RAMAIAH UNIVERSITY OF APPLIED SCIENCES

M S Ramaiah University of Applied Sciences

Program Structure and Course Details of M Tech (Environmental Engineering and Management) Degree Programme

Program Code: 125

Batch 2022-24

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Bangalore - 560 054

Dean - Academics
M.S. Ramaiah University of Applied Sciences
Bangalore-560054

Department of Civil Engineering
Faculty of Engineering and Technology
M S Ramaiah University of Applied Sciences

Dean
Faculty of Engineering and Technology
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University's Vision, Mission and Objectives

The M. S. Ramaiah University of Applied Sciences (MSRUAS) will focus on student-centric professional education and motivates its staff and students to contribute significantly to the growth of technology, science, economy and society through their imaginative, creative and innovative pursuits. Hence, the University has articulated the following vision and objectives.

Vision

MSRUAS aspires to be the premier university of choice in Asia for student centric professional education and services with a strong focus on applied research whilst maintaining the highest academic and ethical standards in a creative and innovative environment

Mission

Our purpose is the creation and dissemination of knowledge. We are committed to creativity, innovation and excellence in our teaching and research. We value integrity, quality and teamwork in all our endeavors. We inspire critical thinking, personal development and a passion for lifelong learning. We serve the technical, scientific and economic needs of our Society.

Objectives

1. To disseminate knowledge and skills through instructions, teaching, training, seminars, workshops and symposia in Engineering and Technology, Art and Design, Management and Commerce, Health and Allied Sciences, Physical and Life Sciences, Arts, Humanities and Social Sciences to equip students and scholars to meet the needs of industries, business and society

2. To generate knowledge through research in Engineering and Technology, Art and Design, Management and Commerce, Health and Allied Sciences, Physical and Life Sciences, Arts, Humanities and Social Sciences to meet the challenges that arise in industry, business and society

3. To promote health, human well-being and provide holistic healthcare

4. To provide technical and scientific solutions to real life problems posed by industry, business and society in Engineering and Technology, Art and Design, Management and Commerce, Health and Allied Sciences, Physical and Life Sciences, Arts, Humanities and Social Sciences

5. To instill the spirit of entrepreneurship in our youth to help create more career opportunities in the society by incubating and nurturing technology product ideas and supporting technology backed business

6. To identify and nurture leadership skills in students and help in the development of our future leaders to enrich the society we live in

7. To develop partnership with universities, industries, businesses, research establishments, NGOs, international organizations, governmental organizations in India and abroad to enrich the experiences of faculties and students through research and developmental programmes

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Programme Specifications: M. Tech. (Environmental Engineering and Management)

Faculty	Engineering and Technology
Department	Civil Engineering
Programme Code	023
Programme Name	M.Tech. (Environmental Engineering and Management)
Dean of the Faculty	Dr. Dilip Kumar Mahanty
Head of the Department	Dr. Nayana N. Patil

1. **Title of the Award:** M.Tech. (Environmental Engineering and Management)
2. **Mode of Study:** Full-Time
3. **Awarding Institution /Body:** M. S. Ramaiah University of Applied Sciences, Bengaluru
4. **Joint Award:** Not Applicable
5. **Teaching Institution:** Faculty of Engineering and Technology, M. S. Ramaiah University of Applied Sciences, Bengaluru

6. **Date of Programme Specifications:** October 2020 7. **Date of Programme Approval by the Academic Council of MSRUAS:** 23-Oct-2020 8. **Next Review Date:** May 2023

9. **Programme Approving Regulating Body and Date of Approval:** All India Council for Technical Education, New Delhi, 30-Jun-2020

10. **Programme Accredited Body and Date of Accreditation:** Not Applicable 11. **Grade Awarded by the Accreditation Body:** Not Applicable 12. **Programme Accreditation Validity:** Not Applicable 13. **Programme Benchmark:** Not Applicable 14. **Rationale for the Programme**

Civil Engineering is primarily infrastructure development involving planning, design, construction, and operation of facilities essential to modern life, ranging from transit systems to offshore structures to space satellites. Major disciplines within civil engineering that are closely interrelated are Structural, Environmental, Geotechnical, Water Resources, Transportation, Construction and Urban Planning.

Until recently Civil Engineering teaching was limited to Planning, Analysis, Design and Execution of different types of infrastructure like buildings, roads, bridges, dams and power plants. However, increasing technological sophistication and demand for higher living standards fulfilled by economic growth and concerns about environmental impact have changed the scope of Civil Engineering curriculum.

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Sanitation generally refers to hygiene and deals with the provision of facilities for the safe disposal of human waste. Sanitary engineering is a sub branch of environmental engineering dealing with matters affecting public health and methods to improve sanitation of human communities, primarily by providing the removal and disposal of human waste, and in addition to the supply of safe potable water.

Rate of urbanization in the developing countries as elsewhere has increased in the recent decades. This has resulted in mega cities in these countries having a staggering share of 80% in world's megacities in recent decades. Population is expected to double in next two decades resulting in high concentration of people in urban areas. This willplace enormous pressure on local environment and resources, requiring high demands on clean water and sanitation.

The explosive growth in urbanization and the massive rural to urban migration necessitated the requirement of rational approaches towards sustainable management of urban drainage, sanitation provision to urban poor, waste collection and its treatment for proper disposal or reclamation / reuse. Services and programmes that include proper waste disposal methods for management of hazardous biological and chemical wastes, minimization and recycling will be needed.

Developing countries are still in the transition towards better waste management but they currently have insufficient collection and improper disposal of wastes. The authorities in the developing countries are crippled by the lack of proper and scientific approach towards the waste management mainly due to the increasing generation of waste. In this scenario, most acute and relevant issues related to sanitation and waste management require special attention so that innovative and sustainable solutions can be formulated.

With a lot of stress on reducing carbon emission and interdependencies between resources, an Engineer needs world-class skill base coupled with flair for innovation and understanding of the interdependencies between resources and infrastructural demands. This can be done only by inculcating multidisciplinary skills in water supply, sanitary, environmental and public health aspects.

Even though there are a large number of institutions in India producing Engineers, there is a shortage of quality multidisciplinary Engineering graduates. The FET at MSRUAS would like to offer interdisciplinary postgraduate Engineering programme to produce imaginative, creative and innovative Engineers.

MSRUAS is offering Environmental sanitation and waste management programme at the post graduate level. The graduates will get opportunities in water supply and waste-water companies, municipal assemblies, government ministries and consulting companies dealing with water supply, sanitation and municipal infrastructure. They will be effective and efficient problem solvers providing economical and sustainable infrastructure solutions in India and abroad.

15. Programme Mission

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The purpose of the programme is to produce postgraduates with advanced knowledge and understanding of Environmental Engineering and Management; higher order critical, analytical, problem solving and transferable skills; ability to think rigorously and independently to meet higher level expectations of civil construction industry, academics, research or take up entrepreneurial route.

16. Graduate Attributes (GAs)

GA-1. Engineering knowledge: Ability to apply knowledge of mathematics, science, and Engineering fundamentals to solve complex problems in engineering

GA-2. Problem Analysis: Ability to analyse engineering problems, interpret data and arrive at meaningful conclusions involving mathematical inferences

GA-3. Design and Development of Solutions: Ability to design an engineering system, component, or process to meet desired needs considering public health and safety, and the cultural, societal, and environmental considerations

GA-4. Conduct Instigations of Complex Problems: Ability to understand and solve complex engineering problems by conducting experimental investigations

GA-5. Modern Tool Usage: Ability to apply appropriate tools and techniques and understand utilization of resources appropriately to complex engineering activities

GA-6. The Engineer and Society: Ability to understand the effect of engineering solutions on legal, cultural, social, and public health and safety aspects

GA-7. Environment and Sustainability: Ability to develop sustainable solutions and understand their effect on society and environment

GA-8. Ethics: Ability to apply ethical principles to engineering practices and professional responsibilities

GA-9. Individual and Teamwork: Ability to work as a member of a team, to plan and to integrate knowledge of various engineering disciplines and to lead teams in multidisciplinary settings

GA-10. Communication: Ability to make effective oral presentations and communicate technical ideas to a broad audience using written and oral means

GA-11. Project Management and Finance: Ability to lead and manage multidisciplinary teams by applying engineering and management principles

GA-12. Life-long learning: Ability to adapt to the changes and advancements in technology and engage in independent and life-long learning

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17. Programme Outcomes (POs)

M.Tech. graduates will be able to:

PO-1. Acquire, comprehensive knowledge and understanding of the methodologies, principles, practices and technologies of the engineering domain to solve complex problems with technical competence

PO-2. Conceptualize, apply, analyze, synthesize and evaluate information related to complex engineering problems using principles of mathematics, science and engineering to create new and innovative solutions

PO-3. Provide solutions to engineering problems by designing systems, components or processes to meet the specified needs considering public health, safety, societal and the environmental considerations

PO-4. Review research literature, standards, guidelines, best practices, research methods and laboratory techniques to solve engineering problems through experimental investigations, analysis and interpretation of results

PO-5. Create, select and apply appropriate techniques and IT tools to model and solve complex engineering activities and utilize available resources effectively

PO-6. Understand the effect of engineering solutions on legal, cultural, social, public health and safety aspects and the consequent responsibilities

PO-7. Develop sustainable engineering solutions and assess their effect on society and environment

PO-8. Understand and apply ethical principles to engineering practices and professional responsibilities

PO-9. Function effectively as an individual or a team player to handle diverse problems in multi-disciplinary settings

PO-10. Make oral and written presentations to communicate technical ideas effectively to engineering community and society at large

PO-11. Apply the knowledge of engineering and management principles to manage projects in multi-disciplinary environments with consideration to cost and time

PO-12. Engage in lifelong learning and adapt to changing engineering/technology and societal requirements

18. Programme Goal

The programme goal is to produce post graduates having critical, analytical and problem-solving skills, and ability to think independently, and to pursue a career in Environmental Engineering and Management.

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19. Program Educational Objectives (PEOs)

The Programme educational objectives of the M.Tech. (Environmental Engineering and Management) Programme are:

PEO-1. To provide in-depth knowledge in the specialized engineering domain to enable them to deliver efficient solutions for complex engineering problems by critical thinking

PEO-2. To enable students to design and develop sustainable innovative solutions for industry and societal requirements through applied research by conducting engineering investigations through experimentation with usage of modern tools

PEO-3. To inculcate ethics, communication, leadership, soft, managerial and entrepreneurial skills for a successful career in industries and to engage in lifelong learning

20. Programme Specific Outcomes (PSOs)

At the end of the M.Tech. (Environmental Engineering and Management) program, the graduate will be able to:

PSO-1. Apply the knowledge of Environmental planning, design, construction and management of facilities and develop sustainable solutions for complex Environmental problems through critical analysis

PSO-2. Design and develop sustainable environmental engineering solutions to industry and societal requirements through applied research, logical concepts and techniques involving experimentation and usage of modern designing, modeling, analytical and simulation tools

PSO-3. Demonstrate ethics, leadership qualities, apt communication, entrepreneurial skills and involvement in lifelong learning for the betterment of organization, environment and society

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21. Programme Structure:

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SEMESTER 1

Sl.No.	Code	Course Title	Theory (h/W/S)	Tutorials (h/W/S)	Practical (h/W/S)	Total Credits	Max. Marks
1	20ESC501A	Public Health Engineering	3	1	2	5	100

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2	20ESC502A	Modern Methods of Waste Characterization	3	1	-	4	100
3	20ESC503A	Waste Water Treatment Plant Design	4	1	--	5	100
4	20ESE51XA	*Refer Elective Course Table*	4	--	--	4	100
5	20ESE52XA	*Refer Elective Course Table*	4	--	--	4	100
6	20FET508A	Research Methodology & IPR	2	--	--	2	50
7	20FET509A	Professional Communication	1	--	--	0	
	Total		**20**	**03**	**02**	**24**	**550**
	Total number of contact hours per week		25 hours				

SEMESTER 2

Sl.No.	Code	Course Title	Theory (h/W/S)	Tutorials (h/W/S)	Practical (h/W/S)	Total Credits	Max. Marks
1	20ESC511A	Solid waste and hazardous waste management	3	1	- -	4	100
2	20ESC512A	Solid waste and hazardous waste treatment plant design	3	1	--	4	100
3	20ESC513A	Environmental biotechnology	3	1	- -	4	100
4	20ESE53XA	*Refer Elective course table/Online course/*	4	--	0	4	100
		MOOC					
5	20ESE54XA	*Refer Elective course table/Online course/ MOOC*	4	--	0	4	100
6	19FET510A	Value Education	1	--	--	0	--
	Total		**18**	**03**	**03**	**20**	**500**
	Total number of contact hours per week		24 hours				

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SEMESTER 3

Sl. No	Course Code	Name of the Course	Theory (h/W/S)	Tutorials (h/W/S)	Practical (h/W/S)	Total Credits	Max. Marks

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1	20ESP501A	Internship			8	4	100
2	20ESP502A	Group project			**16**	8	200
3	20ESP511A	Dissertation and Publication Phase-1					
Total					**24**	**12**	**300**
Total number of contact hours per week			**24 hours**				

SEMESTER 4

Sl. No.	Code	Course Title	Theory (h/W/S)	Tutorials (h/W/S)	Practical (h/W/S)	Total Credits	Max. Marks
1	20ESP511A	Dissertation and Publication Phase-2			48	24	400
Total					**48**	**24**	**400**
Total number of contact hours per week			**48 hours**				

Professional Core Electives List					
Group ▼	Stream ▸	**Group-1**	**Group-2**	**Group-3**	**Group-4**
PCE-1	Course Code	20ESE511A	20ESE521A	20ESE531A	20ESE541A
	Course Title	Air pollution and Control	Energy in built environment	Rural water supply and sanitation	Geo-environmental engineering
PCE-2	Course Code	20ESE512A	20ESE522A	20ESE532A	20ESE542A
	Course Title	Toxicology and environmental risk assessment	Renewable energy sources and environmental Impact	Integrated waste management in smart cities	Remote sensing and GIS in environmental engineering
PCE-3	Course Code	20ESE513A	20ESE523A	20ESE533A	20ESE543A
	Course Title	Environmental remediation of contaminated sites	Alternative fuels	Entrepreneurship in waste management	Treatment Plants Operations and Maintenance
PCE-4	Course Code	20ESE514A	20ESE524A	20ESE534A	20ESE544A
	Course Title	Aquatic biodiversity and environmental pollution	Industrial and commercial applications of renewable energy sources	Transport process and modeling of aquatic system	Environmental policies and legislation
PCE-5	Course Code				
	Course Title				
PCE-6	Course Code				
	Course Title				

Note:

1. Students are required any 4 professional core electives from the list. There is no restriction they should stick to one stream and stream is provided as an opportunity for students to choose particular

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22. Course Delivery: As per the Timetable

23. Teaching and Learning Methods

1. Face to Face Lectures using Audio-Visuals
2. Workshops, Group Discussions, Debates, Presentations
3. Demonstrations
4. Guest Lectures
5. Laboratory work/Field work/Workshop
6. Industry Visit
7. Seminars
8. Group Exercises
9. Project Work
10. Project
11. Exhibitions
12. Technical Festivals

24. Assessment and Grading

24.1. Components of Grading

There shall be **two components** of grading in the assessment of each course:

Component 1, Continuous Evaluation (CE): This component involves multiple subcomponents (SC1, SC2, etc.) of learning assessment. The assessment of the subcomponents of CE is conducted during the semester at regular intervals. This subcomponent represents the formative assessment of students' learning.

Component 2, Semester-end Examination (SEE): This component represents the summative assessment carried out in the form an examination conducted at the end of the semester.

Marks obtained CE and SEE components have equal weightage (CE: 50% and SEE: 50%) in determining the final marks obtained by a student in a Course.

The complete details of Grading are given in the Academic Regulations.

24.2. Continuous Evaluation Policies

Continuous evaluation depends on the type of the course as discussed below:

24.2.1 Theory Courses

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The following **TWO options** are available for each Faculty to perform the CE exercise.

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Option 1 for a Theory Course:

Theory Course			
SC1	SC2	SC3	SC4
25 Marks	25 Marks	25 Marks	25 Marks

In Option 1, there shall be four subcomponents of CE (SC1, SC2, SC3 and SC4). Each subcomponent is evaluated individually for 25 marks. It is mandatory that two of the four subcomponents are term-tests. The remaining two subcomponents can be of any of the following types:

a) Online Test
b) Assignments/Problem Solving
c) Field Assignment
d) Open Book Test
e) Portfolio
f) Reports
g) Case Study
h) Group Task
i) Any other

After the four subcomponents are evaluated, the CE component marks are determined as:
CE Component Marks = (Total of the marks obtained in all the four subcomponents) ÷ 2

An additional subcomponent (SC5) may be used at the discretion of the Faculty/Department. The department can conduct the 5th subcomponent SC5 if this subcomponent gives benefit to students. If the Department/Faculty conducts the SC5 subcomponent of evaluation, and the score obtained by the student in SC5 is greater than the lowest score of the previous four subcomponents SC1 to SC4, then it replaces the lowest of the four scores.

Option 2 for a Theory Course:

Theory Course			
SC1	SC2	SC3	SC4
25 Marks	25 Marks	25 Marks	25 Marks

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In Option 2, there shall be four subcomponents, each carrying 25 marks. Out of these, there shall be two assignments and two term-tests. The assignments can be of any of the following types:

a) Online Test
b) Problem Solving
c) Field Assignment
d) Open Book Test
e) Portfolio
f) Reports
g) Case Study
h) Group Task
i) Any other

After the four subcomponents of CE are evaluated, the CE component Marks are determined as:

CE Component Marks = (Best of two Assignment Marks) + (Best of two Term-Test Marks)
Each Faculty Dean, in consultation with the heads of all departments in the Faculty and the Faculty Academic Registrar, decides whether Option 1 or Option 2 is adopted for each programme offered by the Faculty. He/she notifies the students about the option at the beginning of the semester.

24.2.2 Course Having a Combination of Theory and Laboratory

For a course that contains the combination of theory and laboratory sessions, the scheme for determining the CE marks is as under:

For a Course having a Combination of Theory and Laboratory Sessions			
SC1 (Theory)	SC2 (Theory)	SC3 (Theory)	SC4 (Laboratory)
25 Marks	25 Marks	25 Marks	25 Marks

There shall be four subcomponents, each carrying 25 marks. Out of these, there shall be two term-tests and an assignment to evaluate the students' performance in theory. The fourth subcomponent shall be set to evaluate the students' performance in the laboratory.

The theory assignment can be of any of the following types:

a) Online Test

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b) Problem Solving
c) Field Assignment
d) Open Book Test
e) Portfolio
f) Reports
g) Case Study
h) Group Task
i) Any other

The laboratory subcomponent can be of any of the following types:

a) Laboratory / Clinical Work Record
b) Experiments
c) Computer Simulations
d) Creative Submission
e) Virtual Labs
f) Viva / Oral Exam
g) Lab Manual Report
h) Any other (e.g. combinations)

After the four subcomponents are evaluated, the CE component marks are determined as:
CE Component Marks = (Total of the marks obtained in all the four subcomponents) ÷ 2

25. Student Support for Learning

1. Course Notes
2. Reference Books in the Library
3. Magazines and Journals
4. Internet Facility
5. Computing Facility
6. Laboratory Facility
7. Workshop Facility
8. Staff Support
9. Lounges for Discussions
10. Any other support that enhances their learning

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26. Quality Control Measures

1. Review of Course Notes
2. Review of Question Papers and Assignment Questions

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3. Student Feedback
4. Moderation of Assessed Work
5. Opportunities for students to see their assessed work
6. Review by external examiners and external examiners reports
7. Staff Student Consultative Committee meetings
8. Student exit feedback
9. Subject Assessment Board (SAB)
10. Programme Assessment Board (PAB)

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27. Programme Map (Course-PO-PSO Map)

Sem.	Course Title	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
1	Public Health Engineering	1	3											3		
1	Modern Methods of Waste Characterization			3										3		
1	Waste Water Treatment Plant Design		3		3	3								3	3	
1	Air pollution and Control		3		3	3								3	3	
1	Toxicology and environmental risk assessment	2	3	1										3		
1	Environmental remediation of contaminated sites	2	3											3		
1	Aquatic biodiversity and environmental pollution	2	3											3		
1	Energy in built environment	2	3	1										3		
1	Renewable energy sources and environmental Impact		3		3	3								3	3	
1	Alternative fuels	1	3	1										3		
1	Industrial and commercial applications of renewable energy sources	3	2				2		1	1	1			3	2	1
1	Research Methodology & IPR				3		3	3	3	2	3	3	1		3	3
1	Professional communication					2					2					2
2	Solid waste and hazardous waste management			3		3		3						3	3	
2	Solid waste and hazardous waste treatment plant design	1	3											3		
2	Environmental biotechnology		3											3		
2	Rural water supply and sanitation		3				3			3				3	3	3
2	Integrated waste management in smart cities	3	3	3				3						3	3	
2	Entrepreneurship in waste management		3											3		
2	Transport process and modeling of aquatic system			3	1									3	1	

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2	Geo-environmental engineering		3											3		
2	Remote sensing and GIS in environmental engineering			3				2						3	2	
2	Treatment Plants Operations and Maintenance	3	3	3	3			2						3	3	
2	Environmental policies and legislation	3	2	2			2			1	1			3	2	1
2	Value Education	2						2	3	2			3			2
3	Internship	3	3	3	3	3	3	3	2	3	3	3	2	3	3	3
3	Group project	3	3	3	3	3	2	2	2	2	2	1	2	3	3	2
4	Dissertation and Publication	3	3	3	3	3	1	3	1	3	3	3	1	3	3	3

28. Co-curricular Activities

Students are encouraged to take part in co-curricular activities like seminars, conferences, symposia, paper writing, attending industry exhibitions, project competitions and related activities for enhancing their knowledge and networking.

29. Cultural and Literary Activities

Annual cultural festivals are held to showcase the creative talents in students. They are involved in planning and organizing the activities.

30. Sports and Athletics

Students are encouraged to take part in sports and athletic events regularly. Annual sports meet will be held to demonstrate sportsmanship and competitive spirit.

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Course Specification

Course Details				
Course Code	20ESCS501A			Course Category
Course Title	Public Health Engineering			
Programme	Environmental Engineering and Management			PC
Department	Civil Engineering			
Faculty	Engineering and Technology			
Course Approval Date	May- 2019	Course Next Review Date	May-2021	
Department Responsible for Course Delivery	Civil Engineering			

1. Course Size and Credits	
Number of Credits	5
Duration (Hrs)	90
Course Marks	100
Attendance Requirement	As per M.Tech. Programme Academic Regulations
Course Pass Criteria	As per M. Tech. Programme Specification Document (Annexure-1)

2. Course Summary

Aim and Summary	Students are made conversant with sources and demand of water, the basic characteristics of water and sewage. Different types of sewage water and their effect on environment. Principles and design of water treatment and distribution, sewage collection, conveyance, treatment and disposal system, Different methods of effluent treatment involving Mechanical, Biological and Chemical processes are dealt. They are also trained to choose appropriate method of treatment for industrial waste water. Students are trained to use relevant BIS codes, GIS codes and GOI Manuals.

3. Teaching, Learning and Assessment

After undergoing this module students will be able to:

1. Discuss classification of sources of water, demands of water and conduct survey on source of water and compare basic characteristics of water
2. Discuss classification of wastewater, characteristics of sewage and industrial waste water, various treatment processes available
3. Estimate sewage and storm water flow
4. Distinguish different water treatment processes, sewage lines, process of Effluent Treatment – Pretreatment, Primary, Secondary, Tertiary treatments and their design
5. Compare various disposal standards for sewage and sludge and recommend treatments for a given Industrial waste water
6. Apply environmental treatment technologies and design processes

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3.2 Course Content

Introduction **(08 Hours)**

Scope of Public health – Global environmental Problems - Human activities and environmental pollution. Water for various beneficial uses and quality requirement. Need for protected water supply, necessity for sanitation

Water Supply Engineering

Sources – Surface and subsurface sources suitability with regard to quality and quantity. Identify and discuss the basic elements of hydrology, and apply hydrological principles in water and wastewater engineering, forecast water demand in a city, based on population forecasts, per capita use and water demand management measures.

Water sampling and analysis with respect to ISO 10500 and their relation to public health and environment

Water treatment **(07Hours)**

- Process of treatments - mixing, aeration, sedimentation, coagulation, filtration, and disinfection, softening

Advanced Water Treatment:

- Desalination technologies, low pressure membranes, reverse osmosis, natural systems, advanced oxidation processes.
- Water Distribution Systems:
- System of supply, service reservoirs and their capacity determination, methods of layout of distribution systems.

Sewerage Systems **(08 Hours)**

- Characteristics and composition of sewage. Types of sewerage systems and their suitability. The hydrological processes relevant to urban storm drainage and impacts of urbanization on hydrological processes and discuss basic concepts in catchment modeling.
- Basic concepts of fluid flow and the principles, fundamentals and applicability of methods to analyze conduit and free surface flows.
- Sewer materials, shapes of sewers, laying of sewers, joints and testing of sewers, ventilation and cleaning of sewers.

Disposal of Sewage and Sludge:

- Disposal of wastewater by dilution, self-purification phenomenon. Oxygen sag curve, zones of purification, sewage farming, sewage sickness, wastewater analysis and disposal standards for land, surface water & ocean

Tre atment of Municipal Waste Water **(08 Hour s)**

Primary Treatment

7Flow diagram of municipal waste water treatment plant. Preliminary &

Primary Treatment: Screening, grit chambers, skimming tanks, primary sedimentation tanks

Secondary Treatment

- Suspended growth and fixed film bioprocess. Trickling filter – theory and operation, types and designs. Activated sludge process- Principle and flow diagram, Modifications of ASP, F/M ratio. Design of ASP.

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- Anaerobic Sludge digestion, Sludge digestion tanks, design of sludge drying beds. Low cost waste treatment method. Septic tank, oxidation pond and oxidation ditches – design. Reuse and recycle of waste water

Treatment of Industrial Waste Water **(08 Hours)**

Introduction

- Difference between domestic and Industrial waste water. Effect of industrial waste water on streams, on physical and chemical properties of soil, sewerage system and on municipal sewage treatment plants
- Stream sampling, effluent and stream standards and legislation to control water pollution. Effluent standards and receiving water quality standards. Different aspects and choices of various disposal alternatives.
- Industrial Waste survey-Process flow charts, condition of waste stream. Material balance, stream quality, dissolved oxygen sag curve in stream, Streeter– Phelps formulation

Treatment methods **(06 Hours)**

- Volume reduction, strength reduction, neutralization, equalization and proportioning, removal of suspended solids and colloids-treatment and disposal of sludge solids
- Combined treatment:

  Feasibility of combined treatment of industrial raw waste with domestic wasted, Discharge of raw, partially treated and completely treated wastes to streams

3.3 Teaching and Learning Methods

Methods	Duration in Hrs.	Total Duration in Hrs.
Face to Face Lectures		45
Demonstrations		2
1. Demonstration using Videos	x	
2. Demonstration using Physical Models/ Systems		
3. Demonstration on a Computer	x	
Numeracy		2
1. Solving Numerical Problems	x	
Practical Work		30
1. Course Laboratory	x	
2. Computer Laboratory		
3. Engineering Workshop/ Course Workshop		
4. Model / Model Studio		
Others		1
1. Assignment Discussion / Related Activities		
2. Case Study Presentations	x	
3. Guest Lecture		
4. Industry / Field Visit		

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5. Brain Storming Sessions		
6. Group Discussions		
7. Discussion on Possible Innovations		
Student Presentation, Laboratory Examination, Written Examination		10
Total Duration in Hours		90

4. Course Resources	
a. Essential Reading	1. Class Notes 2. Hammer M. J., (2007), Water and Wastewater Technology, Prentice Hall, 6th edition 3. Garg S. K., (2001), Environmental Engineering, Vol. I, Khanna Publications, New Delhi 4. Birdie G.S. and Birdie J.S., (1998), Water Supply and Sanitary Engineering, Dhanpat Rai & Sons, New Delhi 5. Duggal K.N., (2000), Elements of Environmental Engineering, S Chand & Co. Ltd., New Delhi
b. Recommended Reading	1. Manual on Sewerage and Sewage Treatment, (1997), CPHEEO, Ministry of Urban Development, Government of India, New Delhi 2. Metcalf and Eddy, (2003), Wastewater Engineering – Treatment and Reuse, Tata Mc. Graw- Hill Company, New Delhi 3. Steel E. W. and Mc Ghee T. J., (1990), Water Supply & Sewage, McGraw Hill, New York 4. Ehlers V. M. and Steel E. W., (1987), Municipal and Rural Sanitation, Mc Graw Hill 5. Peavy H. S., Rowe D. R. and Tchobanoglous G., (2000), Environmental Engineering, Mc Graw-Hill Publishing Co., 7th Rev Ed edition
c. Other Resources	**Magazines and Journals** 1. Water Management, ISSN: 17417589 2. Water and Wastes Digest, ISSN: 00431141 3. Asian Journal of Water, Environment and Pollution, ISSN: 09729860 4. Water, Sewage and Effluent, ISSN: 02578700 **Websites** 5. http://ores.su/en/journals/scopus/water-science-and-technology/?page=1 6. UNESCO website **Other Electronic Resources** 7. Electronic resources on the module area are available at MSRUAS library

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Course Specification

Course Details				
Course Code	20ESC502A			Course Category
Course Title	Modern Methods of Waste Characterization			
Programme	Environmental Engineering and Management			PC
Department	Civil Engineering			
Faculty	Engineering and Technology			
Course Approval Date	May- 2019	Course Next Review Date	May-2021	
Department Responsible for Course Delivery	Civil Engineering			
1. Course Size and Credits				
Number of Credits	4			
Duration (Hrs)	60			
Course Marks	100			
Attendance Requirement	As per M.Tech. Programme Academic Regulations			
Course Pass Criteria	As per M. Tech. Programme Specification Document (Annexure-1)			

2. Course Summary

Aim and Summary	This module provides an understanding of wet chemical methods of waste characterization. Emphasis will be given on typical waste characterization methods such as COD, BOD and heavy metal detection. Knowledge of characteristics of municipal wastes, dairy wastes and wastes from other chemical industries are important in designing and development of treatment plants are also dealt. Students will learn instrumental methods like spectrophotometry, fluorimetry, nepholometry and related techniques that aid waste characterization. Chromatographic techniques, electro and radio analytical techniques will also be highlighted.

3. Teaching, Learning and Assessment

After undergoing this Course students will be able to:

1. Discuss the importance of waste characterization
2. Recognize the advantages of instrumental methods over wet chemical methods for waste characterization
3. Recommend suitable spectroscopic method to analyze a particular type of waste
4. Identify chemical compounds in the waste using chromatographic techniques
5. Predict the quality of water using electro and radioanalytical metho

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3.2 Course Content
(09 Hours) Wet chemistry methods of waste characterization and their limitations, instrumental methods and their advantages, selection of methods, precision and accuracy, errors, sample preparation & preservation (including seasonal effects) and analyze isolation techniques. Quality control & assurance.
(09Hours) Waste Characterization: Typical chemical and biological composition of untreated domestic and industrial wastewater, COD, BOD, heavy metal ions, moisture content, proximate and ultimate analysis, particle size, Municipal wastes, dairy wastes, agricultural wastes, slaughter house wastes and Chemical Industry wastes. Radioactive waste sources, characteristics and its assessment, characteristics of hazardous wastes
(09 Hours) Spectroscopic methods Instrumental methods of analysis for organic and inorganic contaminants in water and soil: colorimeter, spectroscopy, electrochemical probes, remote sensing and bioassays. Concepts of resolution, accuracy, precision, sensitivity, calibration and control of error. Laboratory certification and standardization Principles of spectrophotometer, fluorimetry, nephelometry and turbidimetry, infra-red spectroscopy, atomic absorption spectrometry (AAS), atomic emission spectrometry (AES), mass spectroscopy, flame and inductively coupled plasma spectroscopy (ICPS) for trace analysis, total organic content analyzer (TOC), elemental (CHNS) analyzer
(09 Hours) Chromatographic methods Column, paper and thin layer chromatography (TLC) – principles, techniques and applications of gas chromatography (GC), liquid chromatography (LC), GC/MS, LC/MS, high performance liquid chromatography (HPLC) and ion exchange chromatograph (IEC)
(09 Hours) Electro and radio analytical methods: Principles, techniques and applications of conductometry, potentiometry, X-ray fluorescence (XRF) and Xray diffraction (XRD) methods, auto analyzer for water quality using flow injection analysis, toxicity characteristic leaching procedure (TCLP) Laboratory Course on Water Chemistry: Alkalinity and hardness, determination of chlorine in water, breakpoint chlorination, iron, arsenic, fluoride and nitrate analysis, iron (II) oxidation, determination of turbidity of water sample.

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3.3 Teaching and Learning Methods		
Methods	**Duration in Hrs.**	**Total Duration in Hrs.**
Face to Face Lectures		40
Demonstrations		
1. Demonstration using Videos		
2. Demonstration using Physical Models/ Systems		
3. Demonstration on a Computer		
Numeracy		
1. Solving Numerical Problems	x	
Practical Work		
1. Course Laboratory	x	
2. Computer Laboratory		10
3. Engineering Workshop/ Course Workshop		
4. Model / Model Studio		
Others		
1. Assignment Discussion / Related Activities		
2. Case Study Presentation		
3. Guest Lecture		
4. Industry / Field Visit		
5. Brain Storming Sessions		
6. Group Discussions		
7. Discussion on Possible Innovations		
Student Presentation, Laboratory Examination, Written Examination		10
Total Duration in Hours		60

4. Course Resources	
a. **Essential Reading**	1. Class Notes 2. Pecsok, R.L., Shields, L.D., Cairns, T., Mc william, I.G, (1976), Modern Methods of Chemical Analysis, Second Ed. John, Wiley & Sons, New York 3. Douglas A. Skoog, F. James Holler, Stanley R. Crouch,(2007), Principles of Instrumental Analysis. Thomson Brooks/Cole 4. I. Vogel, (1971), A test Book of Quantitative Inorganic Analysis, 3rd Edition, Longman
b.	5.
c. **Recommended Reading**	1. Woodard and Curran, (2011), Industrial Waste Treatment Handbook, Butterworth- Heinemann 2. Frank Woodard, (2001), Industrial Waste Treatment Handbook, Butterworth-Heinemann 3. Birute Vanatta, (2000), Guide for Industrial Waste Management, DIANE Publishing

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	4. Willard, HH. Merritt, LL. Dean, JA. Settle, FA, (1988), Instrumental Methods of Analysis.7th Edition. New Delhi: CBS Publishers and Distributors
d. Other Resources	**Magazines and Journals** 1. Analytical Chemistry 2. Annual review of analytical chemistry **Websites** 1. http://www.chemistryviews.org 2. www.aaas.org 3. www.gdch.de **Other Electronic Resources** 1. http://www.bruker.com/products.html 2. http://www.jeolusa.com/Resources/tabid/328/Default.aspx 3. www.iupac.org

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Course Specification

Course Details				
Course Code	20ESC503A			Course Category
Course Title	WasteWater Treatment Plant Design			
Programme	Environmental Engineering and Management			PC
Department	Civil Engineering			
Faculty	Engineering and Technology			
Course Approval Date	May- 2019	Course Next Review Date	May-2021	
Department Responsible for Course Delivery	Civil Engineering			
1. Course Size and Credits				
Number of Credits	5			
Duration (Hrs)	75			
Course Marks	100			
Attendance Requirement	As per M.Tech. Programme Academic Regulations			
Course Pass Criteria	As per M. Tech. Programme Specification Document (Annexure-1)			

2. Course Summary

Aim and Summary	In this module, student are taught sizing calculations of different units like filter bed size and holding tank size are made for different units in the treatment methods. Student would also be able to design an effluent treatment plant for a given flow rate of influent, including instrumentation required and pump selection.

3. Teaching, Learning and Assessment

After undergoing this course students will be able to:

1. List and explain the characteristics of effluents generated in industries
2. Classify and explain mechanical, chemical and biological treatment methods with respect to on site and combined effluent treatment plants (CETP)
3. Calculate residence time and proportioning of flow variations, state the design criteria for treatment and draw plant layout
4. Suggest Instrumentation for measurement of important characteristics of sewage/effluent including measurement of flow
5. Perform sizing calculations for different units and design an effluent treatment plant for a given influent of waste

3.2 Course Content

(20 Hours)

Design of onsite and centralized water and waste water treatment plants

Mixing tank, flocculator, sedimentation tank, rapid gravity filter, wash water tank, under drainage system.
Design of effluent treatment plant screening tank, grit chamber, primary clarifier, trickling filter, aeration tank, secondary clarifier
Design and drawing of septic tank and soakage pit
Design and drawing of ASP

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Industrial Effluent Treatment Plant Design Considerations, plant layout, effluent flow variations and proportioning Residence time calculations for sedimentation, floatation, Coagulation Sizing calculations for holding tanks (sedimentation), filters, reverse osmosis (RO), ion exchange columns Common or combined ETP (CETP) considerations	**(20 Hours)**
Pump selection for the process treatment units Instrumentation for measurement of important characteristics of sewage/effluent including measurement of flow	**(20 Hours)**

3.3 Teaching and Learning Methods

Methods	Duration in Hrs.	Total Duration in Hrs.
Face to Face Lectures		45
Demonstrations		2
1. Demonstration using Videos	x	
2. Demonstration using Physical Models/ Systems		
3. Demonstration on a Computer	x	
Numeracy		2
1. Solving Numerical Problems	x	
Practical Work		15
1. Course Laboratory	x	
2. Computer Laboratory		
3. Engineering Workshop/ Course Workshop		
4. Model / Model Studio		
Others		1
1. Assignment Discussion / Related Activities		
2. Case Study Presentation	x	
3. Guest Lecture		
4. Industry / Field Visit		
5. Brain Storming Sessions		
6. Group Discussions		
7. Discussion on Possible Innovations		
Student Presentation, Laboratory Examination, Written Examination		10
Total Duration in Hours		75

4. Course Resources

a. Essential Reading	1. Class Notes 2. SyedR. Qasim,(2000), Waste Water Treatment Plants: Planning, Design, and Operation. 2nd Ed. CRC Press. Florida. ISBN: 1-56676-688-5 3. Frank. R. Spellman,(2009), "Handbook of Water and Wastewater Treatment Plant Operations". CRC Press. Florida. ISBN: 978-1-4200-7530-4

b. Recommended Reading	1. Patwardhan. A. D.,(2008), Industrial Waste Water Treatment. PHI India. New Delhi, SBN: 978-81-203-3350-5 2. Rajni Kant,(2010), Water Pollution: Management, Control and Treatment, New Age Publications 3. JT O'Connor,(2009), Water Treatment: Plant Performance Evaluations and Operations", Wiley Publications, New Jersey 4. Clifford Randall, "Design and Retrofit of Wastewater treatment plants for biological nutrient removal",(1992), Technomic Publishing Company, Pennsylvania 5. Water Environment Federation, (2009), Design of Municipal Wastewater Treatment Plants MOP 8, Fifth Edition", Mc Graw Hill International
c. Other Resources	**Magazines and Journals** 1. Water Management, ISSN: 17417589 2. Water and Wastes Digest, ISSN: 00431141 3. Asian Journal of Water, Environment and Pollution, ISSN: 09729860 4. Water, Sewage and Effluent, ISSN: 02578700 **Websites** 1. http://ores.su/en/journals/scopus/water-science-and-technology/?page=1 2. UNESCO website **Other Electronic Resources** 1. Electronic resources on the module area are available at MSRUAS library

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Course Details				
Course Code	20ESE511A			Course Category
Course Title	Air pollution and control			
Programme	Environmental Engineering and Management			PE
Department	Civil Engineering			
Faculty	Engineering and Technology			
Course Approval Date	May- 2019	Course Next Review Date	May-2021	
Department Responsible for Course Delivery	Civil Engineering			
1. Course Size and Credits				
Number of Credits	4			
Duration (Hrs)	60			
Course Marks	100			
Attendance Requirement	As per M.Tech. Programme Academic Regulations			
Course Pass Criteria	As per M. Tech. Programme Specification Document (Annexure-1)			
2. Course Summary				
Aim and Summary	Students are made conversant with science of atmospheric pollution, composition, monitoring, acidic deposition, urban air quality and global changes in the atmosphere, use of models in air pollution studies, sources, effects and control methods of noise pollution. They can established methods for monitoring and modeling spatial and temporal patterns of pollution, assess the environmental impacts of atmospheric pollution, evaluate the scientific basis underlying in controlling of air pollutants and take suitable measures for noise pollution control			
3. Teaching, Learning and Assessment				
After undergoing this Course students will be able to: 1. Discuss outdoor and indoor air pollution, ambient air quality, emission standards, noise pollution and their effect on global environment including human health and vegetation 2. Evaluate the current practices available in air quality monitoring, control of gaseous, particulate pollutants and automobile emission control and their design 3. Analyze dispersion of air pollutants and modeling approaches for air pollution profile 4. Interpret meteorological data, air pollution data and develop capability to assessment of project proposal, air quality pollution index for any region 5. Develop air pollution model and engineering solutions to air pollution and noise pollution problem				

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3.2 Course Content

Introduction **(06 Hours)**

Definition of air pollution- Sources & Classification of air pollutants ,Air resource management system, air quality management, scales of air pollution problem, Effects on human health, vegetation and property, global implications of air pollution, atmospheric stability , micrometeorology, atmospheric turbulence, mechanical &thermal turbulence, wind profile, atmospheric diffusion theories, steady state atmospheric diffusion equation, diffusion models, ambient air quality and emission standards.

Meteorology **(09 Hours)**

Lapse rates, Maximum Mixing Depth (MMD), Temperature Inversions, Windrows diagram, Inversion and its types, Plume behaviours, Plume rise and Dispersion of pollutants in the atmosphere, Box model, eddy diffusion model, the Gaussian dispersion model, Gaussian dispersion coefficient, Pasquill and Gifford atmospheric stability coefficient ISCST3/ISCLT3 model, maximum ground level concentration, Determination of stack height, sampling time corrections.

Air quality monitoring **(07 Hours)**

Objectives, time and space variability in air quality. Repairable, non-repairable and Nano particulate matter. Monitoring gaseous pollutants-CO,CO_2 ,SO_x & NO_x, photochemical oxidants, Chemical analysis of air pollutants CO,$CO2$,SO_x ,NO_x,NH_3,Benzene, toluene, formaldehyde, lead, nickel, arsenic, polyromantic hydrocarbon ,VOC's.

Monitoring equipment's **(08 Hours)**

Stack monitoring and sampling devices- isokinetic sampling, gas exhaust monitoring. Air sampling design, analysis and interpretation of air pollution data, guidelines of network design in urban and rural areas. Air pollution standards and indices.

Control Of Particulate Pollutants **(07 Hours)**

Properties of particulate pollution - Particle size distribution - Control mechanism - Dust removal equipment - Design and operation of settling chambers, cyclones, wet dust scrubbers, fabric filters & Electrostatic Precipitator.

Control Of Gaseous Pollutants **(08 Hours)**

Process and equipment for the removal by chemical methods – absorption principles, description of equipment-packed and plate columns, design and performance equations. Adsorption equipment principles adsorbents, equipment descriptions-PSA-adsorption cycle-solvent recovery system continuous rotary bed fluidized bed, Design and performance equations. Condensation: contact condensers-shell and tube condensers, design and performance equation. Incineration: hydrocarbon incineration kinetics, equipment description, design and performance equations.

Noise Pollution **(07 Hours)**

Basics of acoustics and specification of sound; sound power, sound intensity and sound pressure levels; plane, point and line sources, multiple sources; outdoor and indoor noise propagation; psycho-acoustics and noise criteria, effects of noise on health, annoyance rating schemes; special noise environments: Infra-sound, ultrasound, impulsive sound and sonic boom; noise standards and limit values; noise instrumentation and monitoring procedure. Noise indices

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Indoor air pollution **(08 Hours)** Combustion sources, cigarette smoke as an indoor pollutant, Indoor air quality, indoor air quality model. **Automobile Emission Control** Transport scenario in India, Internal combustion engines, air pollution from petrol engines, nature of diesel emission, reactivity and carcinogenicity of HC emissions, particulate matter in diesel engines, automobile pollution in India. Global climate change, temperature model, greenhouse effect, variability of climate change, global warming indicator, global perspective on greenhouse effect.

3.3 Teaching and Learning Methods

Methods	Duration in Hrs.	Total Duration in Hrs.
Face to Face Lectures		40
Demonstrations		4
1. Demonstration using Videos	x	
2. Demonstration using Physical Models/ Systems		
3. Demonstration on a Computer	x	
Numeracy		2
1. Solving Numerical Problems	x	
Practical Work		
1. Course Laboratory		
2. Computer Laboratory		
3. Engineering Workshop/ Course Workshop		
4. Model / Model Studio		
Others		4
1. Assignment Discussion / Related Activities		
2. Case Study Presentation	x	
3. Guest Lecture		
4. Industry / Field Visit	x	
5. Brain Storming Sessions		
6. Group Discussions		
7. Discussion on Possible Innovations		
Student Presentation, Laboratory Examination, Written Examination		10
Total Duration in Hours		60

4. Course Resources

a Essential . Reading	1.	Class Notes
	2.	Environmental Pollution Control Engineering- CS Rao, Wiley Eastern Ltd., New Delhi, 1996.
	3.	Fundamentals of Air pollution, Richard W. Boubel et al, Academic Press, New York, 1994.

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b. Recommended Reading	1. Handbook of air pollution prevention and control by Nicholas P. Cheremisinoff, ISBN 07506-7499-7, elsevier science (usa) 2002. 2. Air pollution control technology handbook by Karl B. Schnelle, J R., et al. ISBN 0-84939588-7,crc press llc.
c. Other Resources	**Magazines and Journals** 1. The Journal of Atmospheric pollution research 2. Journal of the Air Pollution Control Association. **Websites** 1. www.kspcb.gov.in/ambient_air_quality.html 2. http://cpcb.nic.in/air-pollution **Other Electronic Resources** 1. Electronic resources on the module area are available at MSRUAS library

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Course Specification

Course Details				
Course Code	20ESE512A			Course Category
Course Title	Toxicology and environmental risk assessment			
Programme	Environmental Engineering and Management			PE
Department	Civil Engineering			
Faculty	Engineering and Technology			
Course Approval Date	May- 2019	Course Next Review Date	May-2021	
Department Responsible for Course Delivery	Civil Engineering			
4. Course Size and Credits				
Number of Credits	4			
Duration (Hrs)	60			
Course Marks	100			
Attendance Requirement	As per M.Tech. Programme Academic Regulations			
Course Pass Criteria	As per M. Tech. Programme Specification Document (Annexure-1)			

5. Course Summary

Aim and Summary	The course deals with an aim to provide a better understanding Environmental toxicology involves the studying of sources, pathways, transformations, and effects of chemicals that are harmful in the environment. The study of these harmful effects extends from individuals and populations of organisms to the ecosystem level. This course gives an insight in the area of environmental monitoring of organic and inorganic chemical toxicants.

6. Teaching, Learning and Assessment

After undergoing this Course students will be able to:

1. Discuss fate and effects of pollutants, pollution distribution in the environment (including air, water, soil and food chains) both on a local and a global scale
2. Discuss the interaction between environmental toxicants and organisms, and how their impacts on populations and ecosystems. competencies by augmenting the Environmental Law awareness
3. Discuss the methods of field work and/or experimental exposure studies in laboratory on individual organisms

3.2 Course Content

Concepts of Environmental Toxicology

Study of environmental toxicology, Worldwide development in recent decades, environmental pollution and law, Importance of environmental toxicology, Assessment of toxicity, Toxicity at the molecular level (Carcinogenesis, Genotoxicity assays, Chromosome studies), Damage Process and action of Toxicants, Metabolism of Environmental Chemicals. Defence responses to toxicants.

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Toxicant Uptake, Route, Kinetics Route of toxicant uptake (skin, lungs, gills, digestive system), Uptake at the tissue and cellular level, Toxicokinetics, Single-compartment model, Two-compartment model, Volume of distribution, Transporter-mediated transport, Lethal body burden (critical body residue).
Methodological approaches & Factors Concepts and principles for biological indicators, Tolerance and resistance to potentially toxic substances, Biological & biochemical markers, Community and higher level indicators: The ecological approach to toxicology, Modelling, Advantages, Limitations & pitfalls in the modelling for environmental toxicology. Biotic and Abiotic Factors affecting toxicity.
Toxicology Chemicals and Ionising Radiation
Properties and environmental behaviour of metals and metalloids, Analytical methods, temporal and spatial distribution of metals and metalloids in the environment (Pb, Cd, Cu, Ni, Se,Hg), Organotins, Metabolism of organics, Environmental mobility of organic compounds. Introduction to Ionising Radiation, Effects of radiation at the molecular and cellular level, Assessment of risk from radiation, Ecological effects of radiation
Risk assessment, Recovery & Rehabilitation Basic components of a risk assessment, Use and Importance of ecological risk assessment, Frameworks for ecological risk assessment, Factors triggering risk assessment, Routes for recovery, Recent regulatory approaches to contaminated sites, Updating risk assessment

3.3 Teaching and Learning Methods

Methods	Duration in Hrs.	Total Duration in Hrs.
Face to Face Lectures		45
Demonstrations		2
1. Demonstration using Videos	x	
2. Demonstration using Physical Models/ Systems		
3. Demonstration on a Computer		
Numeracy		
1. Solving Numerical Problems		
Practical Work		
1. Course Laboratory		
2. Computer Laboratory		
3. Engineering Workshop/ Course Workshop		
4. Model / Model Studio		
Others		3
1. Assignment Discussion / Related Activities		
2. Case Study Presentation	x	
3. Guest Lecture		
4. Industry / Field Visit		
5. Brain Storming Sessions	x	
6. Group Discussions	x	
7. Discussion on Possible Innovations		

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Student Presentation, Laboratory Examination, Written Examination	10
Total Duration in Hours	60

7. Course Resources	
a. Essential Reading	1. Class Notes 2. Sigmund F. Zakrzewski, Environmental Toxicology, 2002 by Oxford University Press, Inc 3. Ian Shaw, John Chadwick, Principles of Environmental Toxicology, Taylor & Francis Ltd
b. Recommended Reading	1. Robert J Flanagan et al., Fundamentals of Analytical Toxicology Robert J Flanagan et al., John Wiley & Sons Ltd. 2. David A Wright and Pamela, Environmental Toxicology, Welbourn, Cambridge University Press..
c. Other Resources	**Websites** **Other Electronic Resources** 1. Electronic resources on the module area are available at MSRUAS library

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Course Specification

Course Details				
Course Code	20ESE513A			Course Category
Course Title	Environmental remediation of contaminated sites			
Programme	Environmental Engineering and Management			PE
Department	Civil Engineering			
Faculty	Engineering and Technology			
Course Approval Date	May- 2019	Course Next Review Date	May-2021	
Department Responsible for Course Delivery	Civil Engineering			
8. Course Size and Credits				
Number of Credits	4			
Duration (Hrs)	60			
Course Marks	100			
Attendance Requirement	As per M.Tech. Programme Academic Regulations			
Course Pass Criteria	As per M. Tech. Programme Specification Document (Annexure-1)			
9. Course Summary				
Aim and Summary	The course details the usual remediation techniques practiced worldwide and provide an understanding of the relevant theoretical concepts			
10. Teaching, Learning and Assessment				
After undergoing this Course students will be able to: 1. Develop understanding of integrated approaches to remediating contaminated sites. 2. Develop the ability to screen, choose and design appropriate technologies for remediation.				

3.2 Course Content
Introduction, Laws, Regulations and Remediation, Legal Concepts, Types of Law, Regulations, Federal Laws/ Regulations, History, Objectives, Remediation Process, Definition of hazardous waste, Waste Classification, Corrective Action
Risk Assessment, Introduction, Terminology, History, Steps in Human Health Risk Assessment,Data Collection and Evaluation, Exposure Assessment, Toxicity Assessment, Risk Characterization, Risk Management, Risk Communication, Ecological Risk Assessment, Risk-based Corrective Action.
Remedial Options, Introduction, Administrative Options, Groundwater, Plume Containment, introduction, extraction wells, extraction trenches, injection wells/ trenches, wells/ barriers Pump and Treat, Introduction, Contaminant behavior, Design considerations, Source Control, Philosophy, Options

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Permeable Reactive Barriers, Introduction, Redox reactions, Kinetics, Design considerations, Monitored Natural Attenuation, Introduction, Evaluation, Monitoring, Mechanisms, Plume Types, Lines of Evidence, Case Study Soils/Sediments, Excavation, Use, Techniques, Control of contaminant transport, Typical costs, Land-ll, Hazardous waste land-ll, Solid waste land-ll
Containment, characteristics of barrier materials, alternatives, Solidi-cation/ Stabilization, Introduction, Fundamentals, Chemical, physical, Leaching, single-component, multi-component, Design Considerations, TCLP-based approach, Risk-based approach
Chemical Treatment, Non-redox reactions, Reductive processes, Oxidative processes (ISCO), Surfactant extraction, Introduction, Surfactant properties, Con-gurations, Soil Vapor Extraction,Introduction, Fundamentals, Design considerations
Thermal Processes ,Introduction, Incineration, Thermal Desorption, Aqueous Oxidation, Soil Washing, Introduction, Process Description, Design Considerations

3.3 Teaching and Learning Methods

Methods	Duration in Hrs.	Total Duration in Hrs.
Face to Face Lectures		45
Demonstrations		2
1. Demonstration using Videos	x	
2. Demonstration using Physical Models/ Systems		
3. Demonstration on a Computer		
Numeracy		
1. Solving Numerical Problems		
Practical Work		
1. Course Laboratory		
2. Computer Laboratory		
3. Engineering Workshop/ Course Workshop		
4. Model / Model Studio		
Others		3
1. Assignment Discussion / Related Activities		
2. Case Study Presentation	x	
3. Guest Lecture		
4. Industry / Field Visit		
5. Brain Storming Sessions	x	
6. Group Discussions	x	
7. Discussion on Possible Innovations		
Student Presentation, Laboratory Examination, Written Examination		10
Total Duration in Hours		60

11. Course Resources

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d. Essential Reading	1. Class Notes 2. Krishna R. Reddy Jeffrey A. Adams. 2015. Sustainable Remediation of Contaminated Sites Momentum Press®, LLC, 3. Sharma, H.D., and K.R. Reddy. 2004. Geoenvironmental Engineering: Site Remediation, Waste Containment, and Emerging Waste Management Technologies. Hoboken, NJ: John Wiley.
e. Recommended Reading	1. Illinois EPA (Illinois Environmental Protection Agency). February, 2008. Greener Cleanups: How to Maximize the Environmental Benefits of Site Remediation. http://www.epa.state.il.us/land/greener-cleanups/matrix.pdf 2. ISO (International Organization for Standardization). 2006. "Environmental Management: Life Cycle Assessment—Principles and Framework." ISO 14040:2006. www.iso.org/iso/catalogue_detail?csnumber=37456
f. Other Resources	**Websites** **Other Electronic Resources** 1. Electronic resources on the module area are available at MSRUAS library

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Course Specification

Course Details				
Course Code	20ESE514A			Course Category
Course Title	Aquatic biodiversity and environmental pollution			
Programme	Environmental Engineering and Management			PE
Department	Civil Engineering			
Faculty	Engineering and Technology			
Course Approval Date	May- 2019	Course Next Review Date	May-2021	
Department Responsible for Course Delivery	Civil Engineering			
12. Course Size and Credits				
Number of Credits	4			
Duration (Hrs)	60			
Course Marks	100			
Attendance Requirement	As per M.Tech. Programme Academic Regulations			
Course Pass Criteria	As per M. Tech. Programme Specification Document (Annexure-1)			

13. Course Summary

Aim and Summary	This course is focused on how biodiversity represents the very foundation of human existence in India. The loss of biodiversity has serious economic and social costs due to human influence. The genes, species, ecosystems and human knowledge which are being lost represent a living library of options available for adapting to local and global change. Biodiversity is part of our daily lives and livelihood and constitutes the resources upon which families, communities, nations and future generations depend. This course also focused on conservation and management of biodiversity, remedial options and rejuvenation of lakes in India.

14. Teaching, Learning and Assessment

After undergoing this Course students will be able to:

1. Discuss systematic examination of the full array of organisms.
2. Discuss the methods by which diversity can be maintained and used for the benefit of mankind in India.

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3.2 Course Content
1. Introduction to freshwater ecology, Human impacts on fisheries, Fish diversity and status, Fish sampling mGarg, S. K. (2007) Water supply engineering, 18th ed, Vol. I. New Delhi: Khanna Publisher. 2. Garg, S.K. (2007) Sewage disposal and air pollution engineering, 20th ed, Vol. II. New Delhi: Khanna Publisher. 3. Chatterjee, A. K.2010.Water supply, Waste disposal and environmental Engineering, 8th ed. New Delhi: Khanna Publisher. 4. CPHEEO Manual on Sewerage and Sewage treatment, latest editionGarg, S. K. (2007) Water supply engineering, 18th ed, Vol. I. New Delhi: Khanna Publisher. 5. Garg, S.K. (2007) Sewage disposal and air pollution engineering, 20th ed, Vol. II. New Delhi: Khanna Publisher. 6. Chatterjee, A. K.2010.Water supply, Waste disposal and environmental Engineering, 8th ed. New Delhi: Khanna Publisher. CPHEEO Manual on Sewerage and Sewage treatment, latest editionethods in rivers, lakes, reservoirs, Over fishing and mitigation.
Management and conservation of aquatic biodiversity, Human impacts on biodiversity of aquatic ecosystem, Capture of fisheries, Processing and fish preservation, Electro fishing, Fish sampling techniques, Fishing net and fishing gears.
Socioeconomic status of fisheries, Introduced and invasive fish species, Fisheries and economic development, Aquaculture, Sampling techniques in freshwater fish catch, Fish stock assessment.
Ecology of plankton, Freshwater biotic components, Environmental toxicology, Assessment of freshwater pollution, Coral taxonomy, Coral bleaching, Scuba diving and intertidal and underwater coral transplantation.

3.3 Teaching and Learning Methods

Methods	Duration in Hrs.	Total Duration in Hrs.
Face to Face Lectures		45
Demonstrations		2
1. Demonstration using Videos	x	
2. Demonstration using Physical Models/ Systems		
3. Demonstration on a Computer		
Numeracy		
1. Solving Numerical Problems		
Practical Work		
1. Course Laboratory		
2. Computer Laboratory		
3. Engineering Workshop/ Course Workshop		
4. Model / Model Studio		
Others		3
1. Assignment Discussion / Related Activities		
2. Case Study Presentation	x	
3. Guest Lecture		
4. Industry / Field Visit		

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5. Brain Storming Sessions	x	
6. Group Discussions	x	
7. Discussion on Possible Innovations		
Student Presentation, Laboratory Examination, Written Examination		10
Total Duration in Hours		60

15. Course Resources	
g. Essential Reading	1. Class Notes 2. E.P. Odum 1971, Principles of Environmental Science and Technology. 3. Talwar, P.K. and A.G. Jhingran. 1991. Inland fishes of India.
h. Recommended Reading	1. K.C. Jayaram 2002, Fundamentals of Fish Taxonomy.
i. Other Resources	**Websites** **Other Electronic Resources** 1. Electronic resources on the module area are available at MSRUAS library

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Course Specification

Course Details				
Course Code	209ESE521A			Course Category
Course Title	Energy in built environment			
Programme	Environmental Engineering and Management			PE
Department	Civil Engineering			
Faculty	Engineering and Technology			
Course Approval Date	May- 2019	Course Next Review Date	May-2021	
Department Responsible for Course Delivery	Civil Engineering			
16. Course Size and Credits				
Number of Credits	4			
Duration (Hrs)	60			
Course Marks	100			
Attendance Requirement	As per M.Tech. Programme Academic Regulations			
Course Pass Criteria	As per M. Tech. Programme Specification Document (Annexure-1)			

17. Course Summary

Aim and Summary	The course deals with an aim to provide a better understanding of green law issues poignant worldwide, particularly in the Indian context with a more ecologically and socially conscious milieu. Students will be taught methods of minimizing the adverse impacts of pollution and ecological degradation through proper environmental management, international cooperation and raising awareness of environmental values but also strengthening the delivery capacity of environmental professionals so that they are well equipped to face the challenges in their stream of work..

18. Teaching, Learning and Assessment

After undergoing this Course students will be able to:

1. Discuss various energy use and energy processes in building
2. Discuss interaction of various external parameters influencing building energy requirements
3. Discuss the energy requirements for lighting, air-conditioning, etc.
4. Discuss energy audit and energy conservation measures in buildings
5. Discuss management of indoor environmental requirements

3.2 Course Content

Energy processes and environmental requirements in building
Indoor activities and environmental control - Internal and external factors on energy use - Characteristics of energy use and its management -Macro aspect of energy use in dwellings and its implications - Thermal comfort - Ventilation and air quality - Air-conditioning requirement - Visual perception - Illumination requirement - Auditory requirement

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Influence of climate and solar radiation The sun-earth relationship - Climate, wind, solar radiation and temperature - Sun shading and solar radiation on surfaces - Energy impact on the shape and orientation of buildings – Lighting and daylighting: Characteristics and estimation, methods of day-lighting - Architectural considerations for day-lighting
Thermal performance of Buildings Steady and unsteady heat transfer through wall and glazed window - Standards for thermal performance of building envelope - Evaluation of the overall thermal transfer - Thermal gain and
net heat gain - End-use energy requirements - Status of energy use in buildings - Estimation of energy use in a building
Energy and environment management in building Energy audit and energy targeting - Technological options for energy management - Natural and forced ventilation – Indoor environment and air quality - Airflow and air pressure on buildings - Flow due to stack effect
Technologies for low energy buildings Passive building architecture – Radiative cooling - Solar cooling techniques - Solar desiccant dehumidification for ventilation - Natural and active cooling with adaptive comfort – Evaporative cooling – Zero energy building concept

3.3 Teaching and Learning Methods

Methods	Duration in Hrs.	Total Duration in Hrs.
Face to Face Lectures		45
Demonstrations		2
1. Demonstration using Videos	x	
2. Demonstration using Physical Models/ Systems		
3. Demonstration on a Computer		
Numeracy		
1. Solving Numerical Problems		
Practical Work		
1. Course Laboratory		
2. Computer Laboratory		
3. Engineering Workshop/ Course Workshop		
4. Model / Model Studio		
Others		3
1. Assignment Discussion / Related Activities		
2. Case Study Presentation	x	
3. Guest Lecture		
4. Industry / Field Visit		
5. Brain Storming Sessions	x	
6. Group Discussions	x	
7. Discussion on Possible Innovations		
Student Presentation, Laboratory Examination, Written Examination		10
Total Duration in Hours		60

19. Course Resources

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j. **Essential Reading**	1. Class Notes 2. J. Krieder and A. Rabl (2000), Heating and Cooling of Buildings: Design for Efficiency, McGraw-Hill.
k. **Recommended Reading**	1. S. M. Guinnes and Reynolds (1989), Mechanical and Electrical Equipment for Buildings, Wiley. 2. A. Shaw (1991), Energy Design for Architects, AEE Energy Books. 3. ASHRAE (2001), Handbook of Fundamentals, ASHRAE, Atlanta, GA. 4. Reference Manuals of DOE-2 (1990), Orlando Lawrence-Berkeley Laboratory, University of California, and Blast, University of Illinois, USA.
l. **Other Resources**	**Websites** **Other Electronic Resources** 2. Electronic resources on the module area are available at MSRUAS library

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Course Specification

Course Details				
Course Code	20ESE522A			Course Category
Course Title	Renewable energy sources and environmental Impact			
Programme	Environmental Engineering and Management			PE
Department	Civil Engineering			
Faculty	Engineering and Technology			
Course Approval Date	May- 2019	Course Next Review Date	May-2021	
Department Responsible for Course Delivery	Civil Engineering			
1. Course Size and Credits				
Number of Credits	4			
Duration (Hrs)	60			
Course Marks	100			
Attendance Requirement	As per M.Tech. Programme Academic Regulations			
Course Pass Criteria	As per M. Tech. Programme Specification Document (Annexure-1)			
2. Course Summary				
Aim and Summary	This course deals with understanding the importance of different renewable sources such as, wind, solar, bio-mass, tidal, hydro etc. It also deals the technologies involved in the utilization of renewable energy sources. It gives an insight regarding to the impacts it has created during its installation, operation and maintenance. It also deals with the health and safety measures required during utilization of renewable energy sources.			
3. Teaching, Learning and Assessment				

After undergoing this Course students will be able to:

1. Understand and realize the importance of renewable sources of energy
2. Gain sufficient knowledge about the various renewable energy sources such as wind, solar, bioenergy etc.
3. Describe different technologies involved in the utilization of various renewable energy sources
4. Illustrate the environmental impacts of various renewable energy sources
5. implicate the health and safety impacts of various renewable energy sources

3.2 Course Content

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(09 Hours) Energy-Types of Energy-Non-renewable Energy, Benefits, Non-Benefits, Renewable Energy, Benefits NonBenefits **Wind Power** Introduction-Wind Power Basics, Air in Motion, Wind Energy, Wind Power, Wind Turbine Types, Wind Turbine Components Wind Energy Site Evaluation Impacts, Wind Energy Construction Impacts, Wind Energy Operations Impacts, Wind Energy Impacts on Human Health (Power Transmission Lines Energy Transmission Site Evaluation Impacts), Energy Transmission Construction Impacts, Energy Transmission Operations Impacts (All the above context should focus on Air Quality, Cultural Resources, Ecological Resources, Water Resources, Land Use, Soils and Geologic Resources Paleontological Resources, Transportation, Visual Resources, Socioeconomics, Environmental Justice, Hazardous Materials and Waste Management, Acoustics (Noise))
Wind Energy Impacts on Wildlife, Wind Energy Fatalities/Incidents, Wind Turbine Hazards and Applicable OHSA Standards to Controls
Solar Energy **(07 Hours)** Energy from the Sun, Photovoltaics, Concentrating Solar Power, Environmental Impacts of Solar Energy, Land Use and Siting, Water Resources, Hazardous Waste, Ecological Impacts, Solar Energy Job Hazards, Fatalities and Incidents, Hazards and Controls
Hydropower **(08 Hours)** Hydropower Basic Concepts, Advanced Hydropower Technology, Hydropower Generation, Ecological Impacts of Hydropower, Biological Impacts of Flow Fluctuations, Low Water Levels and Evaporation of Reservoirs, Impacts on Human Health and Safety
Biomass/Bioenergy **(08 Hours)** Biomass-Feedstock Types, Composition of Biomass Plant Basics, Feedstocks, Biomass for Bio-power and Bio-products, Biodiesel (Algae to Biodiesel, Algal Biomass, *Jatropha* to Biodiesel, Pros and Cons of Biodiesel), Biogas (Methane) - Anaerobic Digestion, Landfill Biogas, Impacts of Biomass Construction, Production, and Operation, Biomass Energy Construction Impacts, Biomass Feedstock Production Impacts, Biomass Energy Operations Impacts, Impacts on Human Health and Safety, Biofuel Hazards, Fatalities and Incidents.
Geothermal Energy **(07 Hours)** Geothermal Energy: The Basics, Energy Conversion, Geothermal Power Plant Technologies, Enhanced Geothermal Systems, Geothermal Heat Pumps, Environmental Impacts of Geothermal Power Development, Impacts on Human Health and Safety, Hazards and Controls.
Marine and Hydrokinetic Energy **(07 Hours)** Introduction Oceans and Their Margins, Ocean Floor, Ocean Tides, Currents, and Waves, Coastal Erosion, Transportation, and Deposition, Wave Energy, Tidal Energy, Ocean Thermal Energy Conversion, Ocean Energy and Hydrokinetic Technology Impacts, Environmental Impacts of Hydrokinetic Energy, Impacts on Human Health and Safety

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Fuel Cells	**(07 Hours)**
Introduction to Hydrogen Fuel Cells, Hydrogen Storage, working of Hydrogen Fuel Cell, Environmental Impacts of Fuel Cells.	
Carbon Capture and Sequestration	**(07 Hours)**
Introduction to Carbon Capture and Sequestration, Terrestrial Carbon Sequestration, Geologic Carbon Sequestration, Potential Impacts of Terrestrial Sequestration, Potential Impacts of Geologic Sequestration, Impacts on Human Health and Safety	

3.3 Teaching and Learning Methods

Methods	Duration in Hrs.	Total Duration in Hrs.
Face to Face Lectures		40
Demonstrations		4
1. Demonstration using Videos	x	
2. Demonstration using Physical Models/ Systems		
3. Demonstration on a Computer	x	
Numeracy		2
1. Solving Numerical Problems	x	
Practical Work		
1. Course Laboratory		
2. Computer Laboratory		
3. Engineering Workshop/ Course Workshop		
4. Model / Model Studio		
Others		4
1. Assignment Discussion / Related Activities		
2. Case Study Presentation	x	
3. Guest Lecture		
4. Industry / Field Visit		
5. Brain Storming Sessions		
6. Group Discussions		
7. Discussion on Possible Innovations	x	
Student Presentation, Laboratory Examination, Written Examination		10

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Total Duration in Hours	60

4. Course Resources	
a. **Essential Reading**	Class Notes
b. **Recommended Reading**	1. Biomass Renegerable Energy – D.O.hall and R.P. Overeed (John Wiley and Sons, New york, 1987) 2. Biomass for energy in the developing countries – D.O.Hall, G.W.barnard and P.A.Moss (Pergamon Press Ltd. 1982) 3. Thermo chemical processing of Biomass, Bridgurater A V. 4. Biomass Gasification Principles and Technology, Energy technology review No. 67, - T.B. Read (Noyes Data Corp. , 1981) 5. Wind energy Conversion Systems – Freris L.L. (Prentice Hall1990) 6. Wind Turbine Technology: Fundamental concepts of wind turbine technology Spera D.A. (ASME Press, NY, 1994) 7. Wind Energy Systems – G.L. Johnson (Prentice Hall, 1985)
c. **Other Resources**	**Magazines and Journals** 1. Renewable Energy-An International Journal 2. Nature Energy 3. IEEE Transactions on Sustainable Energy **Websites** 1. https://www.journals.elsevier.com/renewable-energy/ 2. http://www.energynext.in/ 3. https://www.saurenergy.com/solar-energy-magazine-india 4. https://renewablewatch.in/ **Other Electronic Resources** 5. Electronic resources on the module area are available at MSRUAS library

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Course Specification

Course Details				
Course Code	20ESE523A			Course Category
Course Title	Alternative fuels			
Programme	Environmental Engineering and Management			PE
Department	Civil Engineering			
Faculty	Engineering and Technology			
Course Approval Date	May- 2019	Course Next Review Date	May-2021	
Department Responsible for Course Delivery	Civil Engineering			
20. Course Size and Credits				
Number of Credits	4			
Duration (Hrs)	60			
Course Marks	100			
Attendance Requirement	As per M.Tech. Programme Academic Regulations			
Course Pass Criteria	As per M. Tech. Programme Specification Document (Annexure-1)			
21. Course Summary				
Aim and Summary	The course deals with an aim to provide a better understanding of alternative fuels, consideration for use in transportation vehicles, production processes of alternative fuels, typical impacts and vehicle emissions characteristics. Emphasis on advancement in alternative fuels and their implementations.			
22. Teaching, Learning and Assessment				
After undergoing this Course students will be able to: 1. Discuss importance of alternative fuels and various sources of its production 2. Discuss combustion and emission characteristics of various gaseous and liquid alternative flues 3. Discuss engine requirements and adaptability of engines to alternative fuels				

3.2 Course Content
Emerging Alternate Energy Conversion Systems, Alternative Fuels and Their Utilization Strategies in Internal Combustion Engines, production- The Alcohols, Natural Gas, LP Gas, Vegetable Oils, Hydrogen.
Vehicle Emissions Characteristics, Vehicle Performance Impacts of -The Alcohols, Natural Gas, LP Gas, Vegetable Oils, Hydrogen.

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Properties Specifications & Materials Compatibility - The Alcohols ,Methanol, Ethanol, M85 and E85, Natural Gas -Compressed Natural Gas & Liquefied Natural Gas, LP Gas, Vegetable Oils ,Hydrogen
Biofuel Production- Agricultural Waste, Biomass, microalgae. Environment and economical impact of Biofuel production
Various advancements in Alternative fuels- Combustion and Emission Characteristics & Control of CNG Fuelled Vehicles , Biogas for Transport Sector: Current Status, Barriers, and Path Forward for Large-Scale Adaptation, BioGTL Technique ,

3.3 Teaching and Learning Methods

Methods	Duration in Hrs.	Total Duration in Hrs.
Face to Face Lectures		45
Demonstrations		2
1. Demonstration using Videos	x	
2. Demonstration using Physical Models/ Systems		
3. Demonstration on a Computer		
Numeracy		
1. Solving Numerical Problems		
Practical Work		
1. Course Laboratory		
2. Computer Laboratory		
3. Engineering Workshop/ Course Workshop		
4. Model / Model Studio		
Others		3
1. Assignment Discussion / Related Activities		
2. Case Study Presentation	x	
3. Guest Lecture		
4. Industry / Field Visit		
5. Brain Storming Sessions	x	
6. Group Discussions	x	

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7. Discussion on Possible Innovations		
Student Presentation, Laboratory Examination, Written Examination		10
Total Duration in Hours		60

23. Course Resources	
m. Essential Reading	1. Class Notes 2. Bechtold, Richard L.,Alternative fuels guidebook: properties, storage, dispensing, and vehicle facility modifications, SAE Publications Group 3. Akhilendra P. S, Yogesh C.S, Nirendra N.M, Avinash Kumar. A. Alternative Fuels and Their Utilization Strategies in Internal Combustion Engines, Energy, Environment, and Sustainability, Springer Nature Singapore Pte Ltd. 4. Osamu Hirao and Richard Pefley (1988), Present and Future Automotive Fuels, Wiley Interscience Publication, New York.
n. Recommended Reading	1. Frank Kreith and D.Yogi Goswami (2007), Handbook of Energy Efficiency and Renewable Energy, CRC Press. 2. John Twidell and Tony Weir (2006), Renewable Energy Resources, 2nd Edition, Taylor & Francis, USA.
o. Other Resources	**Websites** **Other Electronic Resources** 1. Electronic resources on the module area are available at MSRUAS library

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Course Specification

Course Details				
Course Code	20ESE524A			Course Category
Course Title	Industrial and commercial applications of renewable energy			
Programme	Environmental Engineering and Management			PE
Department	Civil Engineering			
Faculty	Engineering and Technology			
Course Approval Date	May- 2019	Course Next Review Date	May-2021	
Department Responsible for Course Delivery	Civil Engineering			

24. Course Size and Credits	
Number of Credits	4
Duration (Hrs)	60
Course Marks	100
Attendance Requirement	As per M.Tech. Programme Academic Regulations
Course Pass Criteria	As per M. Tech. Programme Specification Document (Annexure-1)

25. Course Summary

Aim and Summary	There is vast potential of usage of renewable energy in industries and commercial sector. With the study of this course one can quantify the energy saved and carbon dioxide mitigation impact. Related latest technologies and economics of renewable energies would also be studied.

26. Teaching, Learning and Assessment

After undergoing this Course students will be able to:

1. Discuss the effects of power generated by renewable energy sources, renewable energy production technology, energy efficiency, and market regulation on carbon emissions
2. Discuss direct and indirect effects on carbon emission reduction.
3. Discuss renewable energy consumption, production technology, market regulation, and their relations
4. Develop the structure of a marketplace for renewable energy sources and outlined the requirements for this market to function effectively.

3.2 Course Content

The Energy and Environment Relationship, Energy Consumption and Economic Growth, Main Drivers for Using Renewable Energy, CO_2 Emission Reduction.

Alternative Renewable Energy Production Technologies, Renewable Energy Supply Technologies, Energy Efficiency Technologies,

Regulatory Frameworks for Renewable Energy Sources

Introduction, Support Policy, Market Regulation, Technology Transfer, Barriers, National and International Environmental Policies

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Financing Renewable Energy Development Introduction, Feed-in Tariff Energy Supply Policy, Tax Incentive Policies, Renewable Portfolio Standard Policy, Cross-Country Public Incentive Policies
Market Design for Trading Commoditized Renewable Energy Introduction, Existing Marketplaces, Stakeholders of the Marketplace, Requirements for a Renewable Power Marketplace, Market Mechanism for Trading Renewable Power, Performance Evaluation.
Impact of Renewable Energy Development on Carbon Dioxide Emission Reduction Introduction, Methodology and Analytic Framework, Model Estimation, Examples of Policy Implications for Developing Countries, Effects of Renewable Energy Development on CO_2 Reduction.
Economic Growth and Energy Consumption Relationship, Energy Efficiency Technologies, Selected Technologies of Renewable-Based Power Generation, The Main Support Mechanisms to Finance Renewable Energy, Market Design for Trading Commoditized Renewable Energy, The Climate Impacts of Alternative Energy Technologies.

3.3 Teaching and Learning Methods

Methods	Duration in Hrs.	Total Duration in Hrs.
Face to Face Lectures		45
Demonstrations		2
1. Demonstration using Videos	x	
2. Demonstration using Physical Models/ Systems		
3. Demonstration on a Computer		
Numeracy		
1. Solving Numerical Problems		
Practical Work		
1. Course Laboratory		
2. Computer Laboratory		
3. Engineering Workshop/ Course Workshop		
4. Model / Model Studio		
Others		3
1. Assignment Discussion / Related Activities		
2. Case Study Presentation	x	
3. Guest Lecture		
4. Industry / Field Visit		
5. Brain Storming Sessions	x	
6. Group Discussions	x	
7. Discussion on Possible Innovations		
Student Presentation, Laboratory Examination, Written Examination		10
Total Duration in Hours		60

27. Course Resources

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p. Essential Reading	1. Class Notes 2. Solar Applications in Industry and Commerce, First Edition, 1984, by JD Myers, Prentice-Hall Inc. 3. Fundamentals of Renewable Energy Processes, Second Edition, 2009, by Aldo V da Rosa, Academic Press
q. Recommended Reading	1. Allen J.A and Roger.D.F.Principles of energy conservation, Mc-Graw Hill,New York 2. Watson C.Non-conventional Energy resources,Elsevier Applied Science London 3. Yaffe.L Energy conservation and Utilization, Mc-Graw Hill,New York
r. Other Resources	**Websites** **Other Electronic Resources** 1. Electronic resources on the module area are available at MSRUAS library

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Course Specification

Course Details				
Course Code	20ESC511A			Course Category
Course Title	Solid waste and hazardous waste management			
Programme	Environmental Engineering and Management			PC
Department	Civil Engineering			
Faculty	Engineering and Technology			
Course Approval Date	May- 2019	Course Next Review Date	May-2021	
Department Responsible for Course Delivery	Civil Engineering			
1. Course Size and Credits				
Number of Credits	4			
Duration (Hrs)	60			
Course Marks	100			
Attendance Requirement	As per M.Tech. Programme Academic Regulations			
Course Pass Criteria	As per M. Tech. Programme Specification Document (Annexure-1)			

2. Course Summary

Aim and Summary	This module deals with management of municipal and industrial solid wastes. Domestic and international solid waste policies will be discussed. Appropriate methods of storage, collection, transfer, treatment and disposal of municipal and industrial solid waste will be studied. The module deals with hazardous waste classification, characteristics and its management. Minimization of hazardous waste and their storage in landfills are discussed. Treatment of hazardous waste by physical, chemical and thermal processes are taught. Various traditional and innovative technologies used in hazardous waste management satisfying regulatory norms are explored.

3. Teaching, Learning and Assessment

After undergoing this Course students will be able to:

1. Discuss causes for the generation of municipal, industrial solid waste, Air pollution and concepts of recycling, reuse and reclamation of solid wastes
2. Evaluate the current practices available in solid waste management and Air pollution control
3. Compare different solid waste storage and collection methods
4. Develop best techniques for municipal and industrial solid waste management satisfying safety and environmental norms

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3.2 Course Content

(10 Hours)

Municipal Solid waste Management
Sources, quantities generated, onsite processing and storage of municipal solid waste.
Characteristics of municipal solid waste.
Solid Waste Management Pyramid – key technologies for SWM of municipal solid waste. Solid waste generation rate – factors responsible for waste generation, socio-economic and cultural effects, typical values for Indian cities, methods to calculate waste generation.
Storage and collection - General considerations for waste storage at source, types of collection systems.
Transfer station - meaning, necessity, location, economic analysis.

(10 Hours)

Transportation of solid waste
Means and methods, routing of vehicles. Sorting and material recovery:

Objectives, stages of sorting, sorting operations. Guidelines for sorting for material recovery, typical material recovery facility for a commingled solid waste, refuse derived fuel (RDF)

Composting of solid waste

Principles, methods, factors affecting, properties of compost, Vermi composting.
Relevant environmental regulations for waste disposal, site investigations, site selection, regulatory permitting process
Disposal of wastes- land fill, ground water and environmental monitoring Landfills:
Definition, essential components, site selection, land filling methods, leachate and landfill gas management.

(10 Hours)

Industrial Solid waste Management
Industrial waste generation and their characteristics, variation in its quality and quantity, Industry specific physico-chemical and biological treatment requirements, alternatives and their evaluation in respect of treatment.

Standards for disposal of industrial solid wastes and treatment systems such as incinerator.
Waste streams and their characteristics in fertilizer plant, thermal power plant, distillery/brewery, paper/pulp industry, tannery, textile unit, oil refinery and agro industries. Methods of waste reduction such as process modification, volume and strength reduction (briquetting), segregation, reuse, recycle, material conservation, good housekeeping. Planning and management of industrial wastes (solid, liquid and gaseous) from small scale industries.
Zero waste techniques for smart cities Visit

(15 Hours)

Hazardous waste Definition, Generation, Effects, Management Options
Identification and characteristics, material safety data sheet, health and safety related problems caused by hazardous wastes
Hazardous waste generation: quantity, compositions and classifications, management options and effects of improper management Regulatory aspects of hazardous waste management
General and legal definitions, precautionary principle, and role of international treaties: The Stockholm convention and national implementation plan (NIP)

Minimization of hazardous waste: principles and methods
Techniques for minimization of hazardous waste, 3Rs of hazardous waste - reduce, re-use, recycle, process design modifications to substitute hazardous material
Hazardous waste Disposal
Treatment, storage, disposal facilitates (TSDF), contaminated sites, land disposal (landfills and sand storage), landfill design for solid hazardous wastes

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(15 Hours)

Storage Facilities and hazardous waste containment
Sequestration methods for hazardous waste, radioactive waste containment, secondary containment requirements and methods

Physical treatment processes:
Encapsulation, filtration / centrifuging / separation
Biological treatment processes:
Types of micro-organism used in biological treatment, aerobic reactions, anaerobic reactions, optimal conditions for micro-organism action Biomedical waste Management
Definition and classification, sources of biomedical waste, collection, transportation and segregation, treatment and disposal

E-Waste management
Waste characteristics, generation, collection and transport, recycling and disposal

Radioactive waste disposal and treatment
Basic radioactive reactions, alpha, beta and gamma decay, exposure pathways, radioactive waste classification, disposal methods: deep geological repository, ocean / sea bed burial, subductive waste disposal, summary of methods, delay / decay, dilute and disperse, concentrate and contain

3.3 Teaching and Learning Methods

Methods	Duration in Hrs.	Total Duration in Hrs.
Face to Face Lectures		40
Demonstrations		4
1. Demonstration using Videos	x	
2. Demonstration using Physical Models/ Systems		
3. Demonstration on a Computer	x	
Numeracy		2
1. Solving Numerical Problems	x	
Practical Work		
1. Course Laboratory		
2. Computer Laboratory		
3. Engineering Workshop/ Course Workshop		
4. Model / Model Studio		
Others		4
1. Assignment Discussion / Related Activities		
2. Case Study Presentation	x	
3. Guest Lecture		
4. Industry / Field Visit	x	
5. Brain Storming Sessions		
6. Group Discussions		

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7. Discussion on Possible Innovations		
Student Presentation, Laboratory Examination, Written Examination		10
Total Duration in Hours		60

4. Course Resources	
a. Essential Reading	Class Notes 1. Gary C. Young. (2010) Municipal Solid Waste to Energy Conversion Processes: Economic, Technical, and Renewable Comparisons, John Wiley & Sons 2. Velma I. Grover, Vaneeta Grover and William Hogland. (2002) Recovering Energy from Waste, Science publishers 3. George Tchobanoglous, Frank Kreith. (2002) Handbook of Solid Waste Management, 2nd edition, McGraw Hill Professional 4. Cliff Vanguilder,(2012), Hazardous Waste Management: An Introduction. Mercury Learning and Information 5. LaGrega, Michael D., Buckingham, Philip L., Evans and Jeffrey C, (2010), Hazardous Waste Management, Reissue Edition, Waveland Press Inc.
b. Recommended Reading	1. Shah, Kanti L. (2000) Basics of Solid & Hazardous Waste Management Technology, Prentice Hall 2. Rogoff and Screve (1987) Waste-to-Energy Elsevier 3. Parker, Colin, & Roberts. (1985) Energy from Waste - An Evaluation of Conversion Technologies, London, Elsevier Applied Science 4. Manoj Datta. (1997) Waste Disposal in Engineered Landfills, Narosa Publishing House 5. Bhide A. D., Sundaresan B. B. (1983) Solid Waste Management in Developing Countries, INSDOC 6. Robert Green. (2009) From Waste to Energy, Cherry Lake Publications 7. G. Evans. (2005) Bio waste and Biological Waste Treatment, James and James Publishers 8. Dieter D. And Angelika S. (2010) Biogas from waste and renewable resources, Wiley-Vch Publications 9. Pichtel, John,(2005), Waste Management Practices: Municipal, Hazardous and Industrial, CRC Press 10. Watts, Richard J,(1998), Hazardous Wastes - Sources, Pathways, Receptors, 1st edition, Wiley 11. Kanti L. Shah,(1999), Basics of Solid and Hazardous Waste Mgmt. Tech, Prentice Hall 4. S.C. Bhatia, (2007), Solid and Hazardous Waste Management, Atlantic Publishers & Dist. 12. Freeman, H.W, (1989), Standard Handbook of Hazardous Waste Treatment and Disposal, New York, McGraw Hill

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	13. Martin, E.J. and Johnson, J.H, (1987), Hazardous Waste Management Engineering, New York, van Nostrand-Reinhold Wentz, C.A, (1995), Hazardous Waste Management, 2nd Edition, New York, McGraw Hill 8.
c. **Other Resources**	**Magazines and Journals** 3. Terra Green 4. MSW Management 5. Waste Age 6. Biocycle 7. The Journal of Solid Waste Technology and Management 8. Waste Management, Elsevier 9. Waste Management and research, International Solid Waste Association 10. HazMat Management Magazine 11. Process safety and environmental protection (PSEP), Institution of chemical engineers 12. Journal of hazardous material, Elsevier 13. Journal of Hazardous, Toxic, and Radioactive Waste, American Society of Civil Engineers Websites 1. www.epa.gov 2. www.envfor.nic.in **Other Electronic Resources** 1. Electronic resources on the module area are available at MSRUAS library

