GANDHI INSTITUTE OF TECHNOLOGY AND MANAGEMENT (GITAM)
(Deemed to be University, Estd. u/s 3 of UGC Act 1956)
VISAKHAPATNAM ∗HYDERABAD ∗BENGALURU
Accredited by NAAC with 'A^{+}' Grade

REGULATIONS AND SYLLABUS

of

M.Sc. Environmental Science

(W.e.f 2019-20 Admitted batch)

Website: www.gitam.edu

Master of Science in Environmental Science
(M.Sc. Environmental Science)
REGULATIONS
(W.e.f. 2019-20 admitted batch)

1. ADMISSION

1.1 Admission into M.Sc. Environmental Science program of GITAM University is governed by GITAM University admission regulations.

2. ELIGIBILITY CRITERIA

2.1. A pass in B.E.M or any B.Sc. degree or equivalent with a minimum aggregate of 50% marks in group (optional) subjects. First preference is for B.E.M students. The remaining seats if any will be filled with B.Sc. students as follows: 50% of seats are allotted for life science and remaining for Physical sciences / B.Tech / B.Pharm students.

2.2. Admission into M.Sc. Environmental Science (Master of Science in Environmental Science) will be based on an All India GITAM Science Admission Test (GSAT) conducted by GITAM University 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 four semesters M.Sc. Environmental Science program is designed to have a total of 96 credits for the award of M.Sc. Environmental Science 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

S. No.	Component of assessment	Marks allotted	Type of Assessment	Scheme of Examination
1	Theory	40	Continuous evaluation	(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.
		60	Semester-end examination	The semester-end examination shall be for a maximum of 60 marks.
	Total	100		
2	Practicals	100	Continuous evaluation	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.
	Total	100		
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. SUPPLEMENTARY EXAMINATIONS & SPECIAL EXAMINATIONS:

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

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

9.3 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.

10. PROMOTION TO THE NEXT YEAR OF STUDY

10.1 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.

10.2 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

11. BETTERMENT OF GRADES

11.1 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.

11.2 Betterment of Grades is permitted 'only once', immediately after completion of the program of study.

12. REPEAT CONTINUOUS EVALUATION:

12.1 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.

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

12.3 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.

12.4 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.

12.5 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.

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

13. GRADING SYSTEM

13.1 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 in 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	-

13.2 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.

14. GRADE POINT AVERAGE

14.1 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.

14.2 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.

14.3 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.

15. ELIGIBILITY FOR AWARD OF THE M.Sc. ENVIRONMENTAL SCIENCE DEGREE

15.1 Duration of the program: A student is ordinarily expected to complete M.Sc Environmental Science program in four semesters of two years. However a student may complete the program in not more than four years including study period.

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

15.3 A student shall be eligible for award of the M.Sc Environmental Science 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.

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

16. 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.

M.Sc Environmental Science
Scheme of Instruction
I SEMESTER

Sl. No.	Course Code	Name of the Course	Category	Credits	Scheme of Instruction		Total	Scheme of Examination		
					Hours per Week			Duration in Hrs.	Maximum Marks	
					L/T	P			Sem. End Exam	Con. Eval
1	SES 701	Ecological Principles and Applications	PC	4	4	0	4	3	60	40
2	SES 703	Environmental Microbiology	PC	4	4	0	4	3	60	40
3	SES 705	Environmental Toxicology	PC	4	4	0	4	3	60	40
4	SES 707	Environmental Chemistry and Instrumentation	PC	4	4	0	4	3	60	40
5	SSE 701	Basic Computer Concepts	SEC	2	0	3	3	3	--	100
	SSE 703	Information Technology Tools								
PRACTICALS :										
1	SES 721	Ecological Principles and Applications	PP	2	0	4	4	3	60	40
2	SES 723	Environmental Microbiology Lab	PP	2	0	4	4	3	60	40
3	SES 725	Environmental Chemistry and Instrumentation lab	PP	2	0	4	4	3	60	40
4	SES 727	Seminar	PP	1	0	4	4			
Total				24	16	19	35	--	420	380

II SEMESTER

Sl. No.	Course Code	Name of the Course	Category	Credits	Scheme of Instruction		Total	Scheme of Examination		
					Hours per Week			Duration in Hrs.	Maximum Marks	
					L/T	P			Sem. End Exam	Con. Eval
1	SES 702	Air Pollution and Control	PC	4	4	0	4	3	60	40
2	SES 704	Solid Waste Management & Soil Pollution	PC	4	4	0	4	3	60	40
3	SES 706	Water and Wastewater Treatment	PC	4	4	0	4	3	60	40
4	SES 708	Earth Science System and its Resources	PC	4	4	0	4	3	60	40
5	SAE 702	Professional Communication Skills	AEC	2	0	3	3	3	--	100
PRACTICALS :										
1	SES 722	Air Pollution and Control Lab	PP	2	0	4	4	3	60	40
2	SES 724	Solid Waste Management & Soil Pollution Lab	PP	2	0	4	4	3	60	40
3	SES 726	Water and Wastewater Treatment Lab	PP	2	0	4	4	3	60	40
4	SES 728	Earth Science System and its Resources Lab	PP	2	0	4	4	3	60	40
			Total	26	16	19	35	--	480	420

III SEMESTER

Sl. No.	Course Code	Name of the Course	Category	Credits	Scheme of Instruction		Total	Scheme of Examination		
					Hours per Week			Duration in Hrs.	Maximum Marks	
					L/T	P			Sem. End Exam	Con. Eval
1	SES 801	Environmental Impact Assessment & Case studies	PC	4	4	0	4	3	60	40
2	SES 803	Industrial Waste Management	PC	4	4	0	4	3	60	40
3	SES 805	Remote sensing Techniques in Environmental Management	PC	4	4	0	4	3	60	40
Choose any one										
4	SES 841	Environmental Biotechnology & Nanotechnology	GE	4	4	0	4	3	60	40
	SES 843	Bio- Geo Chemistry of Marine Science								
	SES 845	Environmental Planning and Sustainable Development								
5	SOE XXX	Open Elective	OE	3	3	0	3	3	60	40
PRACTICALS :										
1	SES 821	Environmental Impact Assessment Lab	PP	2	0	4	4	3	60	40
2	SES 823	Remote sensing Techniques in Environmental Management Lab	PP	2	0	4	4	3	60	40
3	SES 825	Industrial Waste Management Lab	PP	2	0	4	4	3	60	40
4	SES XXX	Generic Elective-I Lab	PP	2	0	4	4	3	60	40
Choose any one (With respect to theory chosen)										
	SES 881	Environmental Biotechnology & Nanotechnology Lab	-	-	-	-	-	-	-	-
	SES 883	Bio- Geo Chemistry of Marine Science Lab								
	SES 885	Environmental Planning and Sustainable Development Lab								
Total										
			Total	27	19	16	35	--	540	360

*Student can choose an open elective from list of open electives offered by the GITAM (Deemed to be University)

IV SEMESTER

Sl. No.	Course Code	Name of the Course	Category	Credits	Scheme of Instruction		Total	Scheme of Examination		
					Hours per Week			Duration in Hrs.	Maximum Marks	
					L/T	P			Sem. End Exam	Con. Eval
1	SES 802	Industrial Safety & Disaster Management	PC	4	4	0	4	3	60	40
Choose any one										
2	SES 842	Environmental Remediation technologies	GE	4	4	0	4	3	60	40
	SES 844	Environmental Modeling Using Mat lab								
	SES 846	Marine Pollution and Coastal Zone Management								
PRACTICALS :										
1	SES XXX	Generic Elective – II Lab	PP	2	0	4	4	3	60	40
Choose any one (With respect to theory chosen)										
	SES 882	Environmental Remediation technologies Lab	-	-	-	-	-	-	-	-
	SES 884	Environmental Modeling Using Mat Lab								
	SES 886	Marine Pollution and Coastal Zone Management								
2	SES892	Project and Viva Voce	PP	8	0	0	0	3	-	200
			Total	18	8	4	12	--	180	320

L = Lecture hours **T**= Tutorials **P**= Practical **C** = Credits

Open Electives offered by Department of Environmental Studies

Sl. No.	Course Code	Name of the Course	Category	Credits	Scheme of Instruction		Total	Scheme of Examination		
					Hours per Week			Duration in Hrs.	Maximum Marks	
					L/T	P			Sem. End Exam	Con. Eval
Choose any one										
1	SOE 855	Environmental Pollution, Monitoring and Control	OE	3	3	0	3	3	60	40
	SOE 857	Climate change and Current Issues								

Total Credits – 96

M.Sc (ES)-I SEMESTER

SES 701: ECOLOGICAL PRINCIPLES & APPLICATIONS

Hours per week	**: 4**	**End Examination**	**: 60 Marks**
Credits	**: 4**	**Sessional**	**: 40 Marks**

Preamble:

Ecological principles and applications is an inclusive course covers integrated approach of ecological studies. The course begins with the structure and functional aspects of ecosystem and moves on, through ecological factors, ecological succession, natural and manmade ecosystems, to global considerations of biodiversity and conservation. Case studies, historical perspectives and ecological theories highlighted.

Course Objectives:

The objective of the course is to make students to understand ecosystem dynamics, effect of environmental factors on organisms, biogeochemical cycles and ecological theories. The use of ecological concepts in management of natural resources including conservation of biodiversity to make students to understand integrated nature of ecological sciences.

UNIT – I

Nature and scope of ecology - Concept of ecosystem: structure - components of ecosystem, trophic levels, Ecological pyramids. Functional aspects, - Food chain, food webs, ecological energetics: energy flow and laws of thermodynamics - ecological efficiencies, productivity of ecosystem, Homeostasis.

Learning Outcomes:

- Upon completion of the unit a student will be able to understand the concept of ecosystems, its structural and functional aspects.

UNIT – II

Biogeochemical cycles: Carbon, nitrogen, phosphorus, sulfur and non-essential nutrients, Hydrological cycle. Effect of climatic, edaphic and biological factors on plants, animals and communities. Liebig's law of minimum, Shelford's law of tolerance.

Learning Outcomes:

- Student will be able to understand role of biogeochemical cycles and effect of different factors on living beings

UNIT – III

Development of communities: General process of ecological succession, types of succession, hydrosere, xerosere, climax concept in succession. Population and community Ecology: population characteristics, population dynamics and regulation. Nature of communities, structure and characteristics (qualitative and quantitative) of communities.

Learning Outcomes:

- Student will be able to understand the process and types of ecological successions and population dynamics

UNIT – IV

Biodiversity: Importance of biodiversity, management and conservation of biodiversity. Wildlife management: wildlife conservation, wildlife protection Act 1972, National parks and sanctuaries in India. Case Studies – Project Tiger and Gir lion project.

Learning Outcomes:

- Student will be able to understand the importance and need for management of biodiversity with suitable case studies.

UNIT – V

Engineered Ecosystems: Man Engineered Ecosystems – aqua culture, agriculture, man and the biosphere. Ecological sustainability: organic farming, Integrated Pest Management (IPM), indicator species.

Learning Outcomes:

- Student will be able to understand the need of engineered ecosystems and ecological sustainability

Reference Books:

1. Cunningham, W. P. and Cunningham, M. A. *Principles of Environment Science and Applications.* 2nd ed. Tata McGraw Hill, New Delhi, India.
2. Odum, E.P. *Fundamentals of Ecology*. W.B. Saunders, USA. Indian Reprint, Natraj Publishers, Dehradun, India.
3. Botkin, Daniel B. and Keller, Edward A. *Environmental Science: Earth as a Living Planet*. 6th ed. John Wiley & Sons, USA.
4. Chapman, J. L. and Reiss, M. J. *Ecology: Principles and Applications.* Cambridge University Press, UK.
5. Kemp, M. J. *Environmental Science*. The McGraw-Hill Companies.
6. Nebel, B. J. and Wright, R. T. *Environmental Science*. Prentice Hall.
7. M.S. Dash, *Fundamentals of Ecology*, Tata Mc Graw Hill Company

Course outcomes:

- Student will gain knowledge on the concept and functioning of ecosystems
- Student will be able to know the types of ecosystems and process of ecological succession and concepts of population and community ecology.
- Student will be able to know about the importance and need for management of biodiversity.
- Student will be able to understand the application of applied ecological concepts.

