Vision:

Department of Chemical Engineering strives to be a premier institute in India, to create quality chemical engineers who will be highly successful in academic, industries and research. Our research motive is to develop sustainable technologies for the betterment of society.

Mission:

1. To disseminate high quality Chemical Engineering Education
2. To perform high impact research for the benefit of community
3. To collaborate with industries for innovative concepts/ideas
4. To develop quality engineers and technocrats with inter-disciplinary skills
1. PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

1. To impart knowledge on modern analytical techniques and computational skills necessary for
to design and evaluate complex environmental problems.
2. To impart students with strong knowledge base through theory courses and sessional that
makes them suitable for industries, academics, research and consultancies.
3. To develop student’s analytical, computational and research skills so as to understand
interactions of pollutants in water, air, and subsurface environments, and design treatment/
remediation systems.
4. To educate students to practice environmental engineering with a global perspective and
appropriate standards pertaining to health, safety, legal and cultural issues to solutions for
complex, engineering problems.
5. To develop in-depth understanding of Environmental technology and developments in the
industry through continuous professional developments.
6. Students are expected to Engage in continued learning through professional development.

2. PROGRAMME OUTCOMES (POs)

On successful completion of this programme, the students will have

PO1: An ability to independently carry out research/investigation and development work to solve
Practical problems.

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

PO3: Students should be able to demonstrate 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: Critical thinking skills in relation to environmental affairs and an integrative approach to
environmental issues with a focus on sustainability

PO5: Capacity to formulate and solve complex problems associated with environmental Engineering

PO6: Ability to identify the impact of engineering solutions in a global, economic, and Societal
context.

PO7: Ability to communicate their thoughts and ideas effectively.
PO8: Interest to acquire knowledge on modern analytical techniques and computational skills necessary for environmental engineers

PO9: The competency in utilizing the available resources effectively and optimally

PO10: The ability to utilize advances in environmental sciences and technology to resolve Environmental issues and anticipate implications

PO11: Inclination towards acquiring knowledge on the latest developments in the field of Environmental engineering

PO12: Ability to use the state of art technology, skills and modern engineering tools necessary for engineering practices

3. MAPPING OF PROGRAMME EDUCATIONAL OBJECTIVE WITH PROGRAMME OUTCOMES

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1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
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## PROFESSIONAL ELECTIVE COURSES (PEC)

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### RESEARCH METHODOLOGY AND IPR COURSES (RMC)

### OPEN ELECTIVE COURSES [OEC]*

*Out of 6 Courses one Course must be selected*

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### AUDIT COURSES (AC)

Registration for any of these courses is optional to students

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### EMPLOYABILITY ENHANCEMENT COURSES (EEC)

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OBJECTIVES

- To learn about unit processes and operations.
- To make the students understand the applications of unit operations and processes in environmental technology.

UNIT I
Selection of unit operations and processes - Principal type of Reactors - Screening - Mixing - Coagulation and Flocculation – Flow equalization

UNIT II
Sedimentation - Type of settling - Removal ratio – Clarifier-thickener- Column flotation- air flotation.

UNIT III
Filtration – classification of filters- Head loss through filters– Darcy equation.

UNIT IV

UNIT V
Kinetics of Biological growth - Suspended and attached growth processes - Aerobic and Anaerobic - Determination of kinetic coefficients.

COURSE OUTCOMES:
This course will make the students to
CO1: Understand the fundamentals of unit operation involve in Environmental process
CO2: Understand the basics of Coagulation and Flocculation, Reactor types
CO3: Understand the basics of Sedimentation - settling - Clarifier- flotation.
CO4: Understand the concept of Adsorption - Isotherms, chlorination
CO5: Understand the concept of Suspended and attached growth processes
CO6: Understand the concept of Aerobic and Anaerobic – processes

REFERENCES
### Course Articulation Matrix:

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<td>CO2</td>
<td>Understand the basics of Coagulation and Flocculation, Reactor types</td>
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<td>CO3</td>
<td>Understand the basics of Sedimentation - settling - Clarifier-flotation.</td>
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<td>CO4</td>
<td>Understand the concept of Adsorption - Isotherms, chlorination</td>
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<td>CO5</td>
<td>Understand the concept of Suspended and attached growth processes</td>
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<td>CO6</td>
<td>Understand the concept of Aerobic and Anaerobic – processes</td>
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1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
OBJECTIVES

- To learn about the methods used for the treatment of wastewater biologically.
- To make the students understand modeling and design aspects of biological techniques available.

UNIT I  FUNDAMENTAL OF BIOCHEMICAL OPERATIONS AND STOICHIOMETRY  9
Classification and fundamental of Biochemical Operations: role, classification and overview of biochemical operations, types of microorganism and their role, microbial eco system, stoichiometry and kinetics of biochemical reactions

UNIT II  MODELLING OF SUSPENDED GROWTH REACTORS  9
Modelling Suspended Growth Systems, Aerobic Growth of Heterotrophs in a Single Continuous Stirred Tank, Reactor, Techniques for evaluating Kinetic and Stoichiometry Parameter

UNIT III  APPLICATION OF SUSPENDED GROWTH REACTORS  9

UNIT IV  MODELING OF ATTACHED GROWTH REACTORS  9
Bio-film Modeling Aerobic Growth of Biomass in Packed Towers, Rotating Biological Contactor, Fluidized Bed Biological Reactors

UNIT V  APPLICATION OF ATTACHED GROWTH REACTORS  9

TOTAL: 45 PERIODS

COURSE OUTCOMES:

This course will make the students to

CO1: Understand the concepts and fundamentals of biochemical operations used in wastewater treatment
CO2: Apprehend the basics of suspended growth reactors and correlate with the equations
CO3: Identify the types and applications of suspended growth reactors used in wastewater treatment
CO4: Learn the mechanism and operations of attached growth reactors used in wastewater treatment
CO5: Relate to the types and applications of attached growth reactors used in wastewater treatment
CO6: Acquire a knowledge of the technological configuration of industrial wastewater treatment plants and reactors

REFERENCES

1. Grady, C.P.L, Daigger, G. T. and Lim, H.C, Biological Wastewater Treatment, 2nd Ed, Marcel Dekker, 1999
# Course Articulation Matrix

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<td>Understand the concepts and fundamentals of biochemical operations used in wastewater treatment</td>
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<td>Apprehend the basics of suspended growth reactors and correlate with the equations</td>
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<td>Identify the types and applications of suspended growth reactors used in wastewater treatment</td>
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<td>Learn the mechanism and operations of attached growth reactors used in wastewater treatment</td>
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<td>Relate to the types and applications of attached growth reactors used in wastewater treatment</td>
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<td>CO6</td>
<td>Acquire a knowledge of the technological configuration of industrial wastewater treatment plants and reactors</td>
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1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
OBJECTIVE

To illustrate the air pollution sources, characteristics and effects of air and noise pollution and the methods of controlling the same. The student is expected to know about source inventory and control mechanism.

UNIT I
Introduction to Air Quality; An Overview of the Clean Air Act Amendments; Fate and Transport in the Environment; Priority Air Pollutants; Indoor Air Quality, Properties of Air Pollutants; Selected Chemical and Physical Properties of Potential Atmospheric Pollutants; Basic Properties and Terminology.

UNIT II
Industrial Air Pollution Sources and Prevention; Air Pollution in the Chemical Process, Petroleum, Iron and Steel Manufacturing, Lead and Zinc Smelting Industries, Air Pollution from Nickel Ore Processing and Refining; Air Pollution from Copper Smelting industries

UNIT III
Ventilation and Indoor Air Quality Control; An Overview of Indoor Air Quality; The Basics of HVAC Systems; IAQ Issues and Impacts on Occupants; Application of Audits to Developing an IAQ Profile; Developing Management Plans; IAQ Problems; Control; Quantification and Measurement, Air Pollution Dispersion-Dispersion Theory Basics- Air Quality Impact of Stationary Sources- Models and Resources

UNIT IV
Prevention Versus Control; Pollution Prevention: Principles of Pollution Prevention; Methods of Particulate Collection; Methods for Cleaning Gaseous Pollutants, Environmental Cost Accounting; Total Cost Accounting Terminology;

UNIT V
Noise pollution –sound level-measuring transient noise-acoustic environment health effects of noise —noise control. Introduction to cosmic pollution

COURSE OUTCOMES:
The students will be able to

CO1: Understand the nature and characteristics of air pollutants, noise pollution and basic concepts of air quality management.

CO2: Identify, formulate and solve air and noise pollution problems

CO3: Design stacks and particulate air pollution control devices to meet applicable standards

CO4: Relate the indoor air quality behaviour and its measurement

CO5: Control the air pollution using various devices and cost accounting

CO6: Analyze the environmental health effects using air and noise pollution.

TEXT BOOKS

REFERENCES
# Course Articulation Matrix:

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<td>Identify, formulate and solve air and noise pollution problems</td>
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<tr>
<td>CO3</td>
<td>Design stacks and particulate air pollution control devices to meet applicable standards</td>
<td>PO 3  3  3  3  3  3  3  3  3  3  3  3  3  3  3</td>
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<tr>
<td>CO4</td>
<td>Relate the indoor air quality behaviour and its measurement</td>
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<td>CO5</td>
<td>Control the air pollution using various devices and cost accounting</td>
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<tr>
<td>CO6</td>
<td>Analyze the environmental health effects using air and noise pollution.</td>
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1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
EV5104   SOLID AND HAZARDOUS WASTE MANAGEMENT

OBJECTIVE

- Students will gain knowledge about valuing the environment and make it cleaner and greener by safe disposal of solid wastes

CO1: Be familiar with legislation pertaining to solid waste management
CO2: Be familiar with solid waste remedial measures and their importance.
CO3: Understand the knowledge of energy production using solid wastes.
CO4: Understand the knowledge of the toxicity of materials over the environment
CO5: Be familiar with the sampling of solid wastes and its analysis
CO6: Will get better knowledge about the safe disposal of solid wastes

UNIT I

Legal and Organizational foundation: Definition of solid waste - waste generation in a technological society - sources and types of solid waste - legislations on management and handling of municipal solid wastes, hazardous wastes, biomedical wastes, batteries waste, E-waste and plastics, monitoring responsibilities - waste minimization at source

UNIT II


UNIT III

Definition and identification of hazardous wastes - sources and characteristics - hazardous wastes in Municipal Waste - Hazardous waste regulations - minimization of Hazardous Waste - compatibility, handling and storage of hazardous waste - collection and Transport-hazardous waste management practice in India

UNIT IV


UNIT V

Sampling and characterization of Solid Wastes; TCLP tests and leachate studies - composition of landfill leachate - leachate management and treatment

TOTAL: 45 PERIODS
COURSE OUTCOMES:
The students will be able to
CO1: Be familiar with legislation pertaining to solid waste management
CO2: Be familiar with solid waste remedial measures and their importance.
CO3: Understand the knowledge of energy production using solid wastes.
CO4: Understand the knowledge of the toxicity of materials over the environment
CO5: Be familiar with the sampling of solid wastes and its analysis
CO6: Will get better knowledge about the safe disposal of solid wastes

TEXT BOOKS
## Course Articulation Matrix:

| Course Outcome | Statements                                                                 | Program Outcomes
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<td>Be familiar with solid waste remedial measures and their importance.</td>
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<td>CO3</td>
<td>Understand the knowledge of energy production using solid wastes.</td>
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<td>CO4</td>
<td>Understand the knowledge of the toxicity of materials over the environment</td>
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<td>Be familiar with the sampling of solid wastes and its analysis</td>
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<td>CO6</td>
<td>Will get better knowledge about the safe disposal of solid wastes</td>
<td>1 2 - 2 3 1 2 - 3 2 1 3 2 2 2 2</td>
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<tr>
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<td>3 2 3 2 3 2 3 3 3 3 3 3 3 3 3 3</td>
</tr>
</tbody>
</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
COURSE OBJECTIVES:
To impart knowledge and skills required for research and IPR:
- Problem formulation, analysis and solutions.
- Technical paper writing / presentation without violating professional ethics
- Patent drafting and filing patents.

UNIT I  RESEARCH PROBLEM FORMULATION  6
Meaning of research problem- Sources of research problem, criteria characteristics of a good research problem, errors in selecting a research problem, scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, necessary instrumentations

UNIT II  LITERATURE REVIEW  6
Effective literature studies approaches, analysis, plagiarism, and research ethics.

UNIT III  TECHNICALWRITING /PRESENTATION  6
Effective technical writing, how to write report, paper, developing a research proposal, format of research proposal, a presentation and assessment by a review committee.

UNIT IV  INTRODUCTION TO INTELLECTUAL PROPERTY RIGHTS (IPR)  6

UNIT V  INTELLECTUAL PROPERTY RIGHTS (IPR)  6

COURSE OUTCOMES:
1. Ability to formulate research problem
2. Ability to carry out research analysis
3. Ability to follow research ethics
4. Ability to understand that today’s world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity
5. Ability to understand about IPR and filing patents in R & D.

TOTAL: 30 PERIODS
<table>
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<th>PO1</th>
<th>PO2</th>
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<td>CO4</td>
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</tbody>
</table>

REFERENCES:

OBJECTIVE

- The course is designed to develop sampling and analytical skills of the students which are required in environmental monitoring.

1. Determination of Acidity and Alkalinity, Chlorides
2. Dissolved and undissolved solids and settleable solids, determination
3. Measurement of turbidity and Jar test
4. Soil analysis: moisture & pH determination, organic content
5. Ground Water and Drinking Water sampling & Analysis.
6. Measurement of heavy metals
7. Analysis of trace organic contaminants, using GC-MS
8. Measurement of viscosity
9. Measurement of surface tension

TOTAL: 60 PERIODS

COURSE OUTCOMES

CO1: The students will know various standard protocols used in environmental monitoring.
CO2: Perform common environmental experiments relating to water and wastewater quality, and know which tests are appropriate for given environmental problem
CO3: Understand and use the water and wastewater sampling procedures and sample preservations.
CO4: Statistically analyze and interpret laboratorial results
CO5: Demonstrate the ability to work in groups
CO6: Demonstrate the ability to write clear technical laboratorial reports
## Course Articulation Matrix:

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statements</th>
<th>Program Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>PO1</td>
</tr>
<tr>
<td>CO1</td>
<td>The students will know various standard protocols used in environmental monitoring.</td>
<td>2</td>
</tr>
<tr>
<td>CO2</td>
<td>Perform common environmental experiments relating to water and wastewater quality, and know which tests are appropriate for given environmental problem</td>
<td>3</td>
</tr>
<tr>
<td>CO3</td>
<td>Understand and use the water and wastewater sampling procedures and sample preservations.</td>
<td>3</td>
</tr>
<tr>
<td>CO4</td>
<td>Statistically analyze and interpret laboratorial results</td>
<td>3</td>
</tr>
<tr>
<td>CO5</td>
<td>Demonstrate the ability to work in groups</td>
<td>3</td>
</tr>
<tr>
<td>CO6</td>
<td>Demonstrate the ability to write clear technical laboratorial reports</td>
<td>3</td>
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<tr>
<td>Overall</td>
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<td>3</td>
</tr>
</tbody>
</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
OBJECTIVE

- To develop sound practical knowledge for students on various Separation processes which have their Environmental applications.

LIST OF EXPERIMENTS

1. Separation using Batch distillation
2. Separation using Continuous distillation
3. Liquid-liquid Extraction
4. Cross current leaching studies
5. Gas – Liquid Absorption
6. Adsorption studies
7. Separation using Ion-Exchange column
8. Determination of permeate flux, permeate rejection and permeate characteristics in membrane.
9. Vacuum Filtration
10. Determination of Moisture content and drying rate in a Dryer.
11. Sieve analysis

TOTAL: 60 PERIODS

COURSE OUTCOMES

The students will be able to

CO1: Perform distillation and Determine Distillation parameters
CO2: Evaluate the performance and determine Extraction parameters
CO3: Estimate the Adsorption/Absorption parameters
CO4: Analyse and perform separation using Ion-Exchange operation
CO5: Analyse and determine various Filtration parameters
CO6: Perform sieve analysis and to Analyse the drying characteristics of a Dryer
Course Articulation Matrix:

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statements</th>
<th>Program Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>Perform distillation and Determine Distillation parameters</td>
<td>PO 1  PO 2  PO 3  PO 4  PO 5  PO 6  PO 7  PO 8  PO 9  PO 10  PO 11  PO 12  PS O1  PS O2  PS O3</td>
</tr>
<tr>
<td>CO2</td>
<td>Evaluate the performance and determine Extraction parameters</td>
<td>3  1  2  3  3  2  3  3  3  2  2  3  3  2  2</td>
</tr>
<tr>
<td>CO3</td>
<td>Estimate the Adsorption/Absorption parameters</td>
<td>3  1  2  3  3  2  3  3  3  2  2  3  3  2  2</td>
</tr>
<tr>
<td>CO4</td>
<td>Analyse and perform separation using Ion-Exchange operation</td>
<td>3  1  2  3  3  2  3  3  3  2  2  3  3  2  2</td>
</tr>
<tr>
<td>CO5</td>
<td>Analyse and determine various Filtration parameters</td>
<td>3  1  2  3  3  2  3  3  3  2  2  3  3  2  2</td>
</tr>
<tr>
<td>CO6</td>
<td>Perform sieve analysis and to Analyse the drying characteristics of a Dryer</td>
<td>3  1  2  3  3  2  3  3  3  2  2  3  3  2  2</td>
</tr>
<tr>
<td>Overall</td>
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</tbody>
</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
SEMINER II

EV5201 SEPARATION PROCESSES IN ENVIRONMENTAL APPLICATIONS

OBJECTIVE

- To learn about the different separation processes available. Also to make the students understand the fundamental mathematical concepts behind the various separation processes.

UNIT I
Pollution sources, Environmental separations - Historic perspective of environmental pollution - Separation mechanisms - Equilibrium-based processes, Rate - based processes, Counter current operation, Productivity and selectivity, separating agents

UNIT II
Degrees of freedom analysis, Phase equilibrium, Equilibrium-limited analysis, Minimum number of stages, Rate-limited processes, Batch and Continuous distillation, Extraction in Environmental applications, Leaching processes, McCabe–Thiele analysis

UNIT III
Absorption and stripping, packed columns, Adsorption principles, Sorbent selection, regeneration, Transport processes, Process design factors, Design of fixed-bed adsorber.

UNIT IV
Ion exchange- Objectives, Environmental applications, Ion-exchange mechanisms, Ion exchange media, Equipment and design procedures.

UNIT V

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1: Identify the nature of pollutants and understand the mechanism of various chemical engineering separation processes.

CO2: Understand the equilibrium relationships, understand the fundamental concepts of distillation, extraction & leaching and perform design calculations

CO3: Design the towers for gas–liquid and fluid – solid operations for environmental applications.

CO4: Understand the Ion exchange mechanism and design the system for environmental application

CO5: Understand the basic principle, different types of membrane, membrane modules and various membrane process and its mechanisms.

CO6: Select the appropriate separation techniques for a given problem.

REFERENCES

## Course Articulation Matrix

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<tr>
<th>Course Outcomes</th>
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<tbody>
<tr>
<td>CO1</td>
<td>Identify the nature of pollutants and understand the mechanism of various chemical engineering separation processes.</td>
<td>3 2 3 3 2 1 1 1 1 1 1 2 - 3 2 2</td>
</tr>
<tr>
<td>CO2</td>
<td>Understand the equilibrium relationships, understand the fundamental concepts of distillation, extraction &amp; leaching and perform design calculations</td>
<td>3 2 3 3 2 1 1 1 1 1 1 2 - 3 2 2</td>
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<tr>
<td>CO3</td>
<td>Design the towers for gas–liquid and fluid – solid operations for environmental applications.</td>
<td>3 2 3 3 2 1 1 1 1 1 1 2 - 3 2 2</td>
</tr>
<tr>
<td>CO4</td>
<td>Understand the Ion exchange mechanism and design the system for environmental application</td>
<td>3 2 3 3 2 1 1 1 1 1 1 2 - 3 2 2</td>
</tr>
<tr>
<td>CO5</td>
<td>Understand the basic principle, different types of membrane, membrane modules and various membrane process and its mechanisms.</td>
<td>3 2 3 3 2 1 1 1 1 1 1 2 - 3 2 2</td>
</tr>
<tr>
<td>CO6</td>
<td>Select the appropriate separation techniques for a given problem.</td>
<td>3 2 3 3 2 1 1 1 1 1 1 2 - 3 2 2</td>
</tr>
<tr>
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<td>3 2 3 3 2 1 1 1 1 1 1 2 - 3 2 2</td>
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</tbody>
</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
OBJECTIVES

- To understand the basics of model construction.
- To learn about the calibration and validation of the models

UNIT I ENVIRONMENTAL SYSTEMS
Principles of Environmental modeling, model building and types, classification of mathematical models, Model Calibration, Validation, Verification and Sensitivity Analysis, uncertainty sources, methods of solution, types of environmental models.

UNIT II ECOLOGICAL SYSTEM

UNIT III HYDROLOGICAL SYSTEM
Climate system modeling, Basic mechanisms of river self-purification, Streeter-Phelps and Dobins models, More complex chemical and ecological models, Pollutant and nutrient dynamics, Dissolved Oxygen dynamics.

UNIT IV MICROBIAL SYSTEM

UNIT V ENVIRONMENTAL APPLICATIONS
Introduction to CFD fundamentals, Applications of CFD in environmental modeling, Fuzzy System Modeling- Introduction to fuzzy sets and systems, Cluster analysis for the classification of ecological data.

COURSE OUTCOMES:
This course will make the students to
CO1: The students will gain knowledge on modeling environmental systems
CO2: Students will get trained about ecology and multidimensional modeling
CO3: Students will gain knowledge in hydrology and behavioural systems.
CO4: The students will adapt themselves to model interactive systems.
CO5: Be familiar with fuzzy logic based models.

REFERENCES

### Course Articulation Matrix

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<th>Course Outcomes</th>
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<th>PS O2</th>
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<tbody>
<tr>
<td>CO1</td>
<td>The students will gain knowledge on modeling environmental systems.</td>
<td>3</td>
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<tr>
<td>CO2</td>
<td>Students will get trained about ecology and multidimensional modeling.</td>
<td>3</td>
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<tr>
<td>CO3</td>
<td>Students will gain knowledge in hydrology and behavioural systems.</td>
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<tr>
<td>CO4</td>
<td>The students will adapt themselves to model interactive systems.</td>
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<tr>
<td>CO5</td>
<td>Be familiar with fuzzy logic based models.</td>
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</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
EV5203  ENVIRONMENTAL IMPACT ASSESSMENT

OBJECTIVE

- To educate the graduates about the importance of Environmental Impact Assessment and to make them understand the methods followed for the impact assessment.

UNIT I

Environmental Impact Assessment (EIA) - Environmental Impact Statement (EIS), Environmental Risk Assessment (ERA) - Legal and Regulatory aspects in India – Types and limitations of EIA - Terms of Reference in EIA- Issues in EIA - national – cross-sectoral - social and cultural.

UNIT II


UNIT III

Trends in EIA practice and evaluation criteria - capacity building for quality assurance. Expert system in EIA - use of regulations and AQM.

UNIT IV


UNIT V

Case studies of EIA of developmental projects

TOTAL: 45 PERIODS

COURSE OUTCOMES:

The students will be able to

CO1: Understand the Environmental Impact and Environmental Risk assessments and related legal procedures.

CO2: Understand various components and assessment techniques of EIA.

CO3: Aware of Standards and guidelines for evaluation procedures.

CO4: Make decisions on the environmental consequences of proposed actions.

CO5: Understand document planning and environmental monitoring through EIA

CO6: Get greater insight about EIA through various case studies promote environmentally sound and sustainable development by identifying appropriate measures.

REFERENCES

# Course Articulation Matrix:

<table>
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<tr>
<th>Course Outcomes</th>
<th>Statements</th>
<th>Program Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>Understand the Environmental Impact and Environmental Risk assessments and related legal procedures.</td>
<td>PO 1 PO 2 PO 3 PO 4 PO 5 PO 6 PO 7 PO 8 PO 9 PO 10 PO 11 PO 12 PS O1 PS O2 PS O3</td>
</tr>
<tr>
<td>CO2</td>
<td>Understand various components and assessment techniques of EIA.</td>
<td>- 2 3 3 2 - 1 - 2 2 2 1 1 2</td>
</tr>
<tr>
<td>CO3</td>
<td>Aware of Standards and guidelines for evaluation procedures.</td>
<td>- 1 2 3 1 1 1 - 2 1 2 1 1 2</td>
</tr>
<tr>
<td>CO4</td>
<td>Make decisions on the environmental consequences of proposed actions.</td>
<td>- 2 2 3 2 - 1 - 2 1 1 1 2</td>
</tr>
<tr>
<td>CO5</td>
<td>Understand document planning and environmental monitoring through EIA</td>
<td>- 2 3 2 1 1 1 2 2 1 2 1 1 2</td>
</tr>
<tr>
<td>CO6</td>
<td>Get greater insight about EIA through various case studies promote environmentally sound and sustainable development by identifying appropriate measures.</td>
<td>- 2 2 3 1 - 1 - 2 1 1 1 1</td>
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<td></td>
<td>- 2 2 3 2 1 1 1 2 2 2 2 1 1 2</td>
</tr>
</tbody>
</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
OBJECTIVE
To make students gain practical knowledge on various analysis and treatment systems in pollution treatment techniques and its application.

LIST OF EXPERIMENTS
2. Sampling and analysis of air pollutants ambient and stacks (SPM, RPM, SO2, NOX and CO).
3. Physiochemical analysis of solid wastes.
4. Design of clarifier by using the data obtained through batch sedimentation.
5. Coagulation and flocculation for removal of suspended solids from water.
10. Treatment of wastewater by Advanced Oxidation Technology

TOTAL: 60 PERIODS

COURSE OUTCOMES
CO1: Students will know how to isolate microorganism from wastewater
CO2: Will be able to evaluate the air pollutant parameters
CO3: Will understand the Adsorption/Absorption mechanism
CO4: To perform batch operation for the treatment of wastewater.
CO5: Will be capable of Analysing and determining COD/BOD
CO6: We know the mechanism involved in AOP techniques
### Course Articulation Matrix:

<table>
<thead>
<tr>
<th>Course Outcomes</th>
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<th>PO 1</th>
<th>PO 2</th>
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<th>PO 12</th>
<th>PS O1</th>
<th>PS O2</th>
<th>PS O3</th>
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<td>Students will know how to isolate microorganism from wastewater</td>
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<td>3</td>
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</tr>
<tr>
<td>CO2</td>
<td>Will be able to evaluate the air pollutant parameters</td>
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<tr>
<td>CO3</td>
<td>will understand the Adsorption/Absorption mechanism</td>
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<td>CO4</td>
<td>To perform batch operation for the treatment of wastewater.</td>
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</tr>
<tr>
<td>CO5</td>
<td>Will be capable of Analysing and determining COD/BOD</td>
<td>3</td>
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<tr>
<td>CO6</td>
<td>We know the mechanism involved in AOP techniques</td>
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</tbody>
</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
EV5212  ADVANCED OXIDATION PROCESS LABORATORY

OBJECTIVE
- To develop sound practical knowledge for students on different types of Advanced Oxidation Process

COURSE OUTCOMES
The students will be able to
CO1: Determine the rate constant experimentally for different AOP.
CO2: Determine the rate constant experimentally for different sequential AOP.
CO3: Determine the rate constant experimentally for different combined AOP.
CO4: Determination of power/energy for different AOP
CO5: Determination of band gap energy for photo-catalyst.
CO6: Understand the Design of experiments software tool for parameter optimization.

LIST OF EXPERIMENTS
1. Kinetic studies of ozonation process
2. Kinetic studies of Sonocatalysis process
3. Kinetic studies of Photocatalysis under visible light
4. Kinetic studies of Photocatalysis under UV light
5. Kinetic studies of electro-oxidation process
6. Kinetic study of Photo Fenton process
7. Kinetic study of sequential AOP
8. Kinetic study of combined AOP
9. Study of energy/power calculation for different AOP
10. Determination of energy/power for photo - catalyst.
11. Design of experiments to analyze the results.

TOTAL: 60 PERIODS

COURSE OUTCOMES
The students will be able to
CO1: Determine the rate constant experimentally for different AOP.
CO2: Determine the rate constant experimentally for different sequential AOP.
CO3: Determine the rate constant experimentally for different combined AOP.
CO4: Determination of power/energy for different AOP
CO5: Determination of band gap energy for photo-catalyst.
CO6: Understand the Design of experiments software tool for parameter optimization.
### Course Articulation Matrix:

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<td>CO1</td>
<td>Determine the rate constant experimentally for different AOP.</td>
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<td>Determine the rate constant experimentally for different sequential AOP.</td>
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<td>CO3</td>
<td>Determine the rate constant experimentally for different combined AOP.</td>
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<td>CO4</td>
<td>Determination of power/energy for different AOP</td>
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<td>CO5</td>
<td>Determination of band gap energy for photo- catalyst.</td>
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<tr>
<td>CO6</td>
<td>Understand the Design of experiments software tool for parameter optimization.</td>
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</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
OBJECTIVE

- To provide exposure to the recent developments, and to improve the student’s presentation skills.

COURSE OUTCOMES:

The students will be able to

CO1: Know the latest improvements in their field of expertise
CO2: Relate the significant works of literature for the selected and suitable topic
CO3: Focus the salient features of the area of study
CO4: Understand the basic concepts and mechanism related to the problem
CO5: Improve the presentation on the topic
CO6: Practice their presentation in written and oral skills
# Course Articulation Matrix:

<table>
<thead>
<tr>
<th>Course Outcomes</th>
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<tbody>
<tr>
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<tr>
<td>CO1</td>
<td>Know the latest improvements in their field of expertise</td>
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<tr>
<td>CO2</td>
<td>Relate the significant works of literature for the selected and suitable topic</td>
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<tr>
<td>CO3</td>
<td>Focus the salient features of the area of study</td>
<td>2</td>
</tr>
<tr>
<td>CO4</td>
<td>Understand the basic concepts and mechanism related to the problem</td>
<td>3</td>
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<tr>
<td>CO5</td>
<td>Improve the presentation on the topic</td>
<td>3</td>
</tr>
<tr>
<td>CO6</td>
<td>Practice their presentation in written and oral skills</td>
<td>3</td>
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<td>Overall</td>
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</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
OBJECTIVES

- To identify a specific problem related to environment and collecting information related to the same through detailed literature review.
- To identify a methodology to carry out the project.
- To guide the students in preparing project reports, to present their findings in reviews and viva-voce examination.

The student individually works on a specific topic selected by him/her which is relevant to his/her specialization of the programme approved by a faculty member who is familiar in the particular area of interest. The topic may be experimental or analytical or case studies. At the end of the semester, a detailed report on the work done should be submitted which contains a clear definition of the identified problem, detailed literature review related to the area of work and methodology for carrying out the work. The students will be evaluated through reviews internally by panel members and a final viva-voce examination conducted at the end of the semester by a panel of one internal and one external examiner.

TOTAL: 180 PERIODS

COURSE OUTCOMES:

The students will be able to

CO1: The students will be in a position to do literature survey for any type of environmental problems.

CO2: At the end of the course, the students will have a clear idea of his/her area of work and they will be in a position to carry out the remaining phase II work in a systematic way.
## Course Articulation Matrix:

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<tr>
<td>CO1</td>
<td>The students will be in a position to do literature survey for any type of environmental problems.</td>
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<tr>
<td>CO2</td>
<td>At the end of the course, the students will have a clear idea of his/her area of work and they will be in a position to carry out the remaining phase II work in a systematic way.</td>
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1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
OBJECTIVE

- To carry out experiments to solve the identified problem based on the identified methodology.
- To develop skills to analyze and discuss the results obtained and make conclusions.

The student should continue the phase I work on the selected topic as per the identified methodology. After completing the work to the satisfaction of the supervisor and review committee a detailed report should be prepared and submitted to the head of the department at the end of the semester. The students will be evaluated based on the reviews and the viva-voce examination conducted by a panel of examiners including one external examiner.

TOTAL: 360 PERIODS

COURSE OUTCOMES:

The students will be able to

CO1: On completion of the project work, students will be in a position to carry out further research at pilot plant level in their field and publish their work in reputed journals.

CO2: Students will have confidence in identifying the cause and solutions to any environmental pollution related problems.
Course Articulation Matrix:

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PROFESSIONAL ELECTIVE COURSES [PEC]
ECOLOGY AND ENVIRONMENT

OBJECTIVE
Students will learn about the structural and functional interactions between the ecological systems and the environment which would help in applications to the prevalent problems in the society.

UNIT I
OBJECTIVE - scope and applications of Ecology, Ecological Engineering and Ecotechnology and their relevance to human civilization - A Perspective on the Relationship Between Engineering and Ecology. Development and evolution of ecosystems – Sustainable Ecosystems, Principles and concepts pertaining to communities in the ecosystem - Energy flow and material cycling in ecosystems - Productivity in ecosystems.

UNIT II

UNIT III
Self-organizing processes - Multiple seeded microcosms- Interface coupling in ecological systems - Concept of energy - Adapting ecological engineering systems to potentially catastrophic events, Engineering Studies Based on Ecological Criteria, Agroecosystems - Determination of sustainable loading of Ecosystems.

UNIT IV

UNIT V
Ecological Effects of Warfare, Effects of Stress on Ecosystem Structure and Function, Case studies of integrated ecological engineering systems.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
The students will be able to
CO1: Understand the fundamentals of ecological systems and their relation with engineering and environment
CO2: Understand the principles in the modeling of environmental systems and design of ecological economic systems
CO3: Carry out engineering studies based on ecological criteria
CO4: Understand the principles and applications in the water management system
CO5: Understand the concept of various systems and their human modification
CO6: Find solutions to problems pertaining to environmental issues.
TEXT BOOKS


REFERENCES

## Course Articulation Matrix

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<td>Understand the fundamentals of ecological systems and their relation with engineering and environment</td>
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<tr>
<td>CO2</td>
<td>Understand the principles in the modeling of environmental systems and design of ecological economic systems</td>
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<td>CO3</td>
<td>Carry out engineering studies based on ecological criteria</td>
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<tr>
<td>CO4</td>
<td>Understand the principles and applications in the water management system</td>
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<td>CO5</td>
<td>Understand the concept of various systems and their human modification</td>
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<td>CO6</td>
<td>Find solutions to problems pertaining to environmental issues.</td>
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1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
INDUSTRIAL POLLUTION PREVENTION

OBJECTIVE

- To provide knowledge on sources and characteristics of industrial pollution, techniques and approaches for minimizing the generation of pollutants.

UNIT I

Basics of Jurisprudence - Environmental law relation with other disciplines - Criminal law - Common Law - Relevant sections of the code of civil procedure, criminal procedure code - Indian Penal code.

UNIT II


UNIT III

Administration regulations - constitution of pollution control Boards Powers, functions, Accounts, Audit etc. - Formal Justice Delivery Mechanism Higher and Lower of judiciary - Constitutional remedies writ jurisdiction Article 32, 226, 136 special reference to mandamus and certioror for pollution abatement - Equitable remedies for pollution control.

UNIT IV


UNIT V

Relevant notifications in connection with Hazardous Wastes (Management and handling), Biomedical Wastes (Management and Handling), Noise pollution, Eco-labelling, and EIA.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
The students will be able to

- Understand the basics of Jurisprudence related to industrial pollution.
- Understand Environmental law relation with other disciplines.
- Understand about Fundamental Rights and Indian Environmental Policy.
- Aware of Administrative regulations and Equitable remedies for pollution control.
- Understand Water and Air Acts and relevant notifications.
- Understand notifications in connections with various pollutions.

REFERENCES

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<td>PO 1</td>
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<tr>
<td>CO1</td>
<td>Understand the basics of Jurisprudence related to industrial pollution.</td>
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<tr>
<td>CO2</td>
<td>Understand Environmental law relation with other disciplines.</td>
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<tr>
<td>CO3</td>
<td>Understand about Fundamental Rights and Indian Environmental Policy.</td>
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<tr>
<td>CO4</td>
<td>Aware of Administrative regulations and Equitable remedies for pollution control.</td>
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<tr>
<td>CO5</td>
<td>Understand Water and Air Acts and relevant notifications.</td>
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<td>CO6</td>
<td>Understand notifications in connections with various pollutions.</td>
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</table>

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OBJECTIVE

- Students will have an understanding of environmental policies and legislation pertaining to industries.

UNIT I  INTRODUCTION


UNIT II  WATER (P&CP) ACT, 1974

Power & functions of regulatory agencies - responsibilities of Occupier Provision relating to prevention and control Scheme of Consent to establish, Consent to operate – Conditions of the consents – Outlet – Legal sampling procedures, State Water Laboratory – Appellate Authority – Penalties for violation of consent conditions etc. Provisions for closure/directions in apprehended pollution situation.

UNIT III  AIR (P&CP) ACT, 1981

Power & functions of regulatory agencies - responsibilities of Occupier Provision relating to prevention and control Scheme of Consent to establish, Consent to operate – Conditions of the consents – Outlet – Legal sampling procedures, State Air Laboratory – Appellate Authority – Penalties for violation of consent conditions etc. Provisions for closure/directions in apprehended pollution situation.

UNIT IV  ENVIRONMENT (PROTECTION) ACT 1986

Genesis of the Act – delegation of powers – Role of Central Government - EIA Notification – Sitting of Industries – Coastal Zone Regulation - Responsibilities of local bodies mitigation scheme etc., for Municipal Solid Waste Management - Responsibilities of Pollution Control Boards under Hazardous Waste rules and that of occupier, authorisation – Biomedical waste rules – responsibilities of generators and role of Pollution Control Boards

UNIT V  OTHER TOPICS

Relevant Provisions of Indian Forest Act, Public Liability Insurance Act, CrPC, IPC -Public Interest Litigation - Writ petitions - Supreme Court Judgments in Landmark cases.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

The students will be able to

CO1: Understand the fundamental national policies pertaining to environmental acts.
CO2: Understand the laws, analytical techniques involved in water pollution control
CO3: Understand the laws, analytical techniques involved in air pollution control
CO4: Understand the concept for waste management and laws involved
CO5: Understand the environmental laws and their applications
CO6: Find solutions to problems present in environment management
TEXT BOOKS

REFERENCES
1. CPCB, “Pollution Control acts, Rules and Notifications issued there under “Pollution Control Series – PCL/2/1992, Central Pollution Control Board, Delhi, 1997.
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<td>Understand the fundamental national policies pertaining to environmental acts.</td>
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<td>CO2</td>
<td>Understand the laws, analytical techniques involved in water pollution control</td>
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<td>CO3</td>
<td>Understand the laws, analytical techniques involved in air pollution control</td>
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<td>Understand the concept for waste management and laws involved</td>
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1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
OBJECTIVE

- To impart knowledge on principles and applications of remote sensing, GIS for environmental engineering and the usage of GIS software and processing of data.

UNIT I  OVERVIEW OF REMOTE SENSING  

UNIT II  REMOTE SENSING TECHNOLOGY  
Classification of Remote Sensing Systems, Energy recording technology, Aerial photographs, Photographic systems – Across track and along track scanning, Multispectral remote sensing, Thermal remote sensing, Microwave remote sensing – Active and passive sensors, RADAR, LIDAR, Satellites and their sensors, Indian space programme - Research and development.

UNIT III  DATA PROCESSING  

UNIT IV  GEOGRAPHICAL INFORMATION SYSTEM  
GIS Concepts – Spatial and non-spatial data, Vector and raster data structures, Data analysis, Database management – GIS software

UNIT V  REMOTE SENSING AND GIS APPLICATIONS  
Monitoring and management of environment, Conservation of resources, Sustainable land use, Coastal zone management – Limitations.

COURSE OUTCOMES:
The students will be able to
CO1: Understand the basic principles in remote sensing.
CO2: Understand the various classification and technology in remote sensing.
CO3: Understand the characteristic of remote sensing.
CO4: Understand the analyzing technique in remote sensing and GIS.
CO5: Understand the concept of geographical information system.
CO6: Application of remote sensing and GIS in detail.

TEXT BOOKS

REFERENCES
## Course Articulation Matrix:

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statements</th>
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<th>PO 12</th>
<th>PS O1</th>
<th>PS O2</th>
<th>PS O3</th>
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<tbody>
<tr>
<td>CO1</td>
<td>Understand the basic principles in remote sensing.</td>
<td>3</td>
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<tr>
<td>CO2</td>
<td>Understand the various classification and technology in remote sensing.</td>
<td>3</td>
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<tr>
<td>CO3</td>
<td>Understand the characteristic of remote sensing.</td>
<td>3</td>
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<tr>
<td>CO4</td>
<td>Understand the analyzing technique in remote sensing and GIS.</td>
<td>2</td>
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<tr>
<td>CO5</td>
<td>Understand the concept of geographical information system.</td>
<td>3</td>
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<tr>
<td>CO6</td>
<td>Application of remote sensing and GIS in detail.</td>
<td>3</td>
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</tbody>
</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
OBJECTIVES:
- To make the students aware of components, thermodynamics and chemistry of atmosphere.
- To make students understand the climatic changes of atmosphere and air pollution

UNIT I  INTRODUCTION
Scope of atmospheric science, structure of atmosphere, A brief survey of atmosphere: Stoichiometry and mass balance, chemical equilibrium, acid-base, optical properties, mass, chemical composition, winds and precipitation. – Hydrologic cycle – Carbon cycle – Climate and earth system.

UNIT II  ATMOSPHERIC THERMODYNAMICS

UNIT III  ATMOSPHERIC CHEMISTRY & AIR POLLUTION
Composition of tropospheric air – Atmospheric circulation patterns, Sources, transport and sinks of trace gases – Tropospheric aerosols – air pollution – tropospheric chemical cycles – stratospheric chemistry.

UNIT IV  ATMOSPHERIC DYNAMICS
Kinematics of the large-scale horizontal flow – Dynamics of horizontal flow – primitive equations — numerical weather prediction

UNIT V  CLIMATE & WEATHER
The present day climate – Climate variability – Climate equilibrium, sensitivity – Green house warming — Climate monitoring and prediction – weather systems – tropical cyclones – case studies: tsunami and sea level rising, Acid rain– The concept of El Nino.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
The students will be able to
CO1: Understand the scope of atmospheric science
CO2: Understand atmospheric thermodynamics
CO3: Understand atmospheric chemistry and air pollution
CO4: Understand the concept of numerical weather prediction
CO5: Understand climate variability of atmosphere.
CO5: Troubleshoot the problems with respect to climatic changes with the knowledge of atmospheric thermodynamics and chemistry.

REFERENCES
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<th>PS O1</th>
<th>PS O2</th>
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</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>Understand the scope of atmospheric science</td>
<td>3</td>
<td>1</td>
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<tr>
<td>CO2</td>
<td>Understand atmospheric thermodynamics</td>
<td>2</td>
<td>1</td>
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<tr>
<td>CO3</td>
<td>Understand atmospheric chemistry and air pollution</td>
<td>3</td>
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<tr>
<td>CO4</td>
<td>Understand the concept of numerical weather prediction</td>
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<tr>
<td>CO5</td>
<td>Understand climate variability of atmosphere.</td>
<td>3</td>
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<tr>
<td>CO6</td>
<td>Troubleshoot the problems with respect to climatic changes with the knowledge of atmospheric thermodynamics and chemistry.</td>
<td>3</td>
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</tbody>
</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
OBJECTIVE

- To make the students aware of global environmental issues, concepts behind pollution prevention, environmental risks, green chemistry and various methods available to evaluate environmental costs and life cycle assessments.

UNIT I

UNIT II

UNIT III

UNIT IV

UNIT V

TOTAL: 45 PERIODS

COURSE OUTCOMES:
The students will be able to

- CO1: Understand the basic principles of Green chemistry.
- CO2: Understand the major environmental issue.
- CO3: Understand the pollution prevention concepts and their environmental risks.
- CO4: Understand the design concept for green chemistry.
- CO5: Understand the procedure for estimating environmental cost.
- CO6: Understand the basic concept behind product life cycle.
TEXT BOOKS


REFERENCES

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<tbody>
<tr>
<td></td>
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<td>PO 1</td>
</tr>
<tr>
<td>CO1</td>
<td>Understand the basic principles of Green chemistry.</td>
<td>3</td>
</tr>
<tr>
<td>CO2</td>
<td>Understand the major environmental issue.</td>
<td>3</td>
</tr>
<tr>
<td>CO3</td>
<td>Understand the pollution prevention concepts and their environmental risks.</td>
<td>3</td>
</tr>
<tr>
<td>CO4</td>
<td>Understand the design concept for green chemistry.</td>
<td>-</td>
</tr>
<tr>
<td>CO5</td>
<td>Understand the procedure for estimating environmental cost.</td>
<td>2</td>
</tr>
<tr>
<td>CO6</td>
<td>Understand the basic concept behind product life cycle.</td>
<td>1</td>
</tr>
</tbody>
</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
CL5024 ENVIRONMENTAL NANOTECHNOLOGY

OBJECTIVE

This course covers the importance of all different aspects and effects of environmental nanotechnology.

UNIT I

Basic concepts of Nanoscience and Nanotechnology – Quantum wire – Quantum well – Quantum dot – nano wires-nano rods-fullerenes – Graphene – Carbon nanotubes. Introduction to Potential uses of nanomaterials in environmental, energy and biomedical field.

UNIT II

Preparation of nano scale metal oxides, metals, CNT, functionalized nano porous materials, nano composite, polymer ceramic nano composites, Material processing by -Chemical vapour deposition, sol gel, sonochemical, microwave, solvothermal, plasma, pulsed laser abalation, magnetron sputtering, electrospinning.

UNIT III

Principle of AFM, STM, SEM, TEM, XRD, ESCA, IR & Raman, UV-DRS, of nanomaterials for structural & chemical nature.

UNIT IV

Nanoparticles in the Environment; Nanoparticles in Mammalian Systems; Health Threats; Toxicological Studies and Toxicity of Manufactured CNTs- case study; Toxicity of CNTs and Occupational Exposure Risk; Toxicity of MWCNTs/SWCNTs and Impact on Environmental Health.

UNIT V

Gas sensors, microfluidics, catalytic and photocatalytic applications, doping of metal oxides to nano materials, Nonmaterials for wastewater treatment, nanomaterials as adsorbents, membrane process. Naomaterial for energy storage applications.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

The students will be able to

CO1: Understand the basic concept of nanotechnology and their applications

CO2: Understand the various preparation methods of nano materials.

CO3: Understand the various instrumental analysis of nano materials.

CO4: Understand the effect of nano materials to human health.

CO5: Understand the nano materials for wastewater treatment applications.

CO6: Understand the nano materials for energy storage applications.

REFERENCES

1. Environmental applications of nanomaterials-Synthesis, Sorbents and Sensors, edited by Glen E Fryxell and Guozhong Cao, worldscibooks, UK
Course Articulation Matrix:

| Course Outcomