- PSO1: Recognize, devise and resolve concerns related to environment towards providing competent solutions
- PSO2: Evaluate and devise techniques and methods of varying intricacies in the emergent areas of pollution abatement.
- PSO3: Provide a platform for involving in research with proficient and ethical responsibilities towards meeting societal needs.

B.Sc. Degree with Environmental Science, Biotechnology, ChemistryScheme of Instruction

I SEMESTER

Course Code	Subject	Category	Instruction Hours/week		Credits	Scheme of Instruction		
			L	P		CE	SE	Total Marks
GEL 131	Communicative English	AECC	3	-	2	40	60	100
SES 101	Understanding Environment	CC	4	-	4	40	60	100
SES 121	Understanding Environment Lab	PPC	-	3	2	100	--	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

II SEMESTER

Course Code	Subject	Category	Instruction Hours/week		Credits	Scheme of Instruction		
			L	P		CE	SE	Total Marks
SES 102	Elements of Ecology	CC	4	-	4	40	60	100
SES 122	Elements of Ecology Lab	PPC	-	3	2	100	--	100
SES 104	Environmental Pollution	CC	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

III SEMESTER

Course Code	Subject	Category	Instruction Hours/week		Credits	Scheme of Instruction		
			L	P		CE	SE	Total Marks
SES 201	Earth Science System and its Resources	CC	4	-	4	40	60	100
SES 221	Earth Science System and its Resources Lab	PPC	-	3	2	100	--	100
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
Choose any one								
SSE 267	Environmental Sanitation	SEC	2	-	2	100	--	100
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
SES 202	Air and Water Pollution Control	CC	4	-	4	40	60	100
SES 222	Air and Water Pollution Control Lab	PPC	-	3	2	100	--	100
SBT 212	Molecular Biology and rDNA technology	CC	4	-	4	40	60	100
SBT 228	Molecular Biology and rDNA technologyLab	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
Choose any one								
SSE 260	Analytical Techniques in Environmental Science	SEC	2	-	2	100	--	100
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								
SES 301	Solid Waste Management	DSE	4	-	4	40	60	100
SES 303	Environmental Impact Assessment	DSE	4	-	4	40	60	100
Choose any one (*corresponding to theory course)								
SES 321	Solid Waste Management Lab	PPC	-	3	2	100	--	100
SES 323	Environmental Impact Assessment Lab	PPC	-	3	2	100	--	100
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								
SSE 361	Disaster Management	SEC	2	-	2	100	--	100
SSE 363	Environmental Management	SEC	2	-	2	100	--	100
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								
SES 302	Global Warming and Climate change	DSE	4	-	4	40	60	100
SES 304	Remote Sensing and GIS	DSE	4	-	4	40	60	100
Choose any one (*corresponding to theory course)								
SES 322	Global Warming and Climate change	PPC	-	3	2	100	--	100
SES 324	Remote Sensing and GIS	PPC	-	3	2	100	--	100
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
SES 392	Minor Project	PPC	-	-	4	200	--	200

L = Lecture hours

P = Practical

CE = Continuous Evaluation

SE = Semester End Evaluation

Total Credits – 122

SEMESTER – I

GEL131: COMMUNICATIVE ENGLISH

L T P C
2 0 2 3

Preamble

The course is a unified approach to enhance language skills of learners with an aim to hone their social skills and to increase their employability. The course is designed to acquaint the learners with the necessary LSRW (Listening/ Speaking / Reading/ Writing) skills needed either for recruitment or further studies abroad for which they attempt international exams like TOEFL, IELTS and GRE. It enables the learners improve their communication skills which are crucial in an academic environment as well as professional and personal lives.

Course Objectives

- To enable learners to develop listening skills for better comprehension of academic presentations, lectures and speeches.
- To hone the speaking skills of learners by engaging them in various activities such as just a minute (JAM), group discussions, oral presentations, and role plays.
- To expose learners to key Reading techniques such as Skimming and Scanning for comprehension of different texts.
- To acquaint the learners with effective strategies of paragraph and essay writing, and formal correspondence such as email, letters and resume.
- To provide learners with the critical impetus necessary to forge a path in an academic environment, in the professional life and in an increasingly complex, interdependent world.

UNIT I

LISTENING: Listening for gist and specific information

SPEAKING: Introducing self and others; Developing fluency through JAM
READING: Skimming for gist and Scanning for specific information

WRITING: Paragraph writing-writing coherent and cohesive paragraph (narrative and descriptive); use of appropriate Punctuation.

GRAMMAR & VOCABULARY: Articles & Prepositions;

Word Families (Verbs, Nouns, Adjectives, Adverbs; Prefixes and Suffixes)

Learning Outcomes:

After completion of this unit, the learners will be able to

- Apply the requisite listening skills and comprehend at local and global level. (L4 and L2) (L5)
- Introduce themselves with accurate structure in diverse social and professional contexts. (L3)
- Apply relevant reading strategies for comprehension of any given text(L3)
- Write a paragraph using cohesive devices maintaining coherence (L3)
- Understand the Use of Articles and Prepositions, and apply appropriately for meaningful communication (L3)

Understand the relevance of various categories in word family and apply them meaningfully in context (L3)

UNIT II

LISTENING: Listening for Note taking and Summarizing
SPEAKING: Role plays and Oral Presentations.
READING: Intensive Reading-Reading for implicit meaning
WRITING: Note making and summarizing
GRAMMAR & VOCABULARY: Verb forms-Tenses; synonyms to avoid repetition in speech and writing.

Learning Outcomes:

After completion of this unit, the learners will be able to

- Employ note taking and summarizing strategies to comprehend the listening text (L2)
- Use strategies for successful and relevant oral presentation (L3, L4)
- Demonstrate effective communication skills by applying turn-taking and role distribution

techniques for meaningful and contextual Speaking (L3 and L4)

- Apply various reading strategies imbibing inferential and extrapolative comprehension of any given text. (L2, L3)
- Apply various note-making techniques while comprehending the reading text to present a complete and concise set of structured notes (, L3, L4, L5)
- Apply the notes to draft a summary (L3)
- Use correct tense forms and appropriate structures in speech and written communication (L3)
- Context specific use of Prefixes and Suffixes for meaningful communication (L3)

UNIT III

LISTENING: Listening for presentation strategies: introducing the topic, organization of ideas, conclusion.

SPEAKING: Aided presentations
READING: Inferring using textual clues
WRITING: Formal Letter and Email writing
GRAMMAR & VOCABULARY: Active and Passive Voice; linkers and discourse markers.

Learning Outcomes:

After completion of this unit, the learners will be able to

- Notice and understand effective listening strategies to identify discourse markers in presentations. (L1, L2)
- Make formal oral presentations using effective strategies such as audio – visual aids (L3)
- Infer meaning and inter – relatedness of ideas (L4)
- Understand relevant structures and draft formal letters in suitable format (L3, L4)
- Construct relevant sentences in active and passive voice for meaningful communication (L2, L3)
- Comprehend and apply available vocabulary items relevant to the context (L1, L2, L3)

UNIT IV

LISTENING: Listening for labeling-maps, graphs, tables, illustrations
SPEAKING: Aided group presentation using charts, graphs etc.

READING: Reading for identification of facts and opinions

WRITING: Information transfer (writing a brief report based on information from graph/chart/table)

GRAMMAR & VOCABULARY: Subject-verb agreement; language for comparison and contrast; Antonyms

Learning Outcomes:

After completion of this unit, the learners will be able to

- Match visual and auditory inputs and use the information comprehensively and will adequately demonstrate important relationships or patterns between data points (L2)
- choose and coordinate resources appropriate to context and speak intelligibly (L3, L4)
- Develop advanced reading skills for analytical and extrapolative comprehension (L4, L5)
- Make decisions on arrangement of ideas and transfer them from visual to verbal form using context appropriate structure. (L3, L4)
- Demonstrate ability to use task specific grammatically correct structures (L3)
  Comprehend and use expressions for negation/contradiction ((L2, L3)

UNIT V

LISTENING: Listening to discussions for opinions
SPEAKING: Group Discussion
READING: Reading for inferences

WRITING**:** Guided Essay Writing (argumentative)

GRAMMAR & VOCABULARY: Editing short texts: correcting common errors in grammar and usage; Action verbs for fluency and effective writing.