M.Sc (ES)-I SEMESTER

SES 703: ENVIRONMENTAL MICROBIOLOGY

Hours per week	**: 4**	**End Examination**	**: 60 Marks**
Credits	**: 4**	**Sessional**	**: 40 Marks**

Preamble:

This paper spot lights on basics in microbiology, morphological features, distribution of microorganisms in the Environment including tools of microbiology. This course also focuses on agricultural uses of micro-organisms, interactions between micro-organisms, control of microorganisms, nutrient cycling, pollution and bioremediation.

Course objectives:

This course will introduce the diversity of microbes, the microbial interactions, and the microbial processes that are relevant for many environmental biotechnological applications (e.g. water supply, wastewater biotechnology, contaminant biodegradation, bioenergy production, water quality management).

UNIT – I

History and development of Microbiology – Classification of microorganisms (Three, four and five kingdoms), differences between prokaryotes and eukaryotes. Salient features of major groups of microorganisms – bacteria, algae, fungi, protozoa, bacteriophages and viruses.

Microbial nutrition and growth – Nutritional requirements, nutritional forms. Microbial growth - growth cycle (only growth phases), types of growth (continuous, synchronous and non synchronous), measurement of microbial growth, Influence of Environmental Factors on Growth.

Learning Outcomes:

Student will get knowledge on Taxonomy, morphological characteristics including growth parameters of microorganisms, structural and cultural aspects of microorganisms

UNIT – II

Tools and Techniques in Microbiology: Microscopy (Resolving power and Numerical Aperture). Working principles of different Microscopes: Simple Microscope, Bright field, Phase Contrast, Fluorescent Microscope and Electron Microscope (SEM & TEM).

Stains and Staining – Types of stains, Staining procedures, Staining of bacteria, Protozoa, Fungi and Algae. Isolation and Pure Culture, Types of Cultures (Pure Culture), Requirements of Cultures and Isolation & Preservation of Pure Cultures.

Learning Outcomes:

Student will get knowledge on

- Tools and Techniques in Microbiology and Staining

UNIT – III

Control of Microorganisms: Terms used in connection with Microbial Control. physical methods- Dry and moist heat Sterilization, Filtration of Air (Laminar Air Flow Operators), Filtration of Liquids, Sterilization by Radiation. Chemical Methods - Gaseous Agents. Evaluation of Antimicrobial Chemicals.

Role of Microorganisms in Biogeochemical cycles (Carbon, Nitrogen and Sulphur) and in sewage treatment. Determination of Water Potability – MPN, IMViC and Membrane Filter Techniques.

Learning Outcomes:
Student will get knowledge on control of microorganisms and Role of Microorganisms in Biogeochemical cycles

UNIT – IV

Milk Microbiology: Sources of Microorganisms in milk, Micro flora of Milk, Microbiological examination of milk, Cattle shed sanitation, Milk House Design, **Milk Handling Techniques:** Cleaning and Sanitizing the equipment and Utensils with both Heat & Chemical Agents. Pasteurization, Types of Pasteurization. Milk Borne Diseases.

Learning Outcomes:
Student will get knowledge on Milk microbiology and milk handling techniques

UNIT – V

Food Microbiology: Microorganisms of food spoilage and their sources, Spoilage of different food materials-fruits, vegetables, meat, fish, canned foods. Food intoxication (Botulism and Staphylococcal poisoning), Food borne diseases (Salmonellosis and Shigellosis) and their detection. General account of food preservation (Heat, Dehydration, Osmotic Pressure, Chemical and Radiation Treatments).

Learning Outcomes:
Student will get knowledge on Food microbiology and Food borne diseases.

Reference Books:

1. Microbiology by M. J. Pelczar, M.A. Reid and Chan E.C.S,7th reprint edition, Tata McGraw Hill Publishing Company, New Delhi.
2. Powar and Daginawala, General Microbiology Vol-I & II**,** 2nd Edition Himalaya Publishing House, Mumbai.
3. Microbiology by Prescott, Harley and Klein's, The McGraw-Hill Companies, Inc., 5th edition.
4. Microbiology by Dr. R.P.Singh, Kalyani Publishers, 3rd edition.
5. Municipal & Rural Sanitation. M. Ehlers & Ernest W. Steel. Tata Mc Graw Hill publishing company. 8th Edition.

Course Outcomes:
Student will get knowledge on

- Morphological characteristics including growth parameters of microorganisms.
- Role of microorganisms in protection of environment and pollution control
- Methods for protection of food from microbial contamination.

M.Sc (ES) I – SEMESTER

SES 705: ENVIRONMENTAL TOXICOLOGY

Hours per week	**: 4**	**End Examination**	**: 60 Marks**
Credits	**: 4**	**Sessional**	**: 40 Marks**

Preamble:

This paper highlights the concept of Toxicology, its history, its disciplines, toxicology texts. Exposure of toxicant, heavy metals in the environment, radiation and health.

Course Objectives:

The main objectives of this paper is to make student aware of the concept of toxicology, history, toxicology tests, exposure to toxicants, bioaccumulation and bio magnification, heavy metals in the environment, radiation and its health effects.

UNIT – I

General Account and definition of toxicology. History of Toxicology (The Early Era, The Middle Age, Recent Developments in toxicology). Disciplines of toxicology (Environmental toxicology, Food & drug toxicology, Industrial toxicology etc.). Scope & importance of Environmental toxicology.

Toxicants and their classification - Definition of toxicant; Toxicants into the Ecosystems; Classification of toxicants (toxicants in air, toxicants in water).

Learning Outcomes:

- Upon completion of the unit a student will be able to understand the scope and importance of environmental toxicology and classification of toxicants

UNIT – II

Toxicity tests. Categories of Toxic Effects. Types of toxicity test (test types based on number and condition; Test types based on exposure of toxicants). Acute toxicity test (definition, objectives of acute toxicity test). Bioassay and types of Bioassays. Maximum acceptable toxicant concentration (MATC).

Concept of Dose-Response relationship, measurement of Dose-Response relationship, LD_{50} and LC_{50}. Dose-Response curves, potency and toxicity. Threshold dose and no observed effect and margin of safety.

Learning Outcomes:

- Upon completion of the unit a student will be able to understand the types of toxicity tests and the concept of dose – response relationship.

UNIT – III

Exposure of Toxicant - Routes and sites of exposure. Duration and frequency of exposure and types of human exposure

Toxicology of pesticides - classification of pesticides. Environmental impact of pesticides. Bioaccumulation and bio magnification in food chain. Case study of - DDT in the environment.

Learning Outcomes:

- Upon completion of the unit a student will be able to understand the classification of pesticides, environmental impacts and their bio magnification in food chain with case studies.

UNIT – IV

Heavy metals in environment: Uses and pollution sources, toxicity, biochemical effects and remedial measures of Arsenic, Cadmium, Lead, Mercury and Chromium.
Environmental carcinogens-Introduction; Characteristics of Cancer and Cancer cells; Effect of Cancer; Types of Cancer (brief); Causes of Cancer. Environmental carcinogens- Types of Carcinogens (based on chemical nature, based on mode of action).

Learning Outcomes:

- Upon completion of the unit a student will be able to understand the sources and toxicity of heavy metals and carcinogens.

UNIT – V

Radiation and Health- Types and sources of ionizing radiation. Units of Radiation. Biological effects of ionizing radiation.
Epidemiological issues goiter, fluorosis and arsenic poisoning.

Learning Outcomes:

- Upon completion of the unit a student will be able to understand the sources and types of ionizing radiation and epidemiological issues.

Reference Books:

1. Concepts of Toxicology by Dr. Omkar, Vishal Publishing Company.
2. Fundamentals of Toxicology by Dr. Kamleshwar Pandey, Dr. J. P. Shukla, Dr. S. P. Trivedi, New Central Book Agency.
3. Environmental Chemistry by A. K. De, New Age International Limited, Publishers.
4. Environmental Science by S. C. Santra, New Central Book Agency.
5. Environmental biology and Toxicology by Sharma P.D., Rastogi and Lamporary.

Course outcomes:

- Student will gain knowledge on classification of toxicants and types of toxicity tests
- Student will be able to know the classification of pesticides, bio magnification and environmental impacts
- Student will be able to understand the sources and toxicity of heavy metals, carcinogens and types of ionizing radiation along with epidemiological issues.

M.Sc (ES)-I SEMESTER
SES 707: ENVIRONMENTAL CHEMISTRY AND INSTRUMENTATION

Hours per week : 4	**End Examination : 60 Marks**
Credits : 4	**Sessional : 40 Marks**

Preamble:
Properties and reactions of substances present in environment profoundly influence the surroundings we live. Hence, there is an increasing interest in the interface between man-made systems and the natural environment. Understanding of the chemical basis of environment is developed in this course via studies in the areas of water, earth and atmosphere.

Learning Objectives:

- To developed expertise relevant to the professional practice of environmental chemistry.
- To understand range and chemistry of compounds in the hydrosphere and geosphere
- To establish an appreciation of the role of chemistry in environmental science

UNIT – I

Concept and scope of environmental chemistry – Composition of the atmosphere, structure of atmosphere. Chemical and photochemical reactions in the atmosphere, Smog formation, Acid rains, Greenhouse effect/Global warming, Ozone hole, El Nino phenomenon.

Learning Outcome:
After completion of the unit the student will be able to comprehend chemistry of atmosphere and various photochemical reactions in the atmosphere.

UNIT – II

Toxic chemicals in the environment, Impact of toxic chemicals on enzymes, biochemical effects of Arsenic, Cadmium, Lead, Mercury. Biochemical effects of Carbon Monoxide, Nitrogen Oxides, Sulphur Dioxide, Ozone and PAN, Cyanide. Pesticides and carcinogens. Heavy metals - Impact on the environment.

Learning Outcome:
After completion of the unit the student will be able to develop an understanding of biochemical effects of heavy metals.

UNIT – III

Fertilizers – Introduction – Classification of fertilizers - Organic and Inorganic fertilizers – Risks of fertilizer use, Global Issues. Pesticides – Types of pesticides, Impact on the environment.

Learning Outcome:
After completion of the unit the student will be able to identify types of fertilizers and pesticides and their impact on environment.

UNIT – IV

Water and Waste Water Analysis – Laboratory procedures and importance of each of the following laboratory tests in the practice of sanitary engineering.
a) (i) Solids total & volatile (ii) Turbidity (iii) Color (iv) pH (v) Acidity (vi) Alkalinity (vii) Coagulation of water (viii) Hardness (ix) Water softening (x) Residual chlorine and chlorine demand (xi) Chlorides.

b) (i) Biochemical Oxygen Demand (ii) Chemical Oxygen Demand (iii) Nitrogen (iv) Iron and Manganese (v) Fluoride (vi) Sulfate (vii) Phosphorous and Phosphate (viii) Grease (ix) Volatile acid (x) Gas analysis

Learning Outcome:

After completion of the unit the student will be able to develop an understanding of chemical methods employed for analysis of environmental samples.

UNIT – V

Instrumentation Principles: Basic principle, schematic diagram, components of the instruments and Environmental application of the following (detailed calculations and problems not necessary). UV – Visible spectrophotometer, Gas Liquid chromatography (GLC), Atomic absorption spectroscopy (AAS), Flame Photometry, Inductively Coupled Plasma Mass Spectrometry (ICPMS)

Learning Outcome:

After completion of the unit the student will be able to cultivate skills in procedures and instrumental methods applied for analytical tasks of environmental chemistry

Reference Books:

1. Vogle's Textbook of Quantitative Chemical Analysis 5th Edition, ELBS.
2. Moore, W.A. and Moore E.A. Environmental Chemistry, Academic Press.
3. Johnson, D.O., Netterville, J.T. Wood, J.c., and James, M., Chemistry and the Environment, W.B. Saunders Company, Philadelphia.
4. De, A. K. Environmental Chemistry. 4th ed. New Age International (P) Ltd., New Delhi, India.
5. Clair Sawyer, Perry McCarty, Gene Parkin, Chemistry for Environmental Engineering and Science. V ed. McGraw-Hill Education.

Course Outcomes:

On successful completion of the course the student will be able to:

- Demonstrate knowledge of chemical principles of various fundamental environmental phenomena and processes in land, water, and air.
- Describe the practical chemistry for analysing environmental samples
- Find and analyse physico-chemical and toxicological information and judge its reliability and significance.

M.Sc (ES)-I SEMESTER

SSE 701: BASIC COMPUTER CONCEPTS

Hours per week : 3 **Continuous Evaluation: 100 Marks**
Credits : 2

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

Basics of Computers: Definition of a Computer - Characteristics and Applications of Computers – Block Diagram of a Digital Computer – Classification of Computers based on size and working – Central Processing Unit – I/O Devices, Primary, Auxiliary and Cache Memory – Memory Devices. Software, Hardware, Firmware and People ware – Definition and Types of Operating System – Functions of an Operating System – MS-DOS –MS Windows, UNIX.

MS-Word

Features of MS-Word – MS-Word Window Components – Creating, Editing, formatting and Printing of Documents – Headers and Footers – Insert/Draw Tables, Table Auto format – Page Borders and Shading – Inserting Symbols, Shapes, Word Art, Page Numbers, Equations – Spelling and Grammar – Thesaurus – Mail Merge.

MS-PowerPoint

Features of PowerPoint – Creating a Blank Presentation - Creating a Presentation using a Template - Inserting and Deleting Slides in a Presentation – Adding Clip Art/Pictures - Inserting Other Objects, Audio, Video- Resizing and Scaling of an Object –Slide Transition – Custom Animation.

MS-Excel

Overview of Excel features – Creating a new worksheet, Selecting cells, Entering and editing Text, Numbers, Formulae, Referencing cells – Inserting Rows/Columns –Changing column widths and row heights, auto format, changing font sizes, colors, shading.

Learning Outcomes:

- Able to understand fundamental hardware components that make up a computer's hardware and the role of each of these components
- Understand the difference between an operating system and an application program, and what each is used for in a computer.
- Acquire knowledge about AI tools.
- Create a document in Microsoft Word with formatting that complies with the APA guidelines.
- Write functions in Microsoft Excel to perform basic calculations and to convert number to text and text to number.
- Create a presentation in Microsoft PowerPoint that is interactive and legible content

M.Sc (ES)-I SEMESTER

SSE 703: INFORMATION TECHNOLOGY TOOLS

Hours per week : 3 **Continuous Evaluation: 100 Marks**
Credits : 2

Preamble: The course enables the student to understand networking concepts related to Internet and introduce the social Networking sites and working of Email. It gives orientation of Block Chain technology. It give hands on training in SPSS, R Programming and creation of simple HTML documents.

Introduction to Internet: Networking Concepts, Data Communication –Types of Networking, Internet and its Services, Internet Addressing –Internet Applications–Computer Viruses and its types –Browser –Types of Browsers.

Internet applications: Using Internet Explorer, Standard Internet Explorer Buttons, Entering a Web Site Address, Searching the Internet– Introduction to Social Networking: twitter, tumblr, Linkedin, facebook, flickr, skype, yahoo!, google+, youtube, WhatsApp, etc.

E-mail : Definition of E-mail, Advantages and Disadvantages, User Ids, Passwords, Email Addresses, Domain Names, Mailers, Message Components, Message Composition, Mail Management, Email Inner Workings.

WWW-Web Applications, Web Terminologies, Web Browsers, URL–Components of URL, Searching WWW –Search Engines and Examples.

Block Chain technology: What is Block Chain, Blockchain Architecture, How Block chain Transaction Works? Why do we need Blockchain? Block chain versions, Block chain Variants, Block chain Use Cases, Important Real-Life Use Cases of Block chain Bitcoin cryptocurrency: Most Popular Application of Block chain, Block chain vs. Shared Database, Myths about Block chain, Limitations of Block chain technology.

SPSS : SPSS Commands, Descriptive Statistics, Hypothesis Testing, Test of Difference, Analysis of Variance- One Way ANOVA, Non Parametric Tests, Correlation Analysis, Regression Analysis.

R Programming: Becoming familiar with R, Working with Objects, Introduction to Graphical Analysis.

HTML: WEB Terminology, Structure of HTML Document, HTML – Head and Body tags, Semantic tags- HR- Heading, Font, Image & Anchor tags, Different Types of Lists using Tags, Table Tags, Image Formats – Creation of Simple HTML Documents.

Reference Books:

- In-line/On-line : Fundamentals of the Internet and the World Wide Web, 2/e -by Raymond Greenlaw and Ellen Hepp, TMH
- Microsoft Office 2010 Bible by John Walkenbach, Herb Tyson, Michael R. Groh and Faithe Wempen, Wiley.

Learning Outcomes:

- Enable to understand the basic networking concepts, types of networks, Internet Explorer and www.
- Outline the Block chain architecture, Bitcoin Crypto currency and Limitations of Block Chain.
- Choose different statistical tests to be performed on the data sets.
- Demonstrate the R programming with simple graphs.
- To make use of commands to structure HTML document.

M.Sc (ES)-I SEMESTER
SES 721: ECOLOGICAL PRINCIPLES AND APPLICATIONS LAB

A) Ground Vegetation Analysis:

1. Fixation of minimum size of Quadrates
2. Fixation of minimum number of Quadrates
3. Determination of Frequency
4. Determination of Density & Abundance
5. Determination of Dominance
6. Importance Value Index (IVI)
7. Vegetation Sampling Transects
8. Diversity Measure: Shannon -Wiener, Simpson and Brillouin‟s Index

B) Soil Analysis:

1. Estimation of soil pH
2. Estimation of Conductivity
3. Estimation of water Holding Capacity
4. Estimation of Organic Carbon
5. Estimation of Soil Humus.

C) Field Study / Visits

1. Rocky and Sandy Coast, Hilly Terrain, Marshy Swamp, Back Waters, Forest Ecosystem
2. Lake Ecosystem, Riverine Ecosystem, Mangrove Ecosystem.

Learning Outcomes:

- Upon completion of this set of experiments, student will be able to understand and perform analysis of ground vegetation, and soil analysis along with field visits.

M.Sc (ES)-I SEMESTER
SES 723: ENVIRONMENTAL MICROBIOLOGY LAB

Environmental microbiology lab experiments:

1. Introduction to Apparatus of Microbiology Lab: Auto Clave, Hot air Oven, Laminar air flow chamber, Inoculation loop, Petri dish, Quebec colony counter
2. Precautions & Care to be taken in Microbiology Lab: Sterilization before experiment, Cotton plugging, Autoclaving after experiment, Hand wash with spirit, wearing gloves, apron, masks. etc.
3. Staining techniques – Gram Staining
4. Culture Media: Solid Media: Nutrient Agar, EMB Agar
5. Liquid Media: Nutrient Broth, Lactose Broth
6. Plating Techniques: Streak Plate Technique, Spread Plate Technique, Pour Plate Technique
7. Hanging –drop technique.
8. Spots

Practical Outcomes:

Student will learn to operate and run instruments used for microbiology. They will be able to prepare media for growth of microbes, stain and identify microorganisms which play vital role in environmental microbial aspects.

M.Sc (ES)-I SEMESTER
SES 725: ENVIRONMENTAL CHEMISTRY AND INSTRUMENTATION LAB

Environmental chemistry and instrumentation lab experiments:

1. Volumetric analysis by EDTA titrations
2. Conductometric experiments:
    i) Redox titrations
    ii) Acid-base titrations
    iii) Determination of solubility and specially soluble salts
    iv) Precipitation titration
3. Potentiometric Experiments
    i) Redox titrations
    ii) Acid-base titrations
    iii) Determination of pH
    iv) Precipitation titration
4. Colorimetric Experiments:

Determination of cation concentrations of a) Fe (II) b) Cr (VI) c) Ni (II) d) Pb (II)

Practical Outcomes:

Student will learn analytical techniques for understanding chemistry of various environmental samples.

M.Sc (ES)-I SEMESTER
SES 727: SEMINAR

Students should submit the record (with a soft copy in the form of a CD) of the seminars the candidate has presented during semester period. The record shall contain the text of the seminar presented with relevant data, tables, figures, references of the information sources etc., incorporating all relevant discussions held on the topic and the record shall be evaluated by the faculty in charge at the end of the semester. The candidates performance in the seminar and the seminar record shall be evaluated.

M.Sc (ES)-II SEMESTER

SES 702: AIR POLLUTION AND CONTROL

Hours per week	**: 4**	**End Examination**	**: 60 Marks**
Credits	**: 4**	**Sessional**	**: 40 Marks**

Preamble:

The main objective of this course is to enhance student knowledge towards the scenario of air pollution in the present situation, air pollutants, and available control technologies for air pollution.

Course objectives:

This paper explains classification between natural and anthropogenic air pollutants, sources of air pollutants and their characteristics. 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, primary parameters – Wind direction and speed, temperature.

Atmospheric stability and temperature inversions, Types of inversions, adiabatic lapse rate. Secondary parameters – mixing height, precipitation, humidity, solar radiation, visibility.

Learning Outcome:

- Upon completion of the unit a student will be able to understand the sources and classification of air pollutants and factors which influence air pollution.

UNIT – II

Industrial plant location and city planning: Introduction, Factors to be considered for industrial plant location, Existing levels of air contaminants, Potential effects on surrounding area, meteorological factors and climate, topographical features, planning and zoning, City planning.

Learning Outcome:

- Upon completion of the unit a student will be able to understand the concept of city planning and factors to be considered during the location of an industrial plant.

UNIT – III

Plume behavior: Single stack and multiple source pollution, wind rose, Stack effluent dispersion theories, effect of dilution, plume rise, stack height. Dispersion model: Wind Tunnel method, Box Model and Gaussian plume model.

Effects of air pollution on human health, plants, animals and property. Major air pollution disasters: Meuse valley (Belgium), Donora (USA), London, Bhopal gas tragedy. Indoor air pollution.

Learning Outcome:

- Upon completion of the unit a student will be able to understand plume behavior, stack effluent dispersion and effects of air pollution on living beings with relevant case studies.

UNIT – IV

Sampling procedures: Classification of sampling methods, instruments for sampling waste gases and for atmospheric sampling, duration and sampling sites, sampling methods, high volume sampler and fine particulate ($PM_{2.5}$ and PM_{10}) sampler. Stack monitoring.

Control of air pollution by equipment: Objectives, Settling chambers, inertial separators, Cyclones, Filters, Electrostatic precipitators and scrubbers – description, advantages and disadvantages.

Learning Outcome:

- Upon completion of the unit a student will be able to understand the procedures of air sampling, equipment used for sampling and air pollution control equipment.

UNIT – V

Air pollution due to automobiles: Exhaust emissions; crank case emission, evaporative emissions, air-fuel ratio. Spark timing, control of exhaust emissions. Air quality and emission standards, air pollution legislations and regulations.

Learning Outcome:

- Upon completion of the unit a student will gain knowledge on automobile and exhaust emission, air pollution standards, legislations and regulations.

Reference Books:

1. Air pollution MN Rao & HVN Rao. Tata McGraw-Hill Publishing Company Limited, New Delhi.
2. Text book of Air Pollution and control Technologies. Y. Anjaneyulu, Allied Publishers (P) Limited, New Delhi.
3. Air Pollution Control Technology Handbook Karl B. Schnelle, Jr., Charles A. Brown, CRC Press
4. Environmental Pollution Control Engineering, CS Rao, New Age International publishers
5. Air Pollution & Control KVSG. Murali Krishna Published by Kaushal & Co.

Course outcomes:

- Student will gain knowledge on the sources and classification of air pollutants, factors effecting air pollution.
- Student will be able to understand the concept of city planning, location of industrial plant, plume behavior and effect of air pollution on living beings.
- Student will be able to understand the procedures of air sampling, equipment used for sampling and control equipment for air pollution.

M.Sc (ES) II – SEMESTER

SES 704: SOLID WASTE MANAGEMENT & SOIL POLLUTION

Hours per week : 4 **End Examination : 60 Marks**

Credits : 4 **Sessional : 40 Marks**

Preamble:

The main objective of solid waste management is to understand the types of solid wastes, its management by Integrated Municipal Solid waste management, hazardous waste management, sources and types of soil pollution.

Course objectives:

This paper explains waste generation in society, types of solid wastes, integrated solid waste management, segregation of materials, hazardous waste management and waste landfills and also soil pollution.

UNIT – I

Solid Waste: Waste generation in society, types of solid wastes, Integrated Municipal Solid Waste Management– Municipal Solid Waste: Sources, types and composition of Municipal Solid Waste - Physical, chemical and biological properties of Municipal Solid Waste.

Learning Outcome:

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

UNIT – II

Segregation and types of materials recovered from Municipal Solid Waste. Collection & transportation of Municipal Solid Waste, Disposal methods of MSW – Land filling, composting, incineration, pyrolysis. recycling and uses of paper, plastics, glass, and garbage.

Learning Outcome:

- Upon completion of the unit a student will be able to understand collection, transportation, disposal and recycling of materials from MSW.

UNIT – III

Hazardous waste Management: Sources and classification of hazardous wastes, storage and collection of hazardous wastes, treatment and disposal techniques: Physical, chemical and biological. Hazardous waste effects on health and the environment.

Learning Outcome:

- Upon completion of the unit a student will be able to understand the sources and classification of hazardous wastes and their management practices.

UNIT – IV

Hazardous waste landfills - Site characteristics. Hazardous waste reduction, recycling and reuse.
Biomedical waste: Definition, sources, classification, collection, segregation, treatment and disposal. Radioactive waste: Definition, sources, low level and high level radioactive wastes and their management, Radiation standard by ICRP and AERB.

Learning Outcome:

- Upon completion of the unit a student will be able to understand different types of hazardous wastes, biomedical, radioactive wastes and their management.

UNIT – V

Sources and types of Soil pollution, effect of industrial effluents, fertilizers, pesticides, heavy metals and urban waste on soil characteristics. Detrimental effects of soil pollutants. Soil pollution control methods.

Faecal Sludge and Septage Management (FSSM): Introduction - Government Policies and Programs on FSSM - Value chain - Environmental Aspects - On site containment system - Characterization - Septage Treatment Options.

Learning Outcome:

- Upon completion of the unit a student will be able to understand the sources and types of soil pollution and faecal sludge and septage management.

Reference Books:

1. Integrated Solid Waste Management George Tchobanoglous, Hilary Theisen, Samuel A.Vigil. Tata Mc Graw Hilll.
2. Manual on solid waste management, Ministry of urban affairs, GOI.
3. Design of landfill and Integrated Solid Waste Management, McGraw-Hill companies
4. Hazardous waste management by Prof. Anjaneyulu, B.S.Publications.
5. Environmental Sciences by Daniel B. Botkin and Edward A. Keller, Wiley student, 6th edition.
6. Standard handbook of Hazardous waste treatment and disposal by Harry M. Freeman, McGraw Hill.
7. Management of Solid waste in developing countries by FrankFlintoff , WHO regional publications.

Course outcomes:

- Student will gain knowledge on the types of solid wastes, their properties and collection, disposal techniques of MSW.
- Student will be able to understand the classification of hazardous wastes and their management practices.
- Student will be able to understand sources and types of soil pollution and faecal sudge and septage management.

M.Sc (ES) II – SEMESTER

SES 706: WATER AND WASTEWATER TREATMENT

Hours per week	**: 4**	**End Examination**	**: 60 Marks**
Credits	**: 4**	**Sessional**	**: 40 Marks**

Preamble:

The purpose of Water and wastewater treatment is to instill students' comprehensive knowledge and understanding on technologies for water and wastewater treatment. This course will cover operations of various types of water treatment facilities and the equipment used within them to treat and manage water.

Course Objectives:

- To identify parameters which characterize various constituents found in drinking water and wastewater.
- To deliver rudimentary indulgent and explanation of chief processes and technologies for treating drinking water and wastewater.

UNIT – I

Sources of water: Hydrological cycle, surface and ground water sources, comparison of surface and ground water sources with respect to their quality and quantity aspects, estimation of demand. Characteristics and quality of water - Physical, chemical and biological characteristics, standards.

Learning Outcomes

Upon completion of the unit the student will be able to:

- Understand Hydrological cycle, sources of water precisely with reference to their quality and quantity
- Comprehend water quality with reference to physical, chemical and biological parameters.

UNIT – II

Water Treatment - Intake unit, Sedimentation, Sedimentation with Coagulation, Filtration and Disinfection.

Learning Outcomes

Upon completion of the unit the student will be able to:

- Recognize and elucidate various treatment units, their principle, working and efficiency.

UNIT – III

Characteristics of waste water: Physical, chemical and biological characteristics, waste water sampling and analysis.

Waste water treatment: necessity of treatment. Preliminary treatment units: Screening, Grit chamber, Skimming. Primary sedimentation: Necessity.

Learning Outcomes

Upon completion of the unit the student will be able to:

- Comprehend wastewater quality with reference to physical, chemical and biological parameters.
- Depict various preliminary treatment unit their principle, working and efficiency

UNIT – IV

Activated sludge processes: biological principle, modification of ASP, Sludge volume index, sludge bulking and control. Trickling filter: biological principle, different trickling filter media &

their characteristics, rotating biological contactors.
Low cost treatment methods: oxidation pond: bacteria- algae symbiosis, advantages and disadvantages of oxidation pond.

Learning Outcomes
Upon completion of the unit the student will be able to:

- Appreciate activated sludge process, trickling filter and rotating biological contactors
- Acquire knowledge on low cost waste treatment methods.

UNIT – V

Low cost treatment methods: Aerated lagoons, Oxidation ditch and septic tank. Sewage disposal. Sludge disposal methods, advantages and disadvantages, UASBR- principle, advantages and disadvantages.

Learning Outcomes
Upon completion of the unit the student will be able to:

- Grasp sludge disposal methods their advantages and disadvantages
- Acquire knowledge advanced treatment methods upflow anaerobic sludge blanket reactor

Reference Books:

1. Wastewater Engineering – Treatment and Reuse, Fourth Edition by Metcalf and Eddy, Tata McGraw Hill Publication, New Delhi.
2. Water Supply & Sanitary Engineering by G.S.Birdie & J.S.Birdie, Dhanpat Rai Publishing Company, New Delhi, India.
3. Elements of Environmental Engineering by K.N.Duggal, S.Chand & Company Ltd. New Delhi.
4. Environmental Engineering by M. Ramachandraiah, Radiant Publishing House, Hyderabad.

Course Outcomes:
Upon completion of the course the student will be able to:

- Recognize and analyze various physical, chemical and biological contaminants present in water and wastewater.
- Be familiar with physical, chemical and biological unit operations in treatment processes.
- Elucidate fundamentals of water and wastewater treatment.
- Appreciate the low cost waste treatment methods and their principles.

M.Sc (ES)-II SEMESTER

SES 708: EARTH SCIENCE - SYSTEM & ITS RESOURCES

Hours per week : 4 **End Examination : 60 Marks**

Credits : 4 **Sessional : 40 Marks**

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 Objectives:

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

Land Topography: Structure and composition of the Earth. Origin of the Earth. Types of Rocks: Igneous, Sedimentary and Metamorphic Rocks, Description of Rocks. Land degradation, Land use pattern. Land conservation, Wastelands, Types of wastelands and their management.
Wetlands (Ramsar Convention) – types of wet lands, significance of wet land – Land management.

Learning Outcome:

- Upon completion of the unit a student will be able to understand the structure and composition of earth and the types of rocks and land conservation practices.

UNIT-II

Mineral Resources: Silicate minerals and Non Silicate minerals, Description of minerals like Pyroxenes, Amphiboles and Feldspars. Economic minerals like Gold, Copper, Aluminum, Iron, Manganese, Chromium, Coal, Petroleum, and Natural gases.

Learning Outcome:

- Upon completion of the unit a student will be able to understand the role of rocks and minerals, different types of minerals.

UNIT-III

Water Resources: Types of Water sources, Ground water, surface water etc. Water conservation – Water conservation strategies in India, watershed management, Cloud seeding for artificial rains.

Learning Outcome:

- Upon completion of the unit a student will be able to understand the types of water resources and water conservation techniques.

UNIT-IV

Energy Resources: Types of resources: Renewable and Non Renewable resources. Fossil Fuels, Nuclear Energy, Hydel Power, Geo thermal, Tidal Energy, Wind Energy and Solar Energy. Land Hazards – Like Earth Quakes and Volcanoes

Learning Outcome:

- Upon completion of the unit a student will be able to understand the types of energy resources, their importance, advantages and disadvantages.

UNIT-V

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

Learning Outcome:

- Upon completion of the unit a student will be able to understand the structure of atmosphere and its related issues.

Reference 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, Longman House.
4. Energy Resources G.D.Rai. Khanna Publishers, New Delhi
5. Environmental Problems & Its Solutions D.K.Asthana & Meera Asthana S.Chand & Co.
6. Environmental Science, S.C. Santra- Publisher New Central Book Agency (P) Ltd.

Course Outcomes:

Upon completion of the course the student will be able to:

- Understand the structure and composition of earth's surface and different types of rocks and minerals available.
- Water conservation techniques and types of energy resources.
- Structure of atmosphere and its related issues.

M.Sc (ES)-I SEMESTER
SAE 702: PROFESSIONAL COMMUNICATION SKILLS

Hours per week : 3 **Continuous Evaluation: 100 Marks**
Credits : 2

Preamble
This course is designed to expose students to the basics of academic and professional communication in order to develop professionals who can effectively apply communication skills, theories and best practices to meet their academic, professional and career communication needs.

Objectives:
To enable students to

- acquaint themselves with basic English grammar
- acquire presentation skills
- develop formal writing skills
- develop creative writing skills
- keep themselves abreast with employment-readiness skills

UNIT - I

BACK TO BASICS: Tenses, Concord – Subject Verb Agreement, Correction of Sentences-Error Analysis, Vocabulary building. (10 hours)

Learning Outcomes:
At the end of the unit, the student will be able to:

- Use structures and tenses accurately
- apply the right verb to the right subject in a sentence
- Detect incorrect sentences in English and write their correct form
- Acquire new vocabulary and use in speaking and writing

UNIT - II

ORAL PRESENTATION: What is a Presentation? Types of Presentations, Technical Presentation – Paper Presentation, Effective Public Speaking, Video Conferencing. (8 hours)

Learning Outcomes:
At the end of the unit, the student will be able to:

- Overcome speaking anxiety prior to presentation
- Plan and structure effective presentations that deliver persuasive messages
- Prepare slides that can catch the attention of the audience
- Engage the audience
- Skills in organizing, phrasing, and expressing the ideas, opinions and knowledge.
- Facilitate and participate in a video conference effectively

UNIT III

DOCUMENTATION : Letter –Writing, E-mail Writing & Business Correspondence, Project Proposals, Report Writing, Memos, Agenda, Minutes, Circulars, Notices, Note Making.
(10 hours)

Learning Outcomes:

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

- Write a business letter, which includes appropriate greetings, heading, closing and body and use of professional tone.
- Draft crisp and compelling emails
- Draft project proposals, reports and memos
- Prepare agenda and draft minutes
- Prepare circulars, notices and make notes.

UNIT IV

CREATIVE WRITING: Paragraph Writing, Essay writing, Dialogue Writing, Précis Writing, Expansion of Hints, Story Writing. (6 hours)

Learning Outcomes:

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

- Write paragraphs on familiar and academic topics using a topic sentence, supporting detail sentences and a conclusion sentence.
- Learn the structure of a five-paragraph essay and write essays that demonstrate unity, coherence and completeness
- Structure natural, lucid and spontaneous dialogues
- Draft clear, compact logical summary of a passage
- Recognize the elements of a short story and develop their functional writing skills.

UNIT V

PLACEMENT ORIENTATION: Resume preparation, group discussion – leadership skills, analytical skills, interviews –Types of Interviews, Preparation for the Interview, Interview Process. (8 hours)

Learning Outcomes:

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

- Write a professional resume that highlights skills, specific to the student's career field
- Acquire the personality traits and skills required to effectively participate in a G.D
- Understand the purpose of interviews
- Be aware of the processes involved in different types of interviews
- Know how to prepare for an interview
- Learn how to answer common interview questions

Text Books :

1. Essentials of Business Communication by Rajendra Pal and J S KorlahaHi, Sultan Chand & Sons.
2. Advanced Communication Skills by V. Prasad, Atma Ram Publications.
3. Effective Communication by Ashraf Rizvi, McGraw Hill Education; 1st Edition , 2005.
4. Interviews and Group Discussions How to face them by T.S.Jain, Gupta,1st Edition, Upkar Prakashan,2010.
5. High School English Grammar and Composition by P.C.Wren & Martin, N.D.V.Prasada Rao S.Chand.

M.Sc (ES)-II SEMESTER
SES 722: AIR POLLUTION AND CONTROL LAB

1. Introduction to Ambient air quality standards.
2. Demonstration of High volume sampler
3. Demonstration of Respirable dust sampler
4. Estimation of Particulate matter ($PM_{2.5}$ and PM_{10}) in ambient air by using dust sampler
5. Estimation of Sulphur dioxide in ambient air
6. Estimation of Oxides of Nitrogen in the ambient air
7. Wind rose preparation
8. Demonstration of Stack monitoring kit.

Practical Outcome:

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

- Demonstration and use of high volume samplers and respirable dust samplers.
- Estimation procedure of Particulate matter, SO_2, NO_2.
- Demonstration of stack monitoring kit.

M.Sc (ES)-II SEMESTER
SES 724: SOLID WASTE MANAGEMENT LAB

1. Physical characteristics of solid waste :
   a) Particle size; Temperature; pH; Conductivity and bulk density
2. Chemical characteristics of solid waste – Nitrogen, Phosphorus, Potassium and Heavy metals (selected).
3. Estimation of organic and Inorganic fraction of solid waste.
4. Determination of moisture in solid wastes.
5. Biological analysis of solid waste.

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.
- Biological analysis of solid waste.

M.Sc (ES) II – SEMESTER
SES 726: WATER AND WASTEWATER ANALYSIS LAB

1. Determination of Temperature, pH and Conductivity in water and wastewater samples.
2. Determination of turbidity of water and wastewater samples.
3. Determination of acidity / alkalinity and chloride in water and wastewater samples.
4. Determination of total solids, total dissolved solids and total suspended solids.
5. Determination of dissolved Oxygen in water and wastewater samples.
6. Determination of hardness in water and wastewater samples.
7. Determination of sulphate present in water and wastewater sample.
8. Determination of phosphate present in water and wastewater sample.
9. Determination of BOD of the wastewater sample.
10. Determination of COD of the wastewater sample.
11. Determination of nitrate content of the wastewater sample.
12. Determination of Coagulant dosage using Jar Test Apparatus.

Practical Outcome:

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

- Characterize water and wastewater through analyzing physical, chemical and biological parameters.
- Develop skill on interpreting dependent chemical and biological parameters from physical and chemical parameters.
- Determine doses of coagulant and chlorine in treating water and wastewater.

M.Sc (ES) II – SEMESTER

SES 728: EARTH SCIENCE - SYSTEM & ITS RESOURCES LAB

1. Identification of Rocks (Mega Scopic)
    a. Igneous Rocks
    b. Sedimentary Rocks
    c. Metamorphic Rocks
2. Identification of Minerals (Mega Scopic)
    a. Pyroxenes
    b. Amphiboles
    c. Feldspars
3. Identification of Economic Minerals (Mega Scopic)
    a. Bauxite
    b. Manganese
    c. Chromium
    d. Iron
4. Soil Particle size (sieve analysis)
5. Estimation of selected Heavy Metals in ores.

Practical Outcome:

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

- Identify different types of rocks based on their properties and structures.
- Analysis of soil particles through sieve analysis
- Analysis of selected heavy metals in ores.

M.Sc (ES) III – SEMESTER
SES 801: ENVIRONMENTAL IMPACT ASSESSMENT & CASE STUDIES

Hours per week	**: 4**	**End Examination**	**: 60 Marks**
Credits	**: 4**	**Sessional**	**: 40 Marks**

Preamble:
This course begins with concepts and procedure for preparation of EIA. To ensure the realistic assessment various impact assessment methodologies discussed along with environmental laws. Environmental management systems – ISO 14001, Lifecycle analysis and Environmental Audit highlighted to assess the impact of organization activities on environment. Environmental issues related to global and urban incorporated to protect nature and its biological diversity.

Course objectives:
The objective of the course is to teach students the process of Environmental Impact Assessment and procedures to be follow in environmental management in Industry. Students gain knowledge on environmental impact assessment methodologies and its applications. The course designed in unit wise format with real life case studies. Environmental management tool designed in such a way that students will be able to learn the procedures in risk assessment, life cycle assessment of industrial processes or products.

UNIT – I

Introduction of EIA – Definition, Function and purpose of impact analysis. EIA in Indian context, EIA Notification 2006, Procedures for preparing EIA - screening, scoping, impact implications, baseline studies and public hearing; Categorization of projects, list of projects and activity, Environmental Impact Statement [EIS].

Learning Outcome:

- Upon completion of the unit a student will be able to understand the procedure of EIA and categorization of projects and Environmental Impact Statement.

UNIT – II

Impact analysis and Predictions, Impact assessment methodologies – checklist, matrices, overlays, networking and Geographical Information System (GIS). Environmental protection acts- Water Act 1972, Air Act 1981, Environmental Protection Act (EPA) 1986, Wild life Act 1972, Hazardous waste rules.

Learning Outcome:

- Upon completion of the unit a student will be able to understand the different methodologies and related acts.

UNIT – III

Environmental Management and ISO Certification: concept of Environmental Management Systems (EMS), ISO 14000. Life Cycle Analysis (LCA), Environmental audit.
Environmental Issues & case studies: Forest – Importance of forests, Forest resources of India; Deforestation – causes, consequences of Deforestation; Forest management – Dimensions of deforestation in India; Chipko Movement.

Learning Outcome:

- Upon completion of the unit a student will be able to understand Environmental Management Systems and procedures of audit.

UNIT – IV

Urbanization trends in India – Impacts of urbanization on environment planning - Housing problem – slums – overcrowding – sanitation problems.
Environmental consideration in town planning. Water borne diseases.

Learning Outcome:

- Upon completion of the unit a student will be able to gain knowledge on problems of slums and town planning understand the types of solid wastes and properties of municipal solid waste.

UNIT – V

Global environmental problems- The threat to the Ozone layer – Causes for depletion of ozone. Antarctica Ozone Hole, The Montreal Protocol, Ozone depletion and related environmental problems and their mitigation. Environmental consequences of greenhouse effect, global warming and related environmental problems and their mitigation.

Learning Outcome:

- Upon completion of the unit a student will be able to understand the global environmental problems and their significant mitigation measures.

Reference Books:

1. Y. Anjaneyulu Environmental Impact Assessment Methodologies,B.S. Publications
2. Sherman, J. Rosen, Manual for Environmental Impact Evaluation. Prentice Hall, New Jersey.
3. Canter, L.W., Environmental Impact Assessment Mc Graw Hill, New York.
4. Rosen, J.J. Manual for Environmental Impact Evaluation Prentice Hall Inc., New Jersey.
5. Environmental Science by S.C. Santra; New Central Book Agency (P) Ltd.,
6. Environment Problems & Solutions by D.K.Asthana and Meera Asthana; S.Chand & Company Ltd.,
7. Introduction to Environmental Science by Y.Anjaneyulu; BS Publications.
8. Urban Sociology by Dr. Kumar; Published by Lakshmi Narain Agarwal.

Course outcomes:

- Student will gain knowledge on the procedure and methodologies of EIA.
- Student will be able to understand the steps and procedure of an Environmental Audit and preparation of Environmental Impact Statement.
- Student will be able to understand the problems of slums and town planning.

M.Sc (ES) III – SEMESTER
SES 803: INDUSTRIAL WASTE MANAGEMENT

Hours per week	**: 4**	**End Examination**	**: 60 Marks**
Credits	**: 4**	**Sessional**	**: 40 Marks**

Preamble

Industrial waste management is a vital means to slash off the toxic pollutants and hazardous substance its way into environment. This paper presents the basic information on a range of processes within each of the industries and gives a scope to understand the characteristics of effluences. Implementation of latest technology and safe disposal of toxic chemicals from various industries is the main objective, with ultimate outcome of Pollution reduction at source resulting in pollution free environment.

Course Objectives

- To make the students understand the definition, principle, scope, objective and various steps in handling the Industrial effluents.
- It gives a better theoretical idea about characterizing of waste water and effluents and helps in attaining the knowledge on implementing safe disposal techniques.
- To gain theoretical experience on the common effluent treatment plant, recirculation of waste waters.

Unit – I

Principles of Industrial Waste Treatment: Introduction, Principles of industrial waste management, sources of pollution, physical, chemical, organic and biological properties, effects of waste water on streams, land environment and human health, water and waste water treatment plants, Self-purification capacity of streams.

Learning Outcome:

- The student achieves knowledge on principals of industrial waste management, sources of pollution and their effects.

Unit – II

Waste reduction, alternatives for raw materials, process changes, housekeeping –
Pretreatment of wastes, collection of wastes, segregation – equalization – reduction
in volume and strength by other methods – theories of neutralization – equalizations and proportioning.

Learning Outcome:

- The student attains theoretical information on waste reduction methods and pretreatment techniques.

Unit – III

Manufacturing processes, characteristics and composition of wastes - treatment and disposal methods.
Food Industries: Sugar, Brewery and Dairy.
Miscellaneous Industries: Textile, Tanning, Fertilizers.

Learning Outcome:

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

Unit – IV

Manufacturing processes, characteristics and composition of wastes - treatment and disposal methods.
Material Industries: Paper, Steel, Metal - Plating and Petroleum refineries Miscellaneous Industries: Pharmaceutical and Atomic energy plants.

Learning Outcome:

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

Unit –V

Common Effluent treatment plants – Advantages and suitability, limitation, effluent disposal methods. Recirculation of Industrial wastes – Use of Municipal wastewater in Industries. Effluent discharge standards (on to land and water bodies).

Learning Outcome:

- The student can focus on handling of the common effluent treatment plant, and recirculation of waste waters.

Reference Books:

1. Water and Wastewater technology, Mark, J Hammer and Mark, J Hammer (Jr). John wiley and Sons, New York.
2. Water and waste water analysis, B.B. Sundaresan, NEERI, Nagpur.
3. Standard methods for examination of Water and waste water, APHA, American Water work Association, Water pollution control federation, New York.
4. Industrial Waste Management, M.N. Rao and A.K. Datta.

Course Outcomes

After reading this paper the student –

- Gain theoretical knowledge on Industrial waste management, characterization waste water.
- Boost up idea on various methods for handling effluents, the common effluent treatment plant, and recirculation of waste waters.
- Improved knowledge on Effluent discharge standards and advance techniques for safe disposal.

M.Sc (ES) III – SEMESTER
(Generic Elective-II)
SES 805: REMOTE SENSING TECHNIQUES IN ENVIRONMENTAL MANAGEMENT

Hours per week	**: 4**	**End Examination**	**: 60 Marks**
Credits	**: 4**	**Sessional**	**: 40 Marks**

Preamble:
Remote Sensing is the science of acquiring information about an object or a phenomenon kept at a distance, involving extraction of information from spectral images and analyzing them to understand various earth surface processes. Geographic Information system (GIS) is software for mapping. The course provides a basic understanding of the process and applications of remote sensing and GIS.

Course Objectives:
- To develop a sound basis for understanding the operation of Remote Sensing and GIS in environmental management.
- To provide exposure to students in gaining knowledge on concepts and applications leading to modeling of earth resources management using Remote Sensing.

UNIT – I

Fundamentals of Remote Sensing:
Introduction – Energy Sources and Radiation Principles: Electromagnetic spectrum – Energy Interactions in the Atmosphere – Energy Interactions with the Earth Surface features – Data Acquisition & Interpretation.
Image characteristics, Scale, Brightness, Tone and other characteristics – Atmosphere Windows – Platforms and Sensors.

Learning Outcomes
Upon completion of the unit the student will be able to:
- Understand the elements of remote sensing and image characteristics.

UNIT – II

Fundamentals of Aerial photography:
Introduction – Early History of Aerial Photography – Aerial Photographs - Scale of Photograph – Image displacements.
Techniques of photo interpretation – Advantages & Disadvantages of aerial photo – interpretation.
Applications of Remote Sensing - Land Use Land Cover analysis.

Learning Outcomes
Upon completion of the unit the student will be able to:
- Appreciate history of remote sensing and photo interpretation techniques

UNIT – III

Applications of Remote Sensing i) Agricultural applications ii) Geology and Mineral Resources iii) Forestry iv) Water resource application

Learning Outcomes
Upon completion of the unit the student will be able to:
- Elucidate environmental applications of remote sensing.

UNIT – IV

Applications of Remote Sensing
v) Urban and Regional Planning Applications vi) Wildlife Ecology
vii) Disaster Monitoring – Earthquakes, landslides, Drought, Desertification, Flood.

Learning Outcomes
Upon completion of the unit the student will be able to:

- Illustrate remote sensing applications for wildlife and disaster monitoring

UNIT – V

Fundamentals of Geographical information system (GIS): Introduction – GIS definition and terminology – GIS categories – Components of GIS – Fundamental operations of GIS – A theoretical framework for GIS.

Learning Outcomes
Upon completion of the unit the student will be able to:

- Comprehend basics of GIS

Reference Books:

1. Remote Sensing Principles and interpretation by Floyd F. Sabins, Jr. New York: W. H. Freeman and Company, New York.
2. Applications of Remote Sensing by Lilliesand. Thomas M. Lillesand, Ralph W. Kiefer. John Wiley & Sons, 7th Edition, New York
3. Textbook of Remote Sensing and Geographic Information System by M. Anjireddy, BSP Publication, Hyderabad.

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

- Elucidate interaction of electromagnetic radiation with atmosphere and earth's surface.
- Achieve knowledge in applications of remote sensing and GIS for solving environmental problems.

M.Sc (ES) III – SEMESTER
(Generic Elective-I)
SES 841: ENVIRONMENTAL BIOTECHNOLOGY & NANOTECHNOLOGY

Hours per week	**: 4**	**End Examination**	**: 60 Marks**
Credits	**: 4**	**Sessional**	**: 40 Marks**

Preamble
Biotechnological applications is an upcoming science, this course highights the aplications and concepts of modern biotechnology.

Course objectives:
This paper highlights the concepts and role of biotechnology in modern applications such as wastewater treatment, crop productivity, bioremediation and the use of nano materials in environmental pollution control.

UNIT – I
Environmental Biotechnology: Definition, Scope and role of Biotechnology in Environment Protection, Current Status of Biotechnology in Environment Protection, Future.
Bioreactors for Waste –Water Treatment: Aerobic biological Treatments (Activated sludge process, biological filters, Rotating Biological Contactors (RBC), Fluidized Bed reactors (FBR). Anaerobic Biological treatments: Contact Digesters, Packed column reactors, Anaerobic Baffled reactor, Upflow Anaerobic Sludge Reactor (UASB).

Learning Outcome:
- Upon completion of the unit a student will be able to gain knowledge on the role and status of biotechnology in environment protection, bioreactors for treatment of wastewater.

UNIT – II
Biomass based energy: Role of microbes in energy production, biogas production (Methanogenic bacteria), microbial hydrogen production, ethyl alcohol production from sugarcane and single cell protein (SCP).
Biofertilizers: Use of microbes as biofertilizers to improve crop productivity, Role nitrogen fixing bacteria in the enrichment of soil, Algal and fungal biofertilizers (VAM).Composting of organic wastes. Biopesticides: Bacterial (Bt pesticides), fungal (Trichoderma).

Learning Outcome:
- Upon completion of the unit a student will be able to gain knowledge on the role of microbes in energy production and use of microbes as biofertilizers.

UNIT – III
Bioremediation: Definition, need and scope of bioremediation, types of bioremediation. Bioremediation of soil and water contaminated with oil spills, heavy metals and pesticides by soil microorganisms.
Phytoremediation- cleaning up the environment by plants. Phytoremediation of heavy metal contaminated soils.

Learning Outcome:
- Upon completion of the unit a student will be able to gain knowledge on techniques and types of bioremediation and phytoremediation.

UNIT – IV

Microbial Mining – Use of microbes in biomineralization. Bioleaching. Basic concepts of Genetic engineering, role of genetic engineering in pollution mitigation
Biotechnology for air pollution abatement and odor control: Deodorization process - bioscrubbers, biobeds, Biotrickling filters.

Learning Outcome:

- Upon completion of the unit a student will be able to gain knowledge on the use of microbes in the process of bioleaching and biotechnology for air pollution and odor control.

UNIT – V

Introduction to Nanomaterials – Nanocrystals, Nanorods, Nanowires and Nanowalls and fullerenes, synthesis and characterization of metal oxide nano particles.
Applications of nano particles and carbon nanotubes in Environmental Pollution control

Learning Outcome:

- Upon completion of the unit a student will be able to gain knowledge on application of nanomaterials in environmental pollution control.

Reference Books:

1. Nanochemistry: A chemical approach to Nanomaterials by G.A.Ozin & A. Arsemault, Royal society of chemistry publications
2. Synthesis of Inorganic materials By Ulrich Schubert and Nicola Housing , wiley-VCH
3. Environmental Biotechnology by T.Srinivas, 1st Edition, New Age International Publications.
4. Environmental bio technology Theory and Application, Gareth M. Evans & Judith Furlong, Wiley Publications.
5. Environmental Biotechnology: A Biosystems Approach, Daniel A. Vallero, AP Publications.
6. Environmental Biotechnology. S.V.S.Rama Rastogi Publications.
7. Introduction to Environmental Biotechnology A.K.Chatterji, P.Hall of India.

Course Outcomes:

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

- Scope and role of Environmental Biotechnology in near future and types of bioremediation technologies.
- Use of microbes in different processes of mining and different types of nano materials available and their applications.

M.Sc (ES) III – SEMESTER

SES 843: BIO-GEO-CHEMISTRY OF MARINE SCIENCE

Hours per week	**: 4**	**End Examination**	**: 60 Marks**
Credits	**: 4**	**Sessional**	**: 40 Marks**

Preamble

Oceans the external skin and universal sink, the study of such envelope is marine science. Ocean being dynamic with majority of water on earth along with carbon and large amounts of biomass and is operated with combination with atmosphere, continents and crysophere. The bio-geo chemistry of marine science is mainly focused by marine scientists.

Course Objectives

- To make the students familiar with history of oceanography, physical properties, chemical composition and biological environment.
- It helps in attaining the knowledge on Estuarine environment, Biogeochemical cycle, nitrification and de-nitrification processes.
- The students will acquire basic knowledge on advanced instrumental techniques like Gas chromatography, High pressure liquid chromatography, Atomic Absorption spectroscopy etc including their application in the field of marine science.

UNIT – I

Introduction to Oceanography: History of oceanography, Marine Biological Institutions, origin of oceans- bottom topography. Physical Properties of Seawater: density, viscosity, surface tension, conductivity and their relationship, temperature distribution in the sea-heat budget. Chemical composition of seawater: ionic, major and minor constituents, trace elements their importance, distribution. Biological environment: Plankton- classification based on size, mode of life and habitat, Phytoplankton and Zooplankton.

Learning Outcome:

- The student gains theoretical knowledge on concept and history of oceanography.

UNIT – II

Estuarine environment: Physico-chemical properties of estuaries; Classification of estuaries Distribution of plankton in estuarine. Biogeochemical cycles: Cycling of Elements among Life and the Ocean (carbon, nitrogen, phosphorus, sulfur, and iron). Different methods for measuring the primary production, methods for measuring phytoplankton growth and zooplankton grazing, methods for measuring bacterial respiration, Estimation of nitrification and de-nitrification in water and sediments.

Learning Outcome:

- The student improves knowledge on classification of estuaries, cycling of Elements among Life and the Ocean.

UNIT – III

Gas chromatography: Principles, Instrumentation and it's applications in trace gases studies (Dimethyl sulphide, Methane, Nitrous oxide), and organic compounds (carbohydrates) separation. High pressure liquid chromatography (HPLC): Principles, Instrumentation and it's applications in Separation of pigments, and Amino Acids.

Learning Outcome:

- The students will have an exposure to estimation of various compounds using advance instrumentation.

UNIT – IV

Spectrophotometer: Principle, instrumentation and it's applications in determination of nutrients ($N0^-_2$, $N0_3^-$, NH_4^+, SIO_4^-, PO_4^{3-}), bio-chemical compounds (Carbohydrates, Proteins). Spectrofluorometer: Principle, instrumentation and it's applications in determination of chlorophyll and amino acids.

Learning Outcome:

- The student gains knowledge on the estimation procedures of nutrients, biochemical compounds etc using instrumentation techniques.

UNIT – V

Atomic Absorption spectroscopy (AAS): Principle, Instrumentation and it's application in determination of trace metals in sediment. Isotopic ratio mass spectrometry (IRMS): Principles, Instrumentation and it's applications in measuring stable isotopic ratios of oxygen, carbon, nitrogen.

Learning Outcome:

- The student gains better theoretical experience on the use of advance instrumentation for the estimation of trace metals and stable isotopes.

Reference Books:

1. Thurman, Harold. Introduction to Oceanography, Prentice Hall Inc. New Jersey.
2. Pilson, M.E.Q. An Introduction to the Chemistry of the Sea Prentice Hall New Jersey.
3. Millero F.J. Chemical Oceanography CRC press.
4. Sumich, J.L. Introduction to the biology of Marine Life 7th Edition. The Mc Graw Hill Companies Inc.
5. Nybakken, J.W. Marine Biology an Ecological Approach 4th edition. Addison Wesley Edu. Pub. Inc.
6. Barnes R.S.K. Introduction to Marine Ecology, Blackwell Science.
7. Jeffery S. Levinton. Marine Ecology, Biodiversity and Function. Oxford University Press.

Course Outcomes

After reading this paper the student –

- Gains theoretical knowledge on history of oceanography.
- Improves knowledge on classification of estuaries, cycling of Elements among Life and the Ocean.
- In the practical sessions the students will have an exposure in collection of marine water and sediment samples, determination of various parameters using advance instrumentation.

M.Sc. (ES) III – SEMESTER

SES 845: ENVIRONMENTAL PLANNING AND SUSTAINABLE DEVELOPMENT

Hours per week	**: 4**	**End Examination**	**: 60 Marks**
Credits	**: 4**	**Sessional**	**: 40 Marks**

Preamble:

The course is tailored to educational goals of students and emphasizes problem-oriented learning and systems approach to sustainability. It also prepares students towards leadership roles at the local, national and regional levels on sustainable development. Students are taught to master concepts on economic progress, environmental protection, social systems and resource conservation issues.

Objectives:

- Analyze the complex and dynamic interactions between humans and their environment;
- Apply professional techniques and procedures for environmental planning;
- Understand the measure to achieve sustainable development;
- Contribute to the development of environmental planning at various levels (company, municipality, national and international).

UNIT - I

Introduction to Environmental planning: Concept of environment planning, Importance of environmental planning.

Resources and environmental degradation, Pollutants and their effects on human health, types of Environmental Planning.

Learning Outcomes

Upon completion of the unit the student will be able to:

- To apply professional techniques and procedures for environmental planning
- Understand the role of natural resources in sustainability

UNIT – II

Analysis and prediction of Environmental issues: Environmental standards in India, Life Cycle Assessment, Material Flow Analysis.

Environmental Auditing and Environmental Management Systems – ISO 140001, Eco-efficiency.

Learning Outcomes

Upon completion of the unit the student will be able to:

- An understanding of life cycle thinking and awareness of resources supporting the adoption of this approach in organizational decision-making
- An ability to describe in everyday language what a life cycle assessment (LCA) is, as well as what it can (and cannot) do in order to apply LCA results appropriately

UNIT – III

Concepts of Sustainable Development, indices of sustainable development, factors affecting sustainable development. Urban environmental issues – Human habitation, ecological sustainability of urban areas.

Rio Earth Summit, Stockholm conference, Kyoto Protocol.

Learning Outcomes:

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

- Describe an integrated understanding of the current principles and practice of sustainable development as it is manifested at local, national and global levels.
- Contextualize any experience in the domain of sustainable development

UNIT – IV

Approaches to study the sustainable development, natural resources exploitation. Patterns of industrialization and harness technology.

Learning Outcomes:

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

- Identify approaches to the study of sustainable development
- Acquire patterns of industrialization

UNIT – V

Coastal Environments, Environmental Education for sustainable development.
Current Environmental issues in India – Case studies: Narmada Dam, Tehri Dam, Alametti Dam.

Learning Outcomes:

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

- Analyze various factors leading to sustainability of forests
- Apprehend the requirement of environmental education for sustainable development

Reference Books:

1. A Practical Guide to Understanding Management and Reviewing Environmental Risk Assessment Reports, Sally L. Benjamin and David, A. Bullock, Lewis Publishers, Washington D.C.
2. Hand Book of Environmental Risk Assessment and Management, Peter Calow, Blackwell-Synergy, London.
3. Environmental Management in Practice, Volume – I to III Instruments for Environmental Management, Nath, B., Hens,L., Compton, P and D. Devuyst, Routledge, London and New York.

Course Outcomes:

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

- Gain knowledge on environmental planning for strategic change and action at the local level.
- Recognize, understand and explain the complexity of linkages between resource use and ecological integrity.
- Contextualize any experience in the domain of sustainable development and identify types of hierarchy that are meaningful in the domain of sustainable development.

M.Sc. (ES) III – SEMESTER
SES 821: ENVIRONMENTAL IMPACT ASSESSMENT LAB

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.

M.Sc. (ES) III – SEMESTER
SES 823: REMOTE SENSING TECHNIQUES IN ENVIRONMENTAL MANAGEMENT LAB

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

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

- Read and interpret toposheet, aerial photos and satellite imageries.
- Prepare thematic maps and base maps.
- Study changes in Land use and Land Cover from aerial photographs and satellite imageries

M.Sc. (ES) III – SEMESTER
SES 823: INDUSTRIAL WASTE MANAGEMENT

Estimation of the following physico-chemical parameters in the given effluent (Food Processing/Diary/Fertilizer/Steel plant/Metal Plate/Petroleum refinery/Sugar/pre and post effluent from CETP & STP)

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
6. Determination of Sulphate concentration
7. Determination of Nitrate concentration

For the available Industrial Effluents like Food Processing, Diary, Fertilizer, Steel plant, Metal Plate, Petroleum refinery, and any other available effluents, comparison with effluent discharge standards given by CPCB

COURSE OUTCOME

Students gain hand on experience with the estimation of physico-chemical parameters in various industrial effluents and its comparison with the effluent discharge standards given by central pollution control board. As the student submit a detail report along with the suggestions with suitable treatment or methods to be adopted for safe disposal of effluent as per the norms of CPCB gets good exposure to report writing skills.

M.Sc. (ES) III – SEMESTER
(Generic Elective-I Lab)
SES 881: ENVIRONMENTAL BIOTECHNOLOGY & NANOTECHNOLOGY LAB

General techniques of microbiology

1. Isolation and Enumeration of soil bacteria
2. Determination of microbiological quality of water H_2S Strip Test
3. Bioreactors
4. Working of bioreactor for waste water treatment
5. Demonstration of other bioreactors.
6. Estimation of pesticide residues in vegetables using Finger printing technique.

Practical Outcome:

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

- Microbial analysis through isolation and enumeration of soil bacteria and analysis of quality of water.
- Pesticide residue analysis through finger printing technique.

M.Sc. (ES) III – SEMESTER
SES 883: BIO-GEO-CHEMISTRY OF MARINE SCIENCE LAB

1. Identification of Phytoplankton- Diatoms, Dinoflagellates, Blue green algae and Coccolithophores.
2. Identification of locally available Seaweeds, Sea grasses.
3. Estimation of Salinity.
4. Estimation of Dissolved Oxygen.
5. Estimation of Biological Oxygen demand.
6. Determination of Nitrite and Nitrate
7. Determination of Phosphate.
8. Determination of Silicate.
9. Estimation of Calcium and magnesium.
10. Estimation of Organic carbon in water and sediment.
11. Estimation of selected heavy metals.

Practical Outcome:

- The student can comprehension and identify the Phytoplankton and locally available Seaweeds, Sea grasses
- The student can handle the collection of marine water and sediment samples, determination of various parameters using advance instrumentation.

M.Sc. (ES) III – SEMESTER

SES 885: ENVIRONMENTAL PLANNING AND SUSTAINABLE DEVELOPMENT LAB

1. 8 Case studies on Environmental Planning
2. 2 case studies on Life Cycle Analysis
3. 2 Case studies on Material Flow Analysis
4. 2 Case studies on Environmental Audit

Practical Outcome:

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

- Compile and draft Environmental planning for a particular project with the information from previous studies.
- Perform inventory analysis and life cycle analysis at bench scale.
- Carry out material flow analysis and environmental audit at basic level.

M.Sc. (ES) IV – SEMESTER

SES 802: INDUSTRIAL SAFETY & DISASTER MANAGEMENT

Hours per week : 4 **End Examination : 60 Marks**

Credits : 4 **Sessional : 40 Marks**

Preamble:

The Course is designed to impart the student with skills and knowledge on the importance and need of safety in industries, during accidents and disaster management.

Course Objectives:

Through the course content, student will learn more about safety, incident management, risk reduction and crowd management along with other principles that relate to law enforcement, safety and public protection.

UNIT – I

Safety: Introduction, importance of the safety, Principles of industrial safety, definitions of Accident, Incident, Hazard, explosion, Contamination, Fire, protection, housekeeping, safe measures. Safety training and education.

Learning Outcome:

- Upon completion of the unit a student will be able to gain knowledge on importance of safety, principles of industrial safety and safety education.

UNIT – II

Occupational Health: Concept of health and occupational health, Spectrum of health, Occupational and work related diseases, Levels of prevention, History of occupational health, Characteristics of occupational diseases, Essentials of occupational health service, personal protective equipments (respiratory and non-respiratory).

Learning Outcome:

- Upon completion of the unit a student will be able to know occupational health disorders and protective equipment needed during occupation.

UNIT – III

Hazards in work places – Safety in Process plants: Nature and types of work places, type of Hazards, hazards due to improper housekeeping, workers exposure to hazardous chemicals, Physical and chemical properties of chemical leading to accidents like fire, explosion, ingestion and inhalation – atmospheric pollution, dangers of dusts, fumes, vapors in work spots, Noise and Vibration hazards.

Case studies - Hazards peculiar to the following industries: Thermal Power plants, Steel industry, Mining Industry, Fertilizers.

Learning Outcome:

- Upon completion of the unit a student will be able to gain knowledge hazards in work place and hazards of improper housekeeping and their related case studies.

UNIT – IV

Environmental Concepts of Disasters: Disaster – natural and manmade, understanding the causative factors vulnerability, their analysis and evolution. Environmental implications of Earthquakes, Avalanches, Volcanic eruptions, landslides, floods and tsunamis, cyclones, hurricanes, typhoons, tornadoes, Disasters due to nuclear chemical and biological weapons, Earthquakes in the areas of larger dams, forest fires and wild life destruction.

Learning Outcome:

- Upon completion of the unit a student will be able to gain knowledge natural and manmade disasters, causative factors and their environmental implications.

UNIT – V

Disasters Mitigation and Management: Identification of disaster prone areas and high risk groups – Disaster warning programmes, Disaster preparedness and prevention of loss to life, livestock, property, natural resources and ecology – development of Disaster Mitigation Plans – Awareness programmes and capacity building among the Risk Groups – Post disaster environmental problems and their management.

Learning Outcome:

- Upon completion of the unit a student will be able to gain knowledge disaster mitigation measures and warning programmes, preparedness during a disaster.

Reference Text Books:

1. R.K.Jain and Sunil S.Rao, Industrial Safety, Health and Environment Management Systems, Khanna publishers, New Delhi.
2. Slote.L.Handbook of Occupational Safety and Health, John Willey and Sons, New York.
3. Industrial Safety -National Safety Council of India.
4. The Factories Act with amendments 1987, Govt. of India Publications DGFASLI, Mumbai
5. Grimaldi and Simonds, Safety Management, AITBS Publishers, New Delhi.
6. Industrial Safety and pollution control handbook: National Safety Council and Associate publishers Pvt. Ltd, Hyderabad.
7. Handbook of Environmental Health and Safety: Herman Koren and Michel Bisesi, Jaico Publishing House, Delhi.
8. Environmental Challenges and Ecological disasters, Gopal Bhargava, Mittal Publication, New Delhi.
9. Environmental Risks and Hazards, Susan L.C., Prentice Hall of India Pvt, Ltd. New Delhi.

Course outcomes:

- Student will gain knowledge on importance of safety and precaution measures.
- Student will be able to understand occupation health hazards, hazards in work place and improper housekeeping.
- Student will be able to understand natural and manmade disasters, disaster mitigation measures and preparedness during a disaster.

M.Sc. (ES) IV – SEMESTER

SES 842: ENVIRONMENTAL REMEDIATION TECHNOLOGIES

Hours per week : 4 **End Examination : 60 Marks**

Credits : 4 **Sessional : 40 Marks**

Preamble:

This paper focuses on the technologies of 20th century, technology for control of air pollution, bioengineering for waste removal and the concept of composting technologies and sustainable agriculture.

Course Objectives:

The main objective of this paper is to make the student aware of the available technologies of 20th century and technologies for the control of air pollution, waste removal and concepts of composting technologies and sustainable agriculture

UNIT – I

Introduction: Technologies of 20th century, Technology transfer- the North to south issue, Technology a double edge sword: A boon or a bane, Technology for sustainable development, the dawn of (Nanotechnology), Negative legacy of Science & Technology.

Learning Outcome:

- Upon completion of the unit a student will be able to gain knowledge on technologies of present generation, their positive and negative issues.

UNIT – II

Technology for air pollution Control, Removal of sulphur from auto fuel, Removal of SO_2 form Coal Power plants by Flue-gas desulphurization, clean coal technology, Control technologies for VOCs.

Learning Outcome:

- Upon completion of the unit a student will be able to gain knowledge on air pollution control technologies.

UNIT – III

Bioengineering for Waste removal – Microremediation Technology, Phytoremediation, plant species involved in Phytoremediation, Mechanism of Phytoremediation. Vetiver Grass Technology (VGT) with case studies.

Learning Outcome:

- Upon completion of the unit a student will be able to gain knowledge on various bioengineered techniques and examples with case studies.

UNIT – IV

Composting Technology with case studies, Composting types, Environmental factors controlling composting. Composting methods (Microbial slurry – windrows technology, Vermi technology), Composting of hazardous wastes & their Significance.

Learning Outcome:

- Upon completion of the unit a student will be able to gain knowledge on composting technologies and its types and significance.

UNIT – V

Concept of Sustainable agriculture and transgenic plants. Biofertililizer technology (Rhizobium, Azospirillum, Mycorrhizal, Bluegreen algae, Azobacter, Azolla- BGA Symbiotic biofertilizer, Biomature technology, vermiculture biotechnology), Biotechnology for pest & disease control.

Learning Outcome:

- Upon completion of the unit a student will be able to gain knowledge on concept of sustainable agriculture and various biofertilizer technologies.

Reference Books:

1. Green Technology – P.K Sinha & Margaret Green way Pioneer Publ. Jaipur.
2. Environmental Biotechnology S.K. Agarwal APH.
3. Managing Industrial Pollution S.K.Bhatia MacMillan
4. Biotechnology and Biotechnology control of insect pests, Techcigl and Recheigl Lewis.
5. Hand book of Bioremediation, Norris et al Lewis.

Course outcomes:

- Student will gain knowledge on the available technologies of 20^{th} century and their issues.
- Student will be able to understand the technologies of air polltution control and bioengineered techniques.
- Student will be able to understand the concept of composting technologies, types and sustainable agriculture.

M.Sc. (ES) IV – SEMESTER

SES 844: ENVIRONMENTAL MODELING USING MATLAB

Hours per week : 4 **End Examination : 60 Marks**

Credits : 4 **Sessional : 40 Marks**

Preamble:

This Course has been introduced to inculcate Mathematical modeling in problem solving of the physical and chemical phenomena in the environment.

Course Objectives:

The main objective of this paper is to make student aware on the basis of environmental modeling using MATLAB technique. Mathematical formulas with computing helps in simulating the physical and chemical phenomena in the environment.

UNIT – I

Outline the nature and scope of modeling within the environmental sciences: Basic concept of environmental modeling, its scope and limitations. What is a model? Types of Models: Physical models, Mathematical models, Empirical models, Simulation models, Physical models.

Learning Outcome:

- By the end of the unit student will gain knowledge on the basic concepts of environmental modeling, its scope, limitations and models.

UNIT – II

Environmental Modeling using MATLAB: Introduction to MATLAB, Fundamentals of Modeling, Principles and MATLAB.

Learning Outcome:

- By the end of the unit student will be able to understand the concept of MATLAB and fundamentals of modeling.

UNIT – III

Transport of contaminants: Transport of solutions, Transport with Decay and Degradation, Transport and Sorption, Transport and Kinetics, Ordinary differential equations: Streeter-Phelps Model for River Purification.

Learning Outcome:

- By the end of the unit student will gain knowledge on the transport of different contaminants and Streeter Phelps model for river purification.

UNIT – IV

Flow Modeling: The Euler Equations and the Bernoulli Theorem, Darcy's Law for Flow in Porous Media, Flow in Unsaturated Porous Media.

Groundwater Drawdown by Pumping: Confined Aquifer, Unconfined Aquifer

Learning Outcome:

- By the end of the unit student will gain knowledge on Flow modeling and groundwater drawdown by pumping.

UNIT – V

2D and 3D Transport Solutions (Gaussian Puffs and Plumes) : 2D Instantaneous Line Source, 2D Constant Line Source, 3D Instantaneous Source, 3D Constant Source

Learning Outcome:

- By the end of the unit student will gain knowledge 2D and 3D transport solutions and models.

