KERALA TECHNOLOGICAL UNIVERSITY

CET Campus, Thiruvananthapuram, Kerala -695 016

ORDINANCE

For

Master of Technology - M.Tech.

In exercise of the Powers conferred under Clause 44 of the Ordinance, the Executive Committee of the University hereby promulgate the Ordinance for the University for the Academic Year 2015-2016.

The Academic ordinance will come into effect from the date of publication in the Gazette.

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O-1 Admission to the M. Tech. Programme

Candidates who have been awarded or qualified for the award of the Bachelor's degree in Engineering / Technology, from an Institution approved by AICTE are eligible for admission to the M. Tech., Programme. Eligibility of candidates having MCA/MSc qualifications will be decided from time to time by following the guidelines issued by All India Council for Technical Education (AICTE) and the Government of Kerala and notified separately. Other important eligibility criteria are as listed out by the Director of Technical Education with the approval of the Government of Kerala.

O-1.1 Candidates qualified in Graduate Aptitude Test in Engineering (GATE) and admitted to the M. Tech. programme are eligible to receive Half Time Teaching Assistantship (HTTA) as per the rules of the All India Council for Technical Education (AICTE)/Ministry of Human Resource Development (MHRD).

O-1.2 Sponsored candidates from Industries, R&D organizations, National Laboratories as well as Educational Institutions, with a bachelor's degree in engineering are eligible for admission to the M. Tech. programme.

O-1.3 Foreign nationals whose applications are received through Indian Council of Cultural Relations, Government of India are also eligible for admission to the M. Tech. programme.

O-1.4 Announcements for M. Tech. Programmes will be made by the DTE, Government of Kerala.

O-1.5 Selection of candidates for the M. Tech programme will be done centrally or monitored by the Directorate of Technical Education as per the guidelines given on this by the Government of Kerala

O-1.6 The number of candidates to be admitted to each M. Tech stream will be as per the approval of the University which shall be based on decision on this given by the All India Council for Technical Education.

O-1.7 Admission will be complete only on meeting all the other requirements mentioned in the letter of admission and on payment of the fees.

O-1.8 Candidates who have the Associate Membership of Professional Bodies that are approved by the University and have qualified in GATE shall also be eligible for admission to the M. Tech. programme.

O-1.9 The reservation policy of the Government of Kerala and the Government of India shall be followed in admission to the M. Tech. programme.

O-1.10 All admission will be governed by the procedure laid down for this by the Director of Technical Education, Kerala and the Government of Kerala.

O-1.11 Notwithstanding all that is stated above, the admission policy may be modified from time to time by the University, particularly to confirm to directions from the Government of Kerala and the Government of India.

O-2 Duration of the Programme

The normal duration of the M. Tech programme, including the project work, shall be four semesters.

O-3 Post Graduate Programme Clusters

The University shall identify clusters of colleges offering M. Tech programmes in different streams and allow them to formulate procedures for the smooth conduct of all academic activities associated with the M. Tech programme, in line with the ordinances/regulations of the University. These clusters shall have academic autonomy, regulated by a Cluster level Graduate Committee [CGPC] consisting of all the principals of the colleges in the cluster. The Chairman of CGPC shall be an eminent academician nominated by the Vice Chancellor. The CGPC will be responsible for all academic matters including the curriculum, syllabi, course plans, internal evaluations, end semester examinations, and grading for all streams of M. Tech. programme offered by the colleges in the cluster.
The CGPC can formulate additional rules for other academic aspects that are not covered by this Ordinance.

O-4 Specialization Streams in M. Tech., Programme

The M. Tech. programme streams offered by each cluster as well as the eligibility of candidates of different B. Tech. branches or having other qualifications, for each of them shall be approved by the CGPC.

O-5 M. Tech. Programme Structure

i) The M. Tech programme in all streams of specialization will be structured on a credit based system following the semester pattern with continuous evaluation.

ii) The University permits regular as well as external registration (part time) for those in employment.

iii) The duration for the M. Tech. programme in all streams of specialization will normally be 4 semesters. The maximum duration is 6 semesters.

iv) For students admitted on external registration, the normal duration will be 6 semesters. Here the maximum duration is 7 semesters.

v) The University permits a regular student to change over to external registration during
the programme, under specific circumstances like initiating a start up venture or to take up a job.

vi) Each semester shall have a minimum of 72 instruction days followed by the end semester examination.

vii) A common course structure for the M. Tech programmes in all streams of specialization is to be followed and consists of the following.
Core Courses
Elective Courses
Laboratory Courses
Seminar
Project

viii) Every stream of specialisation in the M. Tech. programme will have a curriculum and syllabi for the courses. The curriculum should be so drawn up that the minimum number of credits for successful completion of the M. Tech. programme in any stream of specialization is not less than 64 and not more than 68.

Ix) Credits are assigned as follows, for one semester

1 credit for each lecture hour per week
1 credit for each tutorial hour per week
1 credit for each laboratory/ practical of 2 or 3 hours per week
2 credits for the seminar
2 credits for Mini Project
6 credits for Project in the 3rd Semester
12 credits for Project in the 4th Semester

x) A pass is mandatory in all core courses. In case of failure in an elective course, there is the provision to choose another elective listed in the curriculum.

xi) On their request, CGPC shall examine the academic records and permit candidates with B. Tech (Honours) who have earned credits for any relevant graduate level courses to transfer credits towards the M. Tech. programme. Candidates who received B. Tech (Honours) degree just prior to their M. Tech admission are permitted to transfer up to 9 credits. For those who received the B. Tech (Honours) degree within three years prior to their M. Tech. admission are permitted to transfer up to 6 credits.

Xii) The maximum number of lecture based courses and laboratory courses in any semester shall not exceed 5 and 2 respectively. The maximum credits in a semester shall be 23.

Xiii) Extension of Programme duration

The normal duration of the programme shall be four semesters.

In case of prolonged illness or other personal exigencies, the university may allow a student who has earned credits for at least one semester, to extend the programme up to the maximum duration of six semesters.

Students who have earned credits for the courses listed in the first two semesters are permitted to transfer their registration as external candidates if they take up a job. However, they have to complete the programme within six semesters.

O-6. Course Registration and Enrolment

All students have to register for the courses they desire to attend in a semester. Students admitted to the first semester are advised to register for all courses offered in the first semester. They do not have to enrol for the semester. All other students are required to register at the end of the semester for the courses they desire to take in the next semester. Later they have to enrol for these courses in the new semester based on the results in the previous semester. This allows them to make minor changes in the list of courses already registered for. Before enrolment, students should clear all dues including any fees to be paid and should not have any disciplinary proceedings pending. The dates for registration and enrolment will be given in the academic calendar. Any late registration or enrolment, allowed only up to 7 working days from the commencement of the semester, will attract a late fee.

A student can drop a course or substitute one already registered for by another, for valid reasons with the approval of the faculty advisor. However this has to be done within 7 working days from the commencement of the semester.

The maximum number of credits a student can register for in a semester is limited to 24.

O-7 Recommended Credit distribution over the semesters

First Semester : 20 to 23 credits
Second Semester : 18 to 19 credits
Third Semester : 14 credits

Fourth Semester : 12 credits [Project]

O-8. Academic Assessment/Evaluation

The University follows a continuous academic evaluation procedure.

The Assessment procedure and corresponding weights recommended are as follows:-

For theory courses

i) Two internal tests, each having 15%

ii) Tutorials/Assignments/ Mini projects having 10%

iii) End Semester examination having 60%

All the above are mandatory requirements to earn credits.

Students who have missed either the first or the second test can register with the consent of the faculty member and the Head of the Department concerned for a re-test which shall be conducted soon after the completion of the second test and before the end semester examination. The re-test will cover both the first and the second test course plans. If a student misses both the scheduled tests, there is no provision for any retests and zero marks will be given for each test. In case of serious illness and where the attendance is above 70% the Principal may permit the conduct of the tests for a student based on his application and other relevant medical reports. Such cases are to be reported to CGPC.

For Laboratory /Practical courses

i) Practical Records /outputs 40%

ii) Regular Class Viva-Voce 20%

iii) Final Test (Objective) 40%

O-9. Course Completion and earning of credits

Students registered and later enrolled for a course have to attend the course regularly and meet the attendance rules of the University and appear for all internal evaluation procedures for the completion of the course. However, earning of credits is only on completion of the end semester/supplementary examination and on getting a pass grade. Students, who had completed a course but could not write the end semester/supplementary examination for genuine health reasons or personal exigencies, if otherwise eligible are permitted to write the semester examination, at the next opportunity and earn credits without undergoing the course again. Failed candidates having more than 45% marks in their internals can also avail of this option. However, those who are not eligible to appear for the end semester examination have to register and undergo the course again, whenever it is offered, to earn the credits.

O-10. End Semester and Supplementary Examinations

At the end of the semester, the end semester examination will be conducted in all courses offered in the semester and will be of three hours duration unless otherwise specified. Supplementary examinations are to be conducted for eligible candidates registered for them, before the commencement of the next semester.

O-10.1 Eligibility to write the End Semester Examination and Grading

Eligibility criteria to appear for the semester examination are the attendance requirements in the course, 45% or more marks in the internal evaluation and having no pending disciplinary action. The minimum attendance for appearing for the semester examination is 85% in the course. In case of serious illness there is a relaxation for attendance [O-14.xvi]. Those who do not meet the eligibility criteria shall be awarded an FE Grade and have to register again for the course.

A student should have a minimum of 45% marks in the end semester examination to be eligible for grading in a course. Otherwise he/she will be considered to have failed in the course and an F grade will be awarded.

O-10.2 Eligibility to write the Supplementary Examination

Only failed students and those who could not write the semester examination due to health reasons or other personal exigencies that are approved by the Principal can register for the supplementary examination provided they meet the eligibility requirements given in O-10.1. Grades awarded in the supplementary examination will be taken as the semester grades in these courses.

O-11. Conduct of End Semester Examination

The Clusters will prepare the question papers, conduct the end semester examinations, organize the valuation of the answer scripts, finalise the results and submit it to the University, as per the academic calendar.

O-12. Award of M. Tech., Degree

The award of the M. Tech. Degree shall be in accordance with the Ordinances and Procedures given by the University.

A student will be eligible for the award of M. Tech. Degree of the University on meeting the following requirements;

i) Registered and earned the minimum credits, as prescribed in the curriculum, for the stream of specialization.
ii) No pending disciplinary action.

O-13. Amendments to Ordinance:

Notwithstanding all that has been stated above, the University has the right to modify any of the above provisions of the ordinance from time to time.

O- 14. Miscellaneous provisions:

i) Stream of Specialization:

The streams of specializations are to be in line with the approval given on this by the All India Council for Technical Education.

ii) Language of Instruction

Unless otherwise stated, the language of instruction shall be English.

iii) Academic Calendar

The University shall publish in its website the academic calendar for every academic semester indicating the date of commencement of the semester as well as instruction. It will specify the course registration and enrolment dates, the schedule for mandatory internal tests for theory courses, dates by which laboratory/practical evaluations are to be completed, date for finalization of internal marks, last instruction day in the semester, planned schedule of end semester examinations and result declaration as well as approved holidays falling within the semester. Schedules for the supplementary examinations and result declaration dates are to be included in the calendar. Additionally colleges may publish their academic calendar, in line with the University academic calendar, indicating other schedules and events they plan to conduct during the semester.

Iv) Eligibility to continue with the programme

A student has to earn a minimum number of credits in a semester to register for higher semester courses. This should be at least 2/3rd of the credits for the courses listed in for the semester. CGPC shall formulate the rules based on this and spell out the procedure to proceed with the programme.

Failed students who have more than 45% marks in the internal course evaluation are permitted to write the semester examination without registering and undergoing the course. Those with less than 45% in internal course evaluation have to register again for the course, attend the classes and earn the credits.

v) Seminar

Students have to register for the seminar and select a topic in consultation with any faculty member offering courses for the programme. A detailed write-up on the topic of the seminar is to be prepared in the prescribed format given by the Department. The seminar shall be of 30 minutes duration and a committee with the Head of the department as the chairman and two faculty members from the department as members shall evaluate the seminar based on the report and coverage of the topic, presentation and ability to answer the questions put forward by the committee.

Suggested evaluation procedure:-

Faculty member in charge of the seminar and another faculty member in the department nominated by the Head of the Department are the evaluators for the seminar. Distribution of marks for the seminar is as follows.

Marks for the report: 30%
Presentation: 40%
Ability to answer questions on the topic: 30%

vi) Project work

Project work is spread over the third and fourth semesters. Project work is to be evaluated both in the third and the fourth semesters. Based on these evaluations the grade is finalised only in the fourth semester.

Project evaluation weights shall be as follows:-
For convenience the marks are allotted as follows.

Total marks for the Project: 150

In the 3rd Semester:- Marks:50
Project Progress evaluation details:

Progress evaluation by the Project Supervisor	: 20 Marks
Presentation and evaluation by the committee	: 30 Marks

In the 4th Semester:- Mraks:100

Project evaluation by the supervisor/s	: 30 Marks
Presentation & evaluation by the Committee	: 40 Marks
Evaluation by the External expert	: 30 Marks

vii) Faculty Advisor, Class Committee

a) Faculty Advisor

The Head of the Department offering the M. Tech. programme shall nominate senior faculty members as faculty advisors who shall advise the students in academic matters and support them in their studies. Their role is to help the students in academics and personal difficulties related to studies. A faculty advisor may support a group of students in a semester.

b) Class Committees are to be in place for all M. Tech. programs in the college.

Class Committee

All M. Tech streams of specialization will have class committees for each semester, constituted by the respective Heads of Departments.

The Chairman of the committee shall be a senior faculty member who does not offer any course for that stream in that semester.

Members:-

i) All faculty members teaching courses for the stream in that semester.
ii) Two student representatives nominated by the Head of the Department, from the stream.

Class committees shall meet at least thrice in a semester - one in the beginning and one around the middle of the semester and one at least two weeks before the semester examinations. These committees should monitor the conduct of the courses, adherence to the course plan and time schedule, completion of the

syllabus, standards of internal tests and evaluation process and address the difficulties faced by the students and take suitable remedial actions at the appropriate time. Before the end semester examination, the committee should meet without the student representatives and finalise the internal marks. A report on the student performance in each course should be prepared and submitted to the CGPC by the colleges.

viii) Award of Grades

Grading is based on the marks obtained by the student in a course. [O-14 ix]

The grade card will only show the grades against the courses the student has registered.

The semester grade card will show the grade for each registered course, Semester Grade Point Average (SGPA) for the semester as well as Cumulative Grade Point Average (CGPA).

ix) Grades and Grade Points

Grades and Grade Points as per UGC guidelines are to be followed by the University

Grades	Grade Point	% of Total Marks obtained in the course
O	10	90% and above
A^+	9	85% and above but less than 90%
A	8	80% and above but less than 85%
B^+	7	70% and above but less than 80%
B	6	60% and above but less than 70%
C	5	50% and above but less than 60%
P	4	45% and above but less than 50%
F	0	Less than 45%
FE	0	Failed due to eligibility criteria [O.10.1]
I		Course Incomplete

Grade Point Average (GPA) and Cumulative Grade Point Average (CGPA) are calculated based on the above grading norms and are explained at the end of this document.

x) Academic Auditing

The University shall have a detailed academic auditing procedure in place comprising of an internal academic auditing cell within the college and an external academic auditing for each college. The internal academic auditing cell in each college shall oversee and monitor all academic activities including all internal evaluations and semester examinations. This cell is to prepare academic audit statements for each semester at regular intervals of four weeks of instruction. These reports are to be presented to the external academic auditor appointed by

the University, who will use it as a reference for his independent auditing and for the final report to the University.

Academic auditing will cover:-

i) Course delivery covering syllabus, adherence to course plan, quality of question papers for internal examinations, internal evaluation, laboratory experiments, practical assignments, mini projects, conduct of practical classes and their evaluation. Semester examination and academic performance of the students.

ii) Co-curricular and Extra-curricular activities available for students, and their organization.

iii) Academic functioning of the college encompassing students, faculty and college administration covering punctuality, attendance, discipline, academic environment, academic accountability, academic achievements and benchmarking.

xi) Revaluation and Grade improvement

There is no provision for revaluation of the semester answer books or for improving the grade.

