# Department of Civil and Environmental Engineering

**Birla Institute of Technology, Mesra, Ranchi - 835215 (INDIA)**

## Institute Vision

To become a Globally Recognized Academic Institution in consonance with the social, economic and ecological environment, striving continuously for excellence in education, research and technological service to the National needs.

## Institute Mission

To educate students at Undergraduate, Post Graduate Doctoral and Post-Doctoral levels to perform challenging engineering and managerial jobs in industry.

- To provide excellent research and development facilities to take up Ph.D. programmes and research projects.
- To develop effective teaching and learning skills and state of art research potential of the faculty.
- To build national capabilities in technology, education and research in emerging areas.
- To provide excellent technological services to satisfy the requirements of the industry and overall academic needs of society.

## Department Vision

To develop quality intellectuals through education, research and motivation so that they can bring a positive contribution to the society in area of Civil and Environmental Engineering

## Department Mission

- To develop professional skills through quality education & research.
- To outreach various sectors of society through interdisciplinary programmes and practical oriented approach.
- To create dynamic, logical and effective leaders with inspiring mindsets.

## Programme Educational Objectives (PEOs)

**M. Tech. (Environmental Science and Engineering)**

**PEO 1:** To impart students with strong knowledge base through theory courses and sessional that makes them suitable for industries, academics, research and consultancies.

**PEO 2:** To develop students analytical, computational and research skills through assignments, weekly presentations and modelling software.

**PEO 3:** To train the students on developing practical, efficient and cost-effective solutions on problems and challenges on environmental sciences and engineering.

**PEO 4:** To inculcate among student's sensitivity towards social and corporate responsibilities.

## Programme Outcomes (PO)

**M. Tech. (Environmental Science and Engineering)**

**PO1:** Develop an ability to independently carry out research /investigation and development work to solve practical problems

**PO2:** Develop an ability to write and present a substantial technical report/document

**PO3:** Acquire a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.

**PO4:** Acquire in-depth knowledge about various environmental processes, analyze and design solutions for complex problems related to environmental and public health.

**PO5:** Be able to critically evaluate environmental sustainability and sensitize communities through effective communications and assess alternative solutions for adequate decision making for overall environmental management.

**PO6:** Acquire professional and intellectual integrity and ethics to produce socially responsible and competent environmental scientists and engineers.

# COURSE INFORMATION SHEET

**Course code: CE 527**
**Course title: ECOLOGY AND ENVIRONMENT**
**Pre-requisite(s):** B.Tech./ MSc (Environmental Science)
**Co- requisite(s):** knowledge of Environmental science
**Credits: 3** L:3 T:0 P:0
**Class schedule per week: 3**
**Class: M.Tech.**
**Semester / Level: I/5**
**Branch: Environmental Science and Engineering**
**Name of Teacher:**

**Course objectives**

This course enables the students to:

| | |
|---|---|
| 1 | become conversant with the structural and functional attributes of ecosystem and environment. |
| 2 | be aware of the impact of climate change and pollution on its resources including biodiversity. |
| 3 | be able to critically analyze the environmental problems and opt for appropriate solution based on natural ecological principles for sustainable development. |

**Course Outcomes:**

At the end of the course, a student should be able to:

| | |
|---|---|
| CO1 | understand the multidisciplinary nature of environment, its life supporting factors and their operating principles |
| CO2 | conceptualize the structure and function of ecosystem and to be able to determine the ecosystem characteristics on field. |
| CO3 | develop an understanding of the importance, threats and conservation strategies for biodiversity. |
| CO4 | critically analyze the impacts of ever increasing population, their unending demand for resources and unplanned development on environment. |
| CO5 | analyze and think of different ecological processes for remediation of degraded environment. |

## SYLLABUS

**Module I:**

**Basics of Environment:**
Physical, biological and chemical environment, structure and composition of atmosphere, hydrosphere, lithosphere and biosphere, Meteorological elements of environment - Pressure, temperature, precipitation, Humidity, radiation and wind, Mass and energy transfer across the various interface material balance, first and second law of thermodynamics, Heat transfer process

(8L)

**Module II:**

**Fundamentals of Ecology**:
Organizational level of ecological systems, components of ecosystem, Ecosystem structure, Flow of energy and material cycling, Trophic pyramids and food webs, Productivity of ecosystem, Ecological efficiencies, biogeochemical cycles, Ecological succession, Population characteristics, Malthusian growth, species interactions, qualitative and quantitative characteristics of communities.

(8L)

**Module III:**

**Biodiversity and Environment**:
Introduction to Biodiversity, Types of biodiversity, Species richness and evenness, Megadiversity zones and Hot spots, IUCN threat categories, Red data book, importance of biodiversity, Ecosystem services, Threats to biodiversity, In situ and ex-situ conservation, Protected areas and functions.

(8L)

**Module IV:**

**Human population and Environment**:
Human population demographics, Effects of overpopulation on agriculture, urbanization, environmental degradation and public health. Global challenges associated with climate change and growing pollution. Concept of cleaner production and sustainable development, SDGs.

(8L)

**Module V:**

**Application of Ecological principles**:
Landscape ecology, Ecosystem response to environmental contamination (de-oxygenation, eutrophication, pesticides, metals). Principles of Biomagnification and Biotransformation, Biomonitoring – a tool for environmental monitoring, Ecological restoration – from theory to practice, Phytoremediation and bioremediation of environmental contaminants. Microbial Catabolism of Organic Pollutant, Bio adsorbents.

(8L)

**Books recommended:**

**TEXT BOOK**

1. Fundamentals of Ecology (3rd ed.) - Eugene P. Odum. WB Sunders Company, Philadelphia, 1971.(T1)
2. Ecology and environment – P. D. Sharma (T2)
3. Fundamentals of Ecology- MC Dash, Tata - McGraw Hill, New Delhi, 1996. (T3)
4. Introduction to Environmental Engg. - GM Masters, Prentice Hall of India, 1991. (T4)
5. Biodiversity and Conservation - P. C. Joshi (T5)
6. A Text book of Environmental Science -Prabhat Patnaik 6. A Textbook of Environmental Sciences-Purohit (T6)

**REFERENCE BOOK**

1. Microbiology for Environmental Scientists and Engineers – AF Gaudy (R1)
2. Enzymatic Transformation of Metals - Strains for Enhanced Biodegradation - Improved Biodegradation by Protein. T Gaudy, McGraw-Hill, New York, 1980. (R2)
3. Elements of Ecology ($6^{th}$ edition) – Thomas M. Smith and Robert Leo Smith, Pearson Education, 2007. (R3)
4. Biodiversity and Conservation - M. P. Singh and Aravind Kumar (R4)

**Gaps in the syllabus (to meet Industry/Profession requirements)**
Application of real life industrial problems

**POs met through Gaps in the Syllabus: PO5 and PO6**

**Topics beyond syllabus/Advanced topics/Design:**
Application for real life problems arising in industries through lab-based experiments
POs met through Topics beyond syllabus/Advanced topics/Design: **PO5 and PO6**

**COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS AND EVALUATION PROCEDURE**

**Direct Assessment**

| Assessment Tool | % Contribution during CO Assessment |
|---|---|
| Continuous Internal Assessment | 50 |
| Semester End Examination | 50 |

| Continuous Internal Assessment | % Distribution |
|---|---|
| 3 Quizzes | 30 (3 X 10) |
| Assignment(s) | 10 |
| Seminar before a Committee | 10 |

| Assessment Components | CO1 | CO2 | CO3 | CO4 | CO5 |
|---|---|---|---|---|---|
| Continuous Internal Assessment | | | | | |
| Semester End Examination | | | | | |

**Indirect Assessment**

1. Student Feedback on Faculty
2. Student Feedback on Course

**Course Delivery methods**

| | |
|---|---|
| CD1 | Lecture by use of boards/LCD projectors/OHP projectors |
| CD2 | Assignments/Seminars |
| CD3 | Laboratory experiments/teaching aids |
| CD4 | Industrial/guest lectures |
| CD5 | Industrial visits/in-plant training |
| CD6 | Self- learning such as use of NPTEL materials and internets |
| CD7 | Simulation |

**MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES**

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| **CO1** | 3 | 1 | 1 | 1 | 1 | 1 |
| **CO2** | 3 | 3 | 3 | 3 | 2 | 2 |
| **CO3** | 3 | 1 | 3 | 2 | 2 | 2 |
| **CO4** | 3 | 2 | 3 | 2 | 3 | 3 |
| **CO5** | 3 | 2 | 2 | 3 | 2 | 3 |

**< 34% = 1, 34-66% = 2, > 66% = 3**

**MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD**

| Course Outcomes | Course Delivery Method |
|---|---|
| CO1 | CD1,CD2 |
| CO2 | CD1, CD2,CD4, CD5 |
| CO3 | CD1, CD2, CD6,CD7 |
| CO4 | CD1, CD3,CD6,CD7 |
| CO5 | CD1,CD2,CD3,CD7 |

# COURSE INFORMATION SHEET

**Course code: CE 528**
**Course title: ENVIRONMENTAL CHEMISTRY AND MICROBIOLOGY**
**Pre-requisite(s):** B.E./ B.Tech. or equivalent in any branch of Engineering OR M.Sc. in Environmental Sciences or equivalent degree in any branch of Life Sciences and Biological Sciences
**Co- requisite(s):** Basic Chemistry
**Credits: 3** L:3 T:0 P:0
**Class schedule per week: 3**
**Class: M.Tech.**
**Semester / Level: I/5**
**Branch: Environmental Science and Engineering**
**Name of Teacher:**

**Course Objectives**

This course enables the students to:

| | |
|---|---|
| 1 | Describe the fundamentals of chemistry of environment |
| 2 | Explain the environmental chemical processes for its quality monitoring and pollution control |
| 3 | Discover the basic concepts of environmental microbiology |
| 4 | Interpret the importance of microbes in environment |
| 5 | Explain the significance of environmental microbiology in environmental remediation |

**Course Outcomes**

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

| | |
|---|---|
| CO1. | Apply the fundamentals of environmental chemistry and microbiology, which are important for practice of environmental science and engineering |
| CO2. | Interpret the chemistry of air, soil and water pollution enabling them to work on its treatment |
| CO3. | Design and carry out environmental quality management projects |
| CO4. | Relate the concepts of environmental microbiology in aspects related to public health |
| CO5. | Appraise microbes for wastewater treatment and environmental remediation |

## Syllabus

**Module I:**

**Chemistry of atmosphere and lithosphere:**

Chemical composition of atmosphere, photochemical and chemical reactions in the atmosphere - greenhouse gases, ozone layer depletion, photochemical smog, acid rain. Chemical composition of lithosphere, acid, base and ion exchange reactions, soil acidity, salinity and sodicity; Bio-geochemical cycles.

(8L)

**Module II:**

**Aquatic Chemistry:**
Chemistry of natural waters, physico-chemical properties of water, estuarine chemistry, salinity of sea water, Eh-pH diagrams, chemical speciation; Water pollution - deoxygenation processes, eutrophication, fate of metals and xenobiotic organic pollutants.

(8L)

**Module III:**

**Environmental quality assessment:**
Sampling of water, wastewater, soil and sediments, environmental samples analysis - gravimetric and volumetric methods, spectroscopic techniques, chromatographic techniques.

(8L)

**Module IV:**

**Introduction to environmental microbiology:**
classification and characterization of microorganisms, Morphology and structure of bacteria, nutritional requirement, growth of bacteria; Basic microbiology of water and sewage; Basics of analysis of faecal coliforms.

(8L)

**Module V:**

**Microbes in waste treatment:**
Aerobic and anaerobic metabolism, kinetics of microbial growth, biological nutrient removal, role of microbes in biological waste treatment - bioremediation, biodegradation, wastewater treatment.

(8L)

**Books recommended:**

**TEXT BOOK:**


1. Environmental Chemistry – A global perspective, Gary W. Van Loon and Stephen J. Duffy, Oxford University Press (T1)
2. Introduction to Environmental Engineering and Science, G.M. Masters & Wendell Ela, PHI Publishers (T2)

3. Microbiology, Michael Pelczar Jr., ECS Chan, NR Kreig, Tata McGraw-Hill Education (T3)
4. Wastewater Engineering: Treatment and Reuse, Metcalf & Eddy, McGraw-Hill Publishers (T4)

**REFERENCE BOOK:**

1. Environmental Chemistry, Stanley Manahan, Stanley E. Manahan, CRC Press (R1)
2. Environmental Chemistry, Colin Baird and Michael Cann, Freeman and company, New York (R2)
3. Chemistry for Environmental Engineering, Clair N. Sawyer, Perry Mccarty, Gene F. Parkin, McGraw Hill Inc. New York. (R3)
4. Basic Concepts of Environmental Chemistry, DW Conell, CRC Press (R4)
5. Standard Methods of Testing of Water and Wastewater" Use by APHA, AWWA, AND WPCF (USA) (R5)
6. Water and Wastewater Engineering – designs, principle and practice, Mackenzie L. Davis. McGraw-Hill Education (R6)
7. Brock Biology of Microorganisms, Michael T. Madigan, John M. Martinko, Kelly S. Bender, Daniel H. Buckley, David A. Stahl, Thomas Brock (R7)

**Gaps in the syllabus (to meet Industry/Profession requirements):**
Design of real-time industrial projects.
POs met through Gaps in the Syllabus: **PO4, PO5 & PO6**
**Topics beyond syllabus/Advanced topics/Design:**
Environmental monitoring of aquatic system, air quality monitoring
POs met through Topics beyond syllabus/Advanced topics/Design: **PO4, PO5 & PO6**

## COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS AND EVALUATION PROCEDURE

**Direct Assessment**

| Assessment Tool | % Contribution during CO Assessment |
|---|---|
| Continuous Internal Assessment | 50 |
| Semester End Examination | 50 |

| Continuous Internal Assessment | % Distribution |
|---|---|
| 3 Quizzes | 30 (3 X 10) |
| Assignment(s) | 10 |
| Seminar before a Committee | 10 |

| Assessment Components | CO1 | CO2 | CO3 | CO4 | CO5 |
|---|---|---|---|---|---|
| Continuous Internal Assessment | | | | | |
| Semester End Examination | | | | | |

**Indirect Assessment**

1. Student Feedback on Faculty
2. Student Feedback on Course

**Course Delivery Methods**

| | |
|---|---|
| CD1 | Lecture by use of boards/LCD projectors/OHP projectors |
| CD2 | Assignments/Seminars |
| CD3 | Laboratory experiments/teaching aids |
| CD4 | Industrial/guest lectures |
| CD5 | Industrial visits/in-plant training |
| CD6 | Self- learning such as use of NPTEL materials and internets |
| CD7 | Simulation |

**MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES**

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 1 | 2 | 2 | 3 |
| **CO2** | 2 | 3 | 1 | 2 | 1 | 1 |
| **CO3** | 3 | 3 | 1 | 1 | 1 | 2 |
| **CO4** | 3 | 3 | 1 | 1 | 3 | 1 |
| **CO5** | 3 | 3 | 1 | 3 | 3 | 1 |

**< 34% = 1, 34-66% = 2, > 66% = 3**

**MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD**

| Course Outcomes | Course Delivery Method |
|---|---|
| CO1 | CD1,CD6 |
| CO2 | CD1, CD6,CD7 |
| CO3 | CD1, CD2, CD3,CD6,CD7 |
| CO4 | CD1, CD3,CD6,CD7 |
| CO5 | CD1,CD2,CD3,CD4,CD5,CD7 |

# COURSE INFORMATION SHEET

**Course code: CE 529**
**Course title: WATER SUPPLY ENGINEERING**
**Pre-requisite(s): Basic Mathematics and Environmental Science**
**Co- requisite(s):**
**Credits: 3** L:3 T:0 P:0
**Class schedule per week: 3**
**Class: M.Tech.**
**Semester/ Level: I/5**
**Branch: Environmental Science and Engineering**
**Name of Teacher:**

**Course Objectives**

This course enables the students:

| | |
|---|---|
| 1 | To understand the basic concept of water supply engineering |
| 2 | To characterise and classify the water quality |
| 3 | To select an appropriate water treatment technique |
| 4 | To analyse the problem and finding problem solving approach |

**Course Outcomes**
After the completion of this course, students will be:

| | |
|---|---|
| CO1. | Able to assess the water quality for different water supply scheme |
| CO2. | Able to calculate water demand for upcoming or existing establishment over time |
| CO3. | Able to identify the sources for specific requirement |
| CO4. | Able to understand the existing treatment units and recommend the modern technologies required to meet new standards |
| CO5 | Able to understand the existing distribution network and the modernisation of the same |

## Syllabus

**Module I:**

**Water quality:**

Physical, chemical, Bacteriological characteristics, Epidemiological and toxic aspects, water quality standards.

(8L)

**Module II:**

**Basics of water supply engineering:**

Design Period, Population Forecast, Factors affecting population growth, Water Demand.

(8L)

**Module III:**

**Sources of water and its transportation:**

Hydrological cycle, Rainfall and runoff, groundwater and its development, Surface sources, intakes structures and conduits, Pumps.

(8L)

**Module IV:**

**Water treatment units:**

Conventional and modern water treatment technologies.

(8L)

**Module V:**

**Water distribution network:**

Water distribution network and its optimization, service reservoirs, water supply appurtenances, smart water systems.

(8L)

**Books recommended:**
**TEXT BOOKS:**


1. Garg, S. K. (2007) Water supply engineering, 18th ed, Vol. I. New Delhi: Khanna Publisher.
2. Chatterjee, A. K.2010.Water supply, Waste disposal and environmental Engineering, 8th ed. New Delhi: Khanna Publisher.

3. CPHEEO 1999. Manual on water Supply and treatment. 3rd Edition
4. Nathanson, Jerry A. (2009) Basic environmental technology: water supply, waste management and pollution control, 4th ed. New Delhi: PHI Learning.
5. Chatterjee, A. K.2010.Water supply, Waste disposal and environmental Engineering, 8th ed. New Delhi: Khanna Publisher.

**REFERENCE BOOKS:**

1. Mark J Hammer, Mark J Hammer Jr. (2004). Water and Waste water Technology, 4th edition, Prentice Hall pub.
2. American Water Works Association, Manual, AWWA

**Gaps in the syllabus (to meet Industry/Profession requirements) :**
Syllabus is framed according to industrial and professional requirement.