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Course Specification

Course Details				
Course Code	20ESC512A			Course Category
Course Title	Solid waste and hazardous waste treatment plant design			
Programme	Environmental Engineering and Management			PC
Department	Civil Engineering			
Faculty	Engineering and Technology			
Course Approval Date	May- 2019	Course Next Review Date	May-2021	
Department Responsible for Course Delivery	Civil Engineering			
1. Course Size and Credits				
Number of Credits	4			
Duration (Hrs)	60			
Course Marks	100			
Attendance Requirement	As per M.Tech. Programme Academic Regulations			
Course Pass Criteria	As per M. Tech. Programme Specification Document (Annexure-1)			
2. Course Summary				
Aim and Summary	In this module, the student will be taught various methods of treating solid waste and its effects on environment. The important factors that influence the process of each treatment methods will be discussed. Design of a treatment plant for a given amount of waste flow will be taught. Traditional and innovative technologies used in hazardous waste management satisfying regulatory norms are explored. Designing and sizing of treatment plants are discussed.			
3. Teaching, Learning and Assessment				

After undergoing this Course students will be able to:

1. Discuss the process of aerobic, anaerobic digestion, composting of solid waste, absorption, adsorption principles of gaseous air pollutants and different gaseous control equipments
2. Explicate thermal treatment of solid waste, compare different treatment methods
3. Determine factors affecting aerobic , anaerobic digestion, composting and thermal treatment
4. Choose appropriate treatment method based on characteristics of solid waste
5. Perform design calculations for energy extraction from solid waste
6. Design a treatment plant for a given amount of solid waste

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3.2 Course Content

(20 Hours)

Solid Waste Treatment Methods

Aerobic and Anaerobic Digestion

Introduction and Mechanism, kinetics of anaerobic digestion, factors affecting anaerobic digestion, recent practices in anaerobic digestion, introduction to biogas technology, utilization of biogas

Composting:

Introduction and process of composting, factors influencing composting, different methods of composting – vermi composting, barrel composting, self-turning composting

Thermal Treatment of Solid Waste:

Introduction to thermal treatment of solid waste, process of thermal treatment incineration, pyrolysis, plasma thermal treatment, thermal gasification

Factors affecting thermal treatment, effect of treatment methods on environment, factors to be considered for the selection of solid waste treatment method

Plant Design and Energy from Solid Waste **(20 Hours)**

Energy availability in solid waste, energy extraction from biogas plants – sizing calculations, Biogas generators operating principle, emission control and pollution, design of pyrolysis and plasma thermal treatment unit

Extraction of energy from thermal treatment (Incineration and thermal gasification) – sizing calculations, combustion process calculation, waste combustion systems, control of emissions from combustion, Design of energy recovery system and its auxiliaries

(20 Hours)

Thermal treatment processes and plant design

High temperature incineration, combustion parameters, toxic waste combustion byproducts, control of gaseous emissions, plasma arc method for hazardous waste treatment

Design of incinerators – sizing calculations, electro static precipitator, cyclone separator, venturi scrubber, stack size and draft specification

3.3 Teaching and Learning Methods

Methods	Duration in Hrs.	Total Duration in Hrs.
Face to Face Lectures		40
Demonstrations		4
1. Demonstration using Videos	x	
2. Demonstration using Physical Models/ Systems		
3. Demonstration on a Computer	x	
Numeracy		2
1. Solving Numerical Problems	x	
Practical Work		
1. Course Laboratory		
2. Computer Laboratory		
3. Engineering Workshop/ Course Workshop		
4. Model / Model Studio		
Others		4

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1. Assignment Discussion / Related Activities		
2. Case Study Presentation	x	
3. Guest Lecture		
4. Industry / Field Visit	x	
5. Brain Storming Sessions		
6. Group Discussions		
7. Discussion on Possible Innovations		
Student Presentation, Laboratory Examination, Written Examination		10
Total Duration in Hours		60

4. Course Resources	
a. Essential Reading	1. Class Notes 2. Gary C. Young. (2010) Municipal Solid Waste to Energy Conversion Processes: Economic, Technical, and Renewable Comparisons, John Wiley & Sons 3. Velma I. Grover, Vaneeta Grover and William Hogland. (2002) Recovering Energy from Waste, Science publishers 4. George Tchobanoglous, Frank Kreith. (2002) Handbook of Solid Waste Management, 2nd edition, McGraw Hill Professional 5. Cliff Vanguilder,(2012), Hazardous Waste Management: An Introduction. Mercury Learning and Information
	6. LaGrega, Michael D., Buckingham, Philip L., Evans and Jeffrey C, (2010), Hazardous Waste Management, Reissue Edition, Waveland Press Inc.
b. Recommended Reading	1. Shah, Kanti L. (2000) Basics of Solid & Hazardous Waste Management Technology, Prentice Hall 2. Rogoff and Screve (1987) Waste-to-Energy Elsevier 3. Parker, Colin, & Roberts. (1985) Energy from Waste - An Evaluation of Conversion Technologies, London, Elsevier Applied Science 4. Manoj Datta. (1997) Waste Disposal in Engineered Landfills, Narosa Publishing House 5. Bhide A. D., Sundaresan B. B. (1983) Solid Waste Management in Developing Countries, INSDOC 6. Robert Green. (2009) From Waste to Energy, Cherry Lake Publications 7. G. Evans. (2005) Bio waste and Biological Waste Treatment, James and James Publishers 8. Dieter D. And Angelika S. (2010) Biogas from waste and renewable resources, Wiley-Vch Publications 9. Pichtel, John,(2005), Waste Management Practices: Municipal, Hazardous and Industrial, CRC Press 10. Watts, Richard J,(1998), Hazardous Wastes - Sources, Pathways, Receptors, 1st edition, Wiley 11. Kanti L. Shah,(1999), Basics of Solid and Hazardous Waste Mgmt. Tech, Prentice Hall 4. S.C. Bhatia, (2007), Solid and Hazardous Waste Management, Atlantic Publishers & Dist.

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c. Other Resources	**Magazines and Journals** 1. Terra Green 2. MSW Management 3. Waste Age 4. Biocycle 5. The Journal of Solid Waste Technology and Management 6. Waste Management, Elsevier 7. Waste Management and research, International Solid Waste Association 8. HazMat Management Magazine 9. Process safety and environmental protection (PSEP), Institution of chemical engineers 10. Journal of hazardous material, Elsevier 11. Journal of Hazardous, Toxic, and Radioactive Waste, American Society of Civil Engineers **Websites** 1. www.epa.gov 2. www.envfor.nic.in **Other Electronic Resources** 1. Electronic resources on the module area are available at MSRUAS library

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Course Specification

Course Details				
Course Code	20ESC513A			Course Category
Course Title	Environmental biotechnology			
Programme	Environmental Engineering and Management			PC
Department	Civil Engineering			
Faculty	Engineering and Technology			
Course Approval Date	May- 2019	Course Next Review Date	May-2021	
Department Responsible for Course Delivery	Civil Engineering			
1. Course Size and Credits				
Number of Credits	4			
Duration (Hrs)	60			
Course Marks	100			
Attendance Requirement	As per M.Tech. Programme Academic Regulations			
Course Pass Criteria	As per M. Tech. Programme Specification Document (Annexure-1)			
2. Course Summary				
Aim and Summary	The Module deals with purification of the Environment from toxicants, contaminants and prevention of the degradation of valuable natural resources. This module focuses on the utilization of microbial processes in wastewater treatment, water treatment and air pollution control. This module emphasize on microbial energy metabolism, microbial growth kinetics and elementary chemostat theory.			
3. Teaching, Learning and Assessment				

After undergoing this Course students will be able to:

1. Discuss environmental management processes water and wastewater quality monitoring by biotechnological processes
2. Analyse wastewater and air pollution control by biotechnological methods
3. Evaluate alternative methods for combined biological nutrient removal
4. Application of bioaccumulation, biodegradation and bioremediation processes in wastewater, municipal solid waste and hazardous waste management

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3.2 Course Content

(15 Hours)

Introduction

Environmental Management process by Microbial Reactors and genetically modified microorganisms
Environmental monitoring and problem solving through microorganism.

Environmental biotechnology in water and wastewater pollution monitoring

Methods of monitoring; Biological methods; Detection methods for DO, BOD, Pathogen monitoring by heterotrophic plate count; Multiple tube method; Membrane filtration methods; emerging techniques - enzyme detection, hybridization, PCR, Gene probe technology . Strategies for controlling pathogen transfer, detection methods for waterborne pathogens recent improvements in the coliform assay, Biosensors in water treatment

(10 Hours)

Environmental biotechnology in wastewater treatment systems

Biofilms in treatment of waste water- development and Kinetics; Aerobic Biofilms;
Bioreactors for waste water treatments; Reactors types and design; Development and optimization of membrane bioreactor process. [MFC&MEC]
Decolourization of dye-polluted water, Bio-de-emulsifiers, Use of protozoa to control algal blooms
Phytoremediation: Waste water treatment using aquatic plants; Root zone treatment;
Nano-Biotechnology for Environment
Biosensors – types and applications in environmental pollution detection and monitoring.

(15 Hours)

Environmental biotechnology in removal of specific pollution and solving air pollution problems

Biotechnological application of hazardous waste management of – cyanide detoxification - detoxification of oxalate, urea
Environmental biotechnology in the paper industry: Debarking, Chip and pulp bio-delignification, Biobleaching, Pitch and anionic trash elimination, Paper effluent treatment, Dairy industry, sugar industry.
Use of microorganisms in augmentation of petroleum recovery.
Biological techniques in used Air pollution prevention, Removal of chlorinated hydrocarbons from air, Biological Filtration Processes for Decontamination of Air Stream, Bio-trickling Filtration, Bioscrubbers.

(10 Hours)

Bioaccumulation and biodegradation of xenobiotic compounds

Introduction, characteristics of xenobiotics, relationship of bioaccumulation with chemical structure, the process of toxicants uptake-kinetic aspects, factors affecting Bio accumulation of xenobiotics, measurement of Bioaccumulation, Biodegradation of Xenobiotics.

(10 Hours)

Bioremediation

Introduction, constraints and priorities of Bioremediation Wastewater pollution control - Bio augmentation, Bio stimulation; Bioventing & Bio-sparging. , in situ- engineered bioremediation, ex situ- Solid phase bioremediation - land farming, prepared beds, soil piles intrinsic - Liquid phase bioremediation- suspended bioreactors, fixed biofilm reactors.

3.3 Teaching and Learning Methods

Methods	Duration in Hrs.	Total Duration in Hrs.
Face to Face Lectures		40

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Demonstrations		4
1. Demonstration using Videos	x	
2. Demonstration using Physical Models/ Systems		
3. Demonstration on a Computer	x	
Numeracy		2
1. Solving Numerical Problems	x	
Practical Work		
1. Course Laboratory		
2. Computer Laboratory		
3. Engineering Workshop/ Course Workshop		
4. Model / Model Studio		
Others		4
1. Assignment Discussion / Related Activities		
2. Case Study Presentation	x	
3. Guest Lecture		
4. Industry / Field Visit	x	
5. Brain Storming Sessions		
6. Group Discussions		
7. Discussion on Possible Innovations		
Student Presentation, Laboratory Examination, Written Examination		10
Total Duration in Hours		60

4. Course Resources	
a. Essential Reading	1. Class Notes 2. Environmental Biotechnology: A Biosystems Approach. Daniel A. Vallero, ISBN: 978-0-12375089-1 Elsevier, USA.2010. 3. An Introduction to Environmental Biotechnology, Milton Wainwright, ISBN 978-1-4613-73940 Springer Science Business media, LLC New York 1999 4. Applied Environmental Biotechnology: Present Scenario and Future Trends, Garima Kaushik ISBN 978-81-322-2122-7 Springer New Delhi Heidelberg New York Dordrecht London.2015 5. Principles and Applications of Environmental Biotechnology for a Sustainable Future, Ram Lakhan Singh, ISBN 978-981-10-1865-7 Springer Science+Business Media Singapore Pte Ltd.2017
b. Recommended Reading	1. Advances in Environmental Biotechnology, Raman Kumar • Anil Kumar Sharma Sarabjeet Singh Ahluwalia, ISBN 978-981-10-4040-5 Springer Science+Business Media Singapore Pte Ltd.2017 2. Environmental Biotechnology. Concepts and Applications. Edited by H.-J. Jördening and J. Winter WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim ISBN 3-527-30585-8 Germany Air Pollution Control 2014

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	3. Environmental Biotechnology and Engineering Volume-1, Héctor Poggi Varaldo, Beni Camacho Pérez, and others, , ISBN - 978-607-9023-28-7 Bonumedia 2014 4. Environmental Biotechnology and Engineering Volume-2, by Héctor Poggi Varaldo, Beni Camacho Pérez, and others, ISBN - 978-607-9023-29-4 Bonumedia 2014 5. Environmental Biotechnology-New Approaches and Prospective Applications, Marian Petre, InTech, Croatia.
c. **Other Resources**	**Magazines and Journals** 1. The Journal of Biotechnology & Biomaterials 2. Biotechnology Advances 3. International Journal of Energy and Environmental Engineering 4. Journal of Environmental Science and Engineering **Websites** 1. https://swayam.gov.in/course/4392-applied-environmental-microbiology 2. https://www.ntnu.edu/studies/courses/TBT4130 **Other Electronic Resources** 1. Electronic resources on the module area are available at MSRUAS library

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Course Specification

Course Details				
Course Code	20ESE531A			Course Category
Course Title	Rural water supply and sanitation			
Programme	Environmental Engineering and Management			PE
Department	Civil Engineering			
Faculty	Engineering and Technology			
Course Approval Date	May- 2019	Course Next Review Date	May-2021	
Department Responsible for Course Delivery	Civil Engineering			
28. Course Size and Credits				
Number of Credits	4			
Duration (Hrs)	60			
Course Marks	100			
Attendance Requirement	As per M.Tech. Programme Academic Regulations			
Course Pass Criteria	As per M. Tech. Programme Specification Document (Annexure-1)			

29. Course Summary

Aim and Summary	The course explains the impact of various water quality parameters on Rural health and ecosystem. Treatment choices and working of technologies for various water quality parameters are discussed. These ranges from low cost to advance options. Student should be able to make technology choice to deal with rural issues, operate and maintain working of water and sanitary systems and do troubleshooting of the problems in these systems.

30. Teaching, Learning and Assessment

After undergoing this Course students will be able to:

1. Discuss the impact and use of safe water supply facilities in rural areas
2. Discuss sanitation and hygiene practises for rural communities
3. Develop the sector to ensure actually response to the demand of rural population

3.2 Course Content

RURAL WATER SUPPLY

Introduction: Need for a protected water supply, investigation and selection of water sources, water borne diseases, protection of well waters, drinking water quality standards.

Types of pumps

Types of pumps, supply systems viz., BWS MWS, PWS, water treatment methods – disinfection, deflouridation, hardness and iron removal, ground water contamination and control.

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RURAL SANITATION Conservancy, public latrine, concept of Eco-sanitation, trenching and composting methods, Two pit latrines, aqua privy, W.C, septic tank, soak pit.
DRAINAGE SYSTEMS Storm water and sullage disposal, rain water harvesting and uses.
COMMUNICABLE DISEASES Terminology, classifications, methods of communication, general methods of control.
REFUSE COLLECTION AND DISPOSAL Garbage, ash, rubbish, collection methods, transportation, disposal – salvaging, dumping, controlled tipping, incineration, composting, dung disposal – digester, biogas plant.
MILK SANITATION Essentials, test for milk quality, pasteurization, quality control, cattle borne diseases, planning for a cow shed.
INSECT CONTROL House fly and mosquito – life cycle, diseases, transmission and control measures.

3.3 Teaching and Learning Methods

Methods	Duration in Hrs.	Total Duration in Hrs.
Face to Face Lectures		45
Demonstrations		2
1. Demonstration using Videos	x	
2. Demonstration using Physical Models/ Systems		
3. Demonstration on a Computer		
Numeracy		
1. Solving Numerical Problems		
Practical Work		
1. Course Laboratory		
2. Computer Laboratory		
3. Engineering Workshop/ Course Workshop		
4. Model / Model Studio		
Others		3
1. Assignment Discussion / Related Activities		
2. Case Study Presentation	x	
3. Guest Lecture		
4. Industry / Field Visit		
5. Brain Storming Sessions	x	
6. Group Discussions	x	
7. Discussion on Possible Innovations		
Student Presentation, Laboratory Examination, Written Examination		10
Total Duration in Hours		60

31. Course Resources

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s. Essential Reading	1. Class Notes 2. CPHEEO 1999. Manual on water Supply and treatment. 3rd Edition 3. Metcalf & Eddy (2003) Wastewater engineering: treatment and reuse, 4th ed. New Delhi: Tata McGraw- Hill. 4. Nathanson, Jerry A. (2009) Basic environmental technology: water supply, waste management and pollution control, 4th ed. New Delhi: PHI Learning 5. Qasim, Syed R., Motley, Edward M., and Zhu, Guang (2000) Water works engineering: planning, design and operation. New Jersey: Prentice Hall
t. Recommended Reading	7. Garg, S. K. (2007) Water supply engineering, 18th ed, Vol. I. New Delhi: Khanna Publisher. 8. Garg, S.K. (2007) Sewage disposal and air pollution engineering, 20th ed, Vol. II. New Delhi: Khanna Publisher. 9. Chatterjee, A. K.2010.Water supply, Waste disposal and environmental 10. Engineering, 8th ed. New Delhi: Khanna Publisher. CPHEEO Manual on Sewerage and Sewage treatment, latest edition
u. Other Resources	**Websites** **Other Electronic Resources** 11. Electronic resources on the module area are available at MSRUAS library

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Course Specification

Course Details				
Course Code	20ESE532A			Course Category
Course Title	Integrated waste management in smart cities			
Programme	Environmental Engineering and Management			PE
Department	Civil Engineering			
Faculty	Engineering and Technology			
Course Approval Date	May- 2019	Course Next Review Date	May-2021	
Department Responsible for Course Delivery	Civil Engineering			
32. Course Size and Credits				
Number of Credits	4			
Duration (Hrs)	60			
Course Marks	100			
Attendance Requirement	As per M.Tech. Programme Academic Regulations			
Course Pass Criteria	As per M. Tech. Programme Specification Document (Annexure-1)			

33. Course Summary

Aim and Summary	This course has emphasises on Integrated Solid Waste Management aspects within the broad subject area of Integrated Waste Management for a Smart City. The issues of Municipal Solid Waste (MSW) management, Construction and Demolition (C&D) Waste and Electronic Waste Management, environmental impact of waste management and its relationship on the big picture sustainable development and smart city development is discussed. A major focus of this course will be the role of MSW management within the various initiatives of the Govt. of India including: Swachh Bharat Mission, Smart Cities as well as Make in India. The new rules with respect of C&D Waste and E-Waste Management will be covered. The challenges of managing these waste streams effectively will be discussed.

34. Teaching, Learning and Assessment

After undergoing this Course students will be able to:

1. Discuss comprehensive knowledge of municipal waste management
2. Develop knowledge on construction-demolition waste and electronic waste management
3. Develop practical skills to facilitate effective engagement with Swachh Bharat, Smart Cities development mission
4. Discuss new rules with respect of C&D Waste and E-Waste Management

3.2 Course Content
Introduction to Solid Waste Management Municipal Solid Waste Characteristics and Quantities
MSW Rules 2016, Swachh Bharat Mission and Smart Cities Program

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Municipal Solid Waste Collection, Transportation, Segregation and Processing Disposal of Municipal Solid Waste
Biochemical Processes and Composting Energy Recovery from Municipal Solid Waste
Current Issues in Solid Waste Management and Review of MSW Management Status in First List of 20 Smart Cities in the Country
Construction and Demolition (C&D) Waste Management - Overview C&D Waste – Regulation, Beneficial Reuse of C&D Waste Materials
Electronic Waste (E-Waste) Management – Issues and Status in India and Globally E-Waste Management Rules 2016 and Management Challenges

3.3 Teaching and Learning Methods

Methods	Duration in Hrs.	Total Duration in Hrs.
Face to Face Lectures		45
Demonstrations		2
1. Demonstration using Videos	x	
2. Demonstration using Physical Models/ Systems		
3. Demonstration on a Computer		
Numeracy		
1. Solving Numerical Problems		
Practical Work		
1. Course Laboratory		
2. Computer Laboratory		
3. Engineering Workshop/ Course Workshop		
4. Model / Model Studio		
Others		3
1. Assignment Discussion / Related Activities		
2. Case Study Presentation	x	
3. Guest Lecture		
4. Industry / Field Visit		
5. Brain Storming Sessions	x	
6. Group Discussions	x	
7. Discussion on Possible Innovations		
Student Presentation, Laboratory Examination, Written Examination		10
Total Duration in Hours		60

35. Course Resources	
v. Essential Reading	1. Class Notes 2. Manual on Solid Waste Management, prepared by The Central Public Health and Environmental Engineering Organization(CPHEEO), India 3. MSW Management Rules 2016, Govt. of India, available online at CPCB website

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	4. Construction and Demolition Waste Management Rules, 2016, MoEF&CC 5. Electronic Waste Management Rules 2016, Govt. of India, available online at CPCB website.
w. Recommended Reading	1. O P Gupta, Element of hazardous waste management, Khanna Publishing House. 2. George Tchobanoglous, Hilary Theisen and Samuel A Vigil, Integrated Solid Waste management, Tata McGraw Hill 3. Ramachandra T.V., Management of Municipal Solid Waste, 2009; by The Energy and Resource Institute, TERI 4. Sasikumar, K, Gopi Krishna, Sanoop, Solid Waste Management; 2009, PHI. 5. Freeman, M. H.1988. Standard Handbook of Hazardous Waste Treatment and Disposal, McGraw-Hill Book Company, New York
x. Other Resources	**Websites** 1. http://swachhbharatmission.gov.in/sbmcms/index.htm 2. http://swachhbharaturban.gov.in/ **Other Electronic Resources** 14. Electronic resources on the module area are available at MSRUAS library

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Course Specification

Course Details				
Course Code	20ESE533A			Course Category
Course Title	Entrepreneurship in waste management			
Programme	Environmental Engineering and Management			PE
Department	Civil Engineering			
Faculty	Engineering and Technology			
Course Approval Date	May- 2019	Course Next Review Date	May-2021	
Department Responsible for Course Delivery	Civil Engineering			
5. Course Size and Credits				
Number of Credits	4			
Duration (Hrs)	60			
Course Marks	100			
Attendance Requirement	As per M.Tech. Programme Academic Regulations			
Course Pass Criteria	As per M. Tech. Programme Specification Document (Annexure-1)			

6. Course Summary

Aim and Summary	The course deals with concepts and practices related to generating wealth from waste. Students will be taught propelling economic activities from waste. Current and future technologies in waste processing will be discussed. The business model creation and development of entrepreneurship centered on waste management will be dealt with. Generation of feasibility report for business proposals will be taught.

7. Teaching, Learning and Assessment

After undergoing this Course students will be able to:

1. Understand business scope of waste to wealth value chain
2. Discuss on business opportunities and challenges in waste to wealth value chain
3. Develop waste to wealth entrepreneurship proposals
4. Prepare project feasibility report
5. Develop a framework for maintenance and operations of waste to wealth systems

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3.2 Course Content

(20 Hours)

Circular Economy

Need for circular economy, global resources and limitations and role of stakeholders, enablers and delimiters for circular economy and trends in Circular Economy. Business Models that Mainstream circular economy and case studies

Entrepreneurship in waste as resource

Skillsets of an entrepreneur. Need for entrepreneurship, theme of entrepreneurship in waste resource, current and future market requirements, inter and intra entrepreneurship models across industries, opportunities for sustainable business models in waste management and resource. Information technology and stakeholder participation. Waste management startups in India and challenges for Entrepreneurship.

(20 Hours)

Business Opportunities in waste value chain

Business potential in of waste value chains. Pre-requisites for starting a new business, Investment opportunities in Waste management, Products that can be derived from industrial wastes, Preparation of a robust Business plan, Developing and Modelling a Business system, Business strategy and operational structure, Interactions between businesses and the government, Conservation and return of valuable resources for productive use, Environmental challenges and the ways to overcome them, Product lifecycle analysis, Cost-Benefit analysis of large scale recycling, Recycling and Reusing – Private Firm v/s Government Organizations, Environmental protections and precautions to be taken for waste recycling and reuse, Viability for providing waste and resource recovery services, Shared Value Model of Business – Making profits v/s Adding Social Value, Measurement of waste generated by the business, Conceptual framework for waste minimization.

(20 Hours)

Incubation and start up

Need for incubation, processes in incubation, selection of incubator. Lean startup methodology. Starting a new businesses. . Selection of stakeholders, technology, location and market for businesses. Team building and work culture for business success. Challenges and opportunities for startup in waste management business. Journey of an entrepreneur and case studies

Project Management

Understanding of projects and Project management, Project Management triangle and relevance, Project feasibility studies – Financial, Economic, Technical, Operational, Environmental, Social, Work Breakdown structure and milestone scheduling, Resource levelling and Project cost estimation, Project Tradeoff analysis, Risk analysis in projects, Capital budgeting and economics of projects: PBP, NPV, IRR, ARR and PI, Project Proposals, Contracts, Project Audits.

3.3 Teaching and Learning Methods

Methods	Duration in Hrs.	Total Duration in Hrs.
Face to Face Lectures		40
Demonstrations		4
1. Demonstration using Videos	x	
2. Demonstration using Physical Models/ Systems		
3. Demonstration on a Computer	x	
Numeracy		2
1. Solving Numerical Problems	x	
Practical Work		

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1. Course Laboratory		
2. Computer Laboratory		
3. Engineering Workshop/ Course Workshop		
4. Model / Model Studio		
Others		4
1. Assignment Discussion / Related Activities		
2. Case Study Presentation	x	
3. Guest Lecture		
4. Industry / Field Visit	x	
5. Brain Storming Sessions		
6. Group Discussions		
7. Discussion on Possible Innovations		
Student Presentation, Laboratory Examination, Written Examination		10
Total Duration in Hours		60

36. Course Resources	
y. Essential Reading	1. Class Notes 2. Banwari Lal and Priyangshu M S, (2014), Wealth from Waste: trends and technologies, 3rd edition, New Delhi, Teri press 3. Marc J. Rogoff and Francois Screve,(2001), Waste-to-Energy: Technologies and 4. Project Implementation, 2nd edition, Oxford, William Andrew 5. Harold R. Kerzner ,(2013), Project Management: A Systems Approach to Planning,
	6. Scheduling, and Controlling, John Wiley & Sons, New Jersey
z. Recommended Reading	1. Peter Lacy and Jakob Rutqvist, (2015), Waste to Wealth: The Circular Economy Advantage, United Kingdom, Palgrave Macmillan 2. A.K. Shrivastava, (2003), Wealth from Waste, APH Publishing, New Delhi 3. K. Haghi, (2011), Waste Management: Research Advances to Convert Waste to Wealth, Nova Science publishers
aa. Other Resources	**Magazines and Journals** 1. Waste Management, Elsevier 2. Journal of Solid Waste Technology and Management **Websites** 1. www.energyrecoverycouncil.org 2. www.wtert.org **Other Electronic Resources** 1. Electronic resources on the module area are available at MSRUAS library

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Course Specification

Course Details				
Course Code	20ESE534A			Course Category
Course Title	Transport process and modelling of aquatic system			
Programme	Environmental Engineering and Management			PE
Department	Civil Engineering			
Faculty	Engineering and Technology			
Course Approval Date	May- 2019	Course Next Review Date	May-2021	
Department Responsible for Course Delivery	Civil Engineering			
37. Course Size and Credits				
Number of Credits	4			
Duration (Hrs)	60			
Course Marks	100			
Attendance Requirement	As per M.Tech. Programme Academic Regulations			
Course Pass Criteria	As per M. Tech. Programme Specification Document (Annexure-1)			

38. Course Summary

Aim and Summary	The goal of this course to give an introduction to modelling of aquatic ecosystems with a focus on model formulation and use of model simulations to improve understanding of processes that characterize the behaviour of aquatic ecosystems. A very brief introduction is also provided to the estimation of prediction uncertainty, considering demographic and environmental stochasticity and parameter uncertainty, and of the estimation of model parameters from observed data Particular emphasis is on the linkage between ecological and biogeochemical processes through elemental mass balances expressed by stoichoimetric relationships.

39. Teaching, Learning and Assessment

After undergoing this Course students will be able to:

1. Discuss evaluation and control techniques of water quality management in streams, lakes, and estuaries.
2. Develop Mathematical analyses of patterns of water movement and their relation to water quality.
3. Discuss Fate and transport of contaminants in natural aquatic systems
4. Develop the design and management of environmental and water resource systems

3.2 Course Content

Introduction: Modelling: Introduction, applications in environmental management. Physical phenomena – advection, diffusion, dispersion, Fick's laws of diffusion and convective - diffusion equations for turbulent & shear flow regimes

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Steady-state water quality modeling: Models for conservative and non-conservative substances. Data collection and analysis - specialized water quality surveys,estimation of decay and reareation rates
1-D Oxygen balance models: Streeter-Phelps equation,critical point method. Calibration and verification of 1-D oxygen model. Error measures.
Mixing zones in rivers: Types of outfalls and mixing regimes. Steady-state 2-D analysis. Field study methodology. Parameter estimation – lateral mixing co-efficient – critical point method – simple numerical problems. Dissolved oxygen models for lakes under completely mixed and stratified conditions
Eutrophication models: Simplified nutrient loading models for rivers and lakes. Ocean disposal of wastewater: Siting and design of outfalls. Ground water quality modeling concepts: Formulation 1D & 2-D models with decay and retardation for instantaneous sources, plume delineation studies

3.3 Teaching and Learning Methods

Methods	Duration in Hrs.	Total Duration in Hrs.
Face to Face Lectures		45
Demonstrations		2
1. Demonstration using Videos	x	
2. Demonstration using Physical Models/ Systems		
3. Demonstration on a Computer		
Numeracy		
1. Solving Numerical Problems		
Practical Work		
1. Course Laboratory		
2. Computer Laboratory		
3. Engineering Workshop/ Course Workshop		
4. Model / Model Studio		
Others		3
1. Assignment Discussion / Related Activities		
2. Case Study Presentation	x	
3. Guest Lecture		
4. Industry / Field Visit		
5. Brain Storming Sessions	x	
6. Group Discussions	x	
7. Discussion on Possible Innovations		
Student Presentation, Laboratory Examination, Written Examination		10
Total Duration in Hours		60

40. Course Resources	
bb. Essential Reading	1. Class Notes 2. Rich L.G., "Environmental Systems Engineering", McGraw Hill. 3. Schnoor J.L., "Environmental Modelling – Fate and Transport of Pollutants in Water, Air and Soil", John Wiley and Sons.

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cc. Recommended Reading	1. Thomann R.V., and Mueller J.A., "Principles of Water Quality Management and Control", Harper & Row Publications. 2. Thomann R.V., "Systems Approach to Water Quality Management", McGraw Hill. 3. Lee C.C., and Lin S.D., "Handbook of Environmental Engineering Calculations", McGraw Hill, New York
dd. Other Resources	**Websites** **Other Electronic Resources** 4. Electronic resources on the module area are available at MSRUAS library

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Course Specification

Course Details				
Course Code	20ESE541A			Course Category
Course Title	Geo-environmental engineering			
Programme	Environmental Engineering and Management			PE
Department	Civil Engineering			
Faculty	Engineering and Technology			
Course Approval Date	May- 2019	Course Next Review Date	May-2021	
Department Responsible for Course Delivery	Civil Engineering			
41. Course Size and Credits				
Number of Credits	4			
Duration (Hrs)	60			
Course Marks	100			
Attendance Requirement	As per M.Tech. Programme Academic Regulations			
Course Pass Criteria	As per M. Tech. Programme Specification Document (Annexure-1)			

42. Course Summary

Aim and Summary	The course deals with an aim to provide a better understanding of multidisciplinary aspects in geotechnical engineering to solve environmental problems related to the reduction of waste, waste disposal facilities and cleanup of contaminated sites.

43. Teaching, Learning and Assessment

After undergoing this Course students will be able to:

1. Discuss the causes for soil pollution and behaviour of the pollutants.
2. Discuss current practice for waste disposal.
3. Develop remediation of contaminated sites, evaluate and monitor to bring natural attenuation

3.2 Course Content

Fundamentals of Geoenviromental Engineering Scope of geoenvironmental engineering - multiphase behavior of soil – role of soil in geoenvironmental applications – importance of soil physics, soil chemistry, hydrogeology, biological process – sources and type of ground contamination – impact of ground contamination on geoenvironment - case histories on geoenvironmental problems.

Soil-Water-Contaminant Interaction Soil mineralogy characterization and its significance in determining soil behavior – soil-water interaction and concepts of double layer – forces of interaction between soil particles. Concepts of unsaturated soil – importance of unsaturated soil in geoenvironmental problems - measurement of soil suction - water retention curves - water flow in saturated and unsaturated zone. Soil-water-contaminant interactions and its implications – Factors effecting retention and transport of contaminants.

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Characterization, Stabilization and Disposal Safe disposal of waste – site selection for land fills – characterization of land fill sites – waste characterization –stability of land fills – 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
Waste Containment System Evolution of waste containment facilities and disposal practices – Site selection based on environmental impact assessment –different role of soil in waste containment – different components of waste containment system and its stability issues – property evaluation for checking soil suitability for waste containment – design of waste containment facilities.
Transport of Contaminants: Contaminant transport in sub surface – advection – diffusion – dispersion – governing equations – contaminant transformation – sorption – biodegradation – ion exchange – precipitation – hydrological consideration in land fill design – ground water pollution – bearing capacity of compacted fills – pollution of aquifers by mixing of liquid waste – protecting aquifers.
Detection and Testing Methods Methodology- review of current soil testing concepts – Proposed approach for characterization and identification of contaminated ground soil for engineering purposes
Remediation of Contaminated Soils: Rational approach to evaluate and remediate contaminated sites – monitored natural attenuation – exsitu and insitu 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.
Advanced Soil Characterization Contaminant analysis - water content and permeability measurements – electrical and thermal property evaluation – use of GPR for site evaluation - introduction to geotechnical centrifuge modeling

3.3 Teaching and Learning Methods

Methods	Duration in Hrs.	Total Duration in Hrs.
Face to Face Lectures		45
Demonstrations		2
1. Demonstration using Videos	x	
2. Demonstration using Physical Models/ Systems		
3. Demonstration on a Computer		
Numeracy		
1. Solving Numerical Problems		
Practical Work		
1. Course Laboratory		
2. Computer Laboratory		
3. Engineering Workshop/ Course Workshop		
4. Model / Model Studio		
Others		3
1. Assignment Discussion / Related Activities		
2. Case Study Presentation	x	
3. Guest Lecture		

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4. Industry / Field Visit		
5. Brain Storming Sessions	x	
6. Group Discussions	x	
7. Discussion on Possible Innovations		
Student Presentation, Laboratory Examination, Written Examination		10
Total Duration in Hours		60

44. Course Resources	
ee. Essential Reading	1. Class Notes 2. Daniel, B.E., Geotechnical practice for waste disposal, Chapman and Hall, London, 1993. 3. Fang, H.Y. Introduction to environmental Geotechnology, CRC press New York, 1997. 4. Rowe R.K.,"Geotechnical and Geoenvironmental Engineering Handbook" Kluwer Academic Publications, London, 2000. 5. Reddi L.N. and Inyang, H. I.,"Geoenvironmental Engineering,Principles and Applications" Marcel Dekker Inc. New York, 2000.
	6. Yong, R. N.,"Geoenvironmental Engineering, Contaminated Soils,Pollutant Fate, and Mitigation" CRC Press, New York, 2001. 7. Sharma H.D. and Reddy K.R.,"Geoenvironmental Engineering:Site Remediation, Waste Containment, and Emerging Waste Management Technologies" John Wiley & Sons, Inc., USA, 2004. 8. Fredlund D.G. and Rahardjo, H.,"Soil Mechanics for Unsaturated Soils" Wiley-Interscience, USA, 1993. 9. Mitchell, J.K.,"Fundamentals of Soil Behavior" Wiley, 2005. 10. Hillel D.,"Introduction to Environmental Soil Physics" Academic Press, New York, 2003.
ff. Recommended Reading	1. Wentz, C.A., Hazardous Waste Management, McGraw Hill, Singapore, 1989. 2. Lagrega, M.d., Bukingham, P.L., and Evans, J.C., Hazardous Waste Management, McGraw Hill, Inc. Singapore, 1994 3. Hillel D.,"Introduction to Soil Physics" Academic Press, New York, 1982. 4. Sparks, D.L.,"Environmental Soil Chemistry" Academic Press, New York, 2002. 5. Bagchi,A.,"Design of landfills and integrated solid waste management" John Wiley & Sons, Inc., USA, 2004. 6. Alvarez-Benedi J. and Munoz-Carpena, R.,"Soil-WaterSolute Process Characterization:An Integrated Approach" CRC Press, New York, 2005. 7. Berkowitz,B. Dror, I. and Yaron,B.,"Contaminant Geochemistry" Springer, Germany, 2008. 8. Mohamed,A. M. O.,"Principles and Applications of Time Domain Electrometry in Geoenvironmental Engineering" Taylor and Francis, New York, 2006.
gg. Other Resources	**Websites** **Other Electronic Resources** 1. Electronic resources on the module area are available at MSRUAS library

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Course Specification

Course Details				
Course Code	20ESE542A			Course Category
Course Title	Remote sensing and GIS in environmental engineering			
Programme	Environmental Engineering and Management			PE
Department	Civil Engineering			
Faculty	Engineering and Technology			
Course Approval Date	May- 2019	Course Next Review Date	May-2021	
Department Responsible for Course Delivery	Civil Engineering			
45. Course Size and Credits				
Number of Credits	4			
Duration (Hrs)	60			
Course Marks	100			
Attendance Requirement	As per M.Tech. Programme Academic Regulations			
Course Pass Criteria	As per M. Tech. Programme Specification Document (Annexure-1)			

46. Course Summary

Aim and Summary	The course deals with an aim to provide a better understanding of remote sensing implementation in environmental and natural resources mapping and data acquisition to review and report. Application of this helps in urban studies, hydrological modeling of environmental studies. GIS technology is used to assist decision-making by indicating various alternatives in development and conservation planning to protect the environment and by modeling the potential outcomes of a series of scenarios. Data are collected about the real world environment, analyzed and information is compiled to take action plans implementation for environment protection and sustainable development

47. Teaching, Learning and Assessment

After undergoing this Course students will be able to:

1. Discuss the principles and practices of Remote Sensing and GIS
2. Comprehend the knowledge to societal monitoring requirements
3. Develop strong interdisciplinary understanding of critical perspective on Remote Sensing and GIS in monitoring the environment.
4. Discuss application of remote sensing and GIS data in Environmental modeling

3.2 Course Content

FUNDAMENTALS OF REMOTE SENSING Definition, Physics of Remote Sensing, Electromagnetic Radiation and its interactions with atmosphere, Spectral reflectance of earth features, Resolution SpectralSpatial, Temporal and Radiometric.

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PLATFORMS SENSORS AND IMAGE PROCESSING Aerial Photographs, Active and passive sensors, Data products, Various satellites in orbit and their sensors. Image Processing – Visual and digital image, Interpretation, Interpretation keys, Methodology, Training sets, Ground truth verification, Image analysis, Image enhancement, Rectification, Classification methods, Users accuracy, Producers accuracy and overall accuracy.
INTRODUCTION TO GIS Data entry, storage and maintenances, Data output. Data analysis, Hardware and software
Applications of remotely sensed data for identifying solid waste disposal, forest fire mapping, EIA studies etc. Environmental degradation assessment, Airborne and space borne sensors, Applications to rainfall-runoff modelling, Snow mechanics, Watershed management, Irrigation
management, soil moisture estimation, Drought and Flood monitoring, Environment and ecology, using RS and GIS
Optimal routing of solid waste using GIS – Case study, Environmental sitting of industries and zoning atlas development, Remodelling of water distribution system using GIS

3.3 Teaching and Learning Methods

Methods	Duration in Hrs.	Total Duration in Hrs.
Face to Face Lectures		45
Demonstrations		2
1. Demonstration using Videos	x	
2. Demonstration using Physical Models/ Systems		
3. Demonstration on a Computer		
Numeracy		
1. Solving Numerical Problems		
Practical Work		
1. Course Laboratory		
2. Computer Laboratory		
3. Engineering Workshop/ Course Workshop		
4. Model / Model Studio		
Others		3
1. Assignment Discussion / Related Activities		
2. Case Study Presentation	x	
3. Guest Lecture		
4. Industry / Field Visit		
5. Brain Storming Sessions	x	
6. Group Discussions	x	
7. Discussion on Possible Innovations		
Student Presentation, Laboratory Examination, Written Examination		10

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48. se Resources	
hh. Essential Reading	1. Class Notes 2. Lilliesand T.M, Kiefer R.W and Chipman J.W., "Remote Sensing and Image Interpretation", John Wiley and Sons, 6th Edition. 3. Goa, J. "Digital Analysis of Remotely Sensed Imagery", McGrill Publishers. 4. Burrough, P.A. and McDonnell, R.A., "Principles of Geographical Information Systems", Oxford University Press, 5. Chang K.T, "Introduction to Geographic information system", McGraw hill Education Pvt Ltd., 4th edition
ii. Recommended Reading	1. Bonham-carter, G.F. Geographic information system for Geo scintists: Modelling with GIS, Pergamon, 2. Lintz, J. and Simonet, "Remote Sensing of Environment", Addison Wesley Publishing Company, 3. Mishra H.C., "GIS Hand Book", GIS India, Shanthi Nivas, Hyderabad. 4. Syed R. Qasim , Edward M. Motley & Guang Zhu, "Water Works Engineering: Planning, Design And Operation", Eastern Economy Edition, PHI Learning Private Limited, New Delhi.
jj. Other Resources	**Websites** **Other Electronic Resources** 15. Electronic resources on the module area are available at MSRUAS library

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Course Specification

Course Details				
Course Code	20ESE543A			Course Category
Course Title	Treatment Plants Operation and Maintenance			
Programme	Environmental Engineering and Management			PE
Department	Civil Engineering			
Faculty	Engineering and Technology			
Course Approval Date	May- 2019	Course Next Review Date	May-2021	
Department Responsible for Course Delivery	Civil Engineering			
49. Course Size and Credits				
Number of Credits	4			
Duration (Hrs)	60			
Course Marks	100			
Attendance Requirement	As per M.Tech. Programme Academic Regulations			
Course Pass Criteria	As per M. Tech. Programme Specification Document (Annexure-1)			

50. Course Summary

Aim and Summary	In this module, the students will be exposed to operation of solid, liquid and hazardous waste treatment plants that involve handling of equipment and instruments in an effective manner. The students will be taught operation and maintenance of these plants that involves control of toxic gases, chemicals and operating equipment at high temperatures. The module also deals with startup, stabilization and safety aspects of the plants along with their troubleshooting procedures. This module also emphasizes on air pollution sampling, analysis, interpretation of data to develop air pollution indices and noise pollution control.

51. Teaching, Learning and Assessment

After undergoing this Course students will be able to:

1. Discuss treatment plant operating procedures for waste water, sewage, effluent, solid and hazardous wastes
2. Demonstrate effective and safe operating procedures of treatment plants Optimize plant operating parameters
3. Perform indoor / outdoor air pollution sampling and explain noise pollution control
4. Propose appropriate maintenance activities (mechanical equipment, electrical / instruments and annual maintenance procedures)
5. Develop standard operating procedures (SOPs) and operating and maintenance manuals for treatment plants ,

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3.2 Course Content
Introduction to Plant Operation and Maintenance Need for operation and maintenance, corrective and preventive maintenance, reading operation manuals and plant drawings, record keeping / logging, daily log record, computer usage in operation and maintenance (SCADA / Data loggers)
Routine Operation of Treatment Plants Liquid waste treatment plants sewage Treatment Plant (STP) and Effluent Treatment Plant (ETP) - Introduction to general operating procedures of STP, ETP and Common ETP (CETP), Operation of pumps, blowers, compressors, filters, scrubbers, and valves (mechanical, solenoid, pneumatic), handling of chemicals for disinfection (dosage)
Solid waste treatment plants (Municipal, industrial and hazardous waste) - Introduction to thermal treatment processes, operation of Incinerators (combustion chamber, drafts), operation of pyrolysis, gasifiers, biogas and composting units
Maintenance of Treatment Plants Maintenance of mechanical equipment- pumps, blowers and compressors, agitators, filters /scrubbers, valves and seals, combustion chamber, igniters Maintenance of electrical / instrument equipment - electrical motors, meggering of electrical equipment, pneumatic actuators, instruments and circuits, calibration, SCADA, Data loggers annual maintenance activities, plant shutdown (procedures), preventive maintenance of plant equipment
Plant Startup Commissioning and Stabilization Plant startup preparations, initial running and plant stabilization and optimization, checking of mechanical and electrical equipment, quality testing
Emergency and Trouble Shooting Prepare a document / protocol of troubleshooting for different units of the plant - identification of problems and suitable corrective action Quality checking of raw waste and treated waste Safety in operation of treatment plants Safe operating procedures, safety emergencies, safety training of personnel
Air pollution sampling and measurement: Sampling, collection and analysis of air pollutants, Stack monitoring and sampling devices. Air sampling design, analysis and interpretation of air pollution data, guidelines of network design in urban and rural areas. Air pollution standards and indices, Air quality monitoring.

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Noise Pollution:

Specification of sound: sound power, sound intensity and sound pressure levels; plane, point and line sources, multiple sources; outdoor and indoor noise propagation; noise standards and limit values; noise instrumentation and monitoring procedure. Noise indices

3.3 Teaching and Learning Methods

Methods	Duration in Hrs.	Total Duration in Hrs.
Face to Face Lectures		45
Demonstrations		2
1. Demonstration using Videos	x	
2. Demonstration using Physical Models/ Systems		
3. Demonstration on a Computer		
Numeracy		
1. Solving Numerical Problems		
Practical Work		
1. Course Laboratory		
2. Computer Laboratory		
3. Engineering Workshop/ Course Workshop		
4. Model / Model Studio		
Others		3
1. Assignment Discussion / Related Activities		
2. Case Study Presentation	x	
3. Guest Lecture		
4. Industry / Field Visit		
5. Brain Storming Sessions	x	
6. Group Discussions	x	
7. Discussion on Possible Innovations		
Student Presentation, Laboratory Examination, Written Examination		10
Total Duration in Hours		60

52. Course Resources

kk. Essential Reading	1. Class Notes 2. Ministry of Urban Development, (1999), CPHEEO Manual On Water Supply And Treatment 3. Ministry of Urban Development, (2012), CPHEEO Manual ON Sewerage And Sewage Treatment 4. F. R. Spellman, (2009), Handbook of Water and Wastewater Treatment Plant Operations, Florida, CRC Press. 5. Environmental Pollution Control Engineering- CS Rao, Wiley Eastern Ltd., New Delhi, 1996. 6. Fundamentals of Air pollution, Richard W. Boubel et al, Academic Press, New York, 1994.

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II. Recommended Reading	1.R. Kant,(2010), Water Pollution: Management, Control and Treatment, New Age Publications 2.Water Environment Federation,(2009), Design of Municipal Wastewater Treatment Plants MOP 8, 5th edition, McGraw Hill International 3.U. S. Environmental Protection Agency, (1980), Design Manual for Onsite Wastewater Treatment and Disposal Systems, Office of Water Program Operations 4.U. S. Environmental Protection Agency, (2002), Onsite Wastewater Treatment Systems Manual, Office of Water Program Operations 5.Handbook of air pollution prevention and control by Nicholas P. Cheremisinoff, ISBN 0-506-7499-7, elsevier science (usa) 2002. 6. Air pollution control technology handbook by Karl B. Schnelle, J R., et al. ISBN 0-8493-9588-7,crc press llc.
mm. Other Resources	**Websites** 1. www.unesco-ihe.org 2. www.mdws.gov.in 3. www.moud.gov.in 4. www.wateronline.com
	5. www.kspcb.gov.in/ambient_air_quality.html 6. http://cpcb.nic.in/air-pollution **Other Electronic Resources** 16. Electronic resources on the module area are available at MSRUAS library

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Course Specification

Course Details				
Course Code	20ESE544A			Course Category
Course Title	Environmental policies and legislation			
Programme	Environmental Engineering and Management			PE
Department	Civil Engineering			
Faculty	Engineering and Technology			
Course Approval Date	May- 2019	Course Next Review Date	May- 1 202	
Department Responsible for Course Delivery	Civil Engineering			

53. Course Size and Credits	
Number of Credits	4
Duration (Hrs)	60
Course Marks	100
Attendance Requirement	As per M.Tech. Programme Academic Regulations
Course Pass Criteria	As per M. Tech. Programme Specification Document (Annexure-1)

54. Course Summary

Aim and Summary	The course deals with an aim to provide a better understanding of green law issues poignant worldwide, particularly in the Indian context with a more ecologically and socially conscious milieu. Students will be taught methods of minimizing the adverse impacts of pollution and ecological degradation through proper environmental management, international cooperation and raising awareness of environmental values but also strengthening the delivery capacity of environmental professionals so that they are well equipped to face the challenges in their stream of work..

55. Teaching, Learning and Assessment

After undergoing this Course students will be able to:

4. Discuss comprehensive knowledge to the participants in Environmental Law and policy
5. Understanding on key issues related to National as well as International Environmental Law & Policies
6. Develop knowledge on the International Legal & Policy context on thematic issues related to environment
7. Develop practical skills to facilitate effective engagement with the Environmental Law
8. Discuss well-informed professionals in Environmental Law and to upgrade the professional competencies by augmenting the Environmental Law awareness
9. Develop networking and sharing of experiences among participants to actively contribute towards conservation

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3.2 Course Content
Policies to protect environment in India Environment Protection Act, 1986
National Conservation Strategy and Policy Statement on Environment and Development, 1992
Policy Statement for the Abatement of Pollution, 1992
National Environment Policy, 2006
Vision Statement on Environment and Health
Legislations and Rules for the protection of environment in India Water pollution Air Pollution
Wildlife Forest Conservation
Environment Protection National Green Tribunal
Biodiversity Animal Welfare

3.3 Teaching and Learning Methods		
Methods	**Duration in Hrs.**	**Total Duration in Hrs.**
Face to Face Lectures		45
Demonstrations		2
1. Demonstration using Videos	x	
2. Demonstration using Physical Models/ Systems		
3. Demonstration on a Computer		
Numeracy		
1. Solving Numerical Problems		
Practical Work		
1. Course Laboratory		
2. Computer Laboratory		
3. Engineering Workshop/ Course Workshop		
4. Model / Model Studio		
Others		3
1. Assignment Discussion / Related Activities		
2. Case Study Presentation	x	
3. Guest Lecture		
4. Industry / Field Visit		
5. Brain Storming Sessions	x	

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6. Group Discussions	x	
7. Discussion on Possible Innovations		
Student Presentation, Laboratory Examination, Written Examination		10
Total Duration in Hours		60

56. Course Resources	
nn. Essential Reading	1. Class Notes 2. Constitution of India", Eastern Book Company Lucknow, 12thEdn. 2007. 3. Pandey J.N., "Constitutional Law of India", (31st Edn.) Central Law Agency Allahabad – 2007. 4. Kesari U.P.D., "Administrative Law 12008", Universal Book Trade Delhi. 5. "Environmental Policy, Forest Policy", Bare Acts - Government Gazette Notifiaciton
oo. Recommended Reading	5. Tiwari H.N., "Environmental Law", Allahabad Law Agency 2007. 6. Divan A., and Noble M., "Environmental Law and Policy in India (cases, Materials and Statutes)",Tripathi Bombay, 2001.
pp. Other Resources	**Websites** 1. http://iced.cag.gov.in 2. http://moef.gov.in **Other Electronic Resources** 17. Electronic resources on the module area are available at MSRUAS library

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