` Students are permitted to check the answer books of the semester examination, after the results are declared. Any discrepancies in evaluation could be brought to the notice of the teacher concerned who will initiate appropriate action on this and report to the CGPC for a final decision on this.

xii) Grade Cards

Students who have written the semester examination will be given the grade cards for the registered courses, in every semester by the respective colleges. On earning the required credits for the degree, a consolidated grade sheet for the M. Tech programme will be issued by the University on the recommendation of the respective CGPC.
The M. Tech. degree will not have any classification like distinction or first class.

xiii) Academic Discipline and Malpractices in Examinations

Every student is required to observe discipline and decorous behaviour.
Any act of indiscipline, misbehaviour and unfair practice in examinations will be referred to the **Disciplinary Action Committee** (**DAC**). Malpractices in examinations shall be viewed seriously and any such incident observed or reported by a faculty member or an invigilator associated with the examinations shall be reported to the Principle who in turn shall refer it to DAC. On the basis of the report and evidence available or gathered, DAC shall immediately initiate an enquiry giving the concerned student a chance to explain his/her case. Based on this the committee shall recommend the course of action in line with the guidelines formulated for this by the Controller of Examination of the University and forward it to the Principal for action.

Actions are to be based on the severity of the offence and are to be dealt with, on a course basis. Guidelines on this shall be given by the Controller of Examination which is to be followed by the Disciplinary Action Committee of the college.

DAC shall be headed by a department head and shall have three other faculty members drawn from different departments as members. In case of malpractices in end semester examinations, the report given by the college DAC and the action taken by the Principal shall be intimated to the Controller of Examination of the University

xiv) Student's Welfare Committee

Every college shall have a Student's Welfare Committee, constituted by the Principal of the college. This committee shall have at least three faculty members as members and the chairman shall be a senior faculty member in the rank of a Professor. This committee is entrusted with the task of looking after the welfare of the students by taking appropriate steps with the concurrence of the principal.

xv) Grievances and Appeals Committee

Each college should have a Grievances Redress Committee constituted by the Principal to address the grievances of the students and to consider their appeals on any decisions made by the college. This committee consisting of at least three faculty members and chaired by a senior professor shall look into student's grievances and appeals and give its recommendations to the Principal for action.

xvi) Attendance

Attendance is marked for each course. 85% attendance is mandatory for writing the semester examination in a course. Students who get Part Time Teaching Assistantship (PTTA) or Scholarships from the Central or State Governments or any other agencies are expected to have 100 % attendance. However, under unavoidable circumstances students are permitted to take leave. Leave is normally sanctioned for any approved activity taken up by students outside the college covering sports and other extra-curricular activities. Leave is also permitted on medical grounds or on personal exigencies. Leave of absence for all these is limited to 15 % of the academic contact hours for the course.

In case of long illness or major personal tragedies/exigencies the Principal can relax the minimum attendance requirement to 70%, to write the semester examination. This is permitted for one or more courses registered in the semester. The Principal shall keep all records which led to his decision on attendance, for verification by the Academic Auditor. However this concession is applicable only to any one semester during the entire programme. In case of prolonged illness, break of study is permitted up to two semesters which could extend the programme up to six semesters, the maximum permitted by the regulations.

xvii) Leave of Absence

Students who desire to take leave have to apply for it to the teacher conducting the course. This application together with any supporting documents like doctor's certificate or other relevant information is to be forwarded to the Head of the Department with the recommendation of the teacher indicating the total leave of absence the student has so far availed. Approval for leave is to be given by the head of the department. After any prolonged medical leave, normally exceeding five instruction days, on rejoining, the student has to produce the fitness certificate given by the doctor.

xviii) Project Evaluation

Normally students are expected to do the project within the college. However they are permitted to do the project in an industry or in a government research institute under a qualified supervisor from that organization. Progress of the project work is to be evaluated at the end of the third semester. For this a committee headed by the head of the department with two other faculty members in the area of the project and the project supervisor/s. If the project is done outside the college, the external supervisor associated with the student shall also be a member of the committee.

Final evaluation of the project will be taken up only if the student has earned all course credits listed in the first three semesters. Project evaluation shall be done by the same committee mentioned above with an external expert, either from an academic/R&D organization or from Industry, as an additional member. Final project grading shall take into account the progress evaluation done in the third semester and the project evaluation in the fourth semester. If the quantum of work done by the candidate is found to be unsatisfactory, the committee may extend the duration of the project up to one more semester, giving reasons for this in writing to the student. Normally further extension will not be granted and there shall be no provision to register again for the project.

Xix) Project work outside the College

While students are expected to do their projects in their colleges, provision is available for them to do it outside the college either in an industry or in an institute of repute. This is only possible in the fourth semester and the topic of investigation should be in line with the project part planned in the 3rd semester. Student should apply for this through the project supervisor indicating the reason for this well in advance, preferably at the beginning of the 3rd semester. The application for this shall include the following:-

Topic of the Project:
Project work plan in the 3rd Semester:
Reason for doing the project outside:
Institution/Organization where the project is to be done:

External Supervisor – Name:
Designation:
Qualifications:
Experience:

Letter of consent of the External Supervisor as well as from the organization is to be obtained.

This application is to be vetted by the head of the department and based on the decision taken the student is permitted to do the project outside the college.

Ragging

Ragging of any nature is a criminal and non-bailable offence. Involvement in ragging shall lead to stringent punishment, including imprisonment as per the law of the land. A student, whose involvement in ragging is established, shall be summarily dismissed from the college. Each student of the Institute, along with his/her parent, is required to give an undertaking in this regard and the same is to be submitted at the time of registration.

Calculation of SGPA/CGPA

Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA) are calculated as follows.

SGPA = $\Sigma(C_i \times GP_i)/\Sigma C_i$ where C_i is the credit assigned for a course and GP_i is the grade point for that course. Summation is done for all courses registered by the student in the semester. Here the failed courses are also accounted.

CGPA = $\Sigma(C_i \times GP_i)/\Sigma C_i$ where C_i is the credit assigned for a course and GP_i is the grade point for that course. Summation is done for all courses registered by the student during all the semesters for which the CGPA is needed. Here the failed courses are also accounted. CGPA of all courses passed may also be given.

Thiruvanthapuram **Registrar**
26-6-2015

APJ Abdul Kalam Technological University

Cluster 4: Kottayam

M. Tech Program in Environmental Engineering

Scheme of Instruction & Syllabus: 2020 Admissions

Compiled By
Rajiv Gandhi Institute of Technology, Kottayam
July 2020

APJ Abdul Kalam Technological University

(Kottayam Cluster)

M.Tech Program in Environmental Engineering

Scheme of Instruction

Credit Requirements : 67 credits (22+19+14+12)

Normal Duration : Regular: 4 semesters; External 6 semesters

Maximum Duration : Regular: 6 semesters; External 7 semesters

Allotment of Credits and Examination Scheme

Semester I

Exam Slot	Course No.	Course Name	L-T-P	Internal Marks	End Semester Exam		Credits
					Marks	Duration (Hours)	
A	04CH6201	Applied Statistics	4-0-0	40	60	3	4
B	04CH6203	Environmental Chemistry	4-0-0	40	60	3	4
C	04CH6205	Environmental Microbiology	3-0-0	40	60	3	3
D	04CH6207	Physico-chemical Treatment Systems	3-0-0	40	60	3	3
E	04CH62XX*	Elective-I	3-0-0	40	60	3	3
S	04GN6001	Research Methodology	2-0-0	100	0	0	2
T	04CH6291	Seminar-I	0-0-2	100	0	0	2
U	04CH6293	Environmental Analysis Lab-I	0-0-2	100	0	0	1
Total							**22**

* See List of Electives-I for slot E

List of Elective- I Courses

Exam Slot	Course No.	Course Name
E	04CH6209	Solid and Hazardous Waste Management
E	04CH6211	Remote Sensing and GIS
E	04CH6213	Environmental Health and Hygiene
E	04CH6215	Surface Water Hydrology

M.Tech in Environmental Engineering

Semester II

Exam Slot	Course No.	Course Name	L-T-P	Internal Marks	End Semester Exam		Credits
					Marks	Duration (Hours)	
A	04CH6202	Biological Treatment Systems	4-0-0	40	60	3	4
B	04CH6204	Air Quality Monitoring and Control	3-0-0	40	60	3	3
C	04CH6206	Environmental Impact Assessment	3-0-0	40	60	3	3
D	04CH62XX*	Elective-II	3-0-0	40	60	3	3
E	04CH62XX^	Elective-III	3-0-0	40	60	3	3
T	04CH6292	Design Project	0-0-4	100	0	0	2
U	04CH6294	Environmental Analysis Lab-II	0-0-2	100	0	0	1
Total							**19**

* See List of Electives-II for slot D ^ See List of Electives-III for slot E

List of Elective- II Courses

Exam Slot	Course No.	Course Name
D	04CH6208	Environmental Toxicology
D	04CH6210	Water Quality Modeling
D	04CH6212	Environmental Management and Audit
D	04CH6214	Sustainable Development and Green Technology

List of Elective- III Courses

Exam Slot	Course No.	Course Name
E	04CH6216	Environmental Nanotechnology
E	04CH6218	Global Climate Changes and Disaster Management
E	04CH6220	Advanced Waste Water Treatment
E	04CH6222	Water Pollution Control and Stream Sanitation

Summer Term – Field Visit/Professional Practice- 4-6 weeks

Exam Slot	Course No.	Course Name	L-T-P	Internal Marks	End Semester Exam		Credits
					Marks	Duration (Hours)	
NA	04CH7290	Field Visit/ Professional Practice	0-0-4	NA	NA	NA	Pass/Fail

M.Tech in Environmental Engineering

Semester III

Exam Slot	Course No.	Course Name	L-T-P	Internal Marks	End Semester Exam		Credits
					Marks	Duration (Hours)	
A	04CH72XX*	Elective-IV	3-0-0	40	60	3	3
B	04CH72XX^	Elective-V	3-0-0	40	60	3	3
T	04CH7291	Seminar-II	0-0-2	100	0	0	2
W	04CH7293	Project (Phase-I)	0-0-12	50	0	0	6
Total							**14**

* See List of Electives-IV for slot A ^See List of Electives-V for slot B

List of Elective-IV Courses

Exam Slot	Course No.	Course Name
A	04CH7201	Ground Water Contamination Pollution Transport
A	04CH7203	Environmental Geotechnology
A	04CH7205	Air Quality Modeling
A	04CH7207	Environmental Economics

List of Elective- V Courses

Exam Slot	Course No.	Course Name
B	04CH7209	Planning and Design of Environmental Facilities
B	04CH7211	Environmental Systems Analysis
B	04CH7213	Lifecycle Assessment
B	04CH7215	Sustainable Coastal Engineering

Semester IV

Exam Slot	Course No.	Course Name	L-T-P	Internal Marks	End Semester Exam		Credits
					Marks	Duration (Hours)	
NA	04CH7294	Project (Phase-II)	0-0-21	70	30	NA	12
Total							**12**

Course No.	Course Name	L-T-P-Credits	Year of Introduction
04CH6201	APPLIED STATISTICS	4-0-0-4	2020

Course Objectives

To enable the students apply statistics in various areas of environmental engineering like sampling and analysis, stochastic modeling etc.

Syllabus

Probability distributions -Sampling techniques- Regression and correlation- Statistical inference- Applications-Time series models.

Course Outcome

Upon successful completion of this course, the student will have basic knowledge in mathematics which is essential for higher studies and research in engineering.

Text Books

Gupta S.C. and Kapoor V.K, *Fundamentals of Mathematical Statistics*, Sultan Chand and Sons, 1978.

Irwin Miller & Marylees Miller, *Mathematical Statistics*, Pearson Education Inc. 2004.

References

Richard A. Johnson, Miller and Freunds, *Probability and Statistics for Engineers*, Prentice Hall of India, 2007.

Dallas E Johnson, *Applied Multivariate Methods for Data Analysis*, Thomson & Duxbburg Press, Singapore, 2002.

Jay L. Devore, *Probability and Statistics for Engineering and Sciences*, Thomson and Duxbburg Press, Singapore, 2002.

Richard A. Johnson and Dean W. Wichern, *Applied Multivariate Statistical Analysis*, Pearson Education, 2002.

COURSE PLAN

Module	Contents	Contact Hours	% of marks in End Semester Examination
I	**Probability Distributions** Probability mass functions and probability density function, mean and variance, binomial, poisson,	8	15

	exponential, gamma, lognormal and normal distribution, fitting of the distributions.		
II	**Sampling techniques** Simple random sampling, stratified sampling, systematic sampling, sample size determination, application in environmental engineering.	8	15
FIRST INTERNAL EXAM			
III	**Regression and Correlation** Linear regression and correlation, multiple correlation coefficient, standard error of estimate, curvilinear regression, applications.	9	15
IV	**Statistical Inference** Intervals estimation, confidence interval for mean, variances and regression coefficients. Sampling distribution, test of significance of (i) means (ii) mean of two samples (iii) proportions (iv) variance (v) two variances (vi) two observed correlation coefficients (Fishers' z transformation), (vii) paired T-test (viii) regression coefficients (ix) chi-square test of goodness of fit, skewness and kurtosis tests.	11	15
SECOND INTERNAL EXAM			
V	**Applications** Analysis of variance (i) completely randomized designs (ii) randomized block designs., latin squares, grecco latin square design, factorial experiments, graphical presentation techniques.	12	20
VI	**Time Series Models** Components of time series, smoothing, measuring forecasting accuracy, testing of ARIMA models.	8	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
04CH6203	ENVIRONMENTAL CHEMISTRY	4-0-0-4	2020

Course Objectives

Gain knowledge on areas of Chemistry which are valuable for understanding environmental problems.

Understand analytical instrumental techniques used for identification and quantification of various types of contaminants

Syllabus

Introduction to adsorption, buffer capacity of soil, colloids, aerosols, desalination by reverse osmosis, radioactivity, nuclear energy, radioactive waste disposal, chemistry of water, water pollution, advanced oxidation processes, organic pollutants in the environment, biodegradation of pesticides, chromatography, electrophoresis, spectroscopic methods of analysis.

Course Outcome

Upon successful completion of this course, the student will be able to understand the fundamental concepts environmental chemistry and the various phenomena behind toxicity and pollution.

Text Books

1. C. N. Sawyer, Pery L. McCarty - *Chemistry for Environmental Engineering* (Mc Graw Hill)

References

1. APHA – *Standard methods for the examination of water and waste water*.

2. P. K. Ray – *Pollution and Health* (Wiley Eastern Ltd)

3. S. K. Banerjee – *Environmental Chemistry*.

4. Chatwal and Anand – *Instrumental Methods of Analysis* (Dhanpat Rai)

5. David Harvey - *Modern Analytical Chemistry* (McGraw-Hill Higher Edn)

Internal Continuous Assessment: 40 marks

Internal continuous assessment is in the form of periodical tests and assignments/tutorials. Two internal tests each carrying 15 marks will be conducted. Assignments/tutorials carry 10 marks. The assessment details are to be announced to students' in the beginning of the semester itself by the course instructor.

End semester Examination: 60 marks			
COURSE PLAN			
Module	**Contents**	**Contact Hours**	**% of marks in End Semester Examination**
I	**Introduction to Adsorption** Physisorption and chemisorption. Adsorption of pollutants and nutrients introduced to soil - principal factors governing sorption in soils. Acids and bases (different concepts), ionic product of water, pH and buffers – Henderson Hassel Balch's equation. Buffer capacity of soil, soil acidity and liming.	8	15
II	**Colloids** Classification, properties and their stability (zeta potential). Atmospheric (tropospheric and stratospheric) aerosols. Destruction of colloids – basic methods of coagulation. Desalination by reverse osmosis. Spectroscopy based on scattering (Turbidimetry and Nephelometry).	8	15
FIRST INTERNAL EXAM			
III	**Radioactivity** Atoms, nuclear stability and radioactivity, radioactive decay (α, β, γ), half life period, nuclear fission, nuclear energy, storage and disposal of spent fuel and high level radioactive waste. Principles and applications of neutron activation analysis and radiocarbon dating.	9	15

IV	**Chemistry of Water** Pollutants in water – determination of water quality parameters like acidity, alkalinity, BOD, COD. Hardness, hardness removal techniques, analysis of minerals such as Fe, Ca, and Mg in water. Mineralization of organic contaminants in water by advanced oxidation processes.	9	15
SECOND INTERNAL EXAM			
V	**Major Organic Pollutants in the environment** Polycyclic aromatic hydrocarbons, persistent organic pollutants (like DDT and hexachlorobenzene) polychlorinated biphenyls, synthetic pesticides (classification), and volatile organic compounds. Biodegradation of pesticides - enzymatic activities.	11	20
VI	**Chromatography** Thin layer, gas (flame ionization and electron capture detectors), HPLC, size exclusion and supercritical fluid chromatography. Electrophoresis - Theory of capillary electrophoresis and capillary electrochromatography. Spectroscopic methods of analysis – IR, UVvisible – Atomic absorption spectroscopy	11	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
04CH6205	ENVIRONMENTAL MICROBIOLOGY	3-0-0-3	2020

Course Objectives

Understand the role of microorganisms, in various fields viz industry, water and waste water, soil and air

Provide students with a foundation in environmental microbiology for applications in pollution control.

Course Outcome

Upon successful completion of this course, the student will be able plan and design processes involving microorganisms.

Text Books

Pelczar, M.J., Chan E.C.S. and Krieg, N.R. *Microbiology*, Tata McGraw Hill, New Delhi, 1993.

Alan H Varnam, Malcon G Evans, *Environmental Microbiology*, CRC Press

References

Rose E Mckinney. *Microbiology for Sanitary Engineers*-Tata McGraw Hill series in sanitary engineering and science.

Gamey and Lord. *Microbiology for Waste Water and Sewage*

Tortora. G.J, B.R. Furke, and C.L.Case, *Microbiology-An Introduction* (4thEd.), Benjammin/Cummings publ.Co.,Inc., California,1992.

Keya Sen, Nicholas J Ashbolt, *Environmental Microbiology: Current Technology and Water Applications*, Caister Academic press

APHA, *Standard methods*

Roger T Stainer and Michael Dandroff. *General Microbiology*.

Internal Continuous Assessment: 40 marks

Internal continuous assessment is in the form of periodical tests and assignments/tutorials. Two internal tests each carrying 15 marks will be conducted. Assignments/tutorials carry 10 marks. The assessment details are to be announced to students' in the beginning of the semester itself by the course instructor.

End semester Examination: 60 marks

COURSE PLAN			
Module	**Contents**	**Contact Hours**	**% of marks in End Semester Examination**
I	**Introduction to Microbiology** Microorganism and their characteristics- classification, Application in sanitary engineering. General characteristics of the bacteria, algae, fungi, protozoa, viruses.	7	15
II	**Microscopy** Principles and use of light microscopes Dark field, bright field, phase contrast and fluorescent. Electron microscopes- Scanning and Transmission type. Comparison between various types, Merits and Demerits Characteristics of bacteria - Morphology and structure of bacteria Observation of wet and stained preparation - Grams stain	6	15
FIRST INTERNAL EXAM			
III	**Bacterial Growth and Metabolism** Growth of bacteria, growth curve factors influencing growth, Aerobic and anaerobic growth Role of enzymes, mechanism of action and factors influencing enzyme action, Basic concepts of metabolism. Principle of bioenergetics Culture media, composition, classification.	7	15

IV	**Microbiology of Water, Wastewater Soil and Air** Water borne diseases and their causative organisms, Bacteriological analysis of water and sewage, test for coliforms, their significance Bacteriological standards, MPN, Membrane filter technique.	6	15
SECOND INTERNAL EXAM			
V	**Microbial Production of Industrial Products** Microorganisms and Industry, Major classes of products and Processes, Principles of bio technology applied to waste treatment, Waste utilization, Bio-energy conversion	8	20
VI	**Biogeochemical Cycling** Role of microorganisms in biogeochemical cycle Dairy microbiology-diseases transmitted through milk, Pasteurization-different methods-Test for Pasteurization Importance of sterilization, factors influencing sterilization, principles and methods	8	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
04CH6207	PHYSICO-CHEMICAL TREATMENT SYSTEMS	3-0-0-3	2020

Course Objectives

To learn the working principles and design of various physical and chemical treatment systems for water and waste water

Syllabus

Sources of water, physical and chemical quality of water - sedimentation processes- coagulation and flocculation-filtration, design of filters – Disinfection-transportation and distribution of water, Hardy cross method and equivalent pipe method -Wastewater sources, Physical and chemical characteristics of wastewater - Flow rate and fluctuations - Fundamentals of process kinetics- Reactor analysis- Theory and design of physicochemical unit operations for wastewater.

Course Outcome

Upon successful completion of this course, the student will be able to

Understand the quality and treatment methods of water and waste water

Design treatment units of water and waste water

Text Books

Weber W.J *Physico-chemical processes for Water Quality Control*, John Willy and sons ,Newyork, 1990.

References

Metcalf and Eddy Inc., *Wastewater Engineering Treatment Disposal Reuse*, Tata McGraw Hill Publishing Company, 1991.

Ronald L.Droste, *Theory and Practice of Water and Wastewater treatment*, John Willy and sons (ASIA) Pvt Ltd, 1997.

Mark J Hammer, Mark J Hammer Jr, *Water and Wastewater Technology* Prentice Hall of India Pvt Ltd, 2007.

Santhosh Kumar Garg, *Water Supply Engineering*, Khanna publishers, 1996.

Santhosh Kumar Garg, *Sewage Disposal and Air Pollution Engineering*, Khanna publishers, 2008.

Internal Continuous Assessment: 40 marks

Internal continuous assessment is in the form of periodical tests and assignments/tutorials. Two internal tests each carrying 15 marks will be conducted. Assignments/tutorials carry 10 marks. The assessment details are to be announced to students' in the beginning of the semester itself by the course instructor.

End semester Examination: 60 marks

COURSE PLAN			
Module	**Contents**	**Contact Hours**	**% of marks in End Semester Examination**
I	**Physical Processes** Sources of water, physical and chemical quality of water, water quality standards ,sedimentation processes-types of settlings-tube settlers-design of sedimentation tanks, coagulation and flocculation-coagulation processes, filtration-filtration processes-filter media-types of filters, hydraulics of filtration-filter problems-design of filters	7	15
II	**Disinfection and Transport** Disinfection-processes-methods of disinfection, details of chlorination ad other disinfectants. Transportation and distribution of water, distribution system design and analysis. Hardy cross method and equivalent pipe method	6	15
FIRST INTERNAL EXAM			
III	**Water Flow** Wastewater sources, Physical and chemical characteristics of wastewater. Estimation and quantity of wastewater, Flow rate and fluctuations. Effluent standards, variations in concentrations of wastewater constituents Analysis of mass loadings	7	15

IV	**Process Fundamentals** Fundamentals of process kinetics, Zero order, First order, Second order Reactions, Reactor analysis; Completely mixed batch reactor, Continuous flow stirred tank reactor, Plug flow reactor.	8	15
SECOND INTERNAL EXAM			
V	**Design Principles-I** Theory and design of physicochemical unit operations for wastewater: Screening, grit removal Equalization, flotation	7	20
VI	**Design Principles-II** Theory and design of physicochemical unit operations for wastewater: Aeration/gas transfer, Chemical precipitation, Adsorption, adsorption isotherms, Disinfection.	7	20
END SEMESTER EXAM			

List of Courses under Elective-I

Exam Slot	Course No.	Course Name
E	04CH6209	Solid and Hazardous Waste Management
E	04CH6211	Remote Sensing and GIS
E	04CH6213	Environmental Health and Hygiene
E	04CH6215	Surface Water Hydrology

Course No.	Course Name	L-T-P-Credits	Year of Introduction
04CH6209	SOLID AND HAZARDOUS WASTE MANAGEMENT	3-0-0-3	2020

Course Objectives

To provide information regarding different elements of land pollution, various hazardous wastes, their origin, characteristics and treatment.

Maintain a comprehensive integrated solid waste management approaches that addresses collection, transportation and disposal.

Enable protection of the environment by fulfilling the laws, regulations, ordinances and other requirements as set forth by the country.

Provide safe recycling and disposal options for special wastes that may pose harm to the environment and /or to public health and safety.

Create awareness on advanced principles related to the separation, processing and transform technologies of solid wastes.

Syllabus

Legal and Organizational foundation: Definition of solid waste- Determination of composition of MSW- storage and handling of solid waste- Collection and transport of solid waste:. Separation and Processing and Transformation of Solid Waste: unit operations used for separation and processing, Materials Recovery facilities. Waste transformation through combustion and anaerobic composting, anaerobic methods for materials recovery and treatment- Energy recovery – Incinerators. Transfer and Transport: Landfills: Hazardous waste management: Biomedical waste disposal. Solidification, chemical fixation and encapsulation, incineration.

Course Outcome

Upon successful completion of this course, the student will be able to

Promote the management of hazardous substances from the waste point of view

Suggest more efficient recycling methods and to reduce the harmful climatic impacts of waste management.

Text Books
Charles A. Wentz – *Hazardous Waste Management*, McGraw- Hill

References
Technobanoglous et al –*Integrated Solid Waste Management*, McGraw- Hill

Manual on *Municipal Solid Waste Management*, Central Public Health and Environmental Engineering Organization, Government of India, New Delhi, 2000

George Tchobanoglous, Hilary Theisen and Samuel A, Vigil, *Integrated Solid Waste Management*, McGraw-Hill, New York, 1993

Vesilind, Worrell, Reihhart, *Solid Waste Engineering*, RCRA Orientation Manaul 2006, USEPA

Internal Continuous Assessment: 40 marks

Internal continuous assessment is in the form of periodical tests and assignments/tutorials. Two internal tests each carrying 15 marks will be conducted. Assignments/tutorials carry 10 marks. The assessment details are to be announced to students' in the beginning of the semester itself by the course instructor.

End semester Examination: 60 marks

COURSE PLAN

Module	Contents	Contact Hours	% of marks in End Semester Examination
I	**Legal and Organizational foundation** Definition of solid waste-waste generation in a technological society- major legislation, monitoring responsibilities, sources and types of solid waste- sampling and characterization- Determination of composition of MSW- storage and handling of solid waste- Future changes in waste composition.	6	15
II	**Solid Waste Transport** Collection of Solid waste: type of waste collection systems, analysis of collection system- alternative techniques for collection system. Separation and Processing and Transformation of Solid Waste: unit operations used for separation and processing, Materials Recovery facilities.	7	15

FIRST INTERNAL EXAM			
III	**Waste Recycle** Waste transformation through combustion and anaerobic composting, anaerobic methods for materials recovery and treatment- Recycling of plastic materials and metals, Energy recovery – Incinerators. Transfer and Transport: need for transfer operation, transport means and methods, transfer station types and design requirements.	7	15
IV	**Landfills** Site selection, design and operation, drainage and leachate collection systems – requirements and technical solutions, designated waste landfill remediation – Integrated waste management facilities.	6	15
SECOND INTERNAL EXAM			
V	**Hazardous Waste Management** Hazardous waste management: Definition and identification of hazardous wastes- sources and characteristics- hazardous wastes in Municipal Waste- Hazardous waste regulations– minimization of Hazardous Waste–compatibility, handling and storage of hazardous waste- collection and transport, Hazardous waste treatment and design: Hazardous waste treatment technologies – Design and operation of facilities for physical, chemical and thermal treatment of hazardous waste.	8	20
VI	**Biomedical Waste Disposal** Biomedical waste disposal. Solidification, chemical fixation and encapsulation, incineration. Hazardous waste landfills: Site selection, design and operation – remediation of hazardous waste disposal sites.	8	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
04CH6211	REMOTE SENSING AND GIS	3-0-0-3	2020

Course Objectives

To make the students understand the basics of emerging fields -remote sensing principles and Geographic Information System- so that they can utilize it for environmental system modeling

Syllabus

Introduction to remote sensing -Sensors- Satellite system parameters-Different types of data products and their characteristics-Geographic Information system-Data input and data editing Input methods- Integration of RS and GIS

Course Outcome

Upon successful completion of this course, the student will have basic knowledge about the applications of Remote Sensing and GIS in Environmental Engineering.

Text Books

Chang, K, *Introduction to Geographic Information Systems*, Tata McGraw Hills Edition, New Delh, 2005

References

Lillesand T.M. and Kiefer R.W *Remote sensing and Image Interpretation*, Second Edition, John Wiley and Sons, 1987.

AnjiReddy, M *Remote Sensing and Geographical Information System*, BSP Publications, 2001.

Manual of *Remote Sensing*, American Society of Photogrammetry and Remote Sensing, 1993.

Paul Curran P.J, *Principles of Remote Sensing*, ELBS, 1983.

Sabins F.F. Jr., *Remote Sensing Principles and Interpretation*, W. II. Freeman and Company, 1978.

Internal Continuous Assessment: 40 marks

Internal continuous assessment is in the form of periodical tests and assignments/tutorials. Two internal tests each carrying 15 marks will be conducted. Assignments/tutorials carry 10 marks. The assessment details are to be announced to students' in the beginning of the semester itself by the course instructor.

End semester Examination: 60 marks

COURSE PLAN			
Module	**Contents**	**Contact Hours**	**% of marks in End Semester Examination**
I	**Introduction to Remote Sensing** Electromagnetic spectrum – Physics of remote sensing – Effects of atmosphere – Atmospheric windows – Interaction of earth surface features with EMR – Spectral characteristics of vegetation, water and soil.	6	15
II	**Various Types of Platforms** Airborne and space based platforms - Different types of aircraft –Manned and unmanned spacecraft used for data acquisition – Characteristics of different types of platforms – Characteristics of Remote Sensors –Multi spectral sensors – Multi Spectral Scanners – Microwave remote sensing- Factors affecting Microwave Measurement-Radar wave bands- SLAR and SAR.	7	15
FIRST INTERNAL EXAM			
III	**Sensors** Satellite system parameters- sensor parameters-spatial, spectral and radiometric resolution – False colour composite (FCC) – Multi spectral photographs – Thermal and microwave imaging system-Earth Resources satellite and Meteorological satellites	7	15
IV	**Data Characteristics** Different types of data products and their characteristics – Image Interpretation - Basic principles of visual interpretation – Elements of image interpretation - Equipment for visual interpretation – Activities of image interpretation – Ground truth - Basic principles of digital image processing – filtering	6	15

SECOND INTERNAL EXAM			
V	**GIS** Geographic Information system – History and development of GIS – GIS definitions and Terminology -Architecture– System concepts – Coordinate systems – Standard GIS packages Type of data – Spatial and non- spatial data –Data structure – Points – Lines – Polygon –Vector and raster – Files and data formats –Spatial data modeling –Raster GIS model and Vector GIS models.-GIS data file management and Database models	8	20
VI	**Modeling** Data input and data editing-Input methods –GPS as data capture-data editing, Spatial analysis – Data retrieval – Query – Simple analysis – Record – Buffering and Overlay – Vector data analysis – Raster data analysis –Modelling in GIS – Digital elevation model –DTM – Modelling Networks Integration of RS and GIS – Need and Facilities for integration. Application of these to water resources and environmental engineering – Cadastral records and LIS	8	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
04CH6213	ENVIRONMENTAL HEALTH AND HYGIENE	3-0-0-3	2020

Course Objectives

To make the students aware about environmental issues like adverse effect of pollutants on health and control methods for mitigating the effects.

Introduce the students to our natural environment and the human interactions with our environment and global community from a hygienic perspective.

Analyze physical, chemical, biological and ergonomic agents, factors and/or stressors with the human body:

Recognize, evaluate, and control the factors in the environment that may cause illness, injury, or impairment.

Syllabus

Health- various aspects-factors –diseases-worldwide problems- Occupational health related problems- Disease-control, prevention, food borne and water borne diseases - Nuclear energy and environmental health- Environmental health planning-national and international level- law and human welfare- environmental education

Course Outcome

Upon successful completion of this course, the student will be able to

Increase the awareness of environmental issues and how they affect society.

Develop general skills and insight into critical thinking and situational awareness of surrounding environment.

Develop quantitative skills needed to function as a professional in occupational and environmental hygienist.

Understand basic biological concepts needed to evaluate exposure-response relationships.

Text Books

N H Seemayer, W Hadmagy, Edited by Springer- Vorlag Willgoose-*Environmental Health*

References

Morgan, *Environmental Health*

Cairncross and Feachem, *Environmental Health Engineering in Tropics*

H. Koren, *Handbook of Environ mental Health and Safety–Principle and Practices*, Lewis Publishers, 1991.

I. C. Shaw and J. Chadwick, *Principles of Environmental Toxicology*, Taylor & Francis ltd, 1998

Internal Continuous Assessment: 40 marks

Internal continuous assessment is in the form of periodical tests and assignments/tutorials. Two internal tests each carrying 15 marks will be conducted. Assignments/tutorials carry 10 marks. The assessment details are to be announced to students' in the beginning of the semester itself by the course instructor.

End semester Examination: 60 marks

COURSE PLAN			
Module	**Contents**	**Contact Hours**	**% of marks in End Semester Examination**
I	Dimensions of environmental health, causative agents of diseases, social factors, urban problems, housing and health, economy and health, climate and other atmospheric elements, violence, crime and mental health	6	15
II	Industrial and agricultural pollutants, occupational health, epidemiological data, occupational health hazards, environmental exposure and diseases, industrial toxicants, hazardous wastes, preventing exposure to unhealthy and unsafe working conditions.	7	15
FIRST INTERNAL EXAM			

III	Foodborne, air borne and waterborne diseases outbreaks, Disease control, disease prevention, morbidity and mortality, diseases and progressive deterioration, controlling diseases and disability., epidemiology, chronic and communicable diseases, vector control, controlling stress of life.	6	15
IV	Nuclear energy and environmental health, concerns and uncertainties about nuclear power, nuclear power plants, safety, E waste and environmental health, MSW and environmental health.	7	15
SECOND INTERNAL EXAM			
V	Environmental health planning, need for planning, the planning process, Environmental health services, various agencies, International efforts, role of industry, voluntary health agencies. family health practices, health care planning and delivery.	8	20
VI	Law and human welfare, constitutional right to healthy environment, environmental education, worldwide nutrition and population control.	8	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
04CH6215	SURFACE WATER HYDROLOGY	3-0-0-3	2020

Course Objectives

To comprehend the basic concepts of the water cycle and hydrology to get a conceptual and quantitative understanding of hydrology to perform engineering hydrology computations

Syllabus

Fundamental hydrology. Hydrological cycle. Introduction, Components. Catchment description. Introduction to hydrologic models. Precipitation: Characteristics, collection and presentation of rainfall data, Test for consistency and continuity of data, average precipitation depth-area-duration analysis. Hydrologic abstractions: Interception and depression storage, evaporation. Infiltration- process, Infiltration indices. Components of runoff, factors affecting runoff, Hydrograph and its components: Base flow and its separation, Unit hydrograph theory and its application. Synthetic unit hydrograph, conceptual models. Hydrometry, Computation of peak flow. Flood routing. Statistical analyses of hydrologic data - frequency analysis, probability distribution. Recurrence interval, I-D-F curve, flow duration curve, flow mass curve. Probability distribution functions, extreme value distribution, Gumbel's, Pearson Type – III, Stochastic processes, time series analysis, synthetic data generation.

Course Outcome

Upon successful completion of this course, the student will be able to

Analyze components of hydrologic cycle

Predict hydrologic extreme events for hydraulic and hydrologic design

Apply stochastic methods in solving hydrologic problems

Assess surface water resources

Text Books

Subramanya, K, *Engineering Hydrology*, Tata McGraw Hill

Chow, V.T., Maidment, D.R., Mays, L.W., *Applied Hydrology*, McGraw

Hill Jayarami Reddi, P, *A Text Book of Engineering Hydrology*, Laxmi

Publications

References

Linsley, Kohler & Paulhus, *Engineering Hydrology*, McGraw Hill.

Mays, L.W., *Water Resources Engineering*, John Willey and Sons, US, 2001.

Haan, C. T., *Statistical Methods in Hydrology*, Iowa State University Press, 1977.

Alfredo H-S. Ang, Wilson H. Tang-*Probability Concepts in Engineering: Emphasis on Applications to Civil and Environmental Engineering*

Internal Continuous Assessment: 40 marks

Internal continuous assessment is in the form of periodical tests and assignments/tutorials. Two internal tests each carrying 15 marks will be conducted. Assignments/tutorials carry 10 marks. The assessment details are to be announced to students' in the beginning of the semester itself by the course instructor.

End semester Examination: 60 marks

COURSE PLAN

Module	Contents	Contact Hours	% of marks in End Semester Examination
I	**Fundamental Hydrology** Hydrological cycle-components of hydrologic cycle. Catchment – description- stream patterns, Introduction to hydrologic models, Precipitation-forms, measurement, analysis of data, consistency, supplementing missing data, hyetograph, analysis, raingauge network,mean rainfall, DAD curves	6	15
II	**Hydrologic Abstractions** Interception and depression storage, evaporation-factors influencing. Evapotranspiration. Infiltration-process, measurement of infiltration, infiltration models, infiltration indices Runoff: - factors affecting Runoff, components of runoff, basin yield	6	15
FIRST INTERNAL EXAM			

III	**Hydrograph and its Components** Base flow and its separation, Unit hydrograph theory and its application for isolated and complex storms,S- curve, Unit hydrograph of varied durations.	7	15
IV	**Applications** Synthetic unit hydrograph- Snyder method, CWC method, Instantaneous unit hydrograph, conceptual models. Computation of peak flow: - Rational and Empirical relationships.Design flood, design storm, PMP, PMF. Dam safety. Flood rules.-CWC guide lines.	8	15
SECOND INTERNAL EXAM			
V	**Hydrometry** Gauge and discharge sites, velocity measurement, area velocity method, stage-discharge relation, rating curve.Flood routing: Routing through reservoirs and channels .Muskingum Method, Pul's Method	7	20
VI	**Analysis of Hydrologic Data** Statistical analyses of hydrologic data - frequency analysis, probability distribution and its application to rainfall and discharge data. Recurrence interval, I-D-F curve, flow duration curve, flow mass curve Probability distribution functions, extreme value distribution, Gumbel, Pearson Type –III, Stochastic processes, time series analysis, synthetic data generation	8	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
04GN6001	RESEARCH METHODOLOGY	2-0-0-2	2020

Course Objectives

To prepare the student to do the pursue graduate project work with a research bias. To formulate a viable research question.

To develop skill in the critical analysis of research articles and reports. To analyze the benefits and drawbacks of different methodologies.

To understand how to write a technical paper based on research findings.

Syllabus

Introduction to Research Methodology, Research Criteria, Research Design, Quantitative Techniques, Report Writing, Research Documentation

Course Outcome

Upon successful completion of this course, the student will be able to

Understand research concepts in terms of identifying the research problem

Propose possible solutions based on research

Write a technical paper based on the findings. Identify a domain of interest.

Obtain good domain and experience to pursue future research activities

Text Books

C. R. Kothari, *Research Methodology*, New Age International, 2004 Panneerselvam, *Research Methodology*, Prentice Hall of India, New Delhi 2012

References

J. W. Bames, *Statistical Analysis for Engineers and Scientists*, Tata McGraw-Hill, New York.

Donald Cooper, *Business Research Methods*, Tata McGraw-Hill, New Delhi. Leedy

P. D., *Practical Research: Planning and Design*, McMillan Publishing Co.

Day R. A., *How to Write and Publish a Scientific Paper*, Cambridge University Press, 1989.

Manna, Chakraborti, *Values and Ethics in Business Profession*, Prentice Hall of India, New Delhi, 2012.

Sople, *Managing Intellectual Property: The Strategic Imperative*, Prentice Hall of India, New Delhi, 2012.

Internal Continuous Assessment: 100 marks

Internal continuous assessment is in the form of periodical tests and assignments/tutorials. Two internal tests each carrying 15 marks will be conducted. Assignments/tutorials carry 10 marks. The assessment details are to be announced to students' in the beginning of the semester itself by the course instructor.

COURSE PLAN			
Module	**Contents**	**Contact Hours**	**% of marks in End Semester Examination**
I	**Introduction to Research Methodology** Concepts of Research, Meaning and Objectives of Research, Research Process, Types of Research, Type of research: Descriptive vs. Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, and Conceptual vs. Empirical	5	
II	**Research Criteria** Criteria of Good Research, Research Problem, Selection of a problem, Techniques involved in definition of a problem, Research Proposals – Types, contents, Ethical aspects, IPR issues like patenting, copyrights.	4	
FIRST INTERNAL EXAM			
III	**Research Design** Meaning, Need and Types of research design, Literature Survey and Review, Identifying gap areas from literature review, Research Design Process, Sampling fundamentals, Measurement and scaling techniques, Data Collection – concept, types and methods, Design of Experiments.	5	
IV	**Quantitative Techniques** Probability distributions, Fundamentals of Statistical analysis, Data Analysis with Statistical Packages, Multivariate methods, Concepts of correlation and regression - Fundamentals of time series analysis and spectral analysis.	5	

SECOND INTERNAL EXAM			
V	**Report Writing** Principles of Thesis Writing, Guidelines for writing reports & papers, Methods of giving references and appendices, Reproduction of published material, Plagiarism, Citation and acknowledgement.	5	
VI	**Research Documentation** Documentation and presentation tools – LaTeX, Office with basic presentations skills, Use of Internet and advanced search techniques.	4	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
04CH6291	SEMINAR-I	0-0-2-2	2020

Course Objectives

Identify the current topics in the specific stream.

Collect the recent publications related to the identified topics.

Do a detailed study of a selected topic based on current journals, published papers and books.

Present a seminar on the selected topic on which a detailed study has been done.

Improve the writing and presentation skills.

Approach

Students have to register for the seminar and select a topic in consultation with a faculty member offering courses for the program. The seminar shall be of 30 minutes. A detailed write-up on the topic of the seminar is to be prepared in the prescribed format given by the Department. Each student shall submit two copies of a write up of his/her seminar topic. One copy shall be returned to the student after duly certifying it by the chairman of the assessing committee and the other will be kept in the department library.

A committee constituted within the department shall evaluate the seminar based on the coverage of the topic, presentation and ability to answer the questions put forward by the committee/students.

Course Outcome

Upon successful completion of the seminar, the student should be able to

Get good exposure in the current topics in the specific stream.

Improve the writing and presentation skills.

Explore domains of interest so as to pursue the course project.

Internal Continuous Assessment: 100 marks

Each student shall prepare a paper on a topic of interest in the field of Environmental Engineering. He/she shall get the paper approved by the Programme Coordinator/ Faculty in charge and present it in the class in the presence of Faculty in-charge of seminar class. Every student shall participate in the seminar. Marks will be awarded on the basis of the student's paper, presentation and his/her participation in the seminar. Faculty member in charge of the seminar and another faculty member in the department nominated by the Head of the Department are the evaluators for the seminar. Distribution of marks for the seminar is as follows.

Marks for the report:	30%
Presentation:	40%
Ability to answer questions on the topic:	30%

Course No.	Course Name	L-T-P-Credits	Year of Introduction
04CH6293	ENVIRONMENTAL ANALYSIS LAB-I	0-0-2-1	2020

Course Objectives

To determine the biological characteristics of water/waste water samples, estimation of metals by atomic absorption spectrophotometer and flame photometer and estimation of air and noise quality.

Syllabus

Culture media preparation – solid and liquid media.Preparation, distribution and sterilization. -Inoculation, streaking, colony observation.Colony counting technique for bacteria- Determination of total bacterial population by standard plate count technique - Bacteriological examination of water. Multiple tube fermentation test – MPN technique for coliforms in water and sewage- membrane filter technique - Estimation of heavy metals using atomic absorption spectrophotometer - Estimation of Na and Ca by flame photometer - Measurement of noise level - Air quality sampling and analysis

Course Outcome

To equip the students with the biological analysis of waste water samples.

Estimation of metals by advanced instruments.

Estimation of air and noise quality.

Course No.	Course Name	L-T-P-Credits	Year of Introduction
04CH6202	BIOLOGICAL TREATMENT SYSTEMS	4-0-0-4	2020

Course Objectives

To familiarize the students with collection and characterization of wastewater samples, their biological treatment and disposal.

To effectively manage the bio solids resulting from the treatment of wastewater

Introduces students to the biological aspects of wastewater biotechnology.

This course will enable students to expand their background of environmental technology in the biological aspects of wastewater treatment processes, and to integrate the biological aspects of wastewater treatment after the physical and chemical methods.

Syllabus

Objectives of biological treatment – Types of biological processes for waste water treatment – Different microbial metabolisms – Microbiological treatment kinetics and flow regimes – Michaelis-Menten and Monod models – Kinetic coefficients – Effect of temperature – Oxygen requirements – Biomass yield – Observed yield – Kinetic constants evaluation of biological treatment. Aerobic biological treatment – Attached growth and suspended growth treatment systems – Modeling - Activated sludge process – Sequencing Batch Reactor – Process description and operation. Trickling filter –Aerated lagoons – Stabilisation ponds – Sludge treatment and disposal –Aerobic digestion - Anaerobic digestion – Composting – Conditioning – Dewatering - Land Application-Advanced biological treatment processes – Nitrogen removal – Economics of biological treatment – Constructional cost, capital cost, operational cost – Total cost.

Course Outcome

Upon successful completion of this course, the student will be able to

- Plan and design a system component / process with respect to biological treatment and sludge processing facilities
- Design, conduct experiments, analyze and interpret data efficiently
- Gain knowledge about the contemporary issues and research challenges/ opportunities

Text Books

Metcalf & Eddy, Inc. *Wastewater Engineering, Treatment and Reuse*. 5th Edition, Tata McGraw-Hill, New Delhi, 2010

Mark J. Hammer and Mark J Hammer Jr., Fourth Edition, *Water and Wastewater Technology*, Prentice Hall of India Pvt. Ltd.

References

Benefield, L.D. and Randall C.W. *Biological Processes Design for wastewaters*, Prentice-Hall, Inc. Eaglewood Cliffs, 1982.

Grady Jr. C.P.L and Lin H.C. *Biological wastewater treatment: Theory and Applications*, Marcel Dekker, Inc New York, 1980.

Hammer, *Water and Waste Water Technology*, John Wiley and Sons

Quano, *Principles of Waste Water Treatment*,Vol. I, Oxford and IBH

Eckenfelder and Conner, *Biological waste Treatment*

Internal Continuous Assessment: 40 marks

Internal continuous assessment is in the form of periodical tests and assignments/tutorials. Two internal tests each carrying 15 marks will be conducted. Assignments/tutorials carry 10 marks. The assessment details are to be announced to students' in the beginning of the semester itself by the course instructor.

End semester Examination: 60 marks

COURSE PLAN

Module	Contents	Contact Hours	% of marks in End Semester Examination
I	**Objectives of Biological Treatment** – Role of microorganisms in waste water treatment – Types of biological processes for waste water treatment – Different microbial metabolisms – Bacterial growth patterns	7	15

II	**Kinetics** Microbiological treatment kinetics and flow regimes -Michaelis-Menten and Monod models- Rate of biomass growth with soluble substrates - Kinetic coefficients-Effect of temperature- Oxygen requirements- Biomass yield- Observed yield – Kinetic constants evaluation of biological treatment.	10	15
FIRST INTERNAL EXAM			
III	**Aerobic Biological Treatment** Attached growth and suspended growth treatment systems – Modeling suspended growth treatment process – Activated sludge process – Description – Various types – Methods of aeration – Microbiology – Process analysis – Process design considerations – Operational difficulties – Modifications	9	15
IV	**Reactors** Sequencing Batch Reactor – Process description and operation. Trickling filter – Filter classifications – Microbiology – Process design considerations – Design of physical facilities – Recirculation – NRC Equation – Operational difficulties	8	15
SECOND INTERNAL EXAM			
V	**Treatment and Design** Aerated lagoons – Types – Process design considerations. Stabilisation ponds – Classification – Design considerations. Sludge treatment and disposal – Characteristics of sludge – Sludge processing – Preliminary operations – Thickening – Stabilization - Aerobic digestion - Anaerobic digestion – Composting – Conditioning – Dewatering - Heat drying - Incineration- Wet air oxidation – Land application	11	20

VI	**Advanced Biological Treatment Processes** Nitrogen removal – Nitrification and Denitrification -Stoichiometry – Process analysis – Operational and environmental variables. Economics of biological treatment – Constructional cost, capital cost, operational cost – Total cost.	11	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
04CH6204	AIR QUALITY MONITORING AND CONTROL	3-0-0-3	2020

Course Objectives

To familiarize the students with collection and characterization of ambient and stack air samples, their treatment and control.

To analyse the Importance of mathematical models and meteorology in air pollutant dispersion and its concentration.

To equip them with the importance of noise pollution and its control

Syllabus

Air pollution – sources and effects , classification and properties of air pollutants, Photochemical smog, Effects of air pollution -Meteorological aspects of air pollutant dispersion –plume behavior, solutions to the atmospheric dispersion equation, The Gaussian plume model. Air pollution sampling and measurement –ambient air sampling, collection of gaseous air pollutants, collection of particulate pollutants, stack sampling, analysis of air pollutants –Air pollution control methods and equipment – Source correction methods, particulate emission control –Particulate collector, control of gaseous emissions, absorption by liquids, adsorption by solids, combustion, biological methods. Control of specific gaseous pollutants, modification of design conditions, effluent gas treatment methods, Noise Pollution-sources-effects-control.

Course Outcome

Upon successful completion of this course, the student will be able to

Get awareness about the behavior of air pollutants

Achieve fundamental aspects to design air pollution control methodologies

Plan ambient air monitoring and pollution control measures.

Text Books

C.S.Rao, *Environmental Pollution Control Engineering*, New Age International (P) Ltd. Publishers, revised Second Edition

Noel de Nevers, *Air Pollution Control Engineering*, Waveland Press

References

Stern A. Air *Pollution Control* ,vols 1, 2, 3. Academic press, Newyork

Magill. P. L. *Air Pollution* Hand Book McGraw -Hill.

Richard Segar Scorer, *Air Pollution Meteorology*, HorWood publishers.

Chhatwal G.R. *Encyclopedia of Environmental Pollution and Control*. Vol 1,2,3 Anmol Publications

Wark Kenneth and Warner C.F, *Air Pollution its Origin and Control*. Harper and Row Publishers, New York, 1981.

Lawrence K.Wang, Norman C Perelra, Yung Tse Hung, *Air Pollution Control Engineering* Tokyo.

Internal Continuous Assessment: 40 marks

Internal continuous assessment is in the form of periodical tests and assignments/tutorials. Two internal tests each carrying 15 marks will be conducted. Assignments/tutorials carry 10 marks. The assessment details are to be announced to students' in the beginning of the semester itself by the course instructor.

End semester Examination: 60 marks

COURSE PLAN			
Module	**Contents**	**Contact Hours**	**% of marks in End Semester Examination**
I	**Air Pollution** Air pollution – sources and effects, Definition and concentrations, classification and properties of air pollutants, Emission sources, major emissions from global sources, importance of Anthropogenic sources, mobile sources, Behaviour and fate of air pollutants. Photochemical smog, Effects of air	6	15

	pollution on health, vegetation and materials damages		

II	**Meteorology** Meteorological aspects of air pollutant dispersion, Temperature lapse rates and stability, wind velocity and turbulence, plume behavior. Dispersion of air pollutants, solutions to the atmospheric dispersion equation, The Gaussian plume model.-design- Mathematical problems.	7	15
	FIRST INTERNAL EXAM		
III	**Sampling and Measurements** Air pollution sampling and measurement – Types of pollutant Sampling and measurement, ambient air sampling Collection of gaseous air pollutants Collection of particulate pollutants, stack sampling Analysis of air pollutants – Sulphur dioxide, nitrogen oxides, carbon monoxide, oxidants and ozone, hydrocarbons, particulate matter.	6	15
IV	**Control Techniques** Air pollution control methods and equipment – Control methods- source correction methods, cleaning of gaseous effluents - particulate emission control – gravitational settling chambers, cyclone separators-its design selection of a particulate collector	7	15
	SECOND INTERNAL EXAM		
V	**Design Procedures** Air pollution control methods -fabric filters and its design electrostatic precipitators and its design- wet scrubbers, control of gaseous emissions, absorption by liquids, adsorption by solids, combustion, biological methods	8	20

VI	**Gaseous and Noise** Control of specific gaseous pollutants - Control of sulphur dioxide emission - desulphurization of flue gases, Dry methods, wet scrubbing methods-control of nitrogen oxides, Modification of operating conditions, modification of design conditions, effluent gas treatment methods, Carbon monoxide control, control of hydrocarbons, mobile sources, Noise Pollution-sources-effects-control	8	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
04CH6206	ENVIRONMENTAL IMPACT ASSESSMENT	3-0-0-3	2020

Course Objectives

To make the students aware about the ecological and social costs of unrestrained technological progress and the importance of protection of environment through environmental impact assessment

Syllabus

Concept of environmental impact analysis –Legislations; Air quality impact analysis; Noise impact analysis; Water quality impact analysis; Vegetation and wildlife impact analysis; Energy impact analysis; Socioeconomic impact analysis.

Course Outcome

Upon successful completion of this course, the student will be able to

A comprehensive overview of impact assessment in various regions of environment.

Identify current statutory and regulatory cradle to grave framework related impact assessment.

Text Books

John G. Rau and David C. Wooten , "*Environmental Impact Analysis Handbook*"

Larry W Canter, "*Environmental Impact Assessment*", McGraw Hill Book Company, 2010

References

Complete Guide to ISO 14000, R. B. Clements. Simon & Schuster, 2011.

Handbook of Environmental Impact Assessment Vol I and II, J. Petts, Blackwell Science, London, 2010.

Environmental Impact Assessment (EIA) notification 2006, Ministry of Environment and Forests,GOI.

The Theory and the Practice of Environmental Impact Assessment, S. A. Abbasi and N. Ramesh, DPH, New Delhi, 2003.

Internal Continuous Assessment: 40 marks

Internal continuous assessment is in the form of periodical tests and assignments/tutorials. Two internal tests each carrying 15 marks will be conducted. Assignments/tutorials carry 10 marks. The

assessment details are to be announced to students' in the beginning of the semester itself by the course instructor.

End semester Examination: 60 marks

COURSE PLAN			
Module	**Contents**	**Contact Hours**	**% of marks in End Semester Examination**
I	**Concept of environmental impact analysis** – Legislations, laws and Acts relevant to Environmental protection in India – Factors for consideration in assessing environmental impacts- Measurement of environmental impacts – Short term and long term effects.	7	15
II	**Air quality impact analysis** - Air pollutants- sources Atmospheric interaction- Environmental impact assessment methodology Noise impact analysis- typical considerations, Environmental impacts and effects of noise on people, control of noise pollution.	6	15
FIRST INTERNAL EXAM			
III	**Water quality impact analysis** – water quality criteria and standards –Environmental setting- modelling - water quality impacts by projects like highways, power plants, mining, agriculture and irrigation, forest management	8	15
IV	**Vegetation and wildlife impact analysis** – Environment assessment – assessment methodologies Summarization of Environmental Impact –Checklist method, Matrix method, Network method.	7	15
SECOND INTERNAL EXAM			

V	**Energy impact analysis**- Energy impact considerations, organization and methodology.	7	20
VI	**Socioeconomic impact analysis**- Types of socioeconomic impacts – Outline of the basic steps in performing socioeconomic impact assessment. EMS and Case studies in EIA	7	20
END SEMESTER EXAM			

List of Courses under Elective-II

Exam Slot	Course No.	Course Name
D	04CH6208	Environmental Toxicology
D	04CH6210	Water Quality Modeling
D	04CH6212	Environmental Management and Audit
D	04CH6214	Sustainable Development and Green Technology

Course No.	Course Name	L-T-P-Credits	Year of Introduction
04CH6208	**ENVIRONMENTAL TOXICOLOGY**	**3-0-0-3**	**2020**

Course Objectives

Introduces students to the basic principles of toxicology and the application of toxicology to the environment, food, forensics and occupational settings.

Biochemical interactions of industrial, agricultural and household chemicals with elements of soils, plants, animals and humans.

Syllabus

Bio molecules- carbohydrates, proteins, lipids, Nucleic acids, vitamins; Environmental toxicology definition, classification, experimental methods of measuring toxins; Biotransformation, bioaccumulation and biomagnifications of toxicants; Ecological risk assessment process; Mutagenesis, teratogenesis, carcinogens, hallucinogens.

Course Outcome

Upon successful completion of this course, the student will be able to

Understand the basic concepts of toxicology.

Understand the relationship between exposure, hazards and development of disease.

Calculate risk factors associated with exposure to toxic chemicals.

Text Books

Conn E.E and Stumpf P.K, *Outlines of Biochemistry*.

David.A. Wright and Pamela Welcone *Basic Environmental Toxicology*.

References

Albert. L. Lehninger, *Biochemistry*, Kalyani publishers, New Delhi

James A. Anderson, *An Introduction to Neural Networks* Prentice Hall of India, New Delhi.

Internal Continuous Assessment: 40 marks

Internal continuous assessment is in the form of periodical tests and assignments/tutorials. Two internal tests each carrying 15 marks will be conducted. Assignments/tutorials carry 10 marks. The assessment details are to be announced to students' in the beginning of the semester itself by the course instructor.

End semester Examination: 60 marks

COURSE PLAN

Module	Contents	Contact Hours	% of marks in End Semester Examination
I	**Bio molecules** Carbohydrates, proteins, lipids, Nucleic acids, vitamins; Enzymes, factors influencing enzymatic activity, inhibitors and regulation, biodegradability, QSAR.	7	15
II	**Environmental toxicology** Definition, classification, origin and nature of toxicants in the environment.	7	15
FIRST INTERNAL EXAM			

III	**Photoreactions** Photosynthesis, light and dark reactions, biofuels, protein biosynthesis, nitrogen metabolism	7	15
IV	**Mutations** Mutagenesis, teratogenesis, carcinogens, hallucinogens, phytotoxins, animal toxins, animal toxins	7	15
SECOND INTERNAL EXAM			
V	**Measurements** Experimental methods of measuring toxins, methods of assessing the impacts of chemicals on the ecosystem. Biotransformation, bioaccumulation and biomagnifications of toxicants	7	20
VI	**Risk Assessment** Ecological risk assessment process and evaluation of human exposure, case studies related to accidental discharge of pollutants and their impact on ecology and inhabitants in the surrounding areas.	7	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
04CH6210	WATER QUALITY MODELING	3-0-0-3	2020

Course Objectives

To introduce models in environmental systems
To familiarize with some modern tools such as ANN, Fuzzy logic, Genetic Algorithm
To realize the significance of modeling water quality in stream, estuary or lake

Syllabus

Introduction to models- Type and components, modeling mass balance, Conservation of mass, Decay rate, Accumulation rate, Order of reaction-Steady unsteady and transient states, Water uses, water quality criteria and waste inputs, Optimum management model for water quality-BOD and COD determination, Construction and application of stream and river water quality models, Streeter Phelps model, Construction and application of estuarine water quality models, models for lake-Socio economic impact of water quality management, Concepts and benefits of WQM, Introduction to modern tools- ANN –Basic principles, advantages and limitations, Fuzzy sets and fuzzy logic –introduction, Genetic algorithm-principles.

Course Outcome

Upon successful completion of this course, the student will be able to

Understand the concepts of modeling

Understand how to model water quality in stream, estuary or lake

Identify some of the different modeling tools so that student can select accordingly as the situation warrants

Text Books

Gilbert M Masters, *An Introduction to Environmental Engineering and Science*
Prentice Hall of India (P) Ltd.
Davis M.L and Cornwell, *Environmental Engineering*

References

Peavy, Rowu and Tchobanoglous, *Environmental Engineering*, McGraw Hill Publishing Company.
Robert V Thomann, *Systems Analysis and Water Quality Management*, McGraw Hill, New York, 1974.

S Vedula & P P Mujumdar, *Water Resources Systems – Modelling Techniques and Analysis*, Tata Mc Graw Hill Publishing company, 2005.

Hall & Dracup, *Water Resources Systems Engineering*, Tata Mc Graw Hill Publishing company 1970.

Metcalf and Eddy Inc., *Wastewater Engineering Treatment Disposal and Reuse*, Tata McGraw Hill Publishing Company,1981

Internal Continuous Assessment: 40 marks

Internal continuous assessment is in the form of periodical tests and assignments/tutorials. Two internal tests each carrying 15 marks will be conducted. Assignments/tutorials carry 10 marks. The assessment details are to be announced to students' in the beginning of the semester itself by the course instructor.

End semester Examination: 60 marks

COURSE PLAN			
Module	**Contents**	**Contact Hours**	**% of marks in End Semester Examination**
I	**Introduction** Introduction to models- Type and components - mass balance, Conservation of mass, Decay rate, Accumulation rate, transformation and transport processes, Basics of model formulations Order of reaction, Zeroth order, First order and Second order only	8	15
II	**Types and Selection** Model selection, types of data, boundary conditions, bathymetric data. Steady unsteady and transient states. Hydrodynamic modelling, Water uses, water quality criteria and waste inputs, waste load allocation models.	6	1 5
FIRST INTERNAL EXAM			

III	**Model Development** Construction and application of stream and river water quality models, BOD, COD of waste water, coefficients for CBOD and NBOD, reaeration coefficients.	7	15
IV	**Models** Streeter Phelps model, Construction and application of estuarine water quality models, Models for lake, surface water quality, Introduction to QUAL and WASP models. .	7	15
SECOND INTERNAL EXAM			
V	**Calibration** Model calibration, principle of parsimony, statistical methods, least squares, model validation, model testing methods	6	20
VI	**Soft Tools** Introduction to modern tools- ANN –Basic principles, advantages and limitations, Fuzzy sets and fuzzy logic –introduction, Genetic algorithm-principles	8	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
04CH6212	ENVIRONMENTAL MANAGEMENT AND AUDIT	3-0-0-3	2020

Course Objectives

To understand the multidisciplinary nature of environmental management

To understand the basic requirements of environmental management system standards and environmental auditing

Syllabus

Introduction and scope of environmental management - Evolution of Environmental laws and legislations - Legislations, laws and acts relevant to environmental protection in India - Environment Protection Act 1986 - National forest policy of India-. National Population policy of India- Environmental Impact Assessment - Environmental Risk Analysis (ERA) - Case studies - Environmental Management System - Applications of remote sensing and GIS. Environment Management System standards -Industrial ecology –Industrial symbiosis – Ecomapping - Environmental Auditing (EA)- EA in Industrial projects- Types of Environmental Auditing – Case studies

Course Outcome

Upon successful completion of this course, the student will be able to

Student develops ways of bringing about qualitative improvement in the environment by assuming leadership role

Develops skill to undertake and participate in investigative studies on various environmental management and auditing issues

Text Books

Dr. Suresh K. Dhameja, "*Environmental Engineering and Management*"

References

Vijay Kulkarni and T.V. Ramachandra, "*Environmental Management*", Capital Publishing Company, New Delhi.

P. AarneVesilind, *Introduction to Environmental Engineering*, PWS publishing company Boston,1997.

Christopheer Sheldon and Mark Yoxon, *Installing Environmental Management Systems* – a step by step guide, Earthscan Publications Ltd, London, 1999.

Shibu Krishnan, *Introduction To Sustainable Engineering* (4th edition), , PKC Books, 2018

Paul L Bishop, *Pollution Prevention: Fundamentals and Practice*, McGraw – Hill International, Boston, 2000.

Internal Continuous Assessment: 40 marks

Internal continuous assessment is in the form of periodical tests and assignments/tutorials. Two internal tests each carrying 15 marks will be conducted. Assignments/tutorials carry 10 marks. The assessment details are to be announced to students' in the beginning of the semester itself by the course instructor.

End semester Examination: 60 marks

COURSE PLAN

Module	Contents	Contact Hours	% of marks in End Semester Examination
I	**Introduction** Introduction and scope of environmental management - Environment management tools. Evolution of Environmental laws and legislations (Global and Indian Scenario).Legislations, laws and acts relevant to environmental protection in India.	8	15
II	**National Policies** Bhopal Gas Tragedy – Environment protection Act 1986 – Key features National forest policy of India-. National Population policy of India Life cycle design and analysis	6	15
	FIRST INTERNAL EXAM		

III	**EIA** Environmental Impact Assessment - Definition and scope – Key elements in the Environmental Impact Assessment process (followed in India)Environmental Risk Analysis (ERA)Steps in Environmental Risk Assessment.- Case studies	6	15
IV	**EMS** Environmental Management System – Purpose - Core elements of EMS– Basic framework of Environment Management SystemEnvironment Management System model – enefitsApplications of remote sensing and GIS Environment Management System standards – ISO – Evolution – Key principles. ISO 9001 – ISO 14001 (Basic requirements of ISO 14001). Nominative and Informative standards.	8	15
SECOND INTERNAL EXAM			
V	**Industrial Ecology** Industrial ecology-Industrial symbiosis-Ecomapping-Preparation of ecomap, Environmental Auditing (EA)-Scope-Steps-elements - Evolution of Environmental Auditing – Environmental Auditing Cycle – Waste Audit	8	20
VI	**Audit** EA in Industrial projects, ISO 14012 Baseline Environmental Auditing – Steps in Environmental Auditing Types of Environmental Auditing – Case studies	6	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
04CH6214	SUSTAINABLE DEVELOPMENT AND GREEN TECHNOLOGY	3-0-0-3	2020

Course Objectives

To bring in to focus the basics aspects of sustainable development.

To have a general understanding on global environmental issues and the different aspects involved in Green Technology

Syllabus

History and emergence of the concept of Sustainable Development; Economic dimensions, Environmental dimension; Framework for sustainability, assessment of sustainable performance; Industrialization, Globalization and Environment; Global environmental issues; Waste land reclamation, Resource degradation, carbon credits and Carbon trading – Carbon footprint; International summits, conventions agreements, trans boundary issues; Introduction to Renewable energy Technologies, Biomass, Biofuels; Carbon sequestration in biomass; Basics of organic farming and vermicomposting-microbial biofertilizers-biopesticides-bioremediation-biosensors-bio chips- biosurfactants-phyto remediation-E-waste management

Course Outcome

Upon successful completion of this course, the student will be able to

Understand the concept of sustainable development

To have an insight in to global environmental issues

Understand the different aspects of green Technology

Text Books

Shibu Krishnan, *Introduction To Sustainable Engineering* (4th edition), , PKC Books, 2018

S.S Purohit, *Green Technology-An approach for sustainable environment*, Agrobios publication, India, 2008.

References

K. Joseph, R. Nagendran *Essential Environmental studies*. Pearson education, New Delhi, 2004.

S.C Bhatia, *Environmental Pollution and Control in Chemical Process Industries*, Khanna Publishers, Delhi, 2005.

Kirkby, J.O' Keefe, P. and Timberlake, *Sustainable Development*, Earthscan Publication, London, 1996.

Mackenthun, K.M., *Basic Concepts in Environmental Management*, Lewis Publication, London, 1998.

Internal Continuous Assessment: 40 marks

Internal continuous assessment is in the form of periodical tests and assignments/tutorials. Two internal tests each carrying 15 marks will be conducted. Assignments/tutorials carry 10 marks. The assessment details are to be announced to students' in the beginning of the semester itself by the course instructor.

End semester Examination: 60 marks

COURSE PLAN

Module	Contents	Contact Hours	% of marks in End Semester Examination
I	**Origin and History** History and emergence of the concept of Sustainable Development – Framework of Sustainability, economic dimensions- environmental dimension	7	15
II	**Sustainability Framework** Framework for achieving sustainability, assessment of sustainable performance- Industrialization – Globalization and Environment	7	15
	FIRST INTERNAL EXAM		

III	**Global Concerns** Global environmental issues: - Desertification — greenhouse gases-greenhouse effect, ozone layer depletion- global warming – acid rain – deforestation.	7	15
IV	**Carbon Trading** Waste land reclamation-Resource degradation, carbon credits and Carbon trading-International summits- conventions-agreements-trans boundary issues- Carbon footprint	7	15
	SECOND INTERNAL EXAM		
V	**Renewable Energy** Introduction to Renewable energy Technologies, Biomass- Biofuels first, second and third generation bio diesel- advantages and disadvantages-source, efficiency, Emissions-Carbon sequestration in biomass.	7	20
VI	**Green Techniques** Basics of organic farming and vermicomposting , Microbial biofertilizers - biopesticides-bioremediation -biosensors-bio chips-biosurfactants, phyto-remediation, E-waste Management	7	20
	END SEMESTER EXAM		

List of Courses under Elective-III

Exam Slot	Course No.	Course Name
E	04CH6216	Environmental Nanotechnology
E	04CH6218	Global Climate Change and Disaster Management
E	04CH6220	Advanced Waste Water Treatment
E	04CH6222	Water Pollution Control and Stream Sanitation

Course No.	Course Name	L-T-P-Credits	Year of Introduction
04CH6216	ENVIRONMENTAL NANOTECHNOLOGY	3-0-0-3	2020

Course Objectives

To introduce the nanoparticles derived from microorganisms.

To expose to nano polluants and its impact on environment.

To understand the nano remediation method

Syllabus

Synthesis of nanomaterials - Synthesis of nanomaterials by physico- chemical approaches, Bionanocomposites: Nanoparticles and microorganisms- microbial synthesis of NanomaterialsBiological methods for synthesis of nano emulsions using bacteria- Fungi and 5 actinomycetes- Plants based nanoparticle synthesis- Nanocomposite biomaterials- Fibres, devises and Structures- Nano Bio Systems. Nanotechnology in remediation-Nanoremediation-Identification and characterization of Hazardous waste- Nano pollution- air- Water- Soil contaminants-Identification and Characterization Organic and Inorganics-Environmental cleanup technologies.Nanomaterials-RemediationNanomembranes-Nanomeshes-Nanofibres-Nanoclays and Adsorbents- Zeolites- Nano catalysts- Bio polymers-Single enzyme nano particles- Bio metallic iron nanoparticles- Nano photo catalysis.Nano remediation technologies-Environmental nano remediation technology- thermal- Physico- Chemical and biological methods- Nano filtration for treatment of waste- Removal of organics & inorganics and Pathogens- nanotechnology for water remediation and purification. Treatment of hi-tech industrial waste waters using nanoparticles/ modified structures/ devices. Environmental benefits of naomaterials. Sustainable Nanotechnology-Application of industrial ecology to nanotechnology- Fate of Nano materials in environment- Environmental life cycle of nano materials- Environmental and health impacts of nanomaterials- toxicological threats- Eco-toxicology- Exposure to nanoparticles- Biological damage- Threat posed by nano materials to humans- Environmental reconnaissance and surveillance. Corporate social responsibility for nano technology- nanomaterials in future- Implications.

Course Outcome

Upon successful completion of this course, the student will be able to the student will demonstrate knowledge of environmental remedial measures related to nanomaterial.

Text Books

Mao Hong Fan, Chin-Pao Huang, Alan E Bland, Z Honglin Wang, RachidSliman, Ian Wright. *Enviro-nanotechnology*, Elsevier, 2010.

Jo Anne Shatkin*, Nanotechnology: Health and Environmental risk,* CRC press, 2008.

References

M.H. Fulekar, *Nanotechnology: Importance and Application* I K International, 2010.

M. Steinfeldt, Avon Gleich, U. Petschow, R. Haum. *Nanotechnologies, Hazards and Resource efficiency,* Springer, 2007.

Gary Wiederrcht. *Handbook of Nanofabrication*, Elsevier, 2010.

Internal Continuous Assessment: 40 marks

Internal continuous assessment is in the form of periodical tests and assignments/tutorials. Two internal tests each carrying 15 marks will be conducted. Assignments/tutorials carry 10 marks. The assessment details are to be announced to students' in the beginning of the semester itself by the course instructor.

End semester Examination: 60 marks

COURSE PLAN

Module	Contents	Contact Hours	% of marks in End Semester Examination
I	**Nanosynthesis** Synthesis of nanomaterials by physico- chemical approaches, Bionanocomposites Nanoparticles and microorganisms- microbial synthesis of Nanomaterials- Biological methods for synthesis of nano emulsions using bacteria- Fungi and 5 actinomycetes	7	15

II	**Nanobiocomposites** Plants based nanoparticle synthesis- Nanocomposite biomaterials- Fibres, devises and Structures- Nano Bio Systems Nanoremediation- Identification and characterization of Hazardous waste- Nano pollution- air- Water- Soil Contaminants-Identification and Characterization Organic and Inorganics-Environmental cleanup technologies	7	15
FIRST INTERNAL EXAM			
III	**Nanoremediation** Nanomaterials-Remediation-Nanomembranes-Nanomeshes-Nanofibres-Nanoclays and Adsorbents- Zeolites- Nano catalysts Bio polymers-Single enzyme nano particles- Bio metallic iron nanoparticles- Nano photo catalysis.	6	15
IV	**Nanofiltration** Environmental nano remediation technology- thermal- Physico- Chemical and biological methods Nano filtration for treatment of waste- Removal of organics & inorganics and Pathogens- nanotechnology for water remediation and purification.	6	15
SECOND INTERNAL EXAM			
V	**Treatment of Industrial Wastes** Treatment of hi-tech industrial waste waters using nanoparticles/ modified structures/ devices. Environmental benefits of nanomaterials Application of industrial ecology to nanotechnology- Fate of Nano materials in environment- Environmental life cycle of nano materials- Environmental and health impacts of nanomaterials- toxicological threats	8	20
VI	**Ecotoxicology** Eco-toxicology- Exposure to nanoparticles- Biological damage- Threat posed by nano materials to humans- Environmental reconnaissance and surveillance. Corporate social responsibility for nano technology- nanomaterials in future- Implications	8	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
04CH6218	GLOBAL CLIMATE CHANGE AND DISASTER MANAGEMENT	3-0-0-3	2020

Course Objectives

Provide knowledge on aspects of climate change and its relationship with natural disasters

Plan management of disaters

Syllabus

Climate, weather and Climate Change-Modelling of Climate Change-Overview of disaster, major natural disasters -Factors for Disaster-Techniques of monitoring and design against the Disasters-Water supply preparedness and protection

Course Outcome

Upon successful completion of this course, the student will have an idea about the various aspects that relate global climatic changes and disaster management in environmental engineering which can further be used for research purpose

Text Books

H.K. Gupta *Disaster Management, ,* Universiters Press, India, 2003

R.B. Singh*, Disaster Management,* Rawat Publication, New Delhi, 2006

References

Alexander D*, Principles of Emergency Planning and Management,* Oxford University Press, 2002.

Hallow G. and Bullock J *Introduction to Emergency Management, ,* Elsevier, 2002.

Anil Markandya, Routledge *Climate Change and Sustainable Development: Prospects for Developing Countries, ,* 2002.

M.C. Gupta *Manuals on Natural Disaster Management in India, ,* National Centre for Disater Management, IIPA, New Delhi, 2001

Jepma C.J. and Munisinghe M*, Climate Change Policy-Facts, Issues and Analysis,* Cambridge University Press,1998

Internal Continuous Assessment: 40 marks

Internal continuous assessment is in the form of periodical tests and assignments/tutorials. Two internal tests each carrying 15 marks will be conducted. Assignments/tutorials carry 10 marks. The assessment details are to be announced to students' in the beginning of the semester itself by the course instructor.

End semester Examination: 60 marks

COURSE PLAN

Module	Contents	Contact Hours	% of marks in End Semester Examination
I	**Introduction to Climate** Climate, weather and Climate Change; – Overview of Earth's Atmosphere; Layers of Atmosphere; – Temperature, Radiation and Variation; – Heat-Balance of Earth Atmosphere System; – Temporal Variation of Air temperature; – Temperature Change in Soil; – Thermal Time and Temperature Extremes, – Hydrologic cycle. – Climate Variability like Floods, Droughts, Drought Indicators, Heat waves, Climate Extremes Causes of Climate Change; –	7	15
II	**Disasters** Overview of disaster, major natural disasters – flood, tropical cyclone, droughts, landslides, heat waves, earthquakes, fire hazards, tsunami, etc.	7	15
	FIRST INTERNAL EXAM		
III	**Factors affecting Disasters** Factors for disaster – climatic change and global sea rise, erosion, environmental degradation, large dams and earthquakes, road building and landslides, Chemical and Biological weapons – case studies.	6	15

IV	**Disaster Monitoring** Techniques of monitoring and design against the disasters. – Management issues related to disaster; – Mitigation through capacity building, legislative responsibilities of disaster management; – Disaster mapping, assessment, pre-disaster risk and vulnerability reduction, post disaster recovery and rehabilitation; disaster related infrastructure development. – Disaster management plan, national crisis management committee, state crisis management group.	8	15
SECOND INTERNAL EXAM			
V	**Safety and Precautions** Water supply preparedness and protection, emergency water supply strategy, rural and urban emergencies. – Assessment of damage. – Emergency water supply schemes – Sources, quality, treatment, storage and distribution, operation and maintenance. Sanitation – Human waste and health, strategy for excreta disposal in emergencies, techniques for excreta disposal, disposal of wastewater, management of refuse.	7	20
VI	**Climate Modeling** Modelling of Climate Change, Kyoto Protocol Montreal protocol and IPCC Scenarios, difference between climate change and climate variability Carbon trading and clean development mechanism Role of countries and citizens in containing in global warming	7	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
04CH6220	ADVANCED WASTE WATER TREATMENT	3-0-0-3	2020

Course Objectives

To study the basics of biological kinetics influencing waste water treatment

Syllabus

Limitations of conventional wastewater treatment methods, Purpose and benefits of advanced wastewater treatment. Chemical clarification, coagulation, flocculation, sedimentation, Carbonation-sources of carbon dioxide quantities of carbon dioxide required; Filtration, theory and performance of in-depth filters filter problems and their solutions types of in-depth filters, surface filters-Activated carbon adsorption and regeneration, manufacture of activated carbon characteristics of carbon used in wastewater treatment, carbon regeneration-Disinfection, chlorination, system requirements for disinfection-Nitrogen removal, Ammonia stripping, biological nitrogen removal-Demineralization, ion exchange, Electro dialysis, reverse osmosis, Brine disposal, Brine disposal.

Course Outcome

Upon successful completion of this course, the student will be able to

Understand benefits and uses of advanced wastewater treatment.

Identify the applications of advanced treatment methods

Text Books

Russell. L. Culp and Gorden. L. Culp, *Handbook of Advanced Wastewater treatment*, Van Nostrand Reinhold C, New York, 1974

References

Metcalf and Eddy Inc., *Wastewater Engineering Treatment* Disposal Reuse Tata McGraw Hill Publishing Company, 1981.

Ronald L. Droste, *Theory and Practice of Water and Wastewater Treatment*, John Wiley and Sons (ASIA) Pvt Ltd, 1997.

Hammer- *Water and Waste Water Technology*, John Wiley and Sons, New York, 1986

Internal Continuous Assessment: 40 marks

Internal continuous assessment is in the form of periodical tests and assignments/tutorials. Two internal tests each carrying 15 marks will be conducted. Assignments/tutorials carry 10 marks. The assessment details are to be announced to students' in the beginning of the semester itself by the course instructor.

End semester Examination: 60 marks

COURSE PLAN

Module	Contents	Contact Hours	% of marks in End Semester Examination
I	**Treatment Methods** Limitations of conventional wastewater treatment methods, Purpose and benefits of advanced wastewater treatment, Chemical clarification, coagulation, flocculation, sedimentation	8	15
II	**Filtration Theory** Recarbonation-sources of carbon dioxide quantities of carbon dioxide required, Filtration, theory and performance of in-depth filters, Filter problems and their solutions, Types of in-depth filters, surface filters	9	15
	FIRST INTERNAL EXAM		
III	**Carbon Adsorption** Activated carbon adsorption and regeneration, Manufacture of activated carbon characteristics of carbon used in wastewater treatment, Carbon regeneration	6	15
IV	**Disinfection** Disinfection, Chlorination, System requirements for disinfection	7	15
	SECOND INTERNAL EXAM		

V	**Nitrogen Removal** Nitrogen removal, Ammonia stripping, Biological nitrogen removal	6	20
VI	**Membrane Processes** Demineralization, ion exchange, Electro dialysis, Reverse osmosis Brine disposal	6	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
04CH6222	WATER POLLUTION CONTROL AND STREAM SANITATION	3-0-0-3	2020

Course Objectives

To make the students aware about the sources of surface water pollution, their control and stream quality standards

To create awareness about various stream sanitation practices to protect the natural resources.

To describe major source of water, soil and sediment pollution, methods for their management.

Syllabus

Introduction-importance of water sources-socio-economic importance-sources of pollution-types of waste- sources of stream pollution -location and management of waste loads- assessing the carrying capacity of receiving water Bodies-Water quality and stream quality Standards-Eutrophication-organic pollution-oil pollution-radioactive pollution-marine pollution-thermal pollution-pesticide pollutionheavy metal pollution. Organic self-purification- oxygen sag curve-Streeter Phelp's equation-Critical deficit-problems- Microbial self-purification-Classification of streams-natural self-purification process-disposal of wastewater-Rational stream sanitation practices-dual objectives of stream sanitation practices- stream survey-Purification in estuaries-evaluation of self-purification in estuariestides and currents-distribution of waste loads by tidal translation-sea water intrusion-waste assimilation capacity of estuaries-bacterial contamination-stable wastes. Impacts of river developments on waste assimilation capacity-detrimental and beneficial effects-hydroelectric powernavigation works-flood control works-irrigation and other diversions.

Course Outcome

Upon successful completion of this course, the student will be

Capable to formulate and solve various water pollution problems both quantitatively and qualitatively.

Able to understand, predict and quantify the impacts of various industrial discharges and river development works.

Application of mathematical techniques to quantify the above.

Text Books

P. K. Goel, *Water Pollution, Causes, Effects and Control*, New Age Publishers

Phelps E. *Stream Sanitation*, J.Wiley Publishers

References

Roy M Harrison, *Pollution Causes, Effects and Control*, Royal Society of Chemistry

Clarence J Velz, *Applied Stream Sanitation*, John Wiley & Sons

Todd G. K. *Applied Groundwater Hydrology*

Internal Continuous Assessment: 40 marks

Internal continuous assessment is in the form of periodical tests and assignments/tutorials. Two internal tests each carrying 15 marks will be conducted. Assignments/tutorials carry 10 marks. The assessment details are to be announced to students' in the beginning of the semester itself by the course instructor.