**Topics beyond syllabus/Advanced topics/Design:**
Advanced Smart water systems already included in syllabus covers the recent advances in the water supply systems.
POs met through Topics beyond syllabus/Advanced topics/Design: **PO5**

## COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS AND EVALUATION PROCEDURE

### Direct Assessment

| Assessment Tool | % Contribution during CO Assessment |
|---|---|
| Continuous Internal Assessment | 50 |
| Semester End Examination | 50 |

| Continuous Internal Assessment | % Distribution |
|---|---|
| 3 Quizzes | 30 (3 X 10) |
| Assignment(s) | 10 |
| Seminar before a Committee | 10 |

| Assessment Components | CO1 | CO2 | CO3 | CO4 | CO5 |
|---|---|---|---|---|---|
| Continuous Internal Assessment | | | | | |
| Semester End Examination | | | | | |

### Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course

### Course Delivery Methods

| | |
|---|---|
| CD1 | Lecture by use of boards/LCD projectors/OHP projectors |
| CD2 | Assignments/Seminars |

| | |
|---|---|
| CD3 | Laboratory experiments/teaching aids |
| CD4 | Industrial/guest lectures |
| CD5 | Industrial visits/in-plant training |
| CD6 | Self- learning such as use of NPTEL materials and internets |
| CD7 | Simulation |

## MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

| | **Program Outcomes** | | | | | |
|---|---|---|---|---|---|---|
| **CO** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** |
| **CO 1** | 3 | 3 | 1 | 2 | 2 | 3 |
| **CO 2** | 2 | 3 | 1 | 2 | 1 | 1 |
| **CO 3** | 3 | 3 | 1 | 1 | 1 | 2 |
| **CO 4** | 3 | 3 | 1 | 1 | 3 | 1 |
| **CO 5** | 3 | 3 | 3 | 3 | 3 | 1 |

**< 34% = 1, 34-66% = 2, > 66% = 3**

## MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

| Course Outcomes | Course Delivery Method |
|---|---|
| CO1 | CD1,CD2.CD3,CD6 |
| CO2 | CD1,CD2.CD3,CD5, CD6 |
| CO3 | CD1,CD2.CD3,CD6 |
| CO4 | CD1,CD2.CD3,CD4, CD5, CD6 |
| CO5 | CD1,CD2.CD3,CD6 |

# COURSE INFORMATION SHEET

**Course code: CE532**
**Course title: WASTEWATER ENGINEERING**
**Pre-requisite(s):** B.E./ B.Tech. or equivalent in any branch of Engineering OR M.Sc. in Environmental Sciences or equivalent degree in any branch of Life Sciences and Biological Sciences
**Co- requisite(s):** Basic Chemistry
**Credits: 3** L:3 T:0 P:0
**Class schedule per week: 3**
**Class: M.Tech.**
**Semester / Level: II/5**
**Branch: Environmental Science and Engineering**
**Name of Teacher:**

**Course Objectives**

This course enables the students to:

| | |
|---|---|
| 1 | Explain the basics of wastewater treatment |
| 2 | Describe the design and operation of wastewater treatment units |
| 3 | Identify specific processes for treatment of different wastewater |
| 4 | Evaluate the existing problems and finding alternative sustainable methods for wastewater treatment |

**Course Outcomes**

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

| | |
|---|---|
| CO1. | Categorise terminology and parameters frequently used in wastewater management |
| CO2. | Appraise different parameters involved in the design of wastewater treatment plants |
| CO3. | Interpret and illustrate the basics of wastewater treatment methods |
| CO4. | Design aerobic and anaerobic wastewater treatment plants |
| CO5 | Solve the routine problems in operations, control and management of wastewater treatment plants |

## SYLLABUS

**Module I:**

**Basics of wastewater:**
Quality of sewage, sewage estimation, storm water estimation, Flow of sewage, Hydraulic considerations of sewage conveyance.

(8L)

**Module II:**

**Unit operations and unit processes for sewage treatment:**
Preliminary, Primary, Secondary, Tertiary treatment.

(8L)

**Module III:**

**Aerobic treatment processes:**
Attached and suspended growth processes, process kinetics.

(8L)

**Module IV:**

**Anaerobic treatment processes:**
Suspended and attached growth, traditional and modern reactors.

(8L)

**Module V:**

**Solids and residuals management:**
Sludge treatment processes, sludge utilization.

(8L)

**Books recommended:**
**TEXT BOOKS:**


1. Metcalf & Eddy (2003) Wastewater engineering: treatment and reuse, 4th ed. New Delhi: Tata McGrawHill.
2. Water and Wastewater Engineering – designs, principle and practice, Mackenzie L. Davis. McGraw-Hill Education


**REFERENCE BOOKS:**


1. Qasim, Syed R., Motley, Edward M., and Zhu, Guang (2000) Water works engineering: planning, design and operation. New Jersey: Prentice Hall.
2. Nathanson, Jerry A. (2009) Basic environmental technology: water supply, waste management and pollution control, 4th ed. New Delhi: PHI Learning.
3. Garg, S.K. (2007) Sewage disposal and air pollution engineering, 20th ed, Vol. II. New Delhi: Khanna Publisher.
4. Chatterjee, A. K.2010.Water supply, Waste disposal and environmental Engineering, 8th ed. New Delhi: Khanna Publisher.
5. CPHEEO Manual on Sewerage and Sewage treatment, latest edition

**Gaps in the syllabus (to meet Industry/Profession requirements):**
Design of real-time industrial projects.
POs met through Gaps in the Syllabus: **PO4, PO5 & PO6**

**Topics beyond syllabus/Advanced topics/Design:**
Modern methods for nutrients removal, biosolids and energy recovery
POs met through Topics beyond syllabus/Advanced topics/Design: **PO4, PO5 & PO6**

## COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS AND EVALUATION PROCEDURE

### Direct Assessment

| Assessment Tool | % Contribution during CO Assessment |
|---|---|
| Continuous Internal Assessment | 50 |
| Semester End Examination | 50 |

| Continuous Internal Assessment | % Distribution |
|---|---|
| 3 Quizzes | 30 (3 X 10) |
| Assignment(s) | 10 |
| Seminar before a Committee | 10 |

| Assessment Components | CO1 | CO2 | CO3 | CO4 | CO5 |
|---|---|---|---|---|---|
| Continuous Internal Assessment | | | | | |
| Semester End Examination | | | | | |

### Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course

### Course Delivery Methods

| | |
|---|---|
| CD1 | Lecture by use of boards/LCD projectors/OHP projectors |
| CD2 | Assignments/Seminars |
| CD3 | Laboratory experiments/teaching aids |
| CD4 | Industrial/guest lectures |
| CD5 | Industrial visits/in-plant training |
| CD6 | Self- learning such as use of NPTEL materials and internets |
| CD7 | Simulation |

### MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 1 | 2 | 2 | 3 |
| **CO2** | 2 | 3 | 1 | 2 | 1 | 1 |
| **CO3** | 3 | 3 | 1 | 1 | 1 | 2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **CO4** | 3 | 3 | 1 | 1 | 3 | 1 |
| **CO5** | 3 | 3 | 1 | 3 | 3 | 1 |

**< 34% = 1, 34-66% = 2, > 66% = 3**

## MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

| Course Outcomes | Course Delivery Method |
|---|---|
| CO1 | CD1, CD2, CD3, CD6 |
| CO2 | CD1, CD2, CD6 |
| CO3 | CD1, CD2, CD6 |
| CO4 | CD1, CD2, CD6 |
| CO5 | CD1, CD2, CD6 |

# COURSE INFORMATION SHEET

**Course code: CE533**
**Course title: AIR POLLUTION & CONTROL TECHNOLOGY**
**Pre-requisite(s): NA**
**Co- requisite(s): NA**
**Credits: 3** L:3 T:0 P:0
**Class schedule per week: 3**
**Class: M.Tech.**
**Semester / Level: II/5**
**Branch: Environmental Science and Engineering**
**Name of Teacher:**

**Course Objectives**

This course enables the students to:

| | |
|---|---|
| 1. | To understanding the basic concepts of ambient and indoor air pollution. |
| 2. | To plan and execute ambient and stack air pollution sampling and monitoring. |
| 3. | To explain the role of meteorology in air pollutant dispersal. |
| 4. | To apply the knowledge of air pollution modelling. |
| 5. | To identify appropriate air pollution control devices. |
| 6. | To interpret the causes of vehicular and noise pollution and devise control methods. |

**Course Outcomes**

At the end of the course, a student should be able to:

| | |
|---|---|
| CO1 | Able to identify air pollution problems and interpret air quality data. |
| CO2 | Able to design an air pollution sampling and monitoring plan. |
| CO3 | Able to recognize various meteorological condition and their effects in air pollutant dispersal. |
| CO4 | Able to identify modern equipment usage in air pollution control. |
| CO5 | Able to analyse the causes of vehicular emission and the need for technological advancement for control and able to conduct investigations for monitoring and control of noise pollution. |

## Syllabus

**Module I:**

**Air Pollution:**

Sources of ambient and indoor air pollution; types of air pollutants, emission inventory, effects of air pollution in regional and global scale.

(8L)

**Module II:**

**Air Quality Monitoring:**

Objectives, ambient and indoor air sampling methods and devices, stack monitoring, CPCB guidelines for air quality monitoring, analysis of air pollutants and interpretation of air pollution data, air pollution standards and indices.

(8L)

**Module III:**

**Atmospheric meteorology and dispersion of air pollutants:**

Temperature lapse rates and atmospheric stability, inversions, wind profiles, wind velocity and turbulence, plume behaviour, estimation of plume rise, dispersion equations, box model, gaussian plume model.

(8L)

**Module IV:**

**Particulate matter and gaseous pollutants control technologies:**

Control methods for air pollution, factors affecting selection of control equipment, working principle, design, operational considerations, process control and monitoring, costing and performance equations of particulate matter and gaseous air pollution control equipment.

(8L)

**Module V:**

**Vehicular pollution and noise pollution:**

Internal combustion engines, technological improvements of engines for reduction of vehicular emissions, after exhaust treatments, alternative transportation fuels, emission measurement and testing, regulation to control vehicular emission. Sources and effects of noise Pollution, measurement, standards, control and preventive measures.

(8L)

**Books recommended:**

**TEXT BOOKS:**


1. Environmental Engineering- Peavy & Rowe. Prentice Hall Pub.
2. Air Pollution Control – Rao and Rao
3. Environmental Pollution and Control – C.S. Rao

**REFERENCE BOOKS:**


1. Noel de Nevers, Air Pollution Control Engineering, Mc Graw Hill, New York.
2. Arthur C. Stern, Air Pollution (Vol. I – Vol. VIII), Academic Press
3. Introduction to Environmental Engineering and Science, Gilbert M Masters
4. CPCB manual for Guidelines for ambient air quality monitoring. Published By: Dr. B. Sengupta, Member Secretary, Central Pollution Control Board


**Gaps in the syllabus (to meet Industry/Profession requirements)**

Design of real-time industrial projects.
POs met through Gaps in the Syllabus**:** NA

**Topics beyond syllabus/Advanced topics/Design:** Air pollution modelling software
POs met through Topics beyond syllabus/Advanced topics/Design

## COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS AND EVALUATION PROCEDURE

**Direct Assessment**

| Assessment Tool | % Contribution during CO Assessment |
|---|---|
| Continuous Internal Assessment | 50 |
| Semester End Examination | 50 |

| Continuous Internal Assessment | % Distribution |
|---|---|
| 3 Quizzes | 30 (3 X 10) |
| Assignment(s) | 10 |
| Seminar before a Committee | 10 |

| Assessment Components | CO1 | CO2 | CO3 | CO4 | CO5 |
|---|---|---|---|---|---|
| Continuous Internal Assessment | | | | | |
| Semester End Examination | | | | | |

**Indirect Assessment**

1. Student Feedback on Faculty
2. Student Feedback on Course

**Course Delivery Methods**

| | |
|---|---|
| CD1 | Lecture by use of boards/LCD projectors/OHP projectors |
| CD2 | Assignments/Seminars |
| CD3 | Laboratory experiments/teaching aids |
| CD4 | Industrial/guest lectures |

| | |
|---|---|
| CD5 | Industrial visits/in-plant training |
| CD6 | Self- learning such as use of NPTEL materials and internets |
| CD7 | Simulation |

## MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | 3 | 2 | 1 |
| **CO2** | 3 | 3 | 3 | 2 | 3 | 2 |
| **CO3** | 3 | 2 | 3 | 3 | 2 | 1 |
| **CO4** | 3 | 1 | 3 | 1 | 2 | 2 |
| **CO5** | 3 | 2 | 3 | 3 | 3 | 3 |

**< 34% = 1, 34-66% = 2, > 66% = 3**

## MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

| Course Outcomes | Course Delivery Method |
|---|---|
| CO1 | CD1, CD6 |
| CO2 | CD1, CD6 |
| CO3 | CD1, CD2, CD3, CD6 |
| CO4 | CD1, CD3, CD5, CD6 |
| CO5 | CD1, CD2, CD3, CD4 |

# COURSE INFORMATION SHEET

**Course code: CE 534**
**Course title: SOLID WASTE MANAGEMENT**
**Pre-requisite(s): NIL**
**Co- requisite(s): NIL**
**Credits:** 3 L: 3 T: 0 P: 0
**Class schedule per week: 3**
**Class: M.Tech.**
**Semester / Level: II/ 5**
**Branch: Environmental Science and Engineering**
**Name of Teacher:**

**Course Objectives**

This course enables the students:

| | |
|---|---|
| 1 | To understand the components of solid waste management system. |
| 2 | To study the collection, transfer and transport of municipal solid waste. |
| 3 | To examine the various processing/treatment options and study operations of various material recovery, resource recovery and energy recovery facility. |
| 4 | To study the design and operation of a solid waste landfill, site remediation and reclamation. |
| 5 | To develop knowledge about the different industrial solid waste pollutants and their minimisation and recovery technologies. |

**Course Outcomes**
After the completion of this course, students will be:

| | |
|---|---|
| CO1. | Able to review the components and characteristics of a solid waste management system. |
| CO2. | Able to identify the various collection, transfer and transport mechanisms of municipal solid waste management. |
| CO3. | Able to design and operate various processing, material and energy recovery facilities. |
| CO4. | Able to design and operate solid waste landfill. |
| CO5. | Able to identify the different industrial solid waste pollutants and their minimisation and recovery technologies. |

## Syllabus

**Module I:**

**Fundamentals of Solid Waste Management and ISWM system:**

Sources and types of Municipal Solid Waste, waste generation rates, factors affecting generation, composition, characteristics, methods of sampling, effects of improper disposal of solid waste, functional elements of solid waste management, Municipal Solid Waste Rules; concept of ISWM system, source reduction of waste — reduction, reuse, recycling, onsite storage methods, handling and segregation of wastes at source.

(8L)

**Module II:**

**Waste collection and transportation:**

Methods of collection of municipal solid wastes, collection vehicles, primary and secondary collection, manpower, collection routes, vehicle routing, transfer station – location and operation.

(8L)

**Module III:**

**Waste processing techniques:**

Objectives of waste processing, component separation and volume reduction, various processing technologies — biological and chemical conversion methods, resource and energy recovery from composting, biomethanation, thermal processing methods, design of a composting facility and incinerator.

(8L)

**Module IV:**

**Landfill design and operation:**

Various disposal methods, landfills — site selection, site infrastructure, essential components of landfill; types of landfilling methods, landfill planning – phased operation, leachate management and gas control; Environmental monitoring systems for landfill sites, closure and post-closure plans for landfills, landfill site rehabilitation, reclamation and remediation.

(8L)

**Module V:**

**Industrial solid waste management:**

Some important industrial solid waste — their prevention, minimisation, and recovery/reuse. Industry specific solid waste management: Mineral and metallurgical industry, steel plants, coal mining industries.

(8L)

**Books recommended:**

**TEXT BOOKS:**


i. CPHEEO, Ministry of Urban Development: Manual on Municipal Solid Waste Management 2000

ii. CPHEEO, Ministry of Urban Development: Manual on Municipal Solid Waste Management 2016

iii. Tchobanoglous G., Theisen H., Vigil S.: Integrated Solid Waste Management Engineering Principles and Management Issues (McGraw Hill Education)

**REFERENCE BOOKS:**
Bhatia S.C.: Handbook of Industrial Pollution & Control Vol. 1 (CBS Publishers)

**Gaps in the syllabus (to meet Industry/Profession requirements) :**
Syllabus is framed according to industrial and professional requirement.

**Topics beyond syllabus/Advanced topics/Design:**
POs met through Topics beyond syllabus/Advanced topics/Design: **PO4**

## COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS AND EVALUATION PROCEDURE

### Direct Assessment

| Assessment Tool | % Contribution during CO Assessment |
|---|---|
| Continuous Internal Assessment | 50 |
| Semester End Examination | 50 |

| Continuous Internal Assessment | % Distribution |
|---|---|
| 3 Quizzes | 30 (3 X 10) |
| Assignment(s) | 10 |
| Seminar before a Committee | 10 |

| Assessment Components | CO1 | CO2 | CO3 | CO4 | CO5 |
|---|---|---|---|---|---|
| Continuous Internal Assessment | | | | | |
| Semester End Examination | | | | | |

### Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course

### Course Delivery Methods

| | |
|---|---|
| CD1 | Lecture by use of boards/LCD projectors/OHP projectors |
| CD2 | Assignments/Seminars |
| CD3 | Laboratory experiments/teaching aids |
| CD4 | Industrial/guest lectures |
| CD5 | Industrial visits/in-plant training |
| CD6 | Self- learning such as use of NPTEL materials and internets |
| CD7 | Simulation |

## MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

| **CO** | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| **CO** 1 | 1 | 1 | 3 | 3 | 2 | 3 |
| **CO** 2 | 1 | 1 | 3 | 3 | 2 | 3 |
| **CO** 3 | 3 | 2 | 3 | 3 | 2 | 3 |
| **CO** 4 | 3 | 2 | 3 | 3 | 2 | 3 |
| **CO** 5 | 3 | 3 | 3 | 3 | 2 | 3 |

**< 34% = 1, 34-66% = 2, > 66% = 3**

## MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

| **Course Outcome** | **Course Delivery Method** |
|---|---|
| CO1 | CD1, CD2, CD4, CD6 |
| CO2 | CD1, CD2, CD4, CD6 |
| CO3 | CD1, CD2, CD4, CD6 |
| CO4 | CD1, CD2, CD4, CD6 |
| CO5 | CD1, CD2, CD4, CD6 |

# COURSE INFORMATION SHEET

**Course code: CE537**
**Course title: ENVIRONMENTAL IMPACT ASSESSMENT AND LEGISLATION**
**Pre-requisite(s): Basic Science**
**Co- requisite(s): Environmental knowledge**
**Credits: 3** L:3 T:0 P:0
**Class schedule per week: 3**
**Class: M.Tech.**
**Semester / Level: III/5**
**Branch: Environmental Science and Engineering**
**Name of Teacher:**

**Course Objectives**

This course enables the students:

| | |
|---|---|
| 1 | To provide an overview on international conventions, and laws for sustainable environment |
| 2 | To develop a basic understanding on the process of environmental impact assessment |
| 3 | To understand the components of environmental reports and management plans |

**Course Outcomes**

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

| | |
|---|---|
| CO1. | Identify and analyse the international sustainable development initiatives and reports |
| CO2. | Understand the features of laws related to environment protection and pollution control |
| CO3. | Understand the process of Environmental Impact Assessment |
| CO4. | Analyse and document environmental projects and prepare management plan |
| CO5 | Understand and apply the concepts of environmental audits and Clean development initiatives. |

## SYLLABUS

**Module I:**

**International Conventions:**
Rio Declaration and Agenda 21, COP 21, sustainable development initiatives, Basel Convention, Montreal Protocol, Millennium Development goals, IPCC reports.

(8L)

**Module II:**

**Laws and Protocol**:
Salient features of Acts pertaining to protection of Air, Water, Wildlife, Forest, and Environment in India.

(8L)

**Module III:**

**Concepts of EIA:**
Framework for environmental impact assessment. Environmental clearance, EIA process: Screening, Scoping and baseline studies, Impact Assessment Methods, Public hearing, Mitigation. EIA notification.

(8L)

**Module IV:**

**Aspects, Impacts and Management:**
Review of DPRs and Industrial Case studies, EMP preparation.

(8L)

**Module V:**

**Environmental Audits and Carbon Trading:**
Concepts of Environmental auditing, ecolabels and life cycle assessment. Case studies for LCA, Ethics, Carbon trading and foot printing, CDM initiatives in India.

(8L)

**Books recommended:**
**TEXT BOOKS:**


1. Environmental Impact Assessment: Larry Canter. McGraw Hill Publication.
2. Disaster Management- Edited by R. B. Singh. Rawat Publications. India.
3. Environmental Impact Assessment- A. K. Shrivastava. APH Pub. India.
4. Environmental Impact Assessment. Theory and Practice. Anji Reddy Mareddy, 1st Edition, eBook ISBN: 9780128112380, Paperback ISBN: 9780128111390, Butterworth-Heinemann.
5. Environmental Audit: A.K.Shrivastava. APH pub Corp. New Delhi.
6. ISO 14000: Environmental Management 1st Edition, David L. Goetsch , Stanley Davis. ISBN-13: 978-0130812360. Jenson Books Inc

**REFERENCE BOOKS:**


1. Methods of Environmental Impact Assessment, Graham Wood,Riki Therivel. ISBN-13: 978-1138647671. Routledge; 4 editions.
2. Climate Change 2014 – Impacts, Adaptation and Vulnerability: Part A: Global and Sectoral Aspects. Working Group II Contribution to the IPCC Fifth Assessment Report. Volume 1. Global and Sectoral Aspects. Intergovernmental Panel on Climate Change. December 2014, ISBN: 9781107641655
3. Climate Change 2014 – Impacts, Adaptation and Vulnerability: Part B: Regional Aspects Working Group II Contribution to the IPCC Fifth Assessment Report. Volume 2. ,Intergovernmental Panel on Climate Change, December 2014, ISBN: 9781107683860.
4. Global Green standards: ISO 14000 and Sustainable Development. IISD pub. Minitoba.
5. ISO 14000 Answer Book: Environmental Management for the World Market (Wiley Quality Management) 1st Edition. by Dennis R. Sasseville W. Gary Wilson, Robert W. Lawson . ISBN-13: 978-0471179337. John Wiley and sons. Canada.


**Gaps in the syllabus (to meet Industry/Profession requirements) :**

Syllabus is framed according to industrial and professional requirement.

**Topics beyond syllabus/Advanced topics/Design:**

Module 4 covers review of DPRs that will be allow the students to learn and write project reports that require EIA.

POs met through Topics beyond syllabus/Advanced topics/Design: **PO2**

## COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS AND EVALUATION PROCEDURE

### Direct Assessment

| Assessment Tool | % Contribution during CO Assessment |
|---|---|
| Continuous Internal Assessment | 50 |
| Semester End Examination | 50 |

| Continuous Internal Assessment | % Distribution |
|---|---|
| 3 Quizzes | 30 (3 X 10) |
| Assignment(s) | 10 |
| Seminar before a Committee | 10 |

| Assessment Components | CO1 | CO2 | CO3 | CO4 | CO5 |
|---|---|---|---|---|---|
| Continuous Internal Assessment | | | | | |
| Semester End Examination | | | | | |

### Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course

**Course Delivery Methods**

| | |
|---|---|
| CD1 | Lecture by use of boards/LCD projectors/OHP projectors |
| CD2 | Assignments/Seminars |
| CD3 | Laboratory experiments/teaching aids |
| CD4 | Industrial/guest lectures |
| CD5 | Industrial visits/in-plant training |
| CD6 | Self- learning such as use of NPTEL materials and internets |
| CD7 | Simulation |

**MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES**

| **CO** | PO1 | PO 2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| **CO 1** | 3 | 3 | 3 | 2 | 3 | 3 |
| **CO 2** | 2 | 1 | 3 | 1 | 2 | 2 |
| **CO 3** | 3 | 3 | 3 | 3 | 3 | 2 |
| **CO 4** | 3 | 3 | 3 | 2 | 3 | 3 |
| **CO 5** | 1 | 2 | 2 | 2 | 2 | 2 |

**< 34% = 1, 34-66% = 2, > 66% = 3**

**MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD**

| **Course Outcome** | **Course Delivery Method** |
|---|---|
| CO1 | CD1, CD2 |
| CO2 | CD1, CD2 |
| CO3 | CD1, CD2, CD8, CD6 |
| CO4 | CD1, CD2, CD3 |
| CO5 | CD1 ,CD2,CD8,CD6 |

# COURSE INFORMATION SHEET

**Course code: CE563**
**Course title: CLIMATE CHANGE AND ADAPTATION**
**Pre-requisite(s):**
**Co- requisite(s):**
**Credits: 3** L:3 T:0 P:0
**Class schedule per week: 3**
**Class: M.Tech.**
**Semester / Level: /5**
**Branch: Environmental Science and Engineering**
**Name of Teacher:**

**Course Objectives:**

This course enables the students to:

| | |
|---|---|
| 1. | To relate to the natural climate system and causes of climate change. |
| 2. | To predict the vulnerability of natural system due to climate change. |
| 3. | To create risk management plan for climate change. |
| 4. | To develop adaptation strategies based on international and national policies. |

**Course Outcomes:**

At the end of the course, a student should be able to:

| | |
|---|---|
| CO1 | Able to identify the control factors for climate system. |
| CO2 | Able to analyse the causes of climate change. |
| CO3 | Able to speculate the effects of global warming and the role of anthropogenic activities. |
| CO4 | Able to conduct and formulate a risk and vulnerability assessment plan of climatic impacts on major systems. |
| CO5 | Able to develop sustainable mitigation strategies for climate change AND calculate carbon credits for emission trading.. |

## Syllabus

**Module I:**

**Elements of climate:**

Earth's radiation balance, radiation laws, latitudinal and seasonal variation of insolation, temperature, pressure, wind belts, humidity, cloud formation and precipitation, Air masses and fronts, climatic controls, climatic classification.

(8L)

**Module II:**

**Climate change:**

Natural and anthropogenic factors of climate change, greenhouse effect and contribution of greenhouse gases and aerosols, earth's climate data and trends, indicators of climate change, proxy data, climatic feedback mechanism and sensitivity.

(8L)

**Module III:**

**Effects of climate change, vulnerability, and risk:**

Impacts of climate change, assessing climate impacts on key sectors and systems (heat stress, water resources, coastal zones, agricultural systems, biodiversity), concepts of vulnerability and risk, assessing vulnerability and risk, climatic modelling, climate projections and their uncertainties.

(8L)

**Module IV:**

**Adaptation and risk management:**

Concepts of coping, adaptation and risk management, adaptive capacity, indicators and metrics, adaptation planning at different levels, strategies and approaches, implementation.

(8L)

**Module V:**

**Mitigation of climate change:**

Mitigation measures, recent researches to combat climate change, International negotiations and initiatives, UNFCCC, IPCC, policies and measures, carbon credit and emission trading, calculation of carbon footprints, National Action Plan on Climate Change (NAPCC).

(8L)

**Books recommended:**

**TEXT BOOK**


1. Peixoto, J. P., and Oort, A. H., Physics of Climate, Springer, 1992 (**T1)**
2. L. D. Danny Harvey, Global warming The Hard Science, Pearson, 1992. (**T2)**


**REFERENCE BOOK**

1. Climate Change 2007 - Mitigation of Climate Change: Working Group III contribution to the Fourth Assessment Report of the IPCC (Climate Change 2007), Cambridge University Press, 2007 g) Houghton, J., Global Warming: The Complete Briefing, Cambridge University Press; 2004. (**R1**)
2. IPCC, 2013: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

**Gaps in the syllabus (to meet Industry/Profession requirements):**

POs met through Gaps in the Syllabus:

**Topics beyond syllabus/Advanced topics/Design:**

POs met through Topics beyond syllabus/Advanced topics/Design:

## COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS AND EVALUATION PROCEDURE

### Direct Assessment

| Assessment Tool | % Contribution during CO Assessment |
|---|---|
| Continuous Internal Assessment | 50 |
| Semester End Examination | 50 |

| Continuous Internal Assessment | % Distribution |
|---|---|
| 3 Quizzes | 30 (3 X 10) |
| Assignment(s) | 10 |
| Seminar before a Committee | 10 |

| Assessment Components | CO1 | CO2 | CO3 | CO4 | CO5 |
|---|---|---|---|---|---|
| Continuous Internal Assessment | | | | | |
| Semester End Examination | | | | | |

### Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course

## Course Delivery Methods

| | |
|---|---|
| CD1 | Lecture by use of boards/LCD projectors/OHP projectors |
| CD2 | Assignments/Seminars |
| CD3 | Laboratory experiments/teaching aids |
| CD4 | Industrial/guest lectures |
| CD5 | Industrial visits/in-plant training |
| CD6 | Self- learning such as use of NPTEL materials and internets |
| CD7 | Simulation |

### MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 3 | 3 | 3 | 2 |
| **CO2** | 3 | 2 | 3 | 3 | 3 | 3 |
| **CO3** | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO4** | 3 | 3 | 3 | 3 | 2 | 3 |
| **CO5** | 3 | 3 | 3 | 3 | 2 | 3 |

**< 34% = 1, 34-66% = 2, > 66% = 3**

### MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

| Course Outcomes | Course Delivery Method |
|---|---|
| CO1 | CD1, CD2 |
| CO2 | CD1, CD2 |
| CO3 | CD1, CD2 |
| CO4 | CD1, CD2 |
| CO5 | CD1, CD2 |

# COURSE INFORMATION SHEET

**Course code: CE 564**
**Course title: INSTRUMENTS FOR ENVIRONMENTAL ENGINEERING**
**Pre-requisite(s):**
**Co- requisite(s):**
**Credits: 3** L:3 T:0 P:0
**Class schedule per week: 3**
**Class: M.Tech.**
**Semester / Level: /5**
**Branch: Environmental Science and Engineering**
**Name of Teacher:**

**Course Objectives:**

This course enables the students to:

| | |
|---|---|
| 1 | To understand the developments in the field of instrumentation for quantitative and qualitative analysis of environmental samples |
| 2 | To know the applications of spectroscopy, chromatography and electro analytical methods |
| 3 | To select and finalize the instruments for different analysis of environmental samples |
| 4 | Carry out *in situ* and continuous environmental monitoring and assessment studies |

**Course Outcomes:**

At the end of the course, a student should be able to:

| | |
|---|---|
| CO1 | Understand the principle and the components and function of instruments in environmental engineering |
| CO2 | Able to apply spectroscopic techniques for environmental samples analysis |
| CO3 | Knowing about the application of chromatographic processes |
| CO4 | Capable to select appropriate instrumental method for chemical analysis of air, water and soil |
| CO5 | Able to design studies related for in situ and continuous monitoring of atmospheric and aquatic systems |

## Syllabus

**Module I:**

**Environmental samples analysis:**

Conventional methods and their limitations, Modern instrumental methods, selection of method, precision and accuracy, error in measuring signals, quality assurance and quality control, sample preservation, sample preparation and analyte isolation.

(8L)

**Module II:**

**Spectroscopy:**

Principles, techniques and applications of spectroscopy, fluorimetry, nephelometry and turbidimetry, Atomic Absorption Spectrometry (Flame, graphite furnace, cold vapour and hydride generation), Inducted Coupled Plasma Optical Emission Spectroscopy (ICP OES).

(8L)

**Module III:**

**Chromatography**:

Principles, techniques and applications of chromatography, Gas chromatography, GC-Mass spectroscopy, High performance liquid chromatography, LC - Mass spectroscopy, and Ion chromatography.

(8L)

**Module IV:**

**Electro-analytical methods:**

Conductometry, potentiometry, coulometry, AOX analyzer amperometry, polarography, Neutron Activation Analysis, X-ray Fluorescence and X-ray Diffraction.

(8L)

**Module V:**

***In situ* and continuous monitoring systems:**

Principles, techniques and applications of CO analyser, NOx analyser, $SO_2$ analyser, particulate matter sampling and analysis, aethalometer, auto analyzer for water quality using flow injection analysis, in situ water quality parameter loggers.

(8L)

**Books recommended:**

**TEXT BOOK**


3. Chemistry for Environmental Engineering, Clair N. Sawyer, Perry Mccarty, Gene F. Parkin, McGraw Hill Inc. New York (**T1)**
4. Willard H. Merritt, L. Dean, D.A. and Settle, F.A. „Instrumental methods of analysis Edn. Words Worth, New York (**T2)**

5. Paul R. Loconto Trace Environmental Quantitative Analysis: Principles, Techniques, and Applications, Marcel Dekker (**T3)**

**REFERENCE BOOK**

3. Instrumental Methods of Chemical Analysis, Ewing,McGraw-Hill, New York . (**R1**)

**Gaps in the syllabus (to meet Industry/Profession requirements):**

POs met through Gaps in the Syllabus:

**Topics beyond syllabus/Advanced topics/Design:**

POs met through Topics beyond syllabus/Advanced topics/Design:

## COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS AND EVALUATION PROCEDURE

### Direct Assessment

| Assessment Tool | % Contribution during CO Assessment |
|---|---|
| Continuous Internal Assessment | 50 |
| Semester End Examination | 50 |

| Continuous Internal Assessment | % Distribution |
|---|---|
| 3 Quizzes | 30 (3 X 10) |
| Assignment(s) | 10 |
| Seminar before a Committee | 10 |

| Assessment Components | CO1 | CO2 | CO3 | CO4 | CO5 |
|---|---|---|---|---|---|
| Continuous Internal Assessment | | | | | |
| Semester End Examination | | | | | |

### Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course

### Course Delivery Methods

| | |
|---|---|
| CD1 | Lecture by use of boards/LCD projectors/OHP projectors |
| CD2 | Assignments/Seminars |
| CD3 | Laboratory experiments/teaching aids |
| CD4 | Industrial/guest lectures |
| CD5 | Industrial visits/in-plant training |
| CD6 | Self- learning such as use of NPTEL materials and internets |
| CD7 | Simulation |

## MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| **CO1** | 3 | 1 | 3 | 3 | 1 | 1 |
| **CO2** | 3 | 1 | 3 | 3 | 1 | 1 |
| **CO3** | 3 | 1 | 3 | 3 | 1 | 1 |
| **CO4** | 3 | 1 | 3 | 2 | 2 | 1 |
| **CO5** | 3 | 2 | 3 | 3 | 3 | 3 |

**< 34% = 1, 34-66% = 2, > 66% = 3**

## MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

| Course Outcomes | Course Delivery Method |
|---|---|
| CO1 | CD1 |
| CO2 | CD1, CD2, CD3 |
| CO3 | CD1 |
| CO4 | CD1 |
| CO5 | CD1, CD2, CD3 |

# COURSE INFORMATION SHEET

**Course code: CE565**
**Course title: EARTH SCIENCES**
**Pre-requisite(s):**
**Co- requisite(s):**
**Credits: 3** L:3 T:0 P:0
**Class schedule per week: 3**
**Class: M.Tech.**
**Semester / Level: /5**
**Branch: Environmental Science and Engineering**
**Name of Teacher:**

**Course Objectives:**

This course enables the students to:

| | |
|---|---|
| 1 | To understand the earths processes and environmental geology. |
| 2 | To develop an idea about the role of earth processes in modifying the earths landforms. |
| 3 | To identify the role of geological formations suitable for construction purpose. |
| 4 | To detect the causes for geological hazards and suggest management plan. |

**Course Outcomes:**

At the end of the course, a student should be able to:

| | |
|---|---|
| CO1 | Able to apply the knowledge of earth sciences to environmental processes. |
| CO2 | Able to recognize the earth's natural processes and their role for land formation. |
| CO3 | Able to understand the geophysical methods for subsurface investigations. |
| CO4 | Able to identify suitable sites for construction of bridge, tunnels, dams etc. |
| CO5 | Able to analyse the causes of geological hazards and suggest possible management solutions. |

**SYLLABUS**

**Module I:**

**Introduction to earth science:**
Evolution of various branches earth sciences, origin of the earth, primary differentiation and formation of core, mantle, crust, atmosphere and hydrosphere, formation of mountains and the role of plate tectonics, plate tectonics-mountain building, sea floor spreading, evolution of continents and structural deformation continental drift- mechanism and evidences.

(8L)

**Module II:**

**Earth materials:**
Formation of rocks and minerals, types of rocks and minerals, properties of rocks and minerals, weathering process and its environmental consequences, soil formation.

(8L)

**Module III:**

**Earth's natural agentsand physical geology:**
Geological work of wind, river, groundwater, oceans and seas, glaciers, organisms, concept of isostasy.

(8L)

**Module IV:**

**Structural geomorphology:**
Dip, strike, folds faults joints, overlaps, unconformity, concepts of environmental geology (suitable sites for dam, reservoir, tunnel, bridges), geology of water supply, geophysical methods for subsurface investigation.

(8L)

**Module V:**

**Geological Hazards:**
Basic concepts of earth mass movement (landslides, rock falls, subsidence), earthquake, volcanic disaster, tsunami, flood, disaster management and policies.

(8L)

**Books recommended:**

**TEXT BOOK**


1. Earth Part 1 and 2. F. Press and R. Siever, W. H. Freeman (**T1)**
2. A Textbook of Geology. P. K. Mukherjee, World Press (**T2)**
3. Environmental Geography. S. Singh, PrayagPustakBhavan (**T3)**
4. Physical Geography. S. Singh, PrayagPustakBhavan (T4)

**REFERENCE BOOK**

1. Principles of Engineering Geology. K.V.G.K Gokhale. BS Publications

**Gaps in the syllabus (to meet Industry/Profession requirements):**

POs met through Gaps in the Syllabus:

**Topics beyond syllabus/Advanced topics/Design:**

POs met through Topics beyond syllabus/Advanced topics/Design:

## COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS AND EVALUATION PROCEDURE

### Direct Assessment

| Assessment Tool | % Contribution during CO Assessment |
|---|---|
| Continuous Internal Assessment | 50 |
| Semester End Examination | 50 |

| Continuous Internal Assessment | % Distribution |
|---|---|
| 3 Quizzes | 30 (3 X 10) |
| Assignment(s) | 10 |
| Seminar before a Committee | 10 |

| Assessment Components | CO1 | CO2 | CO3 | CO4 | CO5 |
|---|---|---|---|---|---|
| Continuous Internal Assessment | | | | | |
| Semester End Examination | | | | | |

### Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course

### Course Delivery Methods

| | |
|---|---|
| CD1 | Lecture by use of boards/LCD projectors/OHP projectors |
| CD2 | Assignments/Seminars |
| CD3 | Laboratory experiments/teaching aids |
| CD4 | Industrial/guest lectures |
| CD5 | Industrial visits/in-plant training |
| CD6 | Self- learning such as use of NPTEL materials and internets |
| CD7 | Simulation |

**MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES**

**7.**

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 3 | 3 | 2 | 1 |
| **CO2** | 3 | 3 | 3 | 3 | 2 | 2 |
| **CO3** | 2 | 2 | 3 | 3 | 2 | 2 |
| **CO4** | 3 | 3 | 3 | 2 | | 3 |
| **CO5** | 3 | 3 | 3 | 3 | 3 | 3 |

**< 34% = 1, 34-66% = 2, > 66% = 3**

**MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD**

| Course Outcomes | Course Delivery Method |
|---|---|
| CO1 | CD1, CD2 |
| CO2 | CD1, CD2 |
| CO3 | CD1, CD2 |
| CO4 | CD1, CD2 |
| CO5 | CD1, CD2 |

# COURSE INFORMATION SHEET

**Course code: CE566**
**Course title: ENVIRONMENTAL ECONOMICS**
**Pre-requisite(s):** NA
**Co- requisite(s): NA**
**Credits: 3** L:3 T:0 P:0
**Class schedule per week: 3**
**Class: M.Tech.**
**Semester / Level: /5**
**Branch: Environmental Science and Engineering**
**Name of Teacher:**

**Course Objectives:**

This course enables the students to:

| | |
|---|---|
| 1 | To introduce the necessity of natural and ecological resources and their management in terms of economic values. |
| 2 | Conservation of ecological resources and study of their economics. |
| 3 | Students will learn the concept and theories related to environmental economics |
| 4 | To learn about different recent initiatives and guidelines for environmental economics. |

**Course Outcomes:**

At the end of the course, a student should be able to:

| | |
|---|---|
| CO1 | Justify the necessity of natural resource conservation |
| CO2 | The energy flow within different trophic levels of ecosystem |
| CO3 | Able to relate environmental degradation with the economy |
| CO4 | Assist in decision making in terms of resource valuation and conservation |
| CO5 | understand the role of different bodies in controlling pollution |

## Syllabus

**Module II:**

**Historical development of environmental economics:**

The Environment-Economy Interaction, the Materials Balance Model and laws of Thermodynamics; Basic concepts of resource economics; natural capita and equity. Economic principles: Introduction to microeconomic theory covering theories and applications of individual and market demand, as well as production economics. Welfare economics and its application to imperfect competition and factor markets.

(8L)

**Module II:**

**Pollution as an economic problem:**

Market Failure, Externality, Exaction, Insertion, Social Trap; Alternative Definitions of Pollution; Optimal Pollution: Marginal Damage and Marginal Abatement Cost.

**Introduction to environmental economics and policy:**

Essential economic concepts and theory relevant to environmental issues. Economic theories of pollution and management of natural resources. The impact of macroeconomic policies on the environment and the role of international environmental agreements on transboundary issues.

(8L)

**Module III:**

**Instruments of Pollution Control:**

Command and Control and Economic Instruments; International Agencies and Environment: UNEP, UNFCC. Environmental Values beyond use value: Environmental Resources and Market Failure, Signals of Natural Resource Depletion/ Scarcity (Direct and Indirect Approaches and their Limitations).

(8L)

**Module IV:**

Environmental Valuation; Concept of Total Economic Value, Uncertainty and Irreversibility, Economic growth and environment: Fundamentals of Environmental Kuznets Curve, Approaches to Environmental Valuation**:** Cost-Benefit/ Social Cost-Benefit Analysis, Health Cost Approach, Travel Cost Approach, Amenities and Hedonic Pricing, Contingent Valuation Methods: Revealed and Stated preferences, Willingness to pay and Willingness to Accept.

(8L)

**Module V:**

**Natural resource economics:**

Economic models of natural resource allocation and demonstrates their application to policy making and natural resource management to provide useful insights to both policy makers and managers. Application of Environmental Economics in Public Policy and Natural Resource management: Forest, Water, Fisheries and Pollution Management: key issues and options.

(8L)

**Books recommended:**

**TEXT BOOK**

1. Hanley, N., J. Shogren, and B. White (1997): Environmental Economics in Theory and Practice, Macmillan Press,. (T1)
2. Pearce, D. W., and R. K. Turner (1990): Economics of Natural Resources and the Environment, Harvester Wheatsheaf, London. (T2)
3. Perman, R., Y. Ma, J. McGilvray, and M. S. Common (1999), Natural Resources and Environmental Economics, 2nd Edition, Longmans. (T3)

**REFERENCE BOOK**

1.Values for the Environment: A Guide to Economic Approach – Winpeny JT, Overseas Development Institute, London, HMOS, 1991. (**R1**)

2.Economic Analysis of Environmental Impacts – Dixon, John, A, Scura LF, Carpenter RA and Sherman PB, Earthscan Publications Ltd., London 1995. (R2)

**Gaps in the syllabus (to meet Industry/Profession requirements):**

POs met through Gaps in the Syllabus:

**Topics beyond syllabus/Advanced topics/Design:**

POs met through Topics beyond syllabus/Advanced topics/Design:

## COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS AND EVALUATION PROCEDURE

**Direct Assessment**

| Assessment Tool | % Contribution during CO Assessment |
|---|---|
| Continuous Internal Assessment | 50 |
| Semester End Examination | 50 |

| Continuous Internal Assessment | % Distribution |
|---|---|
| 3 Quizzes | 30 (3 X 10) |
| Assignment(s) | 10 |
| Seminar before a Committee | 10 |

| Assessment Components | CO1 | CO2 | CO3 | CO4 | CO5 |
|---|---|---|---|---|---|
| Continuous Internal Assessment | | | | | |
| Semester End Examination | | | | | |

**Indirect Assessment**

1. Student Feedback on Faculty
2. Student Feedback on Course

**Course Delivery Methods**

| | |
|---|---|
| CD1 | Lecture by use of boards/LCD projectors/OHP projectors |
| CD2 | Assignments/Seminars |
| CD3 | Laboratory experiments/teaching aids |
| CD4 | Industrial/guest lectures |
| CD5 | Industrial visits/in-plant training |
| CD6 | Self- learning such as use of NPTEL materials and internets |
| CD7 | Simulation |

**MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES**

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 1 | 2 | 2 | 1 |
| **CO2** | 3 | 2 | 1 | 1 | 1 | 1 |
| **CO3** | 3 | 3 | 2 | 1 | 2 | 2 |
| **CO4** | 3 | 3 | 3 | 2 | 3 | 2 |
| **CO5** | 3 | 3 | 3 | 3 | 2 | 2 |

**< 34% = 1, 34-66% = 2, > 66% = 3**

**MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD**

| Course Outcomes | Course Delivery Method |
|---|---|
| CO1 | CD1 |
| CO2 | CD1 |
| CO3 | CD1 and CD2 |
| CO4 | CD1 |
| CO5 | CD1 and CD2 |

# COURSE INFORMATION SHEET

**Course code: CE567**
**Course title: ENVIRONMENTAL STATISTICS**
**Pre-requisite(s): Basic concepts of Mathematics**
**Co- requisite(s):** N.A.
**Credits: 3** L:3 T:0 P:0
**Class schedule per week: 3**
**Class: M.Tech.**
**Semester / Level: /5**
**Branch: Environmental Science and Engineering**
**Name of Teacher:**

**Course Objectives**

This course enables the students to:

| | |
|---|---|
| 1 | Develop a general understanding on environmental statistics. |
| 2 | Identify the areas of application of statistics in Environmental Science and Engineering. |
| 3 | Apply the knowledge of statistical ideas, tools and to solve problems of industry, management and other engineering fields. |

**Course Outcomes**

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

| | |
|---|---|
| CO1. | Able to demonstrate the applications of statistical techniques in Environmental Science and Engineering. |
| CO2. | Able to understand the necessity of frequency distribution in environmental samples. |
| CO3. | Able to plan and design surveys and experiments. |
| CO4. | Able to statistically analyse the relation and variability in a set of environmental data. |
| CO5. | Able to identify the components of statistical data structure needed for various environmental data collection. |

## Syllabus

**Module I:**

**Introduction to Environmental Statistics:**

Objective and scope of Environmental Statistics, sources of environmental statistics, Framework for the Development of Environment Statistics (FDES), Environmental information, data, statistics and indicators, Spatial, temporal, geospatial information and environmental statistics.

Collection and representation of data- Primary and Secondary data, collection and scrutiny of data, frequency and non-frequency data, diagrammatic representation of data.

(8L)

**Module II:**

**Frequency distributions and measures of central tendency:**

Attribute and variable, discrete and continuous variable, frequency distribution of an attribute and variable. Measures of dispersion, measures of skewness and kurtosis.

(8L)

**Module III:**

**Sampling theory and estimation theory:**

Hypothesis testing and interval estimation for large samples, Chi-square test, t-test and F test of significance, goodness of fit, Estimators: Unbiasedness, Consistency, Efficiency and Sufficiency – Maximum Likelihood Estimation, Interval estimation of parameters.

(8L)

**Module IV:**

**Correlation and regression and analysis of variance:**

Multiple and Partial Correlation - Method of Least Squares- Plane of Regression - Properties of Residuals - Coefficient of Multiple Correlation - Coefficient of Partial Correlation - Multiple Correlation with total and partial correlations - Regression and Partial correlations in terms of lower order coefficients. Analysis of variance – One-way and two-way classifications – Completely randomized design – Randomized block design – Latin square design.

(8L)

**Module V:**

**Environmental applications and components of statistical data:**

Basic and core sets of environmental statistics, environmental applications and components of statistical data on Environmental Conditions and Quality, Environmental Resources and their Use, Residuals, Land Cover, Ecosystems and Biodiversity, Extreme Events and Disasters, Human Settlements and Environmental Health, Environmental Protection, Management and Engagement, Climate change, Agriculture and the environment.

(8L)

**Books recommended:**

**TEXT BOOKS:**


1. Johnson, R. A. and Gupta, C. B., "Miller & Freund"s Probability and Statistics for Engineers", Pearson Education, Asia.
2. Devore, J.L., "Probability and statistics for Engineering and the Sciences", Thomson and Duxbury, Singapore.
3. Johnson, R.A., and Wichern, D.W., "Applied Multivariate Statistical Analysis", Pearson Education, Asia.
4. Gupta, S.C., and Kapoor, V.K., "Fundamentals of Mathematical Statistics", Sultan Chand and Sons.
5. Gupta A. M., Goon M. K., Dasgupta B. Fundamentals of Statistics-I. World Press.


**REFERENCE BOOKS:**


1. Framework for the Development of Environment Statistics. United Nations Publications.


**Gaps in the syllabus (to meet Industry/Profession requirements):**
Design of real-time industrial projects.
POs met through Gaps in the Syllabus: **PO4, PO5 & PO6**

**Topics beyond syllabus/Advanced topics/Design:**
POs met through Topics beyond syllabus/Advanced topics/Design: **PO4, PO5 & PO6**

## COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS AND EVALUATION PROCEDURE

### Direct Assessment

| Assessment Tool | % Contribution during CO Assessment |
|---|---|
| Continuous Internal Assessment | 50 |
| Semester End Examination | 50 |

| Continuous Internal Assessment | % Distribution |
|---|---|
| 3 Quizzes | 30 (3 X 10) |
| Assignment(s) | 10 |
| Seminar before a Committee | 10 |

| Assessment Components | CO1 | CO2 | CO3 | CO4 | CO5 |
|---|---|---|---|---|---|
| Continuous Internal Assessment | | | | | |
| Semester End Examination | | | | | |

### Indirect Assessment

1. Student Feedback on Faculty

2. Student Feedback on Course

**Course Delivery Methods**

| | |
|---|---|
| CD1 | Lecture by use of boards/LCD projectors/OHP projectors |
| CD2 | Assignments/Seminars |
| CD3 | Laboratory experiments/teaching aids |
| CD4 | Industrial/guest lectures |
| CD5 | Industrial visits/in-plant training |
| CD6 | Self- learning such as use of NPTEL materials and internets |
| CD7 | Simulation |

**MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES**

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| **CO1** | 3 | 1 | 3 | 1 | 2 | 3 |
| **CO2** | 1 | 2 | 1 | 3 | 2 | 2 |
| **CO3** | 1 | 2 | 1 | 3 | 2 | 2 |
| **CO4** | 1 | 2 | 3 | 3 | 3 | 3 |
| **CO5** | 3 | 1 | 2 | 3 | 2 | 3 |

**< 34% = 1, 34-66% = 2, > 66% = 3**

**MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD**

| Course Outcomes | Course Delivery Method |
|---|---|
| CO1 | CD1, CD2, CD6 |
| CO2 | CD1, CD2, CD6 |
| CO3 | CD1, CD2, CD6 |
| CO4 | CD1, CD2, CD6 |
| CO5 | CD1, CD2, CD6 |

# COURSE INFORMATION SHEET

**Course code: CE568**
**Course title: ENVIRONMENTAL TOXICOLOGY**
**Pre-requisite(s): knowledge of basics of biology and chemistry**
**Co- requisite(s): Knowledge of environmental pollution and ecosystem functions**
**Credits: 3** L:0 T:3 P:0
**Class schedule per week: 3**
**Class: M.Tech.**
**Semester / Level: /5**
**Branch: Environmental Science and Engineering**
**Name of Teacher:**

**Course objectives**
This course enables the students to:

| | |
|---|---|
| 1 | understand dispersal, build-up, behaviour and fate of toxic contaminants in workplace and environment |
| 2 | have increased understanding of the exposure and effects of toxicants on human beings. |
| 3 | would be able to identify the holistic effects of toxicants on species, population and ecosystem. They would be able to apply basic concepts of toxicology on ecological framework. |
| 4 | would be able to critically monitor fate of toxicants by various chemical and biological monitoring studies |

**Course Outcomes:**

At the end of the course a student should be able to:

| | |
|---|---|
| CO1 | grasp basic concepts of toxicology including movements of toxicants in environment and species and their effects. |
| CO2 | learn about the different types of environmental toxicants in the environment, their fate and distribution. |
| CO3 | understand, how species level effect ultimately impact the ecosystem as a whole |
| CO4 | be familiar with the toxicants arising due to occupational exposure, their monitoring and effects on human health. |
| CO5 | Understand the concept of suitable applications and interpretations of ecotoxicity assays and tests. |

## SYLLABUS

**Module I:**

**Introduction to Toxicology:**

Concept of Environmental Toxicology, Toxicokinetic and Toxicodynamic, Routes of exposure Dose-response relation, concept of NOEL, $LC_{50}$, $LD_{50}$, Absorption, distribution, metabolism, excretion, systemic and non-systemic toxicity, acute and Chronic effects, Delayed effects, effects of extraneous factors on toxicity. Symptoms of toxicity.

(8L)

**Module II:**

**Environmental toxicants:**

Sources and fate of aquatic pollutants, Air pollution transport and transformation, Food toxicants, ionizing and non-ionizing Radiation, pesticides, Transport and mobility of metals: solubilization and precipitation reactions; ligands and metal complexation; metal speciation.

(8L)

**Module III:**

**Ecotoxicology:**

Effects of toxicants on species, population, communities and ecosystem, critical transfer route, synergistic and antagonistic effects of chemicals in the environment. Bio-transformation, pathways and enzymes, bioaccumulation and BCF (Bioconcentration factor), Ecotoxicity of Nano particles and microplastics.

(8L)

**Module IV:**

**Occupational toxicology:**

Threshold Limit Values (TLVs), Permissible Exposure Limits (PEL), Broad Categories and Specific hazards including environmental factors/stresses, Risk assessment, Hierarchy of control, toxicity classifications: Organ toxicity, Hepatotoxicity, toxic effects on reproduction system, respiratory system toxicity, Mutagenesis, carcinogenesis.

(8L)

**Module V:**

**Ecotoxicity studies:**

Physicochemical properties of contaminants affecting their toxicity, Bioassays using bacteria toxicity tests, algae growth inhibition tests, fish toxicity tests, Plant growth inhibition tests. concept of CRED, Issues concerning the welfare of laboratory animals in toxicity testing MSDS.

(8L)

**Books recommended:**

**TEXT BOOKS:**

1. Environmental Toxicology set of 3 volumes- Peter Gomes
2. Aquatic Environment and Toxicology-Pawan Kumar Bhart
3. Toxicology: Principles and Methods-Second Revised Edition - M A Subramanian
4. Toxicology: A Manual for Students and Practitioners. - Edwin Welles Dwigh
5. Toxicology - Vijayan Kannampilly

**REFERENCE BOOKS:**

1. Modern Toxicology Vol I, II and III edited by P.K. Gupta and D.K. Salunkhe, Metropolitan Book Co. Pvt. Ltd.
2. Environmental Biology and Toxicology by P.D. Sharma, Rastogi Publications, ISBN-13: 978-8171339648, 2014
3. Toxicology: The Nature, Effects and Detection of Poisons, with the Diagnosis and Treatment of Poisoning - Cassius M Riley
4. Environmental Toxicology: Biological and Health Effects of Pollutants, Third Edition by Ming-Ho Yu (Author), HumioTsunoda (Author), Masashi Tsunoda (Author) CRC Press; 3 edition (14 December 2011) ISBN-13: 978-1439840382

**Gaps in the syllabus (to meet Industry/Profession requirements)**
Application of real life industrial problems

**POs met through Gaps in the Syllabus: PO6**

**Topics beyond syllabus/Advanced topics/Design:**
Case studies on toxicity studies, their monitoring and remediation
POs met through Topics beyond syllabus/Advanced topics/Design: **PO6**

## COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS AND EVALUATION PROCEDURE

**Direct Assessment**

| Assessment Tool | % Contribution during CO Assessment |
|---|---|
| Continuous Internal Assessment | 50 |
| Semester End Examination | 50 |

| Continuous Internal Assessment | % Distribution |
|---|---|
| 3 Quizzes | 30 (3 X 10) |
| Assignment(s) | 10 |
| Seminar before a Committee | 10 |

| Assessment Components | CO1 | CO2 | CO3 | CO4 | CO5 |
|---|---|---|---|---|---|

| | | | | | |
|---|---|---|---|---|---|
| Continuous Internal Assessment | | | | | |
| Semester End Examination | | | | | |

**Indirect Assessment**

1. Student Feedback on Faculty
2. Student Feedback on Course

**Course Delivery methods**

| | |
|---|---|
| CD1 | Lecture by use of boards/LCD projectors/OHP projectors |
| CD2 | Assignments/Seminars |
| CD3 | Laboratory experiments/teaching aids |
| CD4 | Industrial/guest lectures |
| CD5 | Industrial visits/in-plant training |
| CD6 | Self- learning such as use of NPTEL materials and internets |
| CD7 | Simulation |

**MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES**

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 3 | 2 | 2 | 1 |
| **CO2** | 3 | 2 | 3 | 2 | 3 | 1 |
| **CO3** | 3 | 2 | 2 | 2 | 3 | 1 |
| **CO4** | 3 | 2 | 3 | 3 | 3 | 2 |
| **CO5** | 3 | 3 | 2 | 3 | 3 | 2 |

**< 34% = 1, 34-66% = 2, > 66% = 3**

**MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD**

| Course Outcomes | Course Delivery Method |
|---|---|
| CO1 | CD1,CD2 |
| CO2 | CD1, CD2,CD4, CD5 |
| CO3 | CD1, CD2, CD6,CD7 |
| CO4 | CD1, CD3,CD6,CD7 |
| CO5 | CD1,CD2,CD3,CD7 |

# COURSE INFORMATION SHEET

**Course code: CE569**
**Course title: ENVIRONMENTAL BIOTECHNOLOGY**
**Pre-requisite(s):**
**Co- requisite(s):**
**Credits: 3** L:3 T:0 P:0
**Class schedule per week: 3**
**Class: M.Tech.**
**Semester / Level: /5**
**Branch: Environmental Science and Engineering**
**Name of Teacher:**

**Course Objectives**

This course enables the students:

| | |
|---|---|
| 1 | To develop basic knowledge on environmental biotechnology |
| 2. | To apply the knowledge acquired on environmental biotechnology in environmental quality monitoring and pollution control |
| 3. | To know about various bioremediation processes |
| 4. | To apply the environmental biotechnology developments for cleaner production and biofuels generation |

**Course Outcomes**

After the completion of this course, students will be:

| | |
|---|---|
| CO1. | Understanding the basic concept of environmental biotechnology for applications in environmental protection |
| CO2. | Knowing about the potential of DNA technology and its impacts on environment and society |
| CO3. | Able to apply environmental biotechnology for developing solutions for air pollution control |
| CO4. | Aware about various types of bioremediation processes |
| CO5. | Able to know the importance of environmental biotechnology in cleaner industrial production processes |

## SYLLABUS

**Module I:**

**Overview of Environmental Biotechnology:**
Environmental Biotechnology - scope and importance. present status, enzyme technology and their environmental applications.

(8L)

**Module II:**

**DNA Technology:**
Concept of DNA technology, safety, social, moral and ethical aspects; applications of recombinant technology for enhanced biodegradation; detection of pathogens and parasites in wastewater

(8L)

**Module III:**

**Air pollution control through biotechnology:**
Biotechnology in reduction of $CO_2$ emission, Bioscrubbers, Biobeds, Biotrickling filters and their applications

(8L)

**Module IV:**

**Bioremediation:**
Types of bioremediation, Phytoremediation, Bioaugmentation, Bioreactors, Bioremediation of herbicides, pesticides, hydrocarbons, oil spills, metal removal processes

(8L)

**Module V:**

**Cleaner biotechnological processes:**
Biobleaching in pulp and paper industries; bioleaching, cleaner biotechnologies in agro industries, biological fuel generation: biogas, hydrogen, methane and alcohol production

(8L)

**Books recommended:**

**TEXT BOOKS:**


1. Microbial Biotechnology: A. N. Glazer and H. Nikaids
2. Molecular Biotechnology: Gleek and Pasternack
3. Biotechnology: A Text Book of Industrial Microbilogy, T. D. Brock
4. Industrial Microbiology: Presscott and Dunn.