Learning Outcomes:

After completion of this unit, the learners will be able to

- Apply analytical and problem-solving strategies to identify and interpret facts and opinions from a dialogue. (L3)

- Able to administer group dynamics to contribute valid ideas to a discussion with clarity and precision (L3)
- Demonstrate techniques to analyze contextual clues(L4)
- Compare and correlate ideas and facts to produce an organized essay with adequate supporting evidences (L4, L5)
- Organize the available structural/grammatical knowledge and apply them in a real time context (L3)
- Comprehend meaning for new words/phrases used and apply them in a new context. (L2, L3)

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 analyze different academic texts.
- Make notes effectively and handle academic writing tasks such as Paragraph writing and Essay writing.
- Effectively handle formal correspondence like e-mail drafting and letter writing.

Reference Books:

1. Arosteguy, K.O. and Bright, A. and Rinard, B.J. and Poe, M. ***A Student's Guide to Academic and Professional Writing in Education***, UK, Teachers College Press,2019
2. Raymond Murphy, ***English Grammar in Use A Self-Study Reference and Practice Book for Intermediate Learners of English*** : Cambridge University Press;2019
3. Peter Watkins, ***Teaching and Developing Reading Skills***: UK, CUP, 2018
4. Deeptha Achar et al. ***Basic of Academic Writing***. (1and 2) parts New Delhi: Orient BlackSwan. (2012& 2013).
5. Kumar S and Lata P, ***Communication Skills***: New Delhi Oxford University Press, 2015

I SEMESTER

SES 101: UNDERSTANDING ENVIRONMENT

Hours per week: 04 **Credits: 04**

Preamble:

Understanding Environment mainly focuses on the fundamentals concept. It provides basic knowledge of environment and its components including environmental ethics and current problems. This course also helps in understanding the current environmental problems.

Course Objectives

- To enable the student in understanding environment and its measurements including introduction and scope of Environmental Science and technology and its applications
- It helps in attaining the knowledge on Environmental Ethics, Philosophy of environment for better lifestyle
- The students will acquire basic knowledge on Global and National Environmental Issues and their mitigation measure.

UNIT – I

Introduction to Environmental Science: Definition, principles background and scope of environmental science, Understanding of environment and measurements.

Environmental Science and technology, Media and people, decision making and applications of Environmental Science.

- The student gains theoretical knowledge on environment and its measurements.

UNIT – II

Environmental Ethics: Nature and origin of environmental ethics, ecological consciousness, western and eastern views, philosophy of environment. Environment, community and equity, integrating ethical values and knowledge, self-centered development and Environment.

- The student buildup confidence on Environmental Ethics, Philosophy of environment for better lifestyle

UNIT – III

Environmental Education: Environmental awareness - role of youth, communities, NGO's and professional.

Environmental education at primary and secondary levels, Environmental education for mass - rural and urban communities.

- The students get fascinated towards environmental awareness programs

UNIT – IV

Global and National Environmental Issues: Climate change, ozone depletion, greenhouse effect, Acid rain, sea level rise, Deforestation, Biodiversity loss, desertification, disasters.

- The student understands the Global, National Environmental Issues and can focus on mitigation measure.

UNIT – V

Human impact on environment and its consequences: Hunting and gathering, agriculture societies, industrial societies, impact of cultural change on environment.

Population explosion, degradation of natural resources, urbanization, industrialization, food security, public health, energy crises.

- The ability of the students to understand the environment enhances and makes them think about sustainable development

Reference Books:

(i) Chapman J.L. & Reiss M.J. Ecology: Principles and Applications' Cambridge University Press, U.K, 2nd Edition.

(ii) Cunningham W.P. & Saigo S.W. Environmental Science: A Global Concern' WCB, McGraw Hill, 1st Edition.

(iii) Environmental Science, S.C. Santra, New Central Book Agency (P) LTD, 3rd Edition.

(iv) Environment Problems & Solutions by D.K.Asthana and Meera Asthana; S.Chand & Company Ltd.

(v) Introduction to Environmental Science by Y.Anjaneyulu. BS Publications. 3rd Edition reprint

Course Outcomes

After reading this paper the student –

- Gains theoretical knowledge on environment and its measurements.
- Improves knowledge on Environmental Ethics, Philosophy of environment for better lifestyle

- Clear visualization on the Global, National Environmental Issues including mitigation measure.

I SEMESTER

SES 121: UNDERSTANDING ENVIRONMENT LAB

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

The student shall takeup atleast 10 assignments in form of hand written records based on the current environmental issues and challenges as per the topics in theory paper, the required information is to be collected from print or electronic media of both national and international standards. Continuous evalution each report carries 10 marks.

Lab Course Outcome:

After completing this lab the student –

- Will get comfortable and gain good exposure to the print or electronic media
- Improves knowledge on latest Environmental Issues
- Develops writing skills

SEMESTER – I

SBT 111: MOLECULES OF LIFE

Hours per week: 04 **Credits: 04**

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. Disulphidebridges.

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)

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.

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).

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.

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 **Credits: 02**

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. Estimation of glycine by Sorenson formal titration
4. Determination of isoelectric point of glycine
5. Estimation of proteins by Lowry method
6. Estimation of reducing sugar by DNS method
7. Estimation of cholesterol by Zak's method
8. Separation of amino acids by paper chromatography
9. Ultra violet absorption spectra of proteins / nucleic acids
10. Separation of proteins by SDS-PAGE

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 **Credits: 04**

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 SPHrodinger equation and meaning of various terms in it.Significance of ψ and ψ^2, SPHrödinger 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.

UNIT-II

Chemical Bonding and Molecular Structure

Ionic Bonding: General characteristics of ionic bonding. Energy considerations in ionic bonding, 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^+.

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.

UNIT-IV

Stereochemistry

Conformations with respect to ethane, butane and cyclohexane.Interconversion of Wedge Formula, Newmann, Sawhorse and FiSPHer 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.

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.

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 **Credits: 02**

Section A: Inorganic Chemistry - Volumetric Analysis

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.

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.

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.

Course outcomes: By the end of the course the student will be able to 22
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.

II SEMESTER

SES 102: ELEMENTS OF ECOLOGY

Hours per week: 4 **Credits: 4**

Preamble:

This paper proved the basic information on ecology, history, important terminology and concepts of ecology. It mainly focuses on various factors like climatic, light, temperature etc. This paper gives a clear picture of Ecosystem, Ecological succession, population ecology and other important aspects of ecology.

Course Objectives

- To enable the student to better understanding Ecology including various types of ecosystems.
- To create awareness about the species diversity including flora and fauna of India.
- It helps in attaining the knowledge on Population ecology including the population Characteristics and interactions between the species

UNIT – I

Introduction – Scope of Ecology; Its relation to other Sciences; Historical background; Ecology in India. Important terminology of Ecology; Basic concepts of Ecology: its main subdivisions and developmental facets.

Climatic factors; Environmental complex; Interaction of Ecological factors - Light factor, Temperature factor; Precipitation (rainfall); Humidity of air; Atmosphere-gases; wind factor: fire factor, Topographic factors: Height of mountain chains; Direction of mountains and valleys; steepness of slope; Exposure of slope.

- The student gains theoretical knowledge on Ecology and environment including the environment and its components.

UNIT – II

Ecosystem Introduction, types of Ecosystems; structure and function of an ecosystem; Major ecosystems: Pond ecosystem; Ocean (marine) ecosystem, Grassland Ecosystem, Forest Ecosystems, Desert Ecosystem and Cropland Ecosystem.

Functional aspects of an ecosystem; Food web, Food chains; Ecological Pyramids. Ecological energetics.

(Brief).

- The knowledge of the students enhances on the various types of ecosystems and their functional aspects.

UNIT – III

Population Ecology: Basic Concept of population Ecology; Describing a population, Population Characteristics – Population Size and Density, Dispersion, Age structure, Natality, Mortality and Life tables.

Relationships among organisms; positive interactions and Negative interactions (Brief).

- The student becomes familiar with various concepts of population ecology and their relationships

UNIT – IV

Ecological Succession: Definition and causes of succession. Trends of Succession; Basic types of succession; general process of succession; Hydrosere or hydrarch; Lithosere – a xerosere on rock; Heterotrophic (microbial) succession; Ecosystem development.

- The student can clearly visualize the process of ecological succession and development.UNIT –

V

Phyto-geographical regions of India. Common flora and fauna of India. Rare and threatened plants; role of Botanical Survey of India in exploration of plant wealth. Major categories of animals, rare and threatened species of India. Role of Zoological Survey of India/Zoo Authority of India in exploration and conservation of faunal wealth.

- The student can visualize the Phytogeographical regions of India including Common flora and fauna.

Reference Books:

1. Fundamentals of Ecology – E.P. Odum and Garry W. Barrett, Thomson-Brooks - cole – distributed by East-West press private limited, New Delhi.4th Edition.
2. Environmental Science S. C. Santra, New Central Book Agency (P) Ltd.3rd Edition.
3. Ecology & Environment – P.D. Sharma 10th edition – Rastogi Publications; Meerut, 10th Edition.
4. Text Book plant Ecology – R.S. Ambasht & N. K. Ambasht, 13th edition, CBS Publishers and distributors.

Course Outcomes

After reading this paper the student –

- Adds theoretical knowledge on Ecology and environment including the environment and its components.
- Knowledge enhances on climatic factors, ecosystems and ecological succession.
- Obvious visualization of Phytogeographical regions of India including Common flora and fauna.

II SEMESTER

SES 122: ELEMENTS OF ECOLOGY LAB

Hours per week: 3 **Credits: 2**

1. Estimation of the following parameters in soil and water
   a. pH
   b. Conductivity
2. Determining moisture content of soil
3. Study of pond Ecosystem
4. Determination Dissolved Oxygen
5. Determination minimum size of quadrate by species – area curve method
6. Determination the minimum number of quadrates to be laid down in the fields
7. Study the community by Quadrate Method by determining frequency, density and abundance of different species present in the community
8. Line – Transect Method
9. Determination of leaf area by Kemp‘s constant
10. Estimation of chlorophyll in algae and leaves of higher plants

Course Outcome

The students will gain hands on experience and be familiar with vegetation analysis, chlorophyll estimation in algae and leaves of higher plants including basic soil and water analysis

SEMESTER – II

SES 104: ENVIRONMENTAL POLLUTION

Hours per week: 4 **Credits: 4**

Preamble:

This course examines impacts of air, water, soil, noise pollution among others. Sources of pollutants are examined along with their control methods.

Course Objectives

- To identify sources of air, water and land pollution associated with major industries, understand the impacts to the environment.
- To devise strategies for control and prevention of pollution.

UNIT – I

Introduction to Environmental Pollution: Definitions of pollution and pollutant; Types ofPollutants and their classification.

Air Pollution: Types and sources of air pollutants; Effects of air pollutants on human beings,plants, animals and materials, Control of air pollution

Learning Outcomes:

Upon completion of this unit, the student should be able to:

- Understand impacts of air pollution on human health and environment.
- Gain knowledge on control of air pollution.

UNIT – II

Water Pollution:

Point and Non-point Source of Pollution, Major Pollutants of Water, Water borne diseases, Water Quality standards.

Effects of water pollution - Eutrophication, Control of water pollution.

Learning Outcomes:

Upon completion of this unit, the student should be able to:

- Comprehendsources and impacts of water pollution, its effect on environment and human health.
- Achieve awareness on control of air pollution.

UNIT – III

Soil Pollution: Sources, effects and control of soil pollution.

Pollution and residual toxicity from the application of pesticides and fertilizers.

Learning Outcomes:

Upon completion of this unit, the student should be able to:

- Comprehendsources and impacts of soil pollution, its effect on environment and soil.
- Illustrate effects of pesticides and fertilizers on soil.

UNIT – IV

Noise Pollution: Noise pollution–source, measurement, effects and control;

Thermal pollution: Definition and sources, Chemical and biological effects of thermalpollution, Effect on marine life, bacteria and water quality and other aquatic biota; Thermal pollution from power plants and their control.

Learning Outcomes:

Upon completion of this unit, the student should be able to:

- Comprehendsources and impacts of noise pollution, its effect on human health.
- Realizesources and impacts of thermal pollution, its effect on water quality.

UNIT – V

Electronic waste (E-waste): Sources and types, constituents of E-wastes, recycling of e-waste and its environmental consequences, Management of e-wastes, Basel convention.

Radiation Pollution: Biologicalimpact and health hazards associated with radiation, Protection against ionizing isotopes; Radioactive waste disposal.

Learning Outcomes:

Upon completion of this unit, the student should be able to:

- Recognize sources and impacts of e-waste and its effect on human health.
- Apprehend radiation pollution and its biological hazards.

Reference Books:

1. Environmental Science by S. C. Santra, New Central Book Agency (P) Ltd. 3rd Edition.
2. Introduction to Environmental Science by Y.Anjaneyulu; B.S. Publications
3. Environmental Pollution B.K. Sharma S.H. Kaur Goel Publishing House.

Course Outcomes:

Upon completion of this Course, the student should be able to:

- Develop skill on identifying sources and effects of environmental pollution.
- Synthesize means and methods for control of environmental pollution

SEMESTER – II

SBT 112: CELL BIOLOGY AND GENETICS

Hours per week: 04 **Credits: 04**

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.

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.

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.

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.

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.

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 **Credits: 02**

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.

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

3.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 **Credits: 04**

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*

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

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 and sulphonation. 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's ether synthesis: Elimination vs substitution.

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: KNH_2/NH_3 (or $NaNH_2/NH_3$).

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.

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–HoeSPH Condensation, SPHotten – 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. Aldol Condensation, Cannizzaro's reaction, Wittig reaction, Benzoin condensation. Clemensen reduction and Wolff Kishner reduction. Meerwein-Pondorff Verley reduction.

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 **Credits: 02**

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.

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).

III **SEMESTER**

SES 201: EARTH SCIENCE – SYSTEMS AND ITS RESOURCES

Hours per week: 4 **Credits: 4**

Preamble:

Description of Rocks & Minerals is an inclusive course covers integrated approach of Geological studies and earth sciences. The course begins with the structure and composition of earth, waste lands and its management, management and conservation of natural resources- Land water, minerals & Energy. Mineral resources, Water Resources, Energy Resources

Course Outline:

Application of rocks and minerals is an important aspect in teaching Geology. Lectures and assignments were design to provide basic knowledge in geology and its principles. The objective of the course is to make students to understand basics of rocks and minerals and management concepts of conservation of resources. The use of Geological concepts in management of natural resources to make students to understand integrated nature of Geological sciences.

UNIT- I

Resources: Types of Resources, Renewable & Non Renewable Resources.

Mineral Resources: Silicate Minerals and Non Silicate Minerals, Description of Minerals like Pyroxenes, Amphiboles, Feldspar.

Learning outcome:

By the end of the unit a student will gain knowledge on the types of renewable and non-renewable resources and mineral resources.

UNIT- II

Land Topography and Resources: Types of Rocks, Igneous, Sedimentary and Metamorphic Rocks. Description, Land Hazards Like Earthquakes and Volcanoes.

Land Degradation: Land Degradation, land use pattern, Wasteland types and their management.

Learning outcome:

By the end of the unit a student will be able to understand the type of rocks, land degradation, land use pattern and wasteland management.

UNIT -III

Water Resources: Types of Water sources, Ground Water, Surface Water etc, Water Conservation, Watershed Management, Cloud seeding for artificial rains.

Learning outcome:

By the end of the unit a student will be able to understand the type of water resources and their conservation practices.

UNIT -IV

Energy Resources: Fossil fuels. Nuclear energy, Hydel power, Geothermal and Tidal Energy, Wind Energy and Solar Energy.

Economic Minerals like Gold, Copper, Aluminum, Iron, Manganese, Chromium, Coal, Petroleum, Lead and Zinc.

Learning outcome:

By the end of the unit a student will be able to understand the types of energy resources and economic minerals.

UNIT- V

Structure of Atmosphere, Green House Effect, Ozone depletion, Climate change and its consequences.

Learning outcome:

By the end of the unit a student will be able to understand the structure of atmosphere, greenhouse effect, ozone depletion and its consequences.

Reference Text Books:

1. Rutlys Elements of Mineralogy By HH Read, Blackie and Son Publishers Pvt. Limited
2. A text book of Geology by PK Mukerjee, Madison Wisconsin Publishers.
3. An Introduction to the rock forming minerals by WA Deen, RA Howie & J Zusman Longman Group Limited, Long Man House.
4. Energy Resources G. D. Rai
5. Environmental Problems & Its solutions D.K. Asthana & Meera Asthana S. Chand &Co.

Course Outcomes:

Student will get knowledge on

- Renewable and non-renewable resources, types of rocks, land degradation and waste land management.
- Types of water resources and its conservation practices, types of energy resource.
- Structure of atmosphere, greenhouse effect, ozone depletion and its consequences

III SEMESTER

SES 221: EARTH SCIENCE – SYSTEMS AND ITS RESOURCES LAB

Hours per week: 3 **Credits: 2**

1. Identification of Rocks (Mega scopic)

- Igneous Rocks

Intrusive (Plutonic)	Extrusive (volcanic)
Granite	Rhyolite
Gabbro	Basalt
Diorite	Andesite
Peridotite	Komatiite

- Sedimentary Rocks
- Sand Stone, Lime Stone, Conglomerate, Coal, Brescia, Arkose.
- Metamorphic Rocks
- Marble, SPHist, Quartzite, Gneiss, Amphibolite.

2. Identification of Minerals (Mega Scopic)

- Pyroxenes, Amphiboles, Feldspars

3. Identification of Economic Minerals (Mega Scopic)

- Bauxite, Manganese, Chromium, Iron

4. Estimation of Heavy Metals content in Ores.

Learning Outcomes:

After completion of the practical sessions, students will be able to:

- Identification of rocks and minerals and economic minerals.
- Estimation of different heavy metals in ores.

SEMESTER – III

SBT 211: ENZYMOLOGY AND METABOLISM

Hours per week: 04 **Credits: 04**

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.

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.

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.

UNIT-IV

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

UNIT-V

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

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 **Credits: 02**

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 bovine pancreatic trypsin
3. Assay of potato acid-phosphatase
4. Assay of bovine pancreatic RNase
5. Assay of bovine pancreatic DNase
6. Effect of pH on enzyme activity
7. Effect of temperature on enzyme activity
8. Effect of incubation time on enzyme activity
9. Effect of substrate concentration on enzyme activity
10. Determination of Km and Vmax

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 – 3rdEdition (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 **Credits: 04**

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).

UNIT-II

Conductance

Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. KohlrauSPH 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.

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 their interconversion.

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 Bromamide reaction.

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

Diazonium salts: *Preparation:* from aromatic amines

Reactions: conversion to benzene, phenol, dyes.

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.

UNIT-V

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

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 *7thEd.*, 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 **Credits: 02**

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:

$I_2(aq) + I^-(aq)\ I_3^-(aq)$

$Cu^{2+}(aq) + x NH_2(aq)\ \ [Cu(NH_3)x]^{2+}$

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 possessingmonofunctional 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.Titration curve of glycine
3. Action of salivary amylase on starch
4. Effect of temperature on the action of salivary amylase on starch.
5. 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.

III SEMESTER

SSE267: ENVIRONMENTAL SANITATION

Hours per week: 4 **Credits: 4**

Preamble:

The importance of environmental conditions and personal sanitation in an individual's health cannot be debated. This course is designed in order to provide student with the knowledge of sanitation at various levels in a community and the measures to be taken up to have good sanitation practices.

Course Outline:

The course objective is to make the student understand

- Importance of health and role of environmental sanitation.
- Types of diseases, water borne diseases and low cost sanitation methods.
- Importance of indoor sanitation and institutional sanitation.

Environmental Sanitation: History of sanitation. Definition, Concept and importance of Environmental Sanitation. Rural and urban sanitation. Rural sanitation in India. Urban sanitation in India.

Water sanitation: Water-borne diseases (intestinal diseases).Protection of water storage in reservoirs, wells and overhead tanks.

Low Cost Sanitation: Existing scenario of waste disposal systems. Health and socio-economic criteria for low cost sanitary Privies. Night soil and excreta disposal. Insect vector and rodent control: Mosquitoes, rodent and house fly: habits, life cycle, diseases and their control measures.

Indoor sanitation: Principles of indoor sanitation. Ventilation: type of ventilation and standards for ventilation. Lighting and illumination: Requirement of good lighting, measurement of light, sources of lighting, types of illumination, standards for illumination. Air disinfection, Noise control in indoor environments.

Institutional Sanitation: Sanitation in SPHools. Sanitation of hospitals and nursing homes. Sanitation in restaurants and fairs. Sanitation at public bathing places and swimming pool sanitation.

Reference Books:

1. Environmental Sanitation (Social and Preventive Medicine) I edition by K.V.S.G. Murali Krishna and P.V. Rama Raju, Environmental Protection Society, Kakinada
2. Municipal and Rural Sanitation Sixth Edition by Victor M. Ehler and Ernest W. Steel. Tata Mc Graw-Hill Publishing Company.
3. Environmental Sanitation by Baljeet S. Kapoor, S. Chand & Company Limited, 1st Edition
4. Text Book of Environmental Engineering by P. Venugopala Rao, PHI Learning Private Ltd., 7th Edition.

Course Outcomes:

Upon completion of the course the student will

- Gain knowledge on the types of diseases, importance of sanitation.
- Be able to know the importance of water sanitation and low cost sanitation methods.
  Be able to know about the importance of indoor sanitation and institutional sanitation.

SEMESTER –III

SSE 287: FUNDAMENTALS OF COMPUTERS

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

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 PopularOperating Systems

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

TEXT BOOK

Computer Fundamentals - PradeepK.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 **Credits: 02**

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.

IV SEMESTER

SES 202: AIR AND WATER POLLUTION CONTROL

Hours per week: 04 **Credits: 04**

Preamble: The main objective of this course is to make student understand the problems, effects and the scenarioof air and water pollution in the present world, air pollutants and available control technologies for air pollution. **Course Objective:** This paper explains the different types of air and water pollutants, sources, effects,classification of pollutants and control technologies for air pollution.

UNIT - I

Introduction – Definition, Sources, classification of air pollutants, Natural contaminants, Gases, Primary and secondary air pollutants. Stationary and mobile sources. Meteorology: Meteorology and air pollution, Effects of air pollution on human health, plants, animals, and properties. Major air pollution disasters: Meuse valley (Belgium), Donora (USA), London, Bhopal gas tragedy.

Learning Outcomes: Upon completion of the unit the student will be able to: Know different types of air pollutants,its sources and factors affecting air pollution

UNIT - II

Sampling procedures: instruments for sampling waste gases and for atmospheric sampling, duration and sampling sites, sampling methods, high volume sampler and respirable dust sampler. Air quality and emission standards, airpollution legislations and regulations.

Learning Outcomes: Upon completion of the unit the student will be able to: Understand the procedures of air sampling, equipment used for sampling and air pollution control equipment.

UNIT-III

Hydrological cycle. Sources of Water – Surface sources & Ground Water Sources - Quantity of Water – Typesof demands - Fluctuation in demand of water – Factors affecting the water demand. Quality of Water: Water analysis – Physical tests- Chemical tests- Biological tests- Standards of water quality.

UNIT – IV

Water Treatment: Intakes - Classification of intakes. Objectives of treatment of water – Plain sedimentation – types of sedimentation tanks - Sedimentation with coagulation. Filtration – Classification of filters- Slow SandFilter- Rapid Sand Filter

Disinfection of water - Methods of disinfection – Chlorination. Sewage- Physical, Chemical & biologicalcharacteristics, criteria for selection of site for sewage treatment plant.

UNIT-V

Sewage Treatment - Objectives of treatment- Flow diagram of conventional treatment plant.

Preliminary Treatment- Screenings, Grit chamber, Skimming tanks - Only description (design not required).Primary Treatment- Primary sedimentation – Description & working (Design not required). Secondary Treatment – Trickling filters, Activated Sludge process (Only description, design not required). SludgeTreatment & disposal-Sludge digestion, Sludge drying, Sludge Disposal.

Reference Text Books:

1. Environmental Engineering by M. Ramachandraiah, Radiant Publishing House, Hyderabad.
2. Water Supply & Sanitary Engineering by G. S. Birdie & J. S. Birdie, Dhanapat Rai Publishing Company.
3. Environmental Engineering by P. Venugopal Rao, Publications.

IV SEMESTER

SES 222: AIR AND WATER POLLUTION CONTROL LAB

Hours per week: 3 **Credits: 2**

1. Introduction to Ambient air quality standards.
2. Meteorology parameters – Wind direction and speed, temperature, precipitation, Humidity, solar radiation
3. Demonstration of High volume sampler
4. Demonstration of Respirable dust sampler
5. Dust fall jar experiment
6. Estimation of Particulate matter in ambient air by using respirable dust Sampler.
7. Estimation of Temperature, pH, Conductivity and Turbidity of provided water sample
8. Estimation of Alkalinity of provided water sample.
9. Determination of Residual chlorine from provided water sample.
10. Estimation of hardness from water sample by E. D. T. A. method.
11. Determination of Solids in the given water sample.
12. Estimation of chlorides from water sample by Argentometric method.
13. Estimation of Dissolved oxygen from water by Winkler‘s method.
14. Determination of Biological Oxygen Demand of the given wastewater.
15. Determination of Chemical Oxygen Demand of the given wastewater.
16. Determination of Nitrate concentration of the given wastewater.

SEMESTER – IV

SBT 212: MOLECULAR BIOLOGY AND rDNA TECHNOLOGY

Hours per week: 04 **Credits: 04**

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

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.

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

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.

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, DNAsequencing by chemical, enzymatic and Next Generation Sequencing (NGS) methods, DNA fingerprinting.

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 **Credits: 02**

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 **Credits:04**

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).

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.

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).

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.

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.

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 **Credits: 02**

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

SSE 260: ANALYTICAL TECHNIQUES IN ENVIRONMENTAL SCIENCE

Hours per week: 2 **Credits: 2**

Preamble:

Analytical techniques play an important role in the field of environmental science, it helps in continuous monitoring of various environmental components like air, water, soil and marine for pollution. It focuses on the sources, effects of pollution, common pollutants and its transportation including general approach for analysis

Course Objectives:

- To enable the student to gain theoretical knowledge on Pollution of various environmental components, Sources and effects of pollution, Common Pollutants.
- The students will have a theatrical exposure to the analytical techniques for the estimation of physico-chemical parameters.
- To makes the student to well understands the basic instrumentation used in the field of environment.

Necessity for chemical analysis, General approach for to analysis.Air Analysis – introduction, Composition of atmosphere, Structure of atmosphere, Sources of air pollution, Classification of pollutants, causes and effects of Pollution, Ambient air quality standards (WHO), sampling methods, High volume sampler, PM10 samplers.

Water Analysis – introduction, sampling, major constituents, Drinking water standards (WHO, BIS), water quality measurement – Total solids, organic carbon, pH, EC, Water hardness, dissolved oxygen. Introduction to instrumental techniques for common ions: UV-Visible spectrophotometer, Flame photometer, Ion Chromatography.
Trace pollutants: Gas liquid chromatography, Trace metals: ICP-MS.

Soil Analysis – introduction, sampling, Soil environment - soil profile. Physico-chemical quality of soil, Organic matter decomposition in soils. Soil analysis – pH, EC, Organic carbon, moisture content, water holding capacity, porosity of soil, micro and macro nutrients in soil.

Reference Books:

1. Introduction to Environmental Analysis, Roger Reeve, John Wiley & Sons Ltd.
2. Thurman, Harold, Introduction to Oceanography, Prentice Hall Inc. New Jersey.
3. Alexander, M., 2^{nd} Edn, Introduction to Soil Microbiology.
4. Environmental Pollution & Control, N.H. Gopal Dutt, Neelkamal Publisher; First edition
5. Environmental Pollution by RK Khitoliya - S. Chand Publishing.

Course Outcomes

After reading the subject the student learning outcomes makes them

- Familiar about pollution of various environmental components,
- Expert in understanding the physical, chemical and biological pollutants.
- Acquired theoretical skills on instrumental techniques.

SEMESTER –IV

SSE 274: CHEMICAL TECHNOLOGY & SOCIETY

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

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.

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 **Credits: 02**

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 (8^{th} edition, 2018)Practical Biochemistry by Keith Wilson and Walker. 5^{th} 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 (10^{th} edition). 2014. Peter Atkins and Julio de Paula, Oxford University Press;.

SEMESTER - V

SES 301: SOLID WASTE MANAGEMENT AND SOIL POLLUTION

Hours per week: 4 **Credits: 4**

Preamble:

The main objective of solid waste management is to make student understand the need of solid waste management, types of solid wastes (urban and industrial), hazardous waste management, sources and types of soil pollution.

Course objectives:

This paper explains about types of solid wastes (urban and industrial), segregation of materials, hazardous waste management and soil pollution.

UNIT-I

Municipal solid waste Definition - Sources and types of solid waste, composition and characteristics (physical, chemical and biological). Collection and transportation of Municipal Solid Waste.

Learning Outcome:

- Upon completion of the unit a student will be able to understand the types and composition of solid wastes and factors influencing the generation of municipal solid waste.

UNIT – II

Disposal of Solid Wastes: Disposal methods of MSW – Land filling, composting, incineration. Recycling and uses of paper, plastics, glass, and garbage.

Hazardous waste Management: Sources and classification of hazardous wastes – Storage and collection of hazardous wastes – General treatment and disposal techniques: Physical, chemical and biological.

Learning Outcome:

- Upon completion of the unit a student will be able to understand the methods disposal of solid wastes and recycling of MSW.

UNIT –III

Biomedical wastes – Types – Management and handling and control. Radioactive wastes- sources and types - control and management.

Soil Pollution – Physical, Chemical, Mineralogical and Biological properties of soil, sources of soil pollution, Pollution and residual toxicity from the application of insecticides, pesticides and fertilizers; Soil erosion and land degradation. Control of Soil pollution.

Learning Outcome:

Upon completion of the unit a student will be able to understand the management of Biomedical and radioactive wastes, sources and types of soil pollution and its control methods.

UNIT – IV

Industrial Waste Treatment: Introduction, Principles, sources and characteristics of industrial pollutants, effects of waste water on - streams, land, human health and water and waste water treatment plants. Pretreatment of wastes, collection of wastes, segregation – equalization – reduction in volume and strength – theories of neutralization and proportioning.

- The student achieves basic knowledge on principals of industrial waste management, sources of pollution and their effects. The student gains theoretical knowledge on waste reduction methods and pretreatment techniques.

UNIT – V

Manufacturing processes, flow sheets, characteristics and composition of wastes including waste reduction, treatment and disposal methods of Material Industries: Paper, Steel plant, Plating and Food Industries: Sugar, Dairy. Miscellaneous Industries: Textile, Tanning

- The students will have a theoretical exposure to industrial process up to the level of disposal of waste for material and food industries.

Reference Books:

1. George Techobanoglous and Frank, K**.** Handbook of Solid Waste Management, Second Edition, Mc GRAW-HILL.
2. George Techobanoglous et al, ―Integrated Solid Waste Management‖ Mc Graw - Hill.
3. Techobanoglous Thiesen Ellasen; Solid Waste Engineering Principles and Management, Mc Graw – Hill.
4. Manual on Municipal Solid waste Management, CPHEEO, Ministry of Urban Development, Govt.

of. India, New Delhi.
5. Blide A. D. & Sundaresan, B. B, ―Solid Waste Management in Developing Countries, INSDOC.
6. Waste and waste water technology, Mark, JH. John Wiley and Sons, New York.
7. Water and waste water analysis, B.B. Sundaresan, NEERI, Nagpur.
8. Standard methods for examination of Water and waste water, APHA, American Water work Association, Water pollution control federation, New York.
9. Industrial Waste Management, M.N. Rao and A.K. Datta.

Course Outcomes:

After the completion of this course, student will be able to:

- Types and composition of solid wastes of both urban and industrial, factors influencing generation of solid wastes and methods for disposal and management of solid wastes.
- Methods of composting, recycling and reuse of materials, classification of hazardous wastes properties of soil, sources, types of soil pollution and its control methods.
- Familiar about how the industrial waste is generated, its sources including physical, chemical and biological properties of the effluents.

SEMESTER - V

SES 303: ENVIRONMENTAL IMPACT ASSESSMENT

Hours per week: 4 **Credits: 4**

Preamble:

Includes Environmental Impact Assessment definition, concepts, principles along with its origin and development. Guidelines in preparing EIA with different methodologies are detailed along with its merits and demerits. Concepts of Environmental management plan, disaster management plan and Environmental auditing are covered. Environmental management system (EMS) are detailed along with its standards including ISO 14000 series and ISO 14001 were detailed. This course had also focused on the pollution control norms at source, coastal zone regulation restrictions, zoning atlas, medium related standards.

Course Outline:

To make the students understand the concept of Environmental Impact Assessment. They become familiar with the Environmental Impact Assessment Methodology and its application. The students also understand the Disaster management plan (on site & offsite). The course is designed to enable the student to learn about Environmental management system (EMS) along with its standards including ISO 14000 series and ISO 14001.

UNIT- I

EIA – Introduction -Definition – Basic concepts and principles of EIA – Origin and development of EIA - Short-term and Long-term objectives – EIA guidelines 2006 (Notification of Government of India) — Merits and Demerits of EIA.

Learning outcome:

Upon completion of the unit a student will gain knowledge on concepts and principles of EIA and EIA notification, 2006.

UNIT -II

Basis for Environment Impact Assessment – Types of impacts (Negative & Positive, Primary & Secondary, Reversible and Irreversible Tangible and Intangible) Components of EIA: Screening of Projects - Public Participation - Preparing environmental impact statements.

Learning outcome:

Upon completion of the unit a student will be able to understand the types of impacts and components of EIA.

UNIT -III

EIA Methodologies: Adhoc Method – Checklist Approach – Matrix Methods – Network Methods - Environmental Management Plan.

Learning outcome:

Upon completion of the unit a student will gain knowledge on the procedures of EIA and Environmental Management Plan.

UNIT -IV

Disaster Management plan on site & off site, Environmental Auditing: Scope, Objectives and Procedures for environmental auditing. Environmental Management System (EMS): EMS standards, The ISO 14000 series, The ISO 14001.

Learning outcome:

Upon completion of the unit a student will be able to understand the process of disaster management andthe procedure of environmental auditing an Environmental Management System.

UNIT -V

Pollution control norms at source – Coastal Zone Regulation restrictions – Zoning atlas – Medium related standards (Ambient standards)

Learning outcome:

Upon completion of the unit a student will be able to understand pollution control norms at source and Coastal zone regulation and its management.

Reference Books:

1. Fundamentals of Ecology, E.P. Odum, W.B. Saunders & Co.
2. Das, R.C. and Behera, D.K. Environmental Science – Principles and practice, PHI, New Delhi.
3. Y. Anjaneyulu Environmental Impact Assessment Methodologies , B. S. Publications
4. Sherman, J. Rosen, Manual for Environmental Impact Evaluation. Prentice Hall, New Jersey.
5. Erickson, P.A. Environmental Impact Assessment Principles and Applications.
6. Canter LW. Environmental Impact Assessment. Mc Graw Hill, New York.

Course outcomes:

- Student will gain knowledge on the concepts and principles of EIA and EIA notification, 2006.
- Student will be able to know the types of impacts, components and procedures of EIA and Environmental Management Plan.
- Student will be able to know about pollution control norms and coastal regulation zone.

SEMESTER–V

SES 321: SOLID WASTE MANAGEMENT AND SOIL POLLUTION LAB

Hours per week: 3 **Credits: 2**

Urban Solid waste analysis

1 Determination of Physical characteristics of solid waste :
Particle size; Temperature; pH; Conductivity and bulk density

2 Determination of Chemical characteristics of solid waste – Nitrogen, Phosphorus, Potassium and Heavy metals (selected).

3 Estimation of organic and Inorganic fraction of solid waste.

Industrial solid waste analysis:

Estimation of the following physico-chemical parameters in the given effluent (Food Processing/Diary/Fertilizer/Steel plant/Metal Plate/Petroleum refinery/Sugar)

1. Estimation of pH and Conductivity
2. Estimation of Calcium and Magnesium
3. Determination of Solids.
4. Determination of Biological Oxygen Demand
5. Determination of Chemical Oxygen Demand

COURSE OUTCOME

Practical Outcome:

Upon the completion of laboratory sessions the student will be able to:

- Analysis of physico-chemical characteristics of solid waste.
- Estimation of organic and inorganic fractions of solid waste.
- Students gain hand on experience with the estimation of physico-chemical parameters in various industrial effluents and its comparison with the effluent diSPHarge standards given by Central Pollution Control Board.

SEMESTER–V

SES 323: ENVIRONMENTAL IMPACT ASSESSMENT LAB

Hours per week: 3 **Credits: 2**

1. Comparative analysis of air sampling from clean and polluted area using key Parameters.
2. Collection and Interpretation of weather data and development of wind roses.
3. Measurement of noise in silent, industrial, residential and commercial areas.
4. Effluent analysis (available effluent)
5. Case Study – At least One Situation – a) Questionnaires; b) Data Collection and Generation; c) Integration of Data and Analysis

Practical Outcome:

Upon completing the laboratory sessions the student will be able to:

- Comparative case studies of different areas using different procedures of EIA.
- Measurement of noise levels and air sampling in different areas.
- Analysis of various effluents from industries.

SEMESTER – V

SBT 341: PLANT AND ANIMAL BIOTECHNOLOGY

Hours per week: 04 **Credits: 04**

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 andsomatic embryogenesis.In vitro haploid production: Androgenic and Gynogenic methods. Transgenic plants: Production methods and its applications.

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.

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.

UNIT-IV

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

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.

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 **Credits: 04**

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

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.

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.

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.

UNIT – V

Microbial products of pharmacological interest, steriod 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.

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 **Credits: 02**

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 **Credits: 02**

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 **Credits: 04**

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.

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;

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.

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.

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.

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 6^th^Ed.*, 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 **Credits: 04**

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.

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

UNIT –III

Supercritical CO2- phase diagram - uses in extracting natural products, dry cleaning, bromination, Kolbe-SPHmidt synthesis - Friedel-crafts reaction. Dimethyl carbonate as a methylating agent in green synthesis

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.

UNIT –V

Green Analytical Techniques

Micelle mediated extraction- Cloud point extraction and adsorptive miceller flocculation methods.

Solid Phase Micro Extraction (SPME)

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 **Credits: 02**

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:

(vi) Determination of exchange capacity of cation exchange resins and anion exchange resins.

(vii) 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^- $\rightarrow$ propene + trimethylpropene + water

(II) 1-propanol $\xrightarrow{H_2SO_4/}$ 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

SSE 361: DISASTER MANAGEMENT

Preamble:

The episodes of both natural and man-made disasters have become more repeated, the biggest challenge of the intact world today is the prevent disasters. This paper provides basic information on the concept and definition of disasters, Principles and aspects of disaster prevention, disaster mitigation preparedness and coping with disasters.

Course Objectives

- To enable the student to better understand the concept and definition of disaster including approaches to understand the disaster phenomena.
- To create awareness about the various natural and manmade disasters.
- It helps in attaining the knowledge on Disaster risk reduction, Institutional arrangements, DM Act and policy.

Disaster Management

Understanding Disaster Management: Concept and definition of disaster, approaches to understand disaster phenomena (natural science, applied science, progressive and holistic approaches). Parameters of disaster risk. Levels of disaster as per national guidelines.

Disaster Classification, Causes and Impacts: Overview of Disaster Management in global, national and region level, classification of disasters (Natural and manmade), General characteristics and problem areas of different natural and manmade hazards - floods, earthquake, landslides, cyclones and drought. Response time, frequency forwarding exposure time of different man made hazards.

Approaches to Disaster risk reduction: Disaster risk assessment (Hazardous – Vulnerability-Capacity analysis), Hazardous mapping and forecasting. Principles and aspects of disaster prevention, disaster mitigation preparedness for damage mitigation and coping with disasters. Role & responsibilities of community local bodies (Panchayat Raj & Urban), states, central and other stake holders.

Inter-relationship between disaster and development: Factors affecting Vulnerabilities, differential impacts, impact of development projects such as dams, embankments, changes in land use. Climate change adaptation. Relevance of indigenous knowledge, appropriate technology and local resources.Disaster risk management in India: Hazard and Vulnerability profile of India, components of disaster relief Water, flood, sanitation, shelter, health and Waste Management. Institutional arrangements(mitigation, response and preparedness) DM Act and policy, other related policies plans, programmes and legislation).

Reference Text Books:

1. Disaster Management, M.Sravan Kumar, Himalaya Publishing House, Mumbai
2. Disaster Management, R.B.Singh, Rawat Publications, Jaipur and New Delhi
3. Disaster Management in India, Ministry of Home Affairs, Government of India, New Delhi.
4. National Policy on Disaster Management, NDMA, New Delhi.
5. District Disaster Management Plant-Model Template, NIDM, New Delhi.

Course Outcomes

After reading this paper the student –

- Adds theoretical knowledge on general concept of Disaster Management and levels disaster as per national guidelines.
- Knowledge enhances on Hazardous mapping and forecasting, mitigation and coping with disasters.
- Obvious visualization of Factors affecting Vulnerabilities, Vulnerability profile of India, mitigation, response and preparedness.

SEMESTER – V

SEM 363: ENVIRONMENTAL MANAGEMENT

Hours per week: 2 **Credits: 2**

Environmental Management (EM): Introduction, definition and scope. Need for EM.
Ethics and Environment, Environmental policies and programmes in India.

Environmental Laws – Need and Importance of Environment Protection Act, Air Act, Water Act, Wildlife Protection act and Forest conservation act.

Environmental Impact Assessment (EIA): Introduction, purpose and evolution of EIA, steps involved in EIA process. Environmental clearance procedure.
EIA methodologies in brief. Impact prediction, evaluation and mitigation.

Environmental Auditing (EA): Introduction, objectives and scope. Types of Environmental audits.
Basic structure of EA. General steps in EA. Role of EA in industrial projects.
Life Cycle Assessment (LCA) and its purpose. Procedure for LCA.Different applications of LCA.

Environmental Management Systems (EMS): Significance and core elements of EMS. EMS standards – ISO 14000 – principles and structure, ISO 14001 and OHSAS 18001 certification procedure.

Learning Outcome:

- Upon the completion of the unit student will be able to understand Environmental management systems, its significance and certification procedure.

Reference Books:

1. NPTEL material on Environmental Management – http://nptel.ac.in/courses/120108004/
2. Environmental Impact Analysis by Jain R.K. & Others. New York: Van Nostrand Reinhold Co.
3. Pollution Management in Industries by Trivedi R. K. Environmental Publication.
4. ISO14001 by SPHoffman A. &Tordini A. Oxford University Press
5. Environmental Impact Assessment by Canter Larry W. McGraw Hill Higher Education
6. Environmental Auditing by A.K. Srivastava. APH Publishing.
7. Handbook of Environmental Laws, Acts Guidelines, Compliances & Standards Vol-I & VII by R.K. Trivedi. B.S. Publications.

Course Outcomes

After reading this paper the student –

- Student will be able to gain knowledge on Environmental Management, environmental laws in India and their importance.
- Student will be able to understand the importance of Environmental Impact assessment, procedures and importance of environmental audit in industrial projects.
- Student will be able to gain knowledge on Environmental management systems, significance and certification procedure.

SEMESTER – V

SSE 373: PHARMACEUTICAL CHEMISTRY

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

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 **Credits: 02**

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

SES302: GLOBAL WARMING AND CLIMATE CHANGE

Hours per week: 3 **Credits: 3**

Preamble:

To inculcate fundamental knowledge on the causes and consequences of global warming and climate change. Adaptation of mitigations measures for climate change and to develop awareness on the consequences of global warming.

Course Outline:

To strengthen the understanding of student on the causes and consequences of global warming, climate and climate change, policies initiated for mitigation and adaptation strategies.

UNIT-I

Global climate Change – Evidence, causes and consequences, climate of past, present and future scenarios, concept of climate modeling. Impact on climate change on tropical and temperate regions. Impact of climate change on natural resources and health, causes for climate change, climate change mitigation measures, Adaptation to climate change.

Learning outcome:

Upon completion of the unit a student will be able to understand the causes and consequences of global warming and climate change and the concept of climate modeling.

UNIT-II

Causes for climate change: Greenhouse effect, sources and trends of greenhouse gases, warming potential of gases. Impacts of global warming, Photosynthetic mechanism and global climate change – case studies. Impact of climate change on India.

Learning outcome:

Upon completion of the unit a student will be able to understand greenhouse effect, impacts of global warming and climate change on India.

UNIT–III

Carbon Sequestration- concept, global carbon cycle, carbon sequestration potential in terrestrial and marine ecosystems, anthropogenic impact on carbon sequestration. Forest-Sink of Carbon, Measuring of Carbon Dioxide. Role of forests in climate mitigation potential and its evaluation, land use, land use change and forestry, Policy Perspective: UNFCC, Role and Function of IPCC, Kyoto Protocol and its implication on Developed and developing countries.

Learning outcome:

Upon completion of the unit a student will be able to understand the concept of carbon sequestration and the role of forests in climate mitigation potential.

UNIT - IV

CDM (Clean Development Mechanism): Definition and origin of CDM, CDM potential, CDM Market today, Carbon credits under Kyoto, Emission markets. IPCC (Intergovernmental Panel on Climate Change) UNFCC (United Nations Framework Convention on Climate Change).National Action plan on climate change.

Learning Outcome:

- Upon completion of the unit a student will be able to gain knowledge on the concept of Clean Development Mechanism (CDM), IPCC and UNFCC.

UNIT V

Tools to study climate change: Mitigation and adaptation strategies for global warming, carbon capture and storage technologies. National action plan on climate change in India. Indian approach towards climate change in agriculture and food, energy consumption, water availability, environmental pollution and protection of biodiversity.

Learning Outcome:

- Upon completion of the unit a student will be able to understand the mitigation strategies for global warming, carbon capture and storage technologies, National plan on climate change in India.

Reference text books:

1. Aguado, E. and James, E.B. Understanding weather and climate, Prentice Hall, New Delhi.

2. Gupta, K.R. Encyclopedia of environment global warming: problems and policies, Atlantic Publication, New Delhi.
3. Lovejoy, T.E. and Hannah L. Climate change and biodiversity, TERI press.
4. Owen, O.S., Chiras, D. D. and Reganold, J.P. Natural Resource Conservation: Management for Sustainable Future, Prentice Hall.
5. Jamil Ahmad. Climate Change and Sustainable Development in India. New century publications.
6. Stephen Peake. Climate Change: From science to sustainability. OUP Oxford; 2nd Edition.
7. Sushil Kumar Dash, S K Dash. Climate Change: An Indian Perspective (Environment and Development). Foundation books.

Course outcomes:

- Student will gain knowledge on energy and carbon emissions, global climate change and its related effects.
- Student will be able to understand the impacts of global warming and its effect on human health.
- Student will be able to understand the concept of CDM, IPCC and UNFCC and mitigation strategies for global warming and carbon capturing.

SEMESTER – VI

SES 304: REMOTE SENSING AND GIS

Hours per week: 4 **Credits: 4**

Preamble:

Remote Sensing is science of acquiring information about an object or a phenomenon kept at a distance. This course provides basic understanding about Remote Sensing and GIS. Remote sensing is a powerful tool to study landscapes, which involves extracting information from spectral images and then analyse them to interpret earth surface processes. On the other hand Geographic Information system (GIS) is software for mapping.

Objectives:

- To describe the fundamental principles of remote sensing and GIS.
- To provide exposure to students in gaining knowledge on concepts and applications of remote sensing for environmental science.

UNIT – I

Fundamental principles of Remote Sensing: Definition and Overview of Remote Sensing History and Evolution of Remote Sensing and Remote Sensing Systems.

Electromagnetic energy and its atmospheric interactions; Remote Sensing Data Acquisition.

Learning Outcome:

On completion of this unit student shall be able to

- Elucidate the process of remote sensing
- List and describe the different types of sensors that are used to detect and record certainparts of the electromagnetic spectrum.

UNIT – II

Elements of Image interpretation. Aerial photo-classification, distortions caused due to flight irregularities, overlaps, scale, relief displacement and its effects.

Different types of photographs.

Learning Outcome:

On completion of this unit student shall be able to

- Identify the components on an aerial photograph
- Become familiar with the history, film type, and angles of aerial photography
- Elucidate Distortions and displacement

UNIT – III

Fundamentals of GIS - Role of information technology in human health. Weather forecasting, Agro meteorology.

Learning Outcome:

On completion of this unit student shall be able to

- Understand the principles of geographic information systems (GIS)
- Understand application of RS and GIS for Weather forecasting and agrometerology.

UNIT – IV

Applications of Remote Sensing and GIS in Water Resources management. Mining - Urbanization.

Learning Outcome:

On completion of this unit student shall be able to

- Gain experience in the applications of remote sensing and GIS to solving problems of urbanization and mining.

UNIT – V

Environmental Applications of GIS – Pollution Monitoring – Water – Air – Oil Pollution – Desertification

Learning Outcome:

On completion of this unit student shall be able to

- Understand the concepts involved in monitoring environmental pollution

Reference Books

1. Sabnis F. Remote Sensing, Principles and interpretation -WH & Freeman & Co. NY.
2. Jensen J. R. Introductory Digital Image Processing -Pentice Hall NZ.

3. Remote Sensing and GIS for Environmental Planning, Muralikrishna, I.V. Tata-McGraw Hill
4. Environmental Monitoring: Applications of Remote Sensing and GIS, Singh, R.B, Geocartho International Centre, Hongkong.

Course Outcomes:

Upon completion of this Course, the student should be able to:

- Explain the way in which electromagnetic radiation interacts with the earth’s atmosphere, the earth’s surface and the remote sensing system
- Understand the various applications of remote sensing data towards solving problems related to environment.

SEMESTER – VI

SES322: GLOBAL WARMING AND CLIMATE CHANGE LAB

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

The student shall takeup atleast 10 assignments in form of hand written records based on the current environmental issues related to Global warming and climate change as per the topics in theory paper, the required information is to be collected from print or electronic media of both national and international standards. Continuous evalution each report carries 10 marks.

Lab Course Outcome:

After completing this lab the student –

- Will get comfortable and gain good exposure to the print or electronic media
- Improves knowledge on latest global environmental issues
- Develops scientific report writing skills

SEMESTER– VI

SES 324: REMOTE SENSING AND GIS LAB

Hours per week: 3 **Credits: 2**

1. Toposheet Analysis
2. Preparation of Thematic Maps from Toposheets

Practical Outcome:

After completion of laboratory sessions student will be able to:

- Read and interpret toposheet, aerial images and satellite images
- Draw baseline maps, thematic maps, propose legends etc.

SEMESTER – VI

SBT 342: MARINE BIOTECHNOLOGY

Hours per week: 04 **Credits: 04**

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.Biogeo chemical cycles in 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 SPHedules, feed formulations, wet feeds and dry feeds.Fish byproducts.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.

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.

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)

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 **Credits: 04**

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

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.

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).

UNIT -IV

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

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.

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 **Credits: 02**

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. E SPH ,meyer2ndEdition (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 **Credits: 02**

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 **Credits: 04**

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.

UNIT-II

Environment and its segments

Ecosystems. Biogeochemical cycles of carbon, nitrogen and sulphur.

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, NO_x, SO_x and control procedures.

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.

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 waste water, 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.

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 **Credits: 04**

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 $CuSO_4 \cdot 5H_2O$, $CaC_2O_4 \cdot H_2O$ and $CaCO_3$. Basic idea of differential thermal analysis: principle and instrumentation. Difference between TGA and DTA. Differential scanning calorimetry: principle and instrumentation.

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

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.

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

UNIT V

X-ray Spectroscopy: X-ray spectrometers, energy dispersive and wavelength dispersive techniques, instrumentation, matrix effects and applications.

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 **Credits: 02**

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.

a. Safety Practices in the Chemistry Laboratory

b. Titration curve of an amino acid.

c. Determination of a Mixture of Cobalt and Nickel (UV/Vis spec.)

d. IR Absorption Spectra (Study of Aldehydes and Ketones)

e. Determination of Calcium, Iron, and Copper in Food by Atomic Absorption

f. Quantitative Analysis of Mixtures by Gas Chromatography (i.e., chloroform and carbon tetrachloride)

g. Separation of Carbohydrates by HPLC

h. Potentiometric Titration of a Chloride-Iodide Mixture

i. 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

SES 392: MINOR PROJECT

Students appearing for Bachelor of Science (Environmental Science, Biotechnology, Chemistry) shall carry out a minor project, during the sixth semester, in consultation with the faculty –in-charge and submit a dissertation which will be evaluated for 200 marks.