End semester Examination: 60 marks

COURSE PLAN			
Module	**Contents**	**Contact Hours**	**% of marks in End Semester Examination**
I	Introduction-importance of water sources-socio-economic importance sources of pollution-types of waste-waste products of man's activities sources of stream pollution-types of waste products-location and management of waste loads-projecting waste loadings	6	15
II	Assessing the carrying capacity of receiving water bodies Water quality and stream quality standards.Eutrophication-organic pollution-oil pollution- radioactive pollution marine pollution-thermal- pollution-pesticide pollution-heavy metal pollution	6	15
FIRST INTERNAL EXAM			

III	Organic self-purification-quantitative definition-reoxygenation-oxygen balance and stream dissolved oxygen profile-oxygen sag curve-Streeter Phelp's equation-Critical deficit-problems.Microbial self purificationpathogenic microorganisms of sewage origin-indices of contamination enumeration-per capita contribution-seasonal variations-death rate survival in the stream environment	7	15
IV	Classification of streams-natural self-purification process-disposal of wastewater-Rational stream sanitation practices-dual objectives of stream sanitation practices-the science and art of applied stream sanitation-stream survey-types of stream survey-execution of stream surveys	7	15
SECOND INTERNAL EXAM			
V	Purification in estuaries-evaluation of self-purification in estuaries-tides and currents-distribution of waste loads by tidal translation-sea water intrusion-waste assimilation capacity of estuaries-bacterial contamination stable wastes	8	20
VI	Impacts of river developments on waste assimilation capacity-detrimental and beneficial effects-hydroelectric power-navigation works-flood control works-irrigation and other Diversions	8	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
04CH6292	DESIGN PROJECT	0-0-4-2	2020

Course Objectives

To learn the design principles applicable for designing process systems for pollution abatement

Approach

It is expected that the student will learn complete design of Environmental Engineering Systems – be it in the area of water treatment, wastewater treatment, solid waste management and/or air/ noise pollution control. In the beginning of the semester (preferably within 2 weeks of the semester), the student will choose a design project in consultation with the faculty members. Once the design project is selected, the student will be required to develop the complete project including design calculations, appropriate detail drawings and estimation of quantities. The students will be required to make periodic presentations for purpose of evaluation of the course

Course Outcome

Upon successful completion of the seminar, the student should be able to

Independently or in a team, design treatment systems in the area of environmental pollution.

Develop better communication and presentation skills with confidence

Internal Continuous Assessment: 100 marks

Each student shall prepare a paper on a topic of interest in the field of Environmental Engineering. He/she shall get the paper approved by the Programme Coordinator/ Faculty in charge and present it in the class in the presence of Faculty in-charge of seminar class. Every student shall participate in the seminar. Marks will be awarded on the basis of the student's paper, presentation and his/her participation in the seminar. Faculty member in charge of the seminar and another faculty member in the department nominated by the Head of the Department are the evaluators for the seminar. Distribution of marks for the seminar is as follows.

Marks for the report:	30%
Presentation:	40%
Ability to answer questions on the topic:	30%

Course No.	Course Name	L-T-P-Credits	Year of Introduction
04CH6294	ENVIRONMENTAL ANALYSIS LAB-II	0-0-2-1	2020

Course Objectives

To analyse the characteristics of water/wastewater samples

To analyse the parameters of soil sample

Syllabus

Sampling - Taking Grab and composite Samples-Physical characteristics of water/wastewater – Turbidity, electrical conductivity, Solids-Chemical analysis of water– determination of ions by colorimetric, volumetric analysis, preparation of standards BOD, COD-Analysis of soil for organic content, chloride, sulphate, pH and conductivity.

Course Outcome

Upon successful completion of this course, the student will be able to equip the students with water and waste water quality analysis

Course No.	Course Name	L-T-P-Credits	Year of Introduction
04CH7290	FIELD VISIT/PROFESSIONAL PRACTICE	0-0-4-0	2020

Course Objectives

Provide hands-on experience in converting theory into practice.

Apply the skills acquired through coursework in the field.

Understand duties and responsibilities of professionals and adhere to standards.

Interact and develop professional communication.

Course Outcome

Upon successful completion of this course, the student will be able to gain field/ professional experience.

Apply knowledge and skills learned from classroom work.

Understand career options and define personal career goals.

Internal Continuous Assessment: Pass/Fail

Internal continuous assessment is in the form of periodical review and presentation will be conducted by a departmental committee formed for the same. The student will make a presentation of his/her engagements during the summer term for not less than 30 minutes.

List of Courses under Elective-IV

Exam Slot	Course No.	Course Name
A	04CH7201	Ground Water Contamination Pollution transport
A	04CH7203	Environmental Geotechnology
A	04CH7205	Air Quality Modeling
A	04CH7207	Design of Ocean Structures

Course No.	Course Name	L-T-P-Credits	Year of Introduction
04CH7201	**GROUND WATER CONTAMINATION POLLUTION TRANSPORT**	**3-0-0-3**	**2020**

Course Objectives

To learn the principles of pollution transport, and estimation of extent of contamination by modelling

Syllabus

Ground water and the hydrologic cycles- Physical properties and principles-steady state flow and transient flow- Resource evaluation- Chemical properties and principles- Solute transport- USGSMoc model

Course Outcome

Upon successful completion of this course, the student will have thorough knowledge about pollution transport and estimation by modeling.

Text Books

P. K. Goel, *Water Pollution, Causes, Effects and Control*, New Age Publishers

Phelps E. *Stream Sanitation*, J.Wiley Publishers

References

Randall J. Charbeneau *Ground Water Hydraulics and Pollutant Transport*,

Allen Freeze R. and John A. Cherry *Ground water*, , Prentice Hall.Inc

Roy M Harrison, *Pollution Causes, Effects and Control*, Royal Society of Chemistry

Clarence J Velz, *Applied Stream Sanitation*, John Wiley & Sons

Todd G. K. *Applied Groundwater Hydrology*

Internal Continuous Assessment: 40 marks

Internal continuous assessment is in the form of periodical tests and assignments/tutorials. Two internal tests each carrying 15 marks will be conducted. Assignments/tutorials carry 10 marks. The assessment details are to be announced to students' in the beginning of the semester itself by the course instructor.

End semester Examination: 60 marks

COURSE PLAN

Module	Contents	Contact Hours	% of marks in End Semester Examination
I	**Ground Water Characteristics** Ground water and the hydrologic cycles-Ground water as a resource-Ground water contamination Ground water as a geotechnical problem-Ground water and geologic processes.	6	15

II	**Physical Properties and Principles** Physical properties and principles-Darcy's law-Hydraulic head and fluid potential-piezometers and nests. Hydraulic conductivity and permeability-homogenicity and anisotropy-porosity and voids ratio-Unsaturated flow and the water table-steady state flow and transient flow-compressibility and effective stress-transmissivity and storativity-Equations of ground water flow - Limitations of Darcian Approach-hydro dynamic dispersion	8	15
FIRST INTERNAL EXAM			
III	**Resource Evaluation** Resource evaluation: development of ground water resources-Exploration of Aquifers-the response of ideal aquifers to pumping Measurement of parameters-Laboratory tests-Numerical simulation for aquifer yield predictionArtificial recharge and induced infiltration-land subsidence - sea water intrusion	8	15
IV	**Chemical Properties and Principles** Chemical properties and principles: constituents chemical equilibrium-association and dissociation of dissolved species-effects of concentration gradients-mineral dissolution and solubilityOxidation and reduction process-Ion exchange and adsorption-environmental isotopes-field measurement of index parameters.	6	15
SECOND INTERNAL EXAM			
V	**Chemical Evolution** Chemical evolution: ground water in carbonate terrainground water in crystalline rocks-ground water in complex sedimentary systems - geotechnical interpretation of 14C dates-process rates and molecular diffusion.	6	20
VI	**Solute Transport** Solute transport: water quality standards-transport process-non reactive constituents in homogeneous media-transport in fracture media-hydrochemical behaviour of contaminants-trace metals-	8	20

	nitrogentrace non -metals-organic substances measurement of parameters – velocity-dispersivity-chemical partitioning- sources of contamination-land disposal of solid waste sewage disposal on land. USGS-Moc model: modelling principles-MOC modelling.		
END SEMESTER EXAM			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
04CH7203	ENVIRONMENTAL GEOTECHNOLOGY	3-0-0-3	2020

Course Objectives

Understand the mechanisms of soil, water and contaminants interactions.

Provide the concept of waste containment facilities.

Familiarize with soil characterization techniques

Syllabus

Soil - Pollutant Interaction – Characterization, Stabilization and Disposal – Transport of Contaminants – Detection and Testing Methods – Remediation of Contaminated Soils- Advanced Characterization Techniques.

Course Outcome

Upon successful completion of this course, the student will be able to gain knowledge and understanding on the role of Environmental Geotechnology in Waste Management

Text Books

Fang, H.Y, *Introduction to Environmental Geotechnology*, CRC Press, 1997.

References

Mitchell, J.K and Soga, K *Fundamentals of Soil Behavior*, John Wiley and Sons Inc., 3rd Edition, 2005.

Daniel, D.E, *Geotechnical Practice for Waste Disposal*, Chapman and Hall, 1993.

Rowe, R.K, Quigley, R.M and Booker, *Clay Barrier systems for Waste Disposal Facilities*, J.R., E & FN Spon, 1995.

Rowe, R.K, *Geotechnical and Geoenvironmental Engineering Handbook*, Kluwer Academic Publishers, 2001.

Reddi, L.N. and Inyang H.F, *Geoenvironmental Engineering – Principles and Applications*, Marcel Dekker Inc., 2000.

Sharma, H.D. and Lewis, S.P, *Waste Containment systems, Waste Stabilization and landfills: Design and Evaluation*, John Wiley & Sons Inc., 1994.

Internal Continuous Assessment: 40 marks

Internal continuous assessment is in the form of periodical tests and assignments/tutorials. Two internal tests each carrying 15 marks will be conducted. Assignments/tutorials carry 10 marks. The assessment details are to be announced to students' in the beginning of the semester itself by the course instructor.

End semester Examination: 60 marks

COURSE PLAN			
Module	**Contents**	**Contact Hours**	**% of marks in End Semester Examination**
I	**Soil – Pollutant Interaction** Introduction to geo environmental engineering – environmental cycle – sources, production and classification of waste – causes of soil pollution – factors governing soil – pollutant interaction – Physico-chemical behavior and modelling – failures of foundation due to pollutants	6	15
II	**Characterization, Stabilization and Disposal** Safe disposal of waste – site selection for landfills – characterization of landfill sites – waste characterization – stability of landfills – current practice of waste disposal – passive contaminant system – Hazardous waste control and storage system – mechanism of stabilization – solidification of wastes – micro and macro encapsulation – absorption. Adsorption, precipitation – detoxification – organic and inorganic stabilization	6	15
FIRST INTERNAL EXAM			

III	**Transport of Contaminants** Contaminant transport in sub surface – advection – diffusion – dispersion – governing equations – contaminant transformation – sorption – biodegradation – ion exchange – precipitation – hydrological consideration of landfill design – ground water pollution – bearing capacity of compacted fills – pollution of aquifers by mixing of liquid waste – protecting aquifers	8	15
IV	**Detection and Testing Methods** Methodology – review of current soil testing concepts – proposed approach for characterization and identification of contaminated ground soil for engineering purposes	7	15
SECOND INTERNAL EXAM			
V	**Remediation of Contaminated Soil** Rational approach to evaluate and remediate contaminated sites – monitored natural attenuation – ex situ and in situ remediation – solidification, bio-remediation, incineration, soil washing, electro kinetics, soil heating, verification, bio venting – ground water remediation – pump and treat, air sparging, reactive well – application of geo synthetics in solid waste management – rigid or flexible liners	8	20
VI	**Advanced Methods** Volumetric water content, Gas permeation in soil,Electrical and thermal properties, Pore size distribution and contaminant analysis	7	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
04CH7205	AIR QUALITY MODELING	3-0-0-3	2020

Course Objectives

To introduce models in air quality monitoring systems

To familiarize with some modern tools such as Artificial Neural Networks

Syllabus

Concepts of modeling - Air Pollution Meteorology - Kinetics of air pollutants - Modeling - Transport and dispersion of air pollutants - Advanced techniques in air quality modeling.

Course Outcome

Upon successful completion of this course, the student will be able to

define key terminology in air quality and atmospheric chemistry

describe the major chemical and meteorological processes controlling air pollution

explain how mathematical equations represent physical and chemical processes in the atmosphere

choose the correct type of model for a particular problem and interpret model results

analyze air pollution data from ground-based measurements, satellites, and models

evaluate atmospheric behavior based on widely used data and software tools

build simple models from scratch, using mathematical and computer based tools

Text Books

Zannetti, P., *Air Pollution Modeling, Computational Mechanics Publications*, Southampton, Boston, 1990.

References

Nevers, N.D., *Air Pollution and Control Engineering*, McGraw Hills Publications, 2003.

Barratt. R., *Atmospheric Dispersion Modeling*, Earthscan Publication Ltd, 2003.

Rau J.G and Wooten D.C*, Environmental Impact Analysis; Handbook*, McGraw Hill Publications, 1985.

Khare M. and Sharma P, *Modeling of Vehicular Exhaust Emissions*, WIT press, UK, 2002.

Blackadar A, *Turbulence and Diffusion in Atmosphere, Lectures in Environmental Sciences*, Springer Publications, 1998.

Internal Continuous Assessment: 40 marks

Internal continuous assessment is in the form of periodical tests and assignments/tutorials. Two internal tests each carrying 15 marks will be conducted. Assignments/tutorials carry 10 marks. The assessment details are to be announced to students' in the beginning of the semester itself by the course instructor.

End semester Examination: 60 marks

COURSE PLAN			
Module	**Contents**	**Contact Hours**	**% of marks in End Semester Examination**
I	**Concepts of modeling:** Role of mathematical models; systems approach; systems and models; kinds of mathematical models; model development and validation; ambient air quality standards.	6	15
II	**Air Pollution Meteorology:** Transport, dilution, modification and removal of pollutants; wind velocity profiles, Atmospheric stability; Pasquill-Gifford stability classes; Inversions; Potential temperature gradient; Plume behavior; Mixing heights; Kinetics of air pollutants; Atmospheric advection-diffusion of pollutants; Fick's Law of diffusion; No-flow boundary effect; Models for no flow boundary conditions; Reynolds theory of turbulence; Atmospheric boundary layers.	8	15
FIRST INTERNAL EXAM			
III	**Kinetics of air pollutants:** Atmospheric advection-diffusion of pollutants; Fick's Law of diffusion; No-flow boundary effect; Models for no flow boundary conditions; Reynolds theory of turbulence; Atmospheric boundary layers.	7	15

IV	**Modeling:** Classification of air quality models, Gaussian plume model for a point source, Plume rise; Brigg's and Holand's equations for estimating plume rise; Dispersion coefficient; Buoyancy and flux parameters for plume rise; Gaussian approach to special cases of points; area and line sources of pollution; Pollution concentration in the wake of building; Complex terrain effect; Deterministic models; Puff models; Box model; Special application od Dispersion models;	8	15
SECOND INTERNAL EXAM			
V	**Advanced techniques in air quality modeling:** Artificial Neural Networks (ANN), Hybrid modeling approach; Fuzzy logic theory (FLT) and Environmental wind tunnel (physical) models.	6	20
VI	**Space air quality** Chemistry-Climate Interactions; Air Quality Management; Atmospheres of other planets; Energy and Air Quality	7	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
04CH7207	ENVIRONMENTAL ECONOMICS	3-0-0-3	2020

Course Objectives

To introduce the necessity of natural and ecological resources and their management in terms of economic values.

To learn the concept and theories related to environmental economics.

To learn about different recent initiatives and guidelines for environmental economics.

Syllabus

Historical Development of Environmental Economics– Pollution as an economic problem - Introduction to environmental economics and policy – Instruments in Pollution Control – Environmental evaluation – Natural Resource Economics

Course Outcome

Upon successful completion of this course, the student will be able to

Justify the necessity of natural resource conservation.

Relate environmental degradation with the economy.

Assist in decision making in terms of resource evaluation and conservation.

Understand the role of different bodies in controlling pollution.

Text Books

Hanley, N, Shogren J and White B, *Environmental Economics in Theory and Practice*, McMillan Press

References

Pearce DW and Turner RK, *Economics of Natural Resources and the Environment*, Harvester Wheatsheaf, London

Perman R, Ma Y, McGilvray J and Common M S, *Natural Resources and Environmental Economics*, Longmans

Internal Continuous Assessment: 40 marks

Internal continuous assessment is in the form of periodical tests and assignments/tutorials. Two internal tests each carrying 15 marks will be conducted. Assignments/tutorials carry 10 marks. The assessment details are to be announced to students' in the beginning of the semester itself by the course instructor.

End semester Examination: 60 marks

COURSE PLAN			
Module	**Contents**	**Contact Hours**	**% of marks in End Semester Examination**
I	**Historical Development of Environmental Economics** The Environment-Economy Interaction, the Material Balance Model and laws of Thermodynamics; Basic concepts of resource economics; natural capita and equity. Economic principles: Introduction to microeconomic theory covering theories and applications of individual and market demand, as well as production economics. Welfare economics and its application in imperfect competition and factor markets.	6	15
II	**Pollution as an economic problem** Market failure, externality, Exaction, Insertion, Social trap; Alternative Definition of Pollution; Optimal pollution; Marginal Damage and Marginal Abatement Cost.	6	15
FIRST INTERNAL EXAM			
III	**Introduction to environmental economics and policy** Essential economic concepts and theory relevant to environmental issues. Economic theories of pollution and management of natural resources. The impact of macroeconomic policies on the environment and role of international	7	15

	environmental agreements on transboundary issues.		
IV	**Instruments in Pollution Control** Command and Control and Economic Instruments; International Agencies and Environment: UNEP, UNFCC. Environmental Values beyond use value: Environmental Resources and Market failure, Signals of Natural Resource Depletion/ Scarcity (Direct and Indirect Approaches and their Limitations)	8	15
SECOND INTERNAL EXAM			
V	**Environmental valuation** Concept of total Economic value, uncertainty and irreversibility, economic growth and environment, fundamentals of environmental Kuznets curve, approaches to environmental valuation, cost benefit, social cost benefit analysis, heath cost approach, travel cost approach, amenities and hedonic pricing, contingent valuation methods, revealed and stated preferences, willingness to pay and willingness to update	7	20
VI	**Natural Resource Economics** Economic models of natural resources, Allocation, Applications in policy making, resource management, policy makers, application in public policy and natural resource management, forest, water, fisheries, key issues and options.	8	20
END SEMESTER EXAM			

List of Courses under Elective-V

Exam Slot	Course No.	Course Name
B	04CH7209	Planning And Design Of Environmental Facilities
B	04CH7211	Environmental Systems Modeling
B	04CH7213	Life Cycle Assessment
B	04CH7215	Sustainable Coastal Engineering

Course No.	Course Name	L-T-P-Credits	Year of Introduction
04CH7209	**PLANNING AND DESIGN OF ENVIRONMENTAL FACILITIES**	**3-0-0-3**	**2020**

Course Objectives

To learn in detail the various water and wastewater treatment systems and their layout and design.
To successfully educate the students with a firm foundation related to environmental planning and design
To equip thinking about a green and clean technology
To exploring computer-based design tools for advanced water treatment purification process and wastewater reuse and desalination

Syllabus

Environmental Engineering hydraulic design: Water distribution systems- Design of distribution systems- Distribution system components – Analysis of networks– Computer Programmes. Types of sewerage system – Design of various sewer appurtenances - Structural requirement of sewer under various conditions. Roadways and Airport drainage -- Pumps – Design of water treatment units – sedimentation tanks, Mixing basins, Flash Mixer, Clariflocculator, Slow sand filter, Rapid sand filter, Spray and Cascade aerator, Chlorinator. Design of waste water treatment units – screens, Grit chamber, Sedimentation tank, Activated sludge process. Trickling filter, Aerated lagoons, Stabilization ponds, Oxidation ditch, Septic tank, Inhoff tank, Sequencing batch reactor, Sludge digestion tank.

Course Outcome

Upon successful completion of this course, the student will be able to

Obtain a comprehensive knowledge of the fundamental principles and practices in water and wastewater processing, distribution, collection and treatment

Capable of avoiding or minimizing the production of wastes through technological changes and suggest design alternatives.

Text Books

Metcalf and Eddy Inc. - Waste water Engineering: Treatment, disposal & reuse,Tata Mc Graw Hill

References

Peavy- *Environmental Engineering*, McGraw Hill

Rodger Walker- *Water Supply Treatment and distribution*

Sincero- *Environmental Engineering: A Design Approach*, Prentice Hall of India, Delhi

Wilson- *Design calculations in waste water treatment*, McGraw Hill Kogakusha

Sharma, H.D. and Lewis, S.P, *Waste Containment systems, Waste stabilization and Landfills: Design and evaluation*, John Wiley & sons Inc., 1994

Internal Continuous Assessment: 40 marks

Internal continuous assessment is in the form of periodical tests and assignments/tutorials. Two internal tests each carrying 15 marks will be conducted. Assignments/tutorials carry 10 marks. The assessment details are to be announced to students' in the beginning of the semester itself by the course instructor.

End semester Examination: 60 marks

COURSE PLAN			
Module	**Contents**	**Contact Hours**	**% of marks in End Semester Examination**
I	Environmental Engineering hydraulic design: Water distribution systems- Design of distribution systems- Hydraulic analysis – Distribution system components – Storage tanks -Analysis –Hardy Cross Method- Equivalent Pipe Method- Computer Programmes	6	15

II	Types of sewerage system – Hydraulics of sewers –Design of various sewer appurtenances - Design of sanitary and storm water sewers – Structural requirement of sewer under various conditions.	7	15
FIRST INTERNAL EXAM			
III	Design of surface and subsurface drainage – Roadways and Airport drainage -- Pumps – Design of water and waste water pumping system	6	15
IV	Design of water treatment units – Design of sedimentation tanks, Mixing basins, Flash Mixer, Clariflocculator, Slow sand filter, Rapid sand filter, Spray and Cascade aerator, Chlorinator	7	15
SECOND INTERNAL EXAM			
V	Design of waste water treatment units – Design of screens, Grit chamber, Sedimentation tank, Activated sludge process.	8	20
VI	Trickling filter, Aerated lagoons, Stabilization ponds, Oxidation ditch, Septic tank, Inhoff tank, Sequencing batch reactor, Sludge digestion tank	8	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
04CH7211	ENVIRONMENTAL SYSTEMS ANALYSIS	3-0-0-3	2020

Course Objectives

Identify the impact on environment as a whole system

Introduce optimization models in environmental systems

Familiarize with some modern tools such as ANN, Fuzzy logic, Genetic Algorithm

Syllabus

Introduction-Definition of a Systems, Types of systems, Systems approach concept, Systems analysis, Significance of Systems Engineering, System design, system synthesis-Scope of applications of Environmental engineering systems, and address specific environmental problems Role of optimization models, deterministic models, linear programming, Dynamic programming, Separable and nonlinear programming model-Formulation of objective functions and constraints for environmental engineering planning and design, Application to environmental systems analysis to water resources systems and water quality subsystems-Introduction to modern tools- ANN –Basic principles, advantages and limitations, Fuzzy sets and fuzzy logic –Genetic algorithm- principles, Expert systems briefintroduction.

Course Outcome

Upon successful completion of this course, the student will be able to

Understand the concepts of systems approach and analysis

Understand environment systems optimization and optimization models

Identify some of the different modeling tools so that student can select accordingly as the situation warrants

Text Books

Alexander Kossiakoff, *Systems Engineering Principles and Practice*, Wiley India, Delhi,2011.

References

Timothy J. Ross, *Fuzzy Logic with Engineering Applications*, Wiley India, Delhi, 2010.

KishanMehrotra, *Elements of Artificial Neural Networks*, Penram International Publishing Pvt Ltd, Mumbai, 2009.

Hanif D. Sherali, John J. Jarvis, and M. S. Bazaraa, *Linear Programming and Network Flows*,

Wiley India, Delhi, 2008.

Internal Continuous Assessment: 40 marks

Internal continuous assessment is in the form of periodical tests and assignments/tutorials. Two internal tests each carrying 15 marks will be conducted. Assignments/tutorials carry 10 marks. The assessment details are to be announced to students' in the beginning of the semester itself by the course instructor.

End semester Examination: 60 marks

COURSE PLAN			
Module	**Contents**	**Contact Hours**	**% of marks in End Semester Examination**
I	Introduction-Definition of a Systems, Types of systems, Systems approach concept, Systems analysis, Significance of Systems Engineering, System design, system synthesis.	8	15
	Scope of applications of Environmental engineering systems Address specific environmental problems.	6	15
FIRST INTERNAL EXAM			
III	Role of optimization models, deterministic models, Linear programming, Dynamic programming, Separable and nonlinear programming model	6	15
IV	Formulation of objective functions and constraints for environmental engineering planning and design, Application to environmental systems analysis to water resources systems and water quality subsystems	8	15
SECOND INTERNAL EXAM			
V	Introduction to modern tools- ANN –Basic principles, advantages and limitations, Fuzzy sets and fuzzy logic – introduction	7	20
VI	Genetic algorithm- principles, Expert systems brief introduction	7	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
04CH7213	LIFE CYCLE ASSESSMENT	3-0-0-3	2020

Course Objectives

To evaluate the consequence of products, services and energy systems on the environment

To compare alternate system designs with respect to their environmental performance

To access multiple environmental impact categories

Syllabus

Mathematical Structure of LCA- Modeling of Production Systems - Methods for EIA - Applications of LCA to on and off shore wind and photovoltaic systems with case studies - Applications of LCA to bioenergy and biofuels with case studies - Application of LCA to automobiles with case studies

Course Outcome

Upon successful completion of this course, the student will be

Apply LCA for assessment on various energy, product and transport technologies and systems.

Perform robust assessments of the environmental characteristics of systems.

Assess the environmental performance of energy and production systems.

Text Books

Hauschild, Michael, Rosenbaum, Ralph K., Olsen, Stig, *Life Cycle Assessment- Theory and Practice*, Springer

References

Canter.L.W., Environmental Impact Assessment, McGraw Hill Newyork 1996.

H. Baumann and Annie M T, An orientation in Life Cycle Assessment and Methodology, 2004

Life Cycle Assessment Handbook: A guide for Environmentally Sustainable products, 2012, M.A. Curran

Internal Continuous Assessment: 40 marks

Internal continuous assessment is in the form of periodical tests and assignments/tutorials. Two internal tests each carrying 15 marks will be conducted. Assignments/tutorials carry 10 marks.

The assessment details are to be announced to students' in the beginning of the semester itself by the course instructor.

End semester Examination: 60 marks

COURSE PLAN			
Module	**Contents**	**Contact Hours**	**% of marks in End Semester Examination**
I	**Mathematical Structure of LCA**	6	15
II	**Modeling of Production Systems**	6	15
FIRST INTERNAL EXAM			
III	**Methods for EIA**	7	15
IV	**Applications of LCA to on and off shore wind and photovoltaic systems with case studies**	8	15
SECOND INTERNAL EXAM			
V	**Applications of LCA to bioenergy and biofuels with case studies**	7	20
VI	**Application of LCA to automobiles with case studies**	8	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
04CH7215	SUSTAINABLE COASTAL ENGINEERING	3-0-0-3	2020

Course Objectives

Investigate sustainable shore protection designs such as living shorelines and sills, beach nourishment, and other sustainable methods in order to adapt to coastal hazards such as hurricanes, tsunamis, and sea level rise.

Investigate sustainable energy such as coastal wind energy, wave energy, tidal energy, and other sustainable energy sources and be introduced to alternative energy design.

Investigate the importance of sustainable food production such as ocean aquaculture, shellfish aquaculture and other sustainable food production and be introduced to aquaculture system design.

Syllabus

This course presents a review of sustainable engineering related to the ocean environment. Sustainable shore protection designs will be investigated such as living shorelines and sills, beach nourishment, and other sustainable methods in order to adapt to coastal hazards such as hurricanes, tsunamis, and sea level rise. Sustainable energy such as coastal wind energy, wave energy, tidal energy, and other sustainable energy sources will be also investigated as alternative energy designs. The importance of sustainable food production will be discussed and aquaculture system designs such as ocean aquaculture, shellfish aquaculture, and other sustainable food production will be studied.

Course Outcome

Upon successful completion of this course, the student will be able to understand sustainable engineering in Coastal Engineering including sustainable shore protection, sustainable energy, and sustainable food production.

Text Books

References

Internal Continuous Assessment: 40 marks

Internal continuous assessment is in the form of periodical tests and assignments/tutorials. Two internal tests each carrying 15 marks will be conducted. Assignments/tutorials carry 10 marks. The assessment details are to be announced to students' in the beginning of the semester itself by the course instructor.

End semester Examination: 60 marks

COURSE PLAN			
Module	**Contents**	**Contact Hours**	**% of marks in End Semester Examination**
I	**Introduction to Sustainable Ocean Engineering**	6	15
II	**Mathematics of Growth**	6	15
FIRST INTERNAL EXAM			
III	**Sustainable Shore Protection**	7	15
IV	**FEMA Provisions**	8	15
SECOND INTERNAL EXAM			
V	**Sustainable Energy**	7	20
VI	**Sustainable Food Production**	8	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
04CH7291	SEMINAR-II	0-0-2-2	2020

Course Objectives

Identify the current topics in the specific stream.

Collect the recent publications related to the identified topics.

Do a detailed study of a selected topic based on current journals, published papers and books.

Present a seminar on the selected topic on which a detailed study has been done.

Improve the writing and presentation skills.

Approach

Students shall make a presentation for 20-25 minutes based on the detailed study of the topic and submit a report based on the study.

Course No.	Course Name	L-T-P-Credits	Year of Introduction
04CH7293	PROJECT (PHASE-I)	0-0-12-6	2020

Course Objectives

To improve the professional competency and research aptitude by touching the areas which otherwise not covered by theory or laboratory classes. The project work aims to develop the work practice in students to apply theoretical and practical tools/techniques to solve real life problems related to industry and current research.

Approach

The project work can be a design project/experimental project and or computer simulation project on any of the topics in ENVIRONMENTAL ENGINEERING or related topics. The project work is allotted individually on different topics. As far as possible the students shall be encouraged to do their project work in the parent institute itself. If found essential, they may be permitted to continue their project outside the parent institute subject to the conditions given in M.Tech regulations. Department will constitute an Evaluation Committee to review the project work. The student is required to undertake the masters research project phase 1 during the third semester and the same is continued in the 4^{th} semester (Phase 2). Phase 1 consist of preliminary thesis work, two reviews of the work and the submission of preliminary report. First review would highlight the topic, objectives, methodology and expected results. Second review evaluates the progress of the work, preliminary report and scope of the work which is to be completed in the 4th semester. The Evaluation committee consists of at least three faculty members of which internal guide and another expert. Project work is to be evaluated both in the third and the fourth semesters. Based on these evaluations, grade is finalised in fourth semester.

Course Outcome Upon successful completion of this course, the student will be able to Undertake problem identification and formulation. Design engineering solutions to real life problems using a sytems approach Communicate effectively both in oral and written form with the professionals and society.
Internal Continuous Assessment: 50 marks Progress evaluation by the Project Supervisor : 20 Marks Presentation and evaluation by the committee : 30 Marks

Course No.	Course Name	L-T-P-Credits	Year of Introduction
04CH7294	PROJECT (PHASE-II)	0-0-21-12	2020

Course Objectives

To improve the professional competency and research aptitude by touching the areas which otherwise not covered by theory or laboratory classes. The project work aims to develop the work practice in students to apply theoretical and practical tools/techniques to solve real life problems related to industry and current research.

Approach

Project phase 2 is a continuation of project phase 1 started in the third semester. Towards the end of the semester there would be a pre submission presentation before the evaluation committee to assess the quality and quantum of the work done. This would be a pre-qualifying exercise for the students for getting approval by the departmental committee for the submission of the thesis. At least one technical paper is to be prepared for possible publication in journal or conference. Final evaluation of the project will be taken up only on completion of the project in the fourth semester. This shall be done by a committee constituted for the purpose by the principal of the college

Course Outcome

Upon successful completion of this course, the student will be able to

Apply skills learned from courses.

Develop oral and written communication skills.

Identify areas for future knowledge and skill development.

Internal Continuous Assessment: 100 marks

Project evaluation by the supervisor/s : 30 Marks

Evaluation by the External expert : 30

Marks Presentation & evaluation by the Committee : 40 Marks