Reference Books:

Environmental Modeling using MATLAB by E. Holzbecher, Springer

Course outcomes:

By the completion of the course, the student will be able to

- Gain knowledge on basic concepts of environmental modeling, its scope and limitations.
- Understand the concept of MATLAB and fundamental of modeling
- Transport of different contaminants and model for river purification
- Gain knowledge on flow modeling and groundwater drawdown by pumping.
- Gain knowledge on 2D and 3D transport solutions and models.

M.Sc. (ES) IV – SEMESTER

SES 846: MARINE POLLUTION AND COASTAL ZONE MANAGEMENT

Hours per week : 4 **End Examination : 60 Marks**

Credits : 4 **Sessional : 40 Marks**

Preamble:

The course is designed to expose the students to various dimensions of marine pollution and tools for monitoring of pollution. Management of coastal zone management including coastal ecosystems with high productivity and rich in biodiversity will be dealt.

Course Objectives:

- To provide a multidisciplinary approach in defining major types of chemical, physical, and biological pollutants that impact upon marine environments.
- To examine pathways, fates and effects of these pollutants on marine ecosystems and human health.

UNIT-I

Marine Pollution-definition- role of GESAMP- major pollutant- sources, transport path, dynamics. Toxicology- lethal and sub lethal effects of pollutants to marine organisms, bioconcentration, bioaccumulation and biomagnifications- methods of toxicity testing factors influencing toxicity- synergistic and antagonistic effects- role of microcosms and mesocosms.

Learning Outcomes:

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

- Apprehend source, pathway of pollutants into marine environment and their effects.

UNIT - II

Sewage pollution industrial, agricultural and domestic impact on marine environment, treatment methods. Detergents- composition- eutrophication and ecological significance. Plastics and Litter source and impact in the marine environment.

Heavy Metal pollution- sources, distribution, fate- analytical approaches; Pesticide pollution classification, sources, distribution, fate and ecological impacts with special reference to marine fishes, birds and mammals.

Learning Outcomes:

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

- Scrutinize marine pollution from sewage and heavy metals.

UNIT - III

Oil Pollution- composition, sources, biological impacts on fishes, birds, mammals, treatment techniques. Thermal pollution- sources - uses of waste heat role of biocides, chlorine ecological impacts. Radioactive pollution- sources (natural and artificial) biological effects of radiation.

Environmental monitoring methods for critical pollutants-objectives status limitations, biological indicators - natural bioaccumulations (mussel watch water quality assessment. Use of analytical instruments AAS, ICP, GLC, Spectrofluorometer for analyzing Petroleum hydrocarbon, Pesticides, Heavy metals etc.

Learning Outcomes:

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

- Apprehend oil pollution and tools for monitoring pollutants.

UNIT- IV

Coastal and littoral zones – definitions and scope of study Shore zone processes – waves, tides and currents Coastal landforms; River deltas and dynamics of the delta-fringe coasts coastal classification

Coastal wetlands – Mangrove swamps, marshes, lagoons, tidal channels/creeks and their significance in coastal stability and economic importance Continental margins – forms and processes; territorial waters and Exclusive Economic Zone Sea level changes – factors involved; effects of sea level oscillations on coastal zones

Learning Outcomes:

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

- Appreciate coastal wetlands and littoral zones.

UNIT-V

Coastal Hazards: Storm surges and Tsunamis Origin, propagation and run-up of tsunamis; Tsunami impact – role of coastal topography and vegetation; Global warming and Sea-level rise - impact on coastal zones; coastal vulnerability assessment Coastal hazard preparedness – coastal protection, education and awareness of coastal communities

Coastal zone management – concepts, models and information systems Application of remote sensing in coastal zone studies Role of Geographic Information Systems in coastal zone studies.

Learning Outcomes:

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

- Gain knowledge on coastal hazards and coastal zone management.

Reference Books

1. Clark R.B. Marine pollution 3rd edition Clavendron, Press Oxford.
2. Williams. Introduction to Marine Pollution Control. John Wiley.
3. Michael J. Kennish. Practical Handbook on Estuarine and Marine Pollution.
4. Deltas, Coleman, J.M., Continuing education Publication Co.Inc.
5. Coastal Sedimentary Environments, Davis, A.R. (Jr.), Springer-Verlag.
6. Introduction to Marine Geology and Geomorphology, King, C.A.M., Edward Arnold

Course Outcomes:

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

- Demonstrate their understanding of pollution issues, their sources and the relationship humans have with the ocean as a source of food and a sink for waste.
- Understand the methods used to assess and quantify marine pollution
- Understand the complexity of the marine pollution problem and its impact on human health.

M.Sc. (ES) IV – SEMESTER
SES 882: ENVIRONMENTAL REMEDIATION TECHNOLOGIES LAB

1. Detection of pH, turbidity and odor in waste water
2. Measurement of BOD and COD in waste water
3. C/N ratio and N,P,K in compost and biofertilizers
4. Conduct a biodegradation study for soil organic pollutants
5. Carry out a treatability study of contaminated soil – bio absorption studies by microbes and plants.

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

- Analysis of physico-chemical parameters in water samples and wastewater samples.
- Biodegradation analysis of organic pollutants in soils
- Bio-absorption studies by microbes and plants in contaminated soils.

M.Sc. (ES) IV – SEMESTER
SES 884: Environmental Modeling Lab

1. Streeter –Phelps Model for River Purification
2. Darcy's Law for Flow in Porous Media
3. Confined Aquifer, Unconfined Aquifer
4. 2D Instantaneous Line Source
5. 2D Constant Line Source
6. 3D Constant Source

M.Sc .(ES) IV – SEMESTER
SES 886: Marine Pollution and Coastal zone Management

1. 2 Case studies on Marine Pollution (National and International)
2. 2 Case studies on Biomagnification in Marine environment (National and International)
3. 4 Case studies on Coastal Zone Management (National, International and Regional)

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

- Compile and draft marine pollution causes and propose appropriate measures for control.
- Perform inventory analysis regarding biomagnification in marine environment.
- Use the information from previous case studies to understand, interpret and analyze present scenarios and also to provide appropriate solutions.

M.Sc. (ES) IV – SEMESTER
SES 892: PROJECT & VIVA-VOCE

Students appearing for M.Sc. Environmental Science shall carry out a project in a relevant field, during the fourth semester, in consultation with the faculty –in-charge and submit a dissertation which will be evaluated for 200 marks.

Open Electives offered by the Department

SOE 855: ENVIRONMENTAL POLLUTION, MONITORING AND CONTROL

Hours per week: 3 End Examination: 60 Marks
Credits: 3 Sessionals: 40Marks

Preamble:
Knowledge in Environmental Sciences to all is of prime importance. Through this course student will explore the scientific basis of pollution, study the science behind pollutants and their effect on the environment.

Course Objectives:

- To understand various types of environmental pollution, pollutants, their causes and related diseases.
- To divulge various techniques available for pollution abatement

UNIT – I

Pollution and pollutants. Air pollution and its effects - air pollution - sources - pollutants – organic and inorganic pollutants - gaseous pollutants– nitrogen oxides - particulate pollutants - effect of air pollutants on environment - photochemical smog – Acid Rain - Greenhouse effect - Global warming - Monitoring and control measures of air pollution - dust control equipment's - Electrostatic precipitators and scrubbers.

Learning Outcome:
By the end of the unit the student will be:

- Gain knowledge air pollution, its effects and control methods.

UNIT – II

Water pollution and its effects - water pollution - sources - Pollutants - industrial effluents - domestic wastes - agrochemicals - Heavy metals - effect of water pollutants on environment – Eutrophication.
Waste water treatment - indicator organisms. Drinking Water standards.
Learning Outcome:
By the end of the unit the student will be:

- Achieve familiarity with water pollution, its effects and control methods.

UNIT – III

Soil pollution and its effects - soil pollution - sources - solid waste disposal and their effects - pesticides - biomagnification - fertilizers and their effects - soil pollution control measures - soil microbes and their function - biofertilizers.
Noise pollution and its effects - noise pollution - sources – noise exposure level and standards - impacts - noise control and abatement Measures.

Learning Outcome:
By the end of the unit the student will be:

- Accomplish awareness on soil and noise pollution, their effects and control methods.

UNIT IV

Marine pollution - sources and control of marine pollution – Coastal Zone Management.
Radioactive pollution and its impacts - radioactive - sources - effects of radioactivity on human beings - prevention and control measures of radioactive pollution.

Learning Outcome:
By the end of the unit the student will be:

- Attain familiarity with marine and radioactive pollution and their control.

UNIT V

Biotechnology in pollution control - Microbial role in pollution control - Biomonitoring and Bioremediation - Bioleaching and Biomineralization
Pollution control Legislations for air - water – land.

Learning Outcome:
By the end of the unit the student will be:

- Accomplish expertise role of biotechnology in pollution control.

Reference Text Books:

1. Gilbert M. Masters, Introduction to Environmental Engineering and Science, 3rd Ed. Prentice Hall of India Pvt. Ltd. New Delhi.
2. C.S.Rao, Environmental Pollution Control Engineering, 3rd Ed., New Age International Pvt. Ltd. New Delhi.
3. Jarry A. Nathanson, Basic Environmental Technology, 4th Ed., Prentice Hall of India Pvt. Ltd. New Delhi.
4. Bruce Rittman, Perry L. McCarty. Environmental Biotechnology: Principles and Applications, 2nd Edition, Tata McGraw-Hill, New Delhi.
5. J.N.B. Bell (2002) Air Pollution and Plant Life, 2nd Edition, John Wiley and Sons, New Delhi.

Course Outcomes:

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

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

SOE 857: CLIMATE CHANGE AND CURRENT ISSUES

Hours per week: 3 End Examination: 60 Marks
Credits: 3 Sessionals: 40Marks

Preamble:
Climate change and its related effects are observed worldwide. This course paper covers the topics on current energy scenario, global climate change, impacts of global warming and tools for climate change mitigation.

Course Objectives:
The course covers global climate change issues, energy and carbon emissions, impacts of global warming, clean development mechanism, and the tools to study and mitigate climate change.

UNIT – I

Energy and carbon emissions, World energy use and current energy scenario, Trends in energy use of oil, coal and gas, Energy use and air quality, Nuclear energy and environment.

Learning Outcome:

- Upon completion of the unit a student will be able to gain knowledge on energy and carbon emissions, current scenario and trends.

UNIT – II

Global climate change: Greenhouse effect, sources and trends of greenhouse gases, warming potential of gases. Photosynthetic mechanism and global climate change – case studies.

Learning Outcome:

- Upon completion of the unit a student will be able to gain knowledge on the scenario of global climate change, greenhouse effect and its related effects with case studies.

UNIT–III

Impacts of global warming: Polar ice caps and melting of glaciers, sea level increase, weather extreme conditions, ecosystems (terrestrial and ocean), human health, Climate change modeling studies.

Learning Outcome:

- Upon completion of the unit a student will be able to understand the impacts of global warming and its effect on human health and climate change.

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, biological and geological carbon sequestration, role of forests and drylands in carbon sequestration, carbon capture and storage technologies.

Learning Outcome:

- Upon completion of the unit a student will be able to understand the mitigation strategies for global warming, carbon sequestration and role of forests in carbon capturing.

Reference Text books:

1. Aguado, E. and James, E.B. Understanding weather and climate, Prentice Hall, New Delhi.
2. Armstrong, F. and Blundell, B., K. Energy beyond oil, Oxford, New York.
3. Burroughs, W.J. The climate revealed, Cambridge University Press.
4. Cleveland, C. J. Encyclopedia of Energy, Elsevier, New Delhi.
5. Cleveland, C.J. and Morris, C. Dictionary of energy. Elsevier, Oxford.
6. Goudie, A. S. and Cuff, D. J. Encyclopedia of global change, Oxford, New York.
7. Gupta, K.R. Encyclopedia of environment Global warming: problems and policies, Atlantic Publication, New Delhi.
8. IPCC (Intergovernmental Panel on Climate Change). Climate Change: The IPCC Assessment. Cambridge University Press, Cambridge.
9. Lovejoy, T.E. and Hannah L. Climate change and biodiversity, TERI press.
10. Newton, P. C.D., Carran R.A., Edwards, G.R., Pascal A. and Niklaus. Agroecosystems in a Changing Climate. Advances in Agroecology, CRC/Taylor & Francis.

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.