**REFERENCE BOOKS:**


1. Microbiology, Michael Pelczar Jr., ECS Chan, NR Kreig, Tata McGraw-Hill Education

2. Brock Biology of Microorganisms, Michael T. Madigan, John M. Martinko, Kelly S. Bender, Daniel H. Buckley, David A. Stahl, Thomas Brock

**Gaps in the syllabus (to meet Industry/Profession requirements)**
Application of real life industrial problems

**POs met through Gaps in the Syllabus: PO6**

**Topics beyond syllabus/Advanced topics/Design:**
Real life experiments conducted in lab and large scale
POs met through Topics beyond syllabus/Advanced topics/Design: **PO5 and PO6**

## COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS AND EVALUATION PROCEDURE

### Direct Assessment

| Assessment Tool | % Contribution during CO Assessment |
|---|---|
| Continuous Internal Assessment | 50 |
| Semester End Examination | 50 |

| Continuous Internal Assessment | % Distribution |
|---|---|
| 3 Quizzes | 30 (3 X 10) |
| Assignment(s) | 10 |
| Seminar before a Committee | 10 |

| Assessment Components | CO1 | CO2 | CO3 | CO4 | CO5 |
|---|---|---|---|---|---|
| Continuous Internal Assessment | | | | | |
| Semester End Examination | | | | | |

### Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course

**Course Delivery methods**

| | |
|---|---|
| CD1 | Lecture by use of boards/LCD projectors/OHP projectors |
| CD2 | Assignments/Seminars |
| CD3 | Laboratory experiments/teaching aids |
| CD4 | Industrial/guest lectures |
| CD5 | Industrial visits/in-plant training |
| CD6 | Self- learning such as use of NPTEL materials and internets |
| CD7 | Simulation |

## MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| **CO1** | 2 | 1 | 2 | 3 | 3 | 1 |
| **CO2** | 2 | 1 | 2 | 3 | 3 | 1 |
| **CO3** | 2 | 1 | 3 | 3 | 2 | 1 |
| **CO4** | 3 | 1 | 3 | 3 | 2 | 1 |
| **CO5** | 3 | 1 | 2 | 1 | 2 | 1 |

**< 34% = 1, 34-66% = 2, > 66% = 3**

## MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

| Course Outcomes | Course Delivery Method |
|---|---|
| CO1 | CD1,CD2 |
| CO2 | CD1, CD2,CD4, CD5 |
| CO3 | CD1, CD2, CD6,CD7 |
| CO4 | CD1, CD3,CD6,CD7 |
| CO5 | CD1,CD2,CD3,CD7 |

# COURSE INFORMATION SHEET

**Course code: CE570**
**Course title: ENVIRONMENT AND ENERGY MANAGEMENT**
**Pre-requisite(s): Environmental Science**
**Co- requisite(s): Environmental & Audit Knowledge**
**Credits: 3 L:3 T:0 P:0**
**Class schedule per week: 3**
**Class: M. Tech.**
**Semester / Level: /5**
**Branch: Environmental Science and Engineering**
**Name of Teacher:**

**Course Objectives**

This course enables the students

| | |
|---|---|
| 1 | To develop an understanding of international environmental standards |
| 2 | To develop basic knowledge on components of ISO 14000 |
| 3 | To develop and apply knowledge on Energy Management. |

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

| | |
|---|---|
| CO 1 | Understand the need and origin of Environmental Management Standards |
| CO 2 | Identify environmental aspects and impacts |
| CO 3 | Prepare audit checklist and conduct mock auditing |
| CO 4 | Understand the significance of ecolabels, and processes of life cycle assessment and performance evaluation |
| CO 5 | Assess and understand energy audit and energy management |

## SYLLABUS

**Module 1:**

**History and Origin:**
Industrial Pollution and need for pollution management, The evolution of environmental management standard, Technical Committee 207, ISO 14000 series, applicability of ISO 14000, legal considerations and requirements of ISO 14000.

(8L)

**Module II:**

**Basic Concept:**
ISO 14000 based Environmental Management System: definition, principle, structure and benefits of Environmental Management System, Aspects and impacts, Preparation of documents for ISO 14000, ISO 14000 compliance.

(8L)

**Module III:**

**Environmental Auditing:**
ISO 14010: EMS Audit-definition, objective, general principles, scope, types and guidelines of environmental auditing process. Registration process for implementing ISO 14000, registration problems.

(8L)

**Module IV:**

**Eco Labels and LCA:**

ISO 14024: Eco-labelling communication to the public. Types of ecolabels, benefits of ecolabelling. Global Ecolabels, life cycle assessment, Ethics and Environmental performance

(8L)

**Module V:**

**Energy Management:**

Concepts of energy audit and energy management, Economic analysis, Energy systems: Boilers and condensate, waste to energy recovery, Electrical energy conservation and HVAC systems.

(8L)

**Books recommended:**

**TEXT BOOKS:**

1. Environmental Audit: A.K. Shrivastava. APH pub Corp. New Delhi.
2. ISO 14000: Environmental Management 1st Edition, David L. Goetsch , Stanley Davis. ISBN-13: 978-0130812360. Jenson Books Inc.
3. ISO 14000 Environmental Management Standards: Engineering and Financial Aspects Alan S. Morris. ISBN:9780470851289 |Online ISBN:9780470090787. John Wiley & Sons, Ltd
4. Energy management handbook by Wayne c. Turner. The fairmont press, inc, Georgia. 0-88173-361-x.2001.

**REFERENCE BOOKS:**

1. Global Green standards: ISO 14000 and Sustainable Development. IISD pub. Minitoba.

2. ISO 14000 Answer Book: Environmental Management for the World Market (Wiley Quality Management) 1st Edition. by Dennis R. Sasseville W. Gary Wilson, Robert W. Lawson . ISBN-13: 978-0471179337. John Wiley and sons. Canada.
3. Energy Management Handbook, Eighth Edition 8th Edition, Steve Doty, Wayne C. Turner, ISBN-13: 978-1466578289. Fairmont Press.

**Gaps in the syllabus (to meet Industry/Profession requirements) :**
Syllabus is framed according to industrial and professional requirement.

**Topics beyond syllabus/Advanced topics/Design:**
Module 3 will include preparation of draft audit reports.
POs met through Topics beyond syllabus/Advanced topics/Design: **PO2 and PO4**

## COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS AND EVALUATION PROCEDURE

### Direct Assessment

| Assessment Tool | % Contribution during CO Assessment |
|---|---|
| Continuous Internal Assessment | 50 |
| Semester End Examination | 50 |

| Continuous Internal Assessment | % Distribution |
|---|---|
| 3 Quizzes | 30 (3 X 10) |
| Assignment(s) | 10 |
| Seminar before a Committee | 10 |

| Assessment Components | CO1 | CO2 | CO3 | CO4 | CO5 |
|---|---|---|---|---|---|
| Continuous Internal Assessment | | | | | |
| Semester End Examination | | | | | |

### Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course

**Course Delivery Methods**

| | |
|---|---|
| CD1 | Lecture by use of boards/LCD projectors/OHP projectors |
| CD2 | Assignments/Seminars |
| CD3 | Laboratory experiments/teaching aids |
| CD4 | Industrial/guest lectures |
| CD5 | Industrial visits/in-plant training |
| CD6 | Self- learning such as use of NPTEL materials and internets |
| CD7 | Simulation |

**MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES**

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| CO1 | 1 | 1 | 2 | 1 | 2 | 2 |
| CO2 | 2 | 2 | 2 | 3 | 3 | 3 |
| CO3 | 3 | 2 | 3 | 3 | 3 | 3 |
| CO4 | L | 2 | 2 | 3 | 3 | 3 |
| CO5 | 2 | 2 | 2 | 2 | 2 | 2 |

**< 34% = 1, 34-66% = 2, > 66% = 3**

**MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD**

| **Course Outcome** | **Course Delivery Method** |
|---|---|
| CO1 | CD1, CD2, CD8, CD6 |
| CO2 | CD1, CD2, CD8 |
| CO3 | CD1, CD2, CD6, |
| CO4 | CD1, CD2, CD8, CD6 |
| CO5 | CD1, CD2, CD8, CD6 |

# COURSE INFORMATION SHEET

**Course code: CE571**
**Course title: ADVANCED WASTEWATER TREATMENT**
**Pre-requisite(s): Knowledge of physico chemical and biological treatment of wastewater**
**Co- requisite(s): knowledge of basic mathematics**
**Credits: 3** L:3 T:0 P:0
**Class schedule per week: 3**
**Class: M.Tech.**
**Semester / Level: /5**
**Branch: Environmental Science and Engineering**
**Name of Teacher:**

**Course Objectives**

This course enables the students to:

| | |
|---|---|
| 1 | understand advanced wastewater treatment methods |
| 2 | learn the advance techniques to treat the wastewater to meet stringent disposal standards |
| 3 | understand the wastewater reclamation techniques |

**Course Outcomes**

After the end of the course, students should be able to:

| | |
|---|---|
| CO1. | evaluate the problem and apply advanced technologies in Wastewater treatment. |
| CO2. | apply membrane technique for wastewater reclamation |
| CO3. | apply advanced oxidation processes to treat non-biodegradable wastewater |
| CO4. | apply advanced treatment processes like adsorption, ion exchange to achieve desired objective |
| CO5 | assess and reclaim the municipal wastewater for reuse |

## SYLLABUS

**Module I:**

**Overview of Advanced Waste Water Treatment:**

Introduction, Need of Advanced Waste Water Treatment, Purpose of Advanced Waste Water Treatment

(8L)

**Module II:**

**Nutrient Removal**

**Nitrogen & Phosphorus Nitrogen Removal:** Nitrification, Denitrification Simultaneous nitrification and denitrification Phosphorus Removal: Introduction, Phosphorus removal by Chemical Precipitation: Principles of process, Chemicals applied, Chemistry of phosphorus precipitation, Process configuration, Phosphorus removal by Biological Precipitation: Principles of the process, Microorganisms involved in the process, Process configurations.

(8L)

**Module III:**

**Physicochemical processes**

**Adsorption**: Introduction, Fundamentals of adsorption, Type of adsorbents Development of adsorption isotherms: Freundlich, Langmuir, BET Activated carbon adsorption, Granular carbon adsorption

**Ion Exchange:** Ion Exchange Fundamentals of Ion Exchange Types of Ion Exchange Resins Theory of Ion Exchange Applications: Removal and recovery of heavy metals, Removal of nitrogen, Removal of phosphorus, Organic chemical removal

(8L)

**Module IV:**

**Membrane Filtration:**

Membrane Process Terminology Membrane Process Classification and operation: Microfiltration, Ultrafiltration, Nano filtration, Reverse Osmosis, Electrodialysis Membrane Configurations: Plate-and-frame module, Spiral-wound module, Tubular module, Hollow-fiber module Membrane Fouling: Modes of membrane fouling, Control of membrane fouling Application of membrane processes: Microfiltration, Ultrafiltration, Nanofiltration, Reverse Osmosis

**Membrane Bio Reactor:**

Introduction MBR Process Description: Membrane Bioreactor with Membrane Module Submerged in the Bioreactor, Membrane Bioreactor with Membrane Module Situated Outside the Bioreactor MBR System Features Membrane

Module Design Considerations Process Applications: Industrial Wastewater Treatment, Municipal Wastewater.

(8L)

**Module V:**

**Electrochemical Wastewater Treatment Processes:**

Introduction Electro-coagulation: Factors affecting Electrocoagulation, Electrode materials, Reactor configurations Electro-floatation: Factors affecting electro floatation Comparison with other technology, Reactor configurations Electro-oxidation: Electro oxidation process, Reactor configurations

**Advanced Oxidation Processes:**

Theory of advanced oxidation, Types of oxidizing agents, ozone based and non-ozone-based processes Fenton and photo-Fenton Oxidation Solar Photo Catalytic Treatment Systems

(8L)

**Books recommended:**

**TEXT BOOKS:**

1. Metcalf & Eddy (2003) Wastewater engineering: treatment and reuse, 4th ed. New Delhi: Tata McGrawHill.

2. Qasim, Syed R., Motley, Edward M., and Zhu, Guang (2000) Water works engineering: planning, design and operation. New Jersey: Prentice Hall.

**REFERENCE BOOKS:**

1. Metcalf & Eddy (2006), Water Reuse: Issues, Technologies, and Applications, Edition 1, McGraw-Hill Professional Publishing

2. Mackenzie L Davis, 2010, Water and Wastewater Engineering, Edition 1, McGraw-Hill Professional Publishing

3. Nathanson, Jerry A. (2009) Basic environmental technology: water supply, waste management and pollution control, 4th ed. New Delhi: PHI Learning.

4. AMERICAN WATER WORKS ASSOCIATION, MANUAL, AWWA,

5. CPHEEO Manual on Sewerage and Sewage treatment, latest edition

**Gaps in the syllabus (to meet Industry/Profession requirements) :**

Syllabus is framed according to industrial and professional requirement.

**Topics beyond syllabus/Advanced topics/Design:**

Design and functioning of treatment methods

POs met through Topics beyond syllabus/Advanced topics/Design: **PO2, PO3 and PO4**

## COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS AND EVALUATION PROCEDURE

### Direct Assessment

| Assessment Tool | % Contribution during CO Assessment |
|---|---|
| Continuous Internal Assessment | 50 |
| Semester End Examination | 50 |

| Continuous Internal Assessment | % Distribution |
|---|---|
| 3 Quizzes | 30 (3 X 10) |
| Assignment(s) | 10 |
| Seminar before a Committee | 10 |

| Assessment Components | CO1 | CO2 | CO3 | CO4 | CO5 |
|---|---|---|---|---|---|
| Continuous Internal Assessment | | | | | |
| Semester End Examination | | | | | |

### Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course

### Course Delivery Methods

| | |
|---|---|
| CD1 | Lecture by use of boards/LCD projectors/OHP projectors |
| CD2 | Assignments/Seminars |
| CD3 | Laboratory experiments/teaching aids |
| CD4 | Industrial/guest lectures |
| CD5 | Industrial visits/in-plant training |
| CD6 | Self- learning such as use of NPTEL materials and internets |
| CD7 | Simulation |

### MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 1 | 2 | 2 | 3 |
| CO2 | 2 | 3 | 1 | 2 | 1 | 1 |
| CO3 | 3 | 3 | 1 | 1 | 1 | 2 |
| CO4 | 3 | 3 | 1 | 1 | 3 | 1 |
| CO5 | 3 | 3 | 1 | 3 | 3 | 1 |

**< 34% = 1, 34-66% = 2, > 66% = 3**

**MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD**

| Course Outcome | Course Delivery Method |
|---|---|
| CO1 | CD1, CD2, CD8, CD6 |
| CO2 | CD1, CD2, CD8 |
| CO3 | CD1, CD2, CD6, |
| CO4 | CD1, CD2, CD8, CD6 |
| CO5 | CD1, CD2, CD8, CD6 |

# COURSE INFORMATION SHEET

**Course code: CE572**
**Course title: OCCUPATIONAL HEALTH AND INDUSTRIAL SAFETY**
**Pre-requisite(s): NA**
**Co- requisite(s): NA**
**Credits: 3** L:3 T:0 P:0
**Class schedule per week: 3**
**Class: M.Tech.**
**Semester / Level: /5**
**Branch: Environmental Science and Engineering**
**Name of Teacher:**

**Course Objectives:**

This course enables the students to:

| | |
|---|---|
| 1 | develop a basic understanding of hazards and associated risks prevailing in industries, |
| 2 | have knowledge about the major hazards in industries and their related control measures |
| 3 | get introduced to the safety management system in industries and their method of implication to safeguard the workers. |
| 4 | get conversant with acts and laws applicable for industrial safety |
| 5 | finally, to enhance the students' awareness and sensitivity to Health and Safety practice in industry. |

**Course Outcomes:**

At the end of the course, a student should be able to:

| | |
|---|---|
| CO1 | understanding the safety management system in industries, it development and necessity. |
| CO2 | able to identify potential workplace hazards, risks and their mitigatory measures |
| CO3 | knowing about the different methods of hazard control through engineering control, administrative initiatives and protective equipment |
| CO4 | able to learn about the causation, effects and liabilities of industrial accidents. |
| CO5 | aware of the Acts and laws pertinent to Industrial Health and safety. |

## SYLLABUS

**Module I:**

**Industrial Safety and occupational health:**

History and development of industrial safety movement, OSHA, Safety standards and codes, Safety organization in loss prevention, safety education and training, Occupational health objectives and goals, occupational diseases (pneumoconiosis, metal toxicity etc).

(8L)

**Module II:**

**Major Industrial Hazards:**

**Fire:** properties of fire, Factors contributing to fire, Common cause of industrial fires. Fire prevention and protection system,

**Electricity:** Hazards, safety measures for electric work, over load and other protection, Noise and

**Vibration:** Nature & Types of noise, Health effect of noise and vibration, Statutory provisions, control Method.

(8L)

**Module III:**

**Hazard analysis and control in Industry:**

Hazard assessment, Fault tree analysis, event tree analysis, Risk assessment records and control, Hierarchy of control – Machine guarding and PPE (need, selection, applicable standards, supply, use, care and maintenance. Respiratory PPE and Non- respiratory PPE), Emergency planning in industry

(8L)

**Module IV:**

**Accidents:**

Causation of accidents, Human factors contributing to accidents-causes for unsafe acts. Classification of Accidents need for the Analysis of Accidents, Methods adopted for Reducing Accidents, Investigation of Accidents, first aid training, Financial liabilities associated to accidents.

(8L)

**Module V:**

**Legislation related to Industrial safety:**

The Factories Act, 1948, Contract Labour (Abolition and Regulation) Act, Public Liability Insurance Act, Indian Boilers Act, 1923 with allied Regulations, 1961, Indian Explosives Act, 1984 and Rules. Hazardous Material Transportation Rules. The Dock Workers (Safety, Health & Welfare) Act, 1996 and Rules and Regulations the Building and other Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996 and Cess Act.

(8L)

**Books recommended:**

**TEXT BOOK**

6. R.K.Jain and Sunil S.Rao , Industrial Safety, Health and Environment Management Systems, Khanna publishers , New Delhi (2006) (**T1**)
7. Herman Koren and Michel Bisesi, Handbook of Environmental Health and Safety: Jaico Publishing House, Delhi (1999). (**T2**)
8. Rao.S /Saluja H.L., Electrical Safety, Fire Safety Engineering and Safety Management, Publishers: Khanna Publishers, 1998 (**T3**)
9. L.M. Deshmukh, Industrial safety management, Tata Mcgraw Hill, New Delhi, 2006. (**T4**)

**REFERENCE BOOK**

1. Industrial Safety -National Safety Council of India. (**R1**)
2. The Factories Act with amendments 1987, Govt. of India Publications DGFASLI, Mumbai. (**R2**)
3. Grimaldi and Simonds, Safety Management, AITBS Publishers, New Delhi (2001). (**R3**)
4. Industrial Safety and pollution control handbook: National Safety Council and Associate publishers Pvt. Ltd, Hyderabad (1993). (**R4**)
5. Encyclopedia of occupational health and safety, Inter National Labor Office. (**R5**)

**Gaps in the syllabus (to meet Industry/Profession requirements):**
Design of real-time industrial projects.
POs met through Gaps in the Syllabus: **PO5 & PO6**

**Topics beyond syllabus/Advanced topics/Design:**
POs met through Topics beyond syllabus/Advanced topics/Design: **PO5 & PO6**

## COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS AND EVALUATION PROCEDURE

**Direct Assessment**

| Assessment Tool | % Contribution during CO Assessment |
|---|---|
| Continuous Internal Assessment | 50 |
| Semester End Examination | 50 |

| Continuous Internal Assessment | % Distribution |
|---|---|
| 3 Quizzes | 30 (3 X 10) |
| Assignment(s) | 10 |
| Seminar before a Committee | 10 |

| Assessment Components | CO1 | CO2 | CO3 | CO4 | CO5 |
|---|---|---|---|---|---|
| Continuous Internal Assessment | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| Semester End Examination | | | | | |

**Indirect Assessment**

1. Student Feedback on Faculty
2. Student Feedback on Course

**Course Delivery Methods**

| | |
|---|---|
| CD1 | Lecture by use of boards/LCD projectors/OHP projectors |
| CD2 | Assignments/Seminars |
| CD3 | Laboratory experiments/teaching aids |
| CD4 | Industrial/guest lectures |
| CD5 | Industrial visits/in-plant training |
| CD6 | Self- learning such as use of NPTEL materials and internets |
| CD7 | Simulation |

**MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES**

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 1 | 2 | 2 | 3 |
| **CO2** | 3 | 3 | 2 | 2 | 3 | 3 |
| **CO3** | 3 | 2 | 3 | 3 | 3 | 3 |
| **CO4** | 3 | 3 | 3 | 2 | 3 | 3 |
| **CO5** | 3 | 2 | 2 | 2 | 3 | 3 |

**< 34% = 1, 34-66% = 2, > 66% = 3**

**MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD**

| Course Outcomes | Course Delivery Method |
|---|---|
| CO1 | CD1, CD6 |
| CO2 | CD1, CD6 |
| CO3 | CD1, CD2, CD3, CD6 |
| CO4 | CD1, CD3, CD6 |
| CO5 | CD1,CD2,CD3,CD4,CD5 |

# COURSE INFORMATION SHEET

**Course code: CE573**
**Course title: ECOSYSTEM HEALTH AND ECO RESTORATION**
**Pre-requisite(s): NA**
**Co- requisite(s): Environmental knowledge**
**Credits: 3** L:3 T:0 P:0
**Class schedule per week: 3**
**Class: M.Tech.**
**Semester / Level: /5**
**Branch: Environmental Science and Engineering**
**Name of Teacher:**

**Course Objectives:**
This course enables the students to:

| | |
|---|---|
| 1. | Examine processes and impacts of ecosystem health and degradation |
| 2. | Analyse and assess the mechanisms of ecological restorations of various ecosystems |
| 3. | Connect with ecosystems and their role in maintaining ecosystem health and restoration. |

**Course Outcomes:**
At the end of the course, a student should be able to:

| | |
|---|---|
| CO1 | Understand the role of ecology, ecosystem and human interface in achieving sustainability |
| CO2 | Describe the role of key soil and water conservation concepts in restoration. |
| CO3 | Identify processes and techniques for protecting the health of ecosystems |
| CO4 | Evaluate and apply multidisciplinary approach to restore various ecosystems |
| CO5 | Understand the role of indigenous knowledge in maintaining anthropogenic and natural ecosystem. |

## SYLLABUS

**Module 1:**

**Status Assessment:**
Ecosystem across the globe, degradation of ecosystems, Impacts of ecosystem degradation, ecosystem concepts, Resilience, landscape ecology.

(8L)

**Module II:**

**Soil and Water Conservation:**
**Soil ecosystem:** Roots, Rhizosphere, plant establishment, plant/animal interactions, nutrient cycling, community dynamics, Hydrology, Erosion and Infiltration. Agronomic practices, Water conservation.

(8L)

**Module III:**

**Restoration Methods:**
Approaches: Ecosystem vs species, Revegetation and regeneration, Nursery Techniques, Monitoring Indicators and special plantations

(8L)

**Module IV:**

**Ecosystem Restoration:**
Definition, Watershed management, Degradation of forests, grasslands, agro, wetlands and mountain ecosystems. Restoration practises for managing forest, grasslands, agro, wetland and mountain ecosystems.

(8L)

**Module V:**

**Restoration and People:**
Anthropocene, Participation and Traditional Ecological Knowledge, Ethnoecological Restoration, Urban ecosystems and restoration. CSR, ESR and ISR Activities.

(8L)

**Books recommended:**

**TEXT BOOK**


1. Ecological Restoration: Principles, Values, and Structure of an Emerging profession, Second Edition.Andre F. Clewell and James Aronson. ISBN: 9781610911689. (**T1)**
2. Whisenant, Steven G., 1999. Repairing Damaged Wildlands: A Process-Oriented, Landscape Scale Approach. Cambridge University Press. (**T2)**
3. Jordan, W. R., M. E. Giplin, and H. J. D. Aber, editors. 1987. Restoration ecology: a synthetic approach to ecological research. Cambridge University Press. Cambridge, UK. Temperton, (**T3)**
4. V. M., R. J. Hobbs, T. Nuttle, and S. Hale, editors. 2004. Assembly rules and restoration ecology. Island Press, Washington, USA. (**T4)**

5. Van Andel, J. and J. Aronson. 2006. Restoration ecology. Blackwell Science Publishing, Oxford, UK. (**T5)**

**REFERENCE BOOK**

1. Bainbridge, D. A. 2007. A Guide for Desert and Dryland Restoration. Island Press. (**R1**)
2. Whisenant. 1999. Repairing Damaged Wildlands. Cambridge University Press. (**R2**)
3. Van Andel, J. and J. Aronson. 2012. Restoration Ecology: The New Frontier. Wiley//Blackwell. (**R3**).

**Gaps in the syllabus (to meet Industry/Profession requirements):**
Design of real-time industrial projects.
POs met through Gaps in the Syllabus: **PO5 & PO6**

**Topics beyond syllabus/Advanced topics/Design:**
POs met through Topics beyond syllabus/Advanced topics/Design: **PO5 & PO6**

## COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS AND EVALUATION PROCEDURE

### Direct Assessment

| Assessment Tool | % Contribution during CO Assessment |
|---|---|
| Continuous Internal Assessment | 50 |
| Semester End Examination | 50 |

| Continuous Internal Assessment | % Distribution |
|---|---|
| 3 Quizzes | 30 (3 X 10) |
| Assignment(s) | 10 |
| Seminar before a Committee | 10 |

| Assessment Components | CO1 | CO2 | CO3 | CO4 | CO5 |
|---|---|---|---|---|---|
| Continuous Internal Assessment | | | | | |
| Semester End Examination | | | | | |

### Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course

**Course Delivery Methods**

| | |
|---|---|
| CD1 | Lecture by use of boards/LCD projectors/OHP projectors |
| CD2 | Assignments/Seminars |
| CD3 | Laboratory experiments/teaching aids |

| | |
|---|---|
| CD4 | Industrial/guest lectures |
| CD5 | Industrial visits/in-plant training |
| CD6 | Self- learning such as use of NPTEL materials and internets |
| CD7 | Simulation |

## MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | 3 | 3 | 2 |
| **CO2** | 2 | 2 | 3 | 3 | 3 | 1 |
| **CO3** | 2 | 2 | 2 | 3 | 3 | 3 |
| **CO4** | 3 | 3 | 3 | 2 | 3 | 2 |
| **CO5** | 1 | 1 | 2 | 2 | 3 | 3 |

**< 34% = 1, 34-66% = 2, > 66% = 3**

## MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

| Course Outcomes | Course Delivery Method |
|---|---|
| CO1 | CD1, CD6 |
| CO2 | CD1, CD6 |
| CO3 | CD1, CD2, CD3, CD6 |
| CO4 | CD1, CD3, CD6 |
| CO5 | CD1, CD2, CD3, CD4, CD5 |

# COURSE INFORMATION SHEET

**Course code: CE574**
**Course title: RENEWABLE ENERGY RESOURCES**
**Pre-requisite(s):** Basic Science
**Co- requisite(s):** Environmental Science
**Credits: 3** L:3 T:0 P:0
**Class schedule per week: 3**
**Class: M. Tech.**
**Semester / Level: /5**
**Branch: Environmental Science and Engineering**
**Name of Teacher:**

**Course Objectives**

This course enables the students to:

| | |
|---|---|
| 1 | Gain knowledge about the energy scenario of the world and understand the importance of renewable energy sources |
| 2 | Know the facts and information about the various renewable and non-conventional energy sources |
| 3 | Realize the potential of renewable energy resources globally and in India for a sustainable future |

**Course Outcomes**

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

| | |
|---|---|
| CO1. | Know about the energy demand and crisis globally and learn about prospects of renewable energy sources and ways of energy conservation |
| CO2. | To critically know the design parameters and potential of solar energy |
| CO3 | Assess the extent to apply wind energy systems |
| CO4 | Understand the mechanism and processes of geothermal and ocean energy options |
| CO5 | Understand the principles, processes and application of energy from biomass. |

## SYLLABUS

**Module 1:**

**Conventional and non-conventional energy:**

World energy sources and their classification, Fossil fuels - past, present & future, small hydropower, Alternative energy: Fuel cell: design, operation, classification, conversion efficiency, applications. Hydrogen energy: production methods, storage, transportation and utilization; Thermo nuclear energy; Energy audit – Energy Conservation.

(8L)

**Module II:**

**Solar energy:**

Introduction, storage of solar thermal energy, solar window, flat plate collectors and concentrating collectors, Installation of flat plate collectors, performance analysis, effect of various parameters on collector performance, applications of solar energy.

(8L)

**Module III:**

**Wind energy:**

Introduction, wind characteristics, air density, power in wind, wind turbines, Lift and drag, Types of rotor, wind energy extraction, extraction of wind turbine power, power density duration curve, Weibull probability density function. Wind rose data, Energy pattern factor in wind power, Beaufort wind scale.

(8L)

**Module IV:**

**Geothermal and ocean energy:**

Structure of earth's interior, plate tectonic theory, Geothermal gradients and resources, geothermal power generation, Indian scenario of geothermal energy; Principle of ocean thermal energy conversion system, Principles of Wave and Tidal energy conversion.

(8L)

**Module V:**

**Energy from Biomass:**

Introduction, Biomass resources, biofuels, biogas technology, producer gas, liquid fuel, biochemical conversion, biomass gasification, energy recovery from urban waste, power generation from landfill, biodiesel, biomass energy scenario of India.

(8L)

**Books recommended:**

**TEXT BOOKS:**


1. Renewable energy sources and emerging technologies by D.P. Kothari, K.C. Singal and Rakesh Ranjan, PHI learning private ltd.
2. Non-conventional energy sources by G.D. Rai, Khanna publishers
3. Energy conservation and management by S. s. Thipse, Narosa publication

4. Alternate Energy Sources, Applications and Technologies by N.K. Giri , Khanna Publishers; First edition (2012)
5. Renewable Energy Resources for Sustainable Development, by A.M. Omer, Discovery publishing house (2017)

**Gaps in the syllabus (to meet Industry/Profession requirements):**
POs met through Gaps in the Syllabus: **PO4, PO5 & PO6**

**Topics beyond syllabus/Advanced topics/Design:**
POs met through Topics beyond syllabus/Advanced topics/Design: **PO4, PO5 & PO6**

## COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS AND EVALUATION PROCEDURE

### Direct Assessment

| Assessment Tool | % Contribution during CO Assessment |
|---|---|
| Continuous Internal Assessment | 50 |
| Semester End Examination | 50 |

| Continuous Internal Assessment | % Distribution |
|---|---|
| 3 Quizzes | 30 (3 X 10) |
| Assignment(s) | 10 |
| Seminar before a Committee | 10 |

| Assessment Components | CO1 | CO2 | CO3 | CO4 | CO5 |
|---|---|---|---|---|---|
| Continuous Internal Assessment | | | | | |
| Semester End Examination | | | | | |

### Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course

### Course Delivery Methods

| | |
|---|---|
| CD1 | Lecture by use of boards/LCD projectors/OHP projectors |
| CD2 | Assignments/Seminars |
| CD3 | Laboratory experiments/teaching aids |
| CD4 | Industrial/guest lectures |
| CD5 | Industrial visits/in-plant training |
| CD6 | Self- learning such as use of NPTEL materials and internets |
| CD7 | Simulation |

**MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES**

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 1 | 1 | 1 | 2 |
| **CO2** | 3 | 2 | 1 | 2 | 2 | 2 |
| **CO3** | 3 | 1 | 1 | 2 | 2 | 2 |
| **CO4** | 3 | 2 | 1 | 2 | 2 | 2 |
| **CO5** | 3 | 2 | 2 | 2 | 2 | 3 |

**< 34% = 1, 34-66% = 2, > 66% = 3**

**MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD**

| Course Outcomes | Course Delivery Method |
|---|---|
| CO1 | CD1, CD2, CD6 |
| CO2 | CD1, CD2, CD6 |
| CO3 | CD1, CD2, CD6 |
| CO4 | CD1, CD2, CD6 |
| CO5 | CD1, CD2, CD6 |

# COURSE INFORMATION SHEET

**Course code: CE575**
**Course title: ENVIRONMENTAL AND NATURAL RESOURCE MANAGEMENT (OPEN ELECTIVE)**
**Pre-requisite(s): Basic Science**
**Co- requisite(s): NA**
**Credits: 3** L:3 T:0 P:0
**Class schedule per week: 3**
**Class: MTech.**
**Semester / Level: /5**
**Branch: All**
**Name of Teacher:**

## Course Objectives:

This course enables the students to:

| | |
|---|---|
| 1. | To understand the importance of natural and ecological resources. |
| 2. | To plan eco-restoration of degraded ecosystem and conservation strategies for biodiversity conservation. |
| 3. | To justify the use of non-renewable resources and necessity of environmental safeguards for mineral resource use. |
| 4. | To identify the areas of application of sustainable development in environmental management. |

## Course Outcomes:

At the end of the course, a student should be able to:

| | |
|---|---|
| CO1 | Able to explain ecosystem services and necessity of natural resource conservation. |
| CO2 | Able to relate the laws of ecosystem and the concept of carrying capacity with natural resource management. |
| CO3 | Able to outline a plan to implement successful eco-restoration of degraded natural systems. |
| CO4 | Able to reason out the causes of biodiversity loss and propose plan for conservation. |
| CO5 | Able to differentiate between fuel, non- fuel resources and renewable, non-renewable resources. |

# SYLLABUS

**Module I:**

**Natural Resource and Ecology:**

Importance and classification of natural resources need for conservation of natural resources, role of ecosystems and ecological services in natural resource management, basic concepts of population and community ecology, concept of carrying capacity, laws of ecology.

(8L)

**Module II:**

**Eco- restoration:**

Concept of eco-restoration approaches of eco-restoration, eco-restoration methods, monitoring indicators, management aspects, case studies.

(8L)

**Module III:**

**Conservation of Biodiversity:**

Biodiversity types, keystone species, hotspots, mega-biodiversity zones, threats to biodiversity, conservation methods and legislations.

(8L)

**Module IV:**

**Mineral Resources and renewable resources:**

Types of mineral resources (fuel, non- fuel), mineral reserves, environmental consequences of mineral extraction and its management, types of renewable resources, its application and environmental benefits.

(8L)

**Module V:**

**Sustainability and environmental management:**
Concept of sustainable development, guidelines and strategies for implementing sustainable development, concept of lifecycle assessment, corporate social responsibility, environmental management system (ISO 14001).

(8L)

**Books recommended:**

**TEXT BOOK**


1. Environmental Planning and Management, Christian N Madu, Imperial College Press. **(T1)**
2. Introduction to Ecology, E.P. Odum, Prentice Hall. **(T2)**
3. Ecology and Environment. P. D. Sharma, Rastogi Publications. **(T3)**


**REFERENCE BOOK**


1. Tools to Aid Environmental Decision Making, Virginia H. Dale and Mary R., Springer. **(R1)**
2. Sustainable Natural Resource Management, Daniel R. Lynch, Cambridge University Press.

**(R2)**

**Gaps in the syllabus (to meet Industry/Profession requirements) :**
POs met through Gaps in the Syllabus: **PO5 & PO6**

**Topics beyond syllabus/Advanced topics/Design:**
POs met through Topics beyond syllabus/Advanced topics/Design: **PO5 & PO6**

## COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS AND EVALUATION PROCEDURE

**Direct Assessment**

| Assessment Tool | % Contribution during CO Assessment |
|---|---|
| Continuous Internal Assessment | 50 |
| Semester End Examination | 50 |

| Continuous Internal Assessment | % Distribution |
|---|---|
| 3 Quizzes | 30 (3 X 10) |
| Assignment(s) | 10 |
| Seminar before a Committee | 10 |

| Assessment Components | CO1 | CO2 | CO3 | CO4 | CO5 |
|---|---|---|---|---|---|
| Continuous Internal Assessment | | | | | |
| Semester End Examination | | | | | |

**Indirect Assessment**

1. Student Feedback on Faculty
2. Student Feedback on Course

**Course Delivery Methods**

| | |
|---|---|
| CD1 | Lecture by use of boards/LCD projectors/OHP projectors |
| CD2 | Assignments/Seminars |
| CD3 | Laboratory experiments/teaching aids |
| CD4 | Industrial/guest lectures |
| CD5 | Industrial visits/in-plant training |
| CD6 | Self- learning such as use of NPTEL materials and internets |
| CD7 | Simulation |

## MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 2 | - | 1 | 2 |
| **CO2** | 3 | 2 | 2 | 2 | 2 | 1 |
| **CO3** | 3 | 1 | 2 | 2 | 2 | 3 |
| **CO4** | 3 | 2 | 3 | 2 | 2 | 2 |
| **CO5** | 3 | 2 | 2 | 2 | 2 | 3 |

**< 34% = 1, 34-66% = 2, > 66% = 3**

## MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

| Course Outcomes | Course Delivery Method |
|---|---|
| CO1 | CD1, CD6 |
| CO2 | CD1, CD6 |
| CO3 | CD1, CD2, CD3, CD6 |
| CO4 | CD1, CD3, CD6 |
| CO5 | CD1, CD2, CD3, CD4, CD5 |

# COURSE INFORMATION SHEET

**Course code: CE576**
**Course title: ENVIRONMENTAL SCIENCE AND MANAGEMENT (OPEN ELECTIVE)**
**Pre-requisite(s):** Knowledge of basic sciences
**Co- requisite(s):** Be aware of the environmental scenario in general
**Credits:** L:3 T:0 P:0
**Class schedule per week: 3**
**Class: M.Tech.**
**Semester / Level: /5**
**Branch: All**
**Name of Teacher:**

**Course Objectives:**

This course enables the students to:

| | |
|---|---|
| 1. | To develop an interdisciplinary approach towards sustainable development, keeping in mind about environmental management. |
| 2. | To gain knowledge about different environmental issues, their causes, effects and control technologies globally |
| 3. | To critically analyze the extent of effects due to dilapidating environment and chalk out strategies to mitigate that. |
| 4. | Be aware about the processes and legal bindings related to pollution and environment. |

**Course Outcomes:**

At the end of the course, a student should be able to:

| | |
|---|---|
| CO1 | To get introduced to the structure and composition of different spheres of environment and ecosystem and their functioning |
| CO2 | To acquire knowledge about the major environmental challenges faced by the world, their causes, effects and mitigatory efforts |
| CO3 | To understand the sources, sinks and effects of different environmental pollution |
| CO4 | To analyze and evaluate the pollution control technologies to be applied for effective environmental management |
| CO5 | Be exposed to the legal procedures, rules and regulations for management of environment. |

# SYLLABUS

**Module I:**

**Introduction to Environment:**
Principles and scope of Environmental Science. Ecosystems, structural and functional attributes of Ecosystems. Structure and composition of atmosphere, hydrosphere, lithosphere and biosphere. Mass and Energy transfer across the various interfaces, material balance.

(8L)

**Module II:**

**Global environmental challenges:**
Climate change: Global warming, Drivers of climate change; Greenhouse gases and their sources; Implications on climate, oceans, agriculture, natural vegetation, wildlife and human, control strategies and methods, Stratospheric ozone layer depletion: causes and consequences; efforts to combat ozone depletion, El Nino, Droughts, water scarcity and conflicts; Biodiversity loss

(8L)

**Module III:**

**Environmental pollution:**
Natural and anthropogenic sources of pollution. Primary and Secondary pollutants; Air pollution: types and sources, photochemical smog and particulates aeroallergens. Water Pollution: types and sources; Thermal pollution, eutrophication, emerging contaminants; soil pollution: types and sources, pesticides and heavy metals, hazardous substances, radioactive pollution, biomedical wastes.

(8L)

**Module IV:**

**Technologies for pollution abatement:**
Air pollution control techniques: particulates and gaseous pollutants; waste water treatment: primary, secondary and tertiary treatment, specific advanced treatment; solid waste management. Phytoremediation, bioremediation; Ecological restoration

(8L)

**Module V:**

**Environmental management:**
Environment Impact assessment: methods, guidelines; Environmental audit, Life cycle assessment, Biomedical waste management, concept of sustainable development, SDGs, CSR

(8L)

**Books recommended:**

**TEXT BOOK**


10. N. Adger , K. Brown , D. Conway. (Vol. 22). 2012. Global Environmental Change: Understanding the Human Dimensions. The National Academic Press. **(T1)**
11. J.S.Singh, S.P. Singh and S.R. Gupta. 2008. Ecology, Environment and Resource Conservation. Anamaya Publications (New Delhi). **(T2)**
12. A, K. De. (3rd Ed). 2008 Environmental Chemistry. New Age Publications India Ltd. **(T3)**
13. C. N. Sawyer, P. L. McCarty and G. F. Parkin. 2002. Chemistry for Environmental Engineering and Science. John Henry Press**.(T4)**
14. R. K. Sapru. 1987. Environmental Management in India (Vol. I & II). Ashish Publishing House. **(T5)**
15. S.C. Santra. 2011. Environmental Science. New Central Book Agency. **(T6)**


**REFERENCE BOOK**


1. David Huddart and TimStott. 2010. Earth Environments- Past, Present and Future. Wiley-Blackwell. Karl K. Turekian. 1996. Global Environmental Change-Past, Present, and Future. Prentice-Hall. **(R1)**
2. N. Adger, K. Brown, D. Conway. (Vol. 22). 2012. Global Environmental Change: Understanding the Human Dimensions. The National Academic Press. **(R2)**
3. Bryan F.J. Manly. 2009. Statistics for Environmental Science and Management. CRC Press.**(R3)**
4. E.N. Laboy-Nieves, M.F.A. Goosen and E. Emmanuel. 2010. Environmental and Human Health. CRC Press.**(R4)**


**Gaps in the syllabus (to meet Industry/Profession requirements):**

**Topics beyond syllabus/Advanced topics/Design:**

## COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS AND EVALUATION PROCEDURE

### Direct Assessment

| Assessment Tool | % Contribution during CO Assessment |
|---|---|
| Continuous Internal Assessment | 50 |
| Semester End Examination | 50 |

| Continuous Internal Assessment | % Distribution |
|---|---|
| 3 Quizzes | 30 (3 X 10) |
| Assignment(s) | 10 |
| Seminar before a Committee | 10 |

| Assessment Components | CO1 | CO2 | CO3 | CO4 | CO5 |
|---|---|---|---|---|---|
| Continuous Internal Assessment | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| Semester End Examination | | | | | |

**Indirect Assessment**

1. Student Feedback on Faculty
2. Student Feedback on Course

**Course Delivery Methods**

| | |
|---|---|
| CD1 | Lecture by use of boards/LCD projectors/OHP projectors |
| CD2 | Assignments/Seminars |
| CD3 | Laboratory experiments/teaching aids |
| CD4 | Industrial/guest lectures |
| CD5 | Industrial visits/in-plant training |
| CD6 | Self- learning such as use of NPTEL materials and internets |
| CD7 | Simulation |

**MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES**

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 1 | 1 | 2 | 2 |
| **CO2** | 3 | 3 | 1 | 1 | 2 | 2 |
| **CO3** | 3 | 3 | 2 | 2 | 2 | 2 |
| **CO4** | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO5** | 3 | 3 | 3 | 2 | 3 | 3 |

**< 34% = 1, 34-66% = 2, > 66% = 3**

**MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD**

| Course Outcomes | Course Delivery Method |
|---|---|
| CO1 | CD1,CD6 |
| CO2 | CD1, CD6,CD7 |
| CO3 | CD1, CD2, CD3,CD6,CD7 |
| CO4 | CD1, CD3,CD6,CD7 |
| CO5 | CD1,CD2,CD3,CD4,CD5,CD7 |

# COURSE INFORMATION SHEET

**Course code: CE577**
**Course title: INDUSTRIAL POLLUTION AND CONTROL (OPEN ELECTIVE)**
**Pre-requisite(s):** Basic concepts of Environmental Science
**Co- requisite(s):** NA
**Credits: 3** L:3 T:0 P:0
**Class schedule per week: 3**
**Class: M.Tech.**
**Semester / Level: /5**
**Branch: All**
**Name of Teacher:**

**Course Objectives:**

This course enables the students to:

| | |
|---|---|
| 1. | To develop a general understanding on types of various industrial pollutions. |
| 2. | To analyse the cause and effect of industrial pollution and plan necessary mitigation techniques, reclamation measures. |
| 3. | To understand the importance of occupational health and industrial safety measures. |
| 4. | To relate with the existing laws and policies for industrial pollution control. |

**Course Outcomes:**

At the end of the course, a student should be able to:

| | |
|---|---|
| CO1 | Able to identify sources, types, and control equipment's for industrial air pollution. |
| CO2 | Able to analyse the causes and effect of waste water generation from industries and to select the suitable method for waste water treatment for an industry |
| CO3 | Able to distinguish the role of industry in generation of solid waste and to construct a suitable industrial waste management plan. |
| CO4 | Able to interpret the causes of land degradation due to industrialisation and devise its reclamation. |
| CO5 | Able to conduct investigations to identify the causes of industrial risks and hazards and judge the applicability of pollution control laws in industries |

# SYLLABUS

**Module I:**

**Industrial air pollution:**
Introduction to types of industrial pollution and pollutants, causes and types of industrial air pollutants, control techniques for industrial air pollution. Case studies of air pollution of various industries (thermal power plant, cement, nuclear power plant, mining etc), air pollution disasters of industry, environmental laws related to air pollution in industry.

(8L)

**Module II:**

**Industrial water pollution:**
Constituents of aquatic environment, industrial use of water, effect of oxygen demanding industrial waste on natural water and aquatic life, methods of waste water treatment in industries, case studies of specific industries (pulp and paper, mining, textile, etc), waste water discharge norms and laws related to water pollution.

(8L)

**Module III:**

**Industrial solid waste management:**
Classification of solid wastes, types of solid waste generated from industry, impacts of industrial solid waste dumps on ecosystem and humans, functional elements of solid waste management, treatment of solid waste, existing legislations for industrial solid waste management.

(8L)

**Module IV:**

**Land degradation and reclamation:**
Land degradation due to industrialisation and various reclamation techniques, concept of industrial ecosystem, concept of cleaner production in industries for reduction of waste. Rehabilitation and resettlement (R & R) issues due to industrialisation, existing policies for R&R. Case studies of industrial rehabilitation and resettlement, eco restoration and land reclamation.
(8L)

**Module V:**

**Occupational Safety, hazards and health:**
Identification of potential risks and hazards in industrial and development projects, reduction strategies, policies and legislation, safety standards (OSHA) and management systems, ISO 18000. Occupational diseases: pneumoconiosis, silicosis, asbestosis, byssinosis, bagassosis, metal poisoning (lead, mercury, manganese, copper etc) Notifiable Diseases; possible symptoms and target organs. Synergistic effects: enhancement in toxic effects to extraneous factors.

(8L)

**Books recommended:**

**TEXT BOOK**

1. Introduction to Environmental Engineering – Gilbert and Masters v. Wastewater engineering: Metcalf & Eddy, et.al., Mcgraw Hill Pub. **(T1)**
2. Textbook of Environmental Sudies – by E. Bharucha. **(T2)**

**REFERENCE BOOK**

1. Handbook of Industrial pollution & Control- Vol 1 & 2, S. C. Bhatia, CBS Publishers. **(R1)**
2. Industrial waste treatment Handbook- Woodward and Cirran, Elsevier Pub **(R2)**
3. Industrial Pollution Control Handbook- Edited by Herbert, F. Lund, McGrawhill Pub **(R3)**

**Gaps in the syllabus (to meet Industry/Profession requirements):**

**Topics beyond syllabus/Advanced topics/Design:**

## COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS AND EVALUATION PROCEDURE

### Direct Assessment

| Assessment Tool | % Contribution during CO Assessment |
|---|---|
| Continuous Internal Assessment | 50 |
| Semester End Examination | 50 |

| Continuous Internal Assessment | % Distribution |
|---|---|
| 3 Quizzes | 30 (3 X 10) |
| Assignment(s) | 10 |
| Seminar before a Committee | 10 |

| Assessment Components | CO1 | CO2 | CO3 | CO4 | CO5 |
|---|---|---|---|---|---|
| Continuous Internal Assessment | | | | | |
| Semester End Examination | | | | | |

### Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course

### Course Delivery Methods

| | |
|---|---|
| CD1 | Lecture by use of boards/LCD projectors/OHP projectors |
| CD2 | Assignments/Seminars |
| CD3 | Laboratory experiments/teaching aids |
| CD4 | Industrial/guest lectures |

| | |
|---|---|
| CD5 | Industrial visits/in-plant training |
| CD6 | Self- learning such as use of NPTEL materials and internets |
| CD7 | Simulation |

## MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| **CO1** | 1 | 1 | 3 | 3 | 2 | 3 |
| **CO2** | 1 | 1 | 3 | 3 | 2 | 2 |
| **CO3** | 1 | 1 | 3 | 3 | 2 | 2 |
| **CO4** | 1 | 2 | 1 | 1 | 1 | 1 |
| **CO5** | 2 | 3 | | 3 | 2 | 1 |

**< 34% = 1, 34-66% = 2, > 66% = 3**

## MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

| Course Outcomes | Course Delivery Method |
|---|---|
| CO1 | CD1,CD2 |
| CO2 | CD1, CD2 |
| CO3 | CD1, CD2 |
| CO4 | CD1, CD2 |
| CO5 | CD1,CD2 |
| CO6 | CD1, CD2 |
| CO7 | CD1, CD2 |

# COURSE INFORMATION SHEET

**Course code: CE578**
**Course title: WASTE MANAGEMENT (OPEN ELECTIVE)**
**Pre-requisite(s):**
**Co- requisite(s):**
**Credits: 3** L:3 T:0 P:0
**Class schedule per week: 3**
**Class: M.Tech.**
**Semester / Level: /5**
**Branch: All**
**Name of Teacher:**

**Course Objectives:**

This course enables the students to:

| | |
|---|---|
| 1. | About the processes involved in the management of municipal solid waste - from source to final disposal |
| 2. | To understand the management of hazardous solid waste - from source to final disposal |
| 3. | Learn about the processes for conversion of wastes into resources |
| 4. | To acquire knowledge on municipal and industrial wastewater treatment |

**Course Outcomes:**

At the end of the course, a student should be able to:

| | |
|---|---|
| CO1 | Identify and interpret the criteria for classification of wastes along with waste minimization source reduction and describe the procedures of various waste processing options |
| CO2 | Explain and interpret the regulations concerning the handling, transportation and disposal of municipal, hazardous, radioactive and biomedical wastes |
| CO3 | Define and elucidate treatment and management of municipal solid wastes, hazardous wastes, radioactive wastes and biomedical wastes |
| CO4 | Assess various physical/chemical/biological treatment techniques for conversion of wastes to resources |
| CO5 | Evaluate various treatment technologies for wastewater management |

# SYLLABUS

**Module I:**

**Management of municipal solid wastes (MSW):**

Sources, physical and chemical characteristics, MSW sampling and analysis, collection, storage, transport and disposal methods. Sanitary landfills - design, operation and closure. Reduction, reuse and recycling of solid wastes. Technologies for processing of MSW: Incineration, composing, pyrolysis

(8L)

**Module II:**

**Hazardous waste management:**
Sources and characteristics, Classification, health and environmental impacts. Safe storage, transport and treatment of hazardous waste, Hazardous waste management, handling and transboundary movement rules.

(8L)

**Module III:**

**Radioactive and biomedical waste management:**

sources, classification, health and safety aspects, management of radioactive wastes; Biomedical wastes: sources and categories of biomedical wastes, segregation and color coding, treatment and disposal of biomedical wastes, biomedical wastes management and handling rules.

(8L)

**Module IV:**

**Waste to Resources:**
Incineration, composing, pyrolysis; Energy from biomass, agricultural and industrial wastes. Biogas production, Biofuels: ethanol, methanol, hydrogen.

(8L)

**Module V:**

**Wastewater Treatment:**

Physico-chemical treatment, aerobic and anaerobic treatment, attached and suspended growth processes. Industrial wastewater treatment - textile, paper, tanneries, distiller.

(8L)

**Books recommended:**

**TEXT BOOK**

1. Integrated Solid Waste Management, George Tchobanoglous, McGraw-Hill Publishers. **(T1)**
2. Introduction to Environmental Engineering and Science – G.M.Masters & W. Ela, PHI Publishers. **(T2)**
3. Environmental Engineering, Peavey, Rowe & George Tchobanoglous **(T3)**
4. Textbook of Solid Wastes Management, IH Khan & N Ahsan **(T4)**

**REFERENCE BOOK**

1. Manual on Municipal Solid Waste Management, CPHEEO, Ministry of Urban Development, Government of India, New Delhi **(R1)**
2. Solid and hazardous waste management, Liu and Liptak **(R2)**

**Gaps in the syllabus (to meet Industry/Profession requirements):**

**Topics beyond syllabus/Advanced topics/Design:**

## COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS AND EVALUATION PROCEDURE

### Direct Assessment

| Assessment Tool | % Contribution during CO Assessment |
|---|---|
| Continuous Internal Assessment | 50 |
| Semester End Examination | 50 |

| Continuous Internal Assessment | % Distribution |
|---|---|
| 3 Quizzes | 30 (3 X 10) |
| Assignment(s) | 10 |
| Seminar before a Committee | 10 |

| Assessment Components | CO1 | CO2 | CO3 | CO4 | CO5 |
|---|---|---|---|---|---|
| Continuous Internal Assessment | | | | | |
| Semester End Examination | | | | | |

### Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course

## Course Delivery Methods

| | |
|---|---|
| CD1 | Lecture by use of boards/LCD projectors/OHP projectors |
| CD2 | Assignments/Seminars |
| CD3 | Laboratory experiments/teaching aids |
| CD4 | Industrial/guest lectures |
| CD5 | Industrial visits/in-plant training |
| CD6 | Self- learning such as use of NPTEL materials and internets |
| CD7 | Simulation |

### MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 2 | 3 | 2 | 1 |
| **CO2** | 3 | 3 | 2 | 3 | 1 | 2 |
| **CO3** | 2 | 2 | 2 | 3 | 2 | 3 |
| **CO4** | 2 | 3 | 3 | 1 | 3 | 3 |
| **CO5** | 2 | 3 | 3 | 1 | 3 | 3 |

**< 34% = 1, 34-66% = 2, > 66% = 3**

### MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

| Course Outcomes | Course Delivery Method |
|---|---|
| CO1 | CD1 |
| CO2 | CD1, CD2, CD3 |
| CO3 | CD1 |
| CO4 | CD1 |
| CO5 | CD1, CD2, CD3 |

# COURSE INFORMATION SHEET

**Course code: CE 530**
**Course title: Environmental Engineering Laboratory 1**
**Pre-requisite(s):**
**Co- requisite(s):**
**Credits: 2** L: 0 T: 0 P: 4
**Class schedule per week: 4**
**Class: M. Tech**
**Semester / Level: Ist SEMESTER/ LEVEL 5**
**Branch: Environmental Science and Engineering**
**Name of Teacher:**

**Course Objectives**

This course enables the students:

| | |
|---|---|
| A. | To introduce the students about the importance of water and its properties and given standards (K2,K3) |
| B. | To make students aware about the procedure for the analysis of various water quality parameters (K2) |
| C. | To introduce the students how to make water quality assessment report (K2,K3, K5) |
| D. | To make students aware about the required type of treatment to purify a given water sample.(K3, K5) |
| E. | To introduce students about the quality requirements of water in various uses of water for example, industrial purpose and domestic purpose.(K4,K5,K6) |

**Course Outcomes**

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

| | |
|---|---|
| 1. | Understand the importance of water and its quality requirement (K2,K3) |
| 2. | Understand the procedure for analysis of various quality paramenters (K2) |
| 3. | Understand the procedure of making water quality assessment report (K2,K3, K5) |
| 4. | Understand and suggess the the water treatment process for a raw water(K3, K5) |
| 5. | Understand and suggess the water quality requirements for industrial and domestic purposes (K4, K5,K6) |

## Syllabus

1. To determine pH, EC, and Turbidity and T.D.S.of a given water sample.
2. To determine total alkalinity of a given water sample.
3. To determine acidity of a given water sample
4. To determine total hardness of a given water sample
5. To determine dissolved oxygen (DO) of a given water sample
6. To determine B.O.D. of a given water sample
7. To determine C.O.D. of a given water sample
8. To determine the residual chlorine in a given water sample.
9. To determine nitrates of a given water sample
10. To determine phosphates of a given water sample

11. To determine Fluoride in a given water sample
12. To determine Iron of a given water sample
13. To determine the bacteriological quality of a given water sample.

**Text books:**

- Standard methods for the examination of water and wastewater published by APHA
- Water supply Engineering, by Santhosh Kumar Garg, Khanna publishers

**Gaps in the syllabus (to meet Industry/Profession requirements)**
**POs met through Gaps in the Syllabus**
**Topics beyond syllabus/Advanced topics/Design**

**POs met through Topics beyond syllabus/Advanced topics/Design**

| **Course Delivery methods** | |
|---|---|
| Lecture by use of boards/LCD projectors/OHP projectors | ✓ |
| Tutorials/Assignments | ✓ |
| Seminars | |
| Mini projects/Projects | |
| Laboratory experiments/teaching aids | ✓ |
| Industrial/guest lectures | |
| Industrial visits/in-plant training | ✓ |
| Self- learning such as use of NPTEL materials and internets | ✓ |
| Simulation | |

## Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

**Direct Assessment**

| **Assessment Tool** | **% Contribution during CO Assessment** |
|---|---|
| Progressive Evaluation Marks | 60 |
| EndExamination Marks | 40 |

| **Assessment Components** | **CO1** | **CO2** | **CO3** | **CO4** | **CO5** |
|---|---|---|---|---|---|
| Progressive Evaluation Marks | ✓ | ✓ | ✓ | ✓ | ✓ |
| EndExamination Marks | ✓ | ✓ | ✓ | ✓ | ✓ |

**Indirect Assessment –**

1. Student feedback on teaching quality and teaching methods adopted
2. Student feedback on course syllabus and course outcome

**Mapping of Course Outcomes onto Program Outcomes and Program Specific Outcomes**

| **Course Outcome** | **Program Outcomes** | | | | | | **Program Specific Outcome** | | |
|---|---|---|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **6** | **1** | **2** | **3** |
| **1** | 3 | 3 | 3 | 3 | 3 | 1 | 3 | 3 | 3 |

| Mapping Between COs and Course Delivery (CD) methods | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | |
| **CD** | **Course Delivery methods** | | | | | | **Course Outcome** | | **Course Delivery Method** | |
| CD1 | Lecture by use of boards/LCD projectors/OHP projectors | | | | | | CO1 | | CD1, CD2, CD5, CD8 | |
| CD2 | Tutorials/Assignments | | | | | | CO2 | | CD1, CD2, CD5, CD7,CD8 | |
| CD3 | Seminars | | | | | | CO3 | | CD1, CD2, CD5, CD8, | |
| CD4 | Mini projects/Projects | | | | | | CO4 | | CD1, CD2, CD5, CD7,CD8, | |
| CD5 | Laboratory experiments/teaching aids | | | | | | CO5 | | CD1, CD2, CD5, CD8 | |
| CD6 | Industrial/guest lectures | | | | | | | | | |
| CD7 | Industrial visits/in-plant training | | | | | | | | | |
| CD8 | Self- learning such as use of NPTEL materials and internets | | | | | | | | | |
| CD9 | Simulation | | | | | | | | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **2** | 3 | 3 | 3 | 3 | 3 | 1 | 3 | 3 | 3 |
| **3** | 3 | 3 | 3 | 3 | 3 | 1 | 3 | 3 | 3 |
| **4** | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 |
| **5** | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 |

# COURSE INFORMATION SHEET

**Course code: CE 531**
**Course title: ECOLOGY AND MICROBIOLOGY LAB**
**Pre-requisite(s):**
**Co- requisite(s):**
**Credits: 2** L: 0 T: 0 P: 4
**Class schedule per week: 4**
**Class: M. Tech**
**Semester / Level: 1ST SEMESTER/ LEVEL 5**
**Branch: Environmental Science and Engineering**
**Name of Teacher:**

**Course Objectives**

This course enables the students:

| | |
|---|---|
| A. | To analyse the community structure of vegetation patch for biodiversity study. (K4) |
| B. | To understand the concept of productivity in aquatic ecosystem. (K4) |
| C. | To learn the techniques related to environmental microbiology. (K2) |
| D. | To isolate and employ bacterial strains for environmental pollutant degradation study. (K2) |

**Course Outcomes**

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

| | |
|---|---|
| 1. | Design and enumerate floral diversity of an ecosystem. (K6) |
| 2. | Analyse the state of an aquatic ecosystem according to its productivity rate. (K5) |
| 3. | Isolate and culture bacterial strains from the environmental samples. (K4) |
| 4. | Examine the water quality in terms of biological water pollutants (K4) |
| 5. | To design and implement bacterial degradation studies in lab scale against environmental pollutants. (K5) |

## Syllabus

1. Vegetation community structure study: Determination of minimum size of a quadrat.
2. Vegetation community structure study: Determination of minimum numbers of a quadrat.
3. To determine the frequency, abundance and dominance of plant species in a vegetation community.
4. Aquatic productivity estimation through Light and Dark Bottle method
5. Microbiological Media preparation and sterilization
6. Isolation of bacterial strain from environmental samples (air, water and soil)
7. Total Coliform estimation through membrane- filter technique
8. Total coliform estimation through MPN
9. Gram staining technique
10. Handling of liquid cultures and monitoring microbial growth phases via spectrophotometry

**Text books:**

1. Practical Ecology by Rao K.S, K.S. Rao, Anmol Publications
2. Practical field Ecology by Wheater C. Philip, Publisher: John Wiley and Sons Ltd
3. Practical Microbiology by R.C. Dubey and Maheswari D.K. (S.Chand Publication)
4. Microbiology A laboratory Manual by Cappuccino Sherman (Pearson Education Publication)

**Gaps in the syllabus (to meet Industry/Profession requirements)**
**POs met through Gaps in the Syllabus**
**Topics beyond syllabus/Advanced topics/Design**

**POs met through Topics beyond syllabus/Advanced topics/Design**

| **Course Delivery methods** | |
|---|---|
| Lecture by use of boards/LCD projectors/OHP projectors | ✓ |
| Tutorials/Assignments | |
| Seminars | |
| Mini projects/Projects | |
| Laboratory experiments/teaching aids | ✓ |
| Industrial/guest lectures | ✓ |
| Industrial visits/in-plant training | ✓ |
| Self- learning such as use of NPTEL materials and internets | ✓ |
| Simulation | |

## Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

**Direct Assessment**

| **Assessment Tool** | **% Contribution during CO Assessment** |
|---|---|
| Progressive Evaluation Marks | 60 |
| End Examination Marks | 40 |

| **Assessment Components** | **CO1** | **CO2** | **CO3** | **CO4** | **CO5** |
|---|---|---|---|---|---|
| Progressive Evaluation Marks | ✓ | ✓ | ✓ | ✓ | ✓ |
| End Examination Marks | ✓ | ✓ | ✓ | ✓ | ✓ |

**Indirect Assessment –**

1. Student feedback on teaching quality and teaching methods adopted
2. Student feedback on course syllabus and course outcome

| Course Outcome | Program Outcomes | | | | | |
|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **6** |
| **1** | 3 | 3 | 2 | 1 | 2 | 1 |
| **2** | 3 | 2 | 2 | 3 | 2 | 1 |
| **3** | 3 | 3 | 3 | 3 | 2 | 2 |
| **4** | 3 | 2 | 3 | 2 | 2 | 2 |
| **5** | 3 | 2 | 2 | 2 | 2 | 1 |

| **Mapping Between COs and Course Delivery (CD) methods** | | | | |
|---|---|---|---|---|
| | | | | |
| **CD** | **Course Delivery methods** | | **Course Outcome** | **Course Delivery Method** |
| CD1 | Lecture by use of boards/LCD projectors/OHP projectors | | CO1 | CD1, CD5, CD7, CD8, CD9 |
| CD2 | Tutorials/Assignments | | CO2 | CD1, CD5, CD7, CD8, CD9 |
| CD3 | Seminars | | CO3 | CD1, CD5, CD7, CD8, CD9 |
| CD4 | Mini projects/Projects | | CO4 | CD1, CD5, CD8, CD9 |
| CD5 | Laboratory experiments/teaching aids | | CO5 | CD1, CD5, CD8 |
| CD6 | Industrial/guest lectures | | | |
| CD7 | Industrial visits/in-plant training | | | |
| CD8 | Self- learning such as use of NPTEL materials and internets | | | |
| CD9 | Simulation | | | |

# COURSE INFORMATION SHEET

**Course code: CE 535**
**Course title: ENVIRONMENTAL ENGINEERING LABORATORY-II**
**Pre-requisite(s):**
**Co- requisite(s):**
**Credits: 2** L: 0 T: 0 P: 4
**Class schedule per week: 4**
**Class: M. Tech**
**Semester / Level: 2ND SEMESTER/ LEVEL 5**
**Branch: Environmental Science and Engineering**
**Name of Teacher:**

**Course Objectives**

This course enables the students:

| | |
|---|---|
| A. | To monitor and analyse the air pollution level of the ambient air. (K4) |
| B. | To select the suitable plant species for green belt development. (K4) |
| C. | To determine some important soil properties and assess its effect on environmental quality. (K6) |
| D. | To demonstrate some solar powered instrument as a renewable energy source. (K2) |

**Course Outcomes**

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

| | |
|---|---|
| 1. | Design and implement ambient air quality monitoring plan. (K6) |
| 2. | Interpret the air quality data and evaluate the air pollution status. (K5) |
| 3. | Recommend suitable plant species with dust capturing capacity. (K5) |
| 4. | Examine some of the soil physico-chemical properties. (K4) |
| 5. | To understand the use of some of the solar powered instruments. (K2) |

## Syllabus

11. Monitoring and analysis of $PM_{10}$ and $PM_{2.5}$ in the ambient air.
12. Sampling and analysis of NOx by chemiluminescence method.
13. Sampling and analysis of $CO_2$ and CO by NDIR method.
14. Sampling and analysis of sulphur dioxide in ambient air (Improved West and Gaeke method)
15. Sampling and analysis of Lead, Nickel and Arsenic in ambient air.
16. Estimation of dust retention capacity of leaves of various species.
17. Determination of particle size distribution in fine aggregates.
18. To determine the soil particle size distribution by hydrometer analysis.
19. To determine the moisture content of soil by gravimetric method.
20. Introduction to solar lab and study various solar powered equipment.

**Text books:**


1. Soil Testing for Engineers- Lambe T.W., Wiley Eastern Ltd., New Delhi. 5. Manual of
2. Soil Laboratory Testing- Head K.H., (1986)- Vol. I, II, III, Princeton Press, London


Reference books:

1. Guidelines for the Measurement of Ambient Air Pollutants, CPCB ,2013.

**Gaps in the syllabus (to meet Industry/Profession requirements)**
**POs met through Gaps in the Syllabus**
**Topics beyond syllabus/Advanced topics/Design**

**POs met through Topics beyond syllabus/Advanced topics/Design**

| **Course Delivery methods** | |
|---|---|
| Lecture by use of boards/LCD projectors/OHP projectors | ✓ |
| Tutorials/Assignments | |
| Seminars | |
| Mini projects/Projects | |
| Laboratory experiments/teaching aids | ✓ |
| Industrial/guest lectures | |
| Industrial visits/in-plant training | ✓ |
| Self- learning such as use of NPTEL materials and internets | ✓ |
| Simulation | |

## Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

**Direct Assessment**

| Assessment Tool | % Contribution during CO Assessment |
|---|---|
| Progressive Evaluation Marks | 60 |
| End Examination Marks | 40 |

| Assessment Components | CO1 | CO2 | CO3 | CO4 | CO5 |
|---|---|---|---|---|---|
| Progressive Evaluation Marks | ✓ | ✓ | ✓ | ✓ | ✓ |
| End Examination Marks | ✓ | ✓ | ✓ | ✓ | ✓ |

**Indirect Assessment –**

1. Student feedback on teaching quality and teaching methods adopted
2. Student feedback on course syllabus and course outcome

**Mapping of Course Outcomes onto Program Outcomes and Program Specific Outcomes**

| Course Outcome | Program Outcomes | | | | | |
|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **6** |
| **1** | 3 | 2 | 3 | 2 | 3 | 1 |
| **2** | 3 | 3 | 3 | 3 | 3 | 2 |
| **3** | 3 | 3 | 3 | 3 | 3 | 2 |
| **4** | 3 | 2 | 3 | 2 | 2 | 2 |
| **5** | 2 | 2 | 1 | 2 | 2 | 1 |

| **Mapping Between COs and Course Delivery (CD) methods** | | | | |
|---|---|---|---|---|
| | | | | |
| **CD** | **Course Delivery methods** | | **Course Outcome** | **Course Delivery Method** |
| CD1 | Lecture by use of boards/LCD projectors/OHP projectors | | CO1 | CD1, CD5, CD7, CD8, CD9 |
| CD2 | Tutorials/Assignments | | CO2 | CD1, CD5, CD8, CD9 |
| CD3 | Seminars | | CO3 | CD1, CD5, CD7, CD8, CD9 |
| CD4 | Mini projects/Projects | | CO4 | CD1, CD5, CD8, CD9 |
| CD5 | Laboratory experiments/teaching aids | | CO5 | CD1, CD5, CD8 |
| CD6 | Industrial/guest lectures | | | |
| CD7 | Industrial visits/in-plant training | | | |
| CD8 | Self- learning such as use of NPTEL materials and internets | | | |
| CD9 | Simulation | | | |

# COURSE INFORMATION SHEET

**Course code: CE 536**
**Course title: DESIGN OF WATER AND WASTEWATER SYSTEM**
**Pre-requisite(s):**
**Co- requisite(s):**
**Credits: 2** L: 0 T: 0 P: 4
**Class schedule per week: 4**
**Class: M. Tech**
**Semester / Level: 2ND SEMESTER/ LEVEL 5**
**Branch: CIVIL & ENVIRONMENTAL ENGINEERING**
**Name of Teacher:**

**Course Objectives**

This course enables the students:

| | |
|---|---|
| A. | To introduce the students about the basic concepts of water supply system(K2,K3) |
| B. | To make students aware about design criteria's for water supply systems(K6) |
| C. | To introduce the students about the basic concepts of wastewater treatment system (K2,K3) |
| D. | To make students aware about design criteria's for wastewater treatment systems(K6) |
| E. | To introduce softwares for water and waste water treatment designing(K5,K6) |

**Course Outcomes**

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

| | |
|---|---|
| 1. | Understand the designing concepts of water supply (K2,K3) |
| 2. | Design water supply systems(K6) |
| 3. | Understand the designing criteria and concepts of waste water treatment systems (K2,K6) |
| 4. | Design wastewater treatment systems(k6) |
| 5. | Design water and waste water treatment systems using softwares (K5,K6) |

## Syllabus

14. To Identify and understand the basic design criteria of water supply systems.
15. To design a sedimentation tank in water supply system
16. To design a aeration tank in water supply system
17. To design a chlorination dosage for water supply system
18. To design filtration units for water supply system
19. To design a storm-water management system
20. To design a water distribution network system using a software
21. To Design a primary treatment facility for WWT.
22. To Design a secondary treatment facility for WWT.
23. To Design a tertiary treatment facility for WWT.
24. To design a decentralised wastewater treatment system
25. An introduction to softwares on Wastewater treatment design facilities.

**Text books:**

- Peavy H S., Rowe DR, Tchobanoglous G., Environmental Engineering, McGraw Hill International.
- Bhave PR, Gupta R, Analysis of Water Distribution Network, Narosa Publishing House, New Delhi
- Qasim SR, Motley EM, Zhu G., Water works engineering0Plaanning, design and Operation. Prentice hall.
- CPHEEO manual on water supply and treatment, 2nd ed. MoUD. New Delhi

**Gaps in the syllabus (to meet Industry/Profession requirements)**
**POs met through Gaps in the Syllabus**
**Topics beyond syllabus/Advanced topics/Design**

**POs met through Topics beyond syllabus/Advanced topics/Design**

| **Course Delivery methods** | |
|---|---|
| Lecture by use of boards/LCD projectors/OHP projectors | ✓ |
| Tutorials/Assignments | ✓ |
| Seminars | |
| Mini projects/Projects | ✓ |
| Laboratory experiments/teaching aids | ✓ |
| Industrial/guest lectures | |
| Industrial visits/in-plant training | ✓ |
| Self- learning such as use of NPTEL materials and internets | ✓ |
| Simulation | |

## Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

**Direct Assessment**

| **Assessment Tool** | **% Contribution during CO Assessment** |
|---|---|
| Progressive Evaluation Marks | 60 |
| End Examination Marks | 40 |

| **Assessment Components** | **CO1** | **CO2** | **CO3** | **CO4** | **CO5** |
|---|---|---|---|---|---|
| Progressive Evaluation Marks | ✓ | ✓ | ✓ | ✓ | ✓ |
| EndExamination Marks | ✓ | ✓ | ✓ | ✓ | ✓ |

**Indirect Assessment –**

1. Student feedback on teaching quality and teaching methods adopted
2. Student feedback on course syllabus and course outcome

**Mapping of Course Outcomes onto Program Outcomes and Program Specific Outcomes**

| Course Outcome | Program Outcomes | | | | | |
|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **6** |
| **1** | 1 | 2 | 3 | 2 | 3 | 1 |
| **2** | 2 | 2 | 3 | 3 | 3 | 2 |
| **3** | 1 | 2 | 3 | 2 | 3 | 1 |
| **4** | 2 | 2 | 3 | 3 | 3 | 2 |
| **5** | 2 | 2 | 3 | 2 | 3 | 2 |

| **Mapping Between COs and Course Delivery (CD) methods** | | | | |
|---|---|---|---|---|
| | | | | |
| **CD** | **Course Delivery methods** | | **Course Outcome** | **Course Delivery Method** |
| CD1 | Lecture by use of boards/LCD projectors/OHP projectors | | CO1 | CD1, CD2, CD5, CD8 |
| CD2 | Tutorials/Assignments | | CO2 | CD1, CD2, CD5, CD7,CD8 |
| CD3 | Seminars | | CO3 | CD1, CD2, CD5, CD8, |
| CD4 | Mini projects/Projects | | CO4 | CD1, CD2, CD5, CD7,CD8, |
| CD5 | Laboratory experiments/teaching aids | | CO5 | CD1, CD2, CD8,Cd9 |
| CD6 | Industrial/guest lectures | | | |
| CD7 | Industrial visits/in-plant training | | | |
| CD8 | Self- learning such as use of NPTEL materials and internets | | | |
| CD9 | Simulation | | | |

# COURSE INFORMATION SHEET

**Course code: CE538**
**Course title: Environmental System Engineering**
**Pre-requisite(s):**
**Co- requisite(s):**
**Credits: 2** L: T: P:4
**Class schedule per week: 4**
**Class: M. Tech**
**Semester / Level: III/VI**
**Branch: Environmental Science & Eng.**
**Name of Teacher:**

**Course Objectives**

This course enables the students:

| | |
|---|---|
| A. | To Identify the impact of industrial activities on the environment and apply the knowledge of environmental system engineering in the choice of cost-effective remediation strategies (K3, K5) |
| B. | To identify the system boundary of the existing problem (K3, K4) |
| C. | To address the critical environmental issues with optimization techniques for the useful utilization of land and mineral resources, wastewater treatment, and solid waste management and disposal. (K3, K5) |
| D. | To understand the importance of time by solving 'optimization over time' problems (K3, K4) |
| .E | To identify the contemporary issues, design, formulate and solve the problem. (K5, K6) |

**Course Outcomes**
After the completion of this course, students will be able to:

| | |
|---|---|
| 1. | apply the knowledge of science, mathematics and engineering and work with multidisciplinary team (K3, K4) |
| 2. | An ability to analyze, interpret data and use appropriate optimization techniques (K3, K6) |
| 3. | An ability to design & formulate a system and its components as per the desired need and solve engineering problems (K5, K6) |
| 4. | An understanding of professional, ethical responsibility and knowledge of contemporary issues (K4, K5) |
| 5 | An ability to minimize the environmental impact and opt for cost-effective remediation techniques (K4, K5) |

## Syllabus

1. problem formulation, model construction and deriving solution from models. (Graphical methods)
2. Simplex and Dual Simplex Method. Limitations of LPP. Sensitivity analysis
3. LPP (Artificial Variable: M method and 2 phase)
4. Transportation models
5. Coal mine transportation problem
6. Application of ILPM (municipal solid waste management)

7. air quality management
8. Agricultural non-point source pollution: pesticide management problems
9. Lagrange's multipliers: Unconstrained and constrained optimization
10. Sequential search algorithms (Box algorithm)
11. Separable and integer programming (multi-objective planning)
12. Dynamic programming models (land use planning)
13. Optimization over time (Wildlife habitat)

**Text books:**

1. Environmental Systems Optimization – D.A.Haith , 1982, Wiley Sons, NY.
2. Operations Research: An Introduction - Hamdy A. Taha, Prentice Hall Pub.
3. Environmental System Engineering & Economics – Robert Wills & Brad A. Finney, Kluwer Academic Pub.
4. Techniques for Environmental System Analysis - R.H.Pantell Wiley, NY, 2001.

**Reference books:**

1. Operation Research: theory & applications – J. K. Sharma,

**Gaps in the syllabus (to meet Industry/Profession requirements)**
**POs met through Gaps in the Syllabus**
**Topics beyond syllabus/Advanced topics/Design**

**POs met through Topics beyond syllabus/Advanced topics/Design**

| **Course Delivery methods** | |
|---|---|
| Lecture by use of boards/LCD projectors/OHP projectors | ✓ |
| Tutorials/Assignments | ✓ |
| Seminars | |
| Mini projects/Projects | |
| Laboratory experiments/teaching aids | |
| Industrial/guest lectures | |
| Industrial visits/in-plant training | |
| Self- learning such as use of NPTEL materials and internets | ✓ |
| Simulation | |

## Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

## Direct Assessment

| **Assessment Tool** | **% Contribution during CO Assessment** |
|---|---|
| Progressive Evaluation Marks | 60 |
| End Examination Marks | 40 |

| **Assessment Compoents** | **CO1** | **CO2** | **CO3** | **CO4** | **CO5** |
|---|---|---|---|---|---|
| Progressive Evaluation Marks | ✓ | ✓ | ✓ | ✓ | ✓ |
| End Examination Marks | ✓ | ✓ | ✓ | ✓ | ✓ |

**Indirect Assessment –**

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

## Mapping between Objectives and Outcomes

**Mapping of Course Outcomes onto Program Outcomes**

| Course Outcome | Program Outcomes | | | | | | Program Specific Outcome | | |
|---|---|---|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **6** | **1** | **2** | **3** |
| **1** | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 3 |
| **2** | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 3 |
| **3** | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 3 |
| **4** | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 3 |
| **5** | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 3 |

| Mapping Between COs and Course Delivery (CD) methods | | | | |
|---|---|---|---|---|
| | | | | |
| **CD** | **Course Delivery methods** | | **Course Outcome** | **Course Delivery Method** |
| CD1 | Lecture by use of boards/LCD projectors/OHP projectors | | CO1 | CD1, CD2, CD8 |
| CD2 | Tutorials/Assignments | | CO2 | CD1, CD2, CD8 |
| CD3 | Seminars | | CO3 | CD1, CD2, CD8 |
| CD4 | Mini projects/Projects | | CO4 | CD1, CD2, CD8 |
| CD5 | Laboratory experiments/teaching aids | | CO5 | CD1, CD2, CD8 |
| CD6 | Industrial/guest lectures | | | |
| CD7 | Industrial visits/in-plant training | | | |
| CD8 | Self- learning such as use of NPTEL materials and internets | | | |
| CD9 | Simulation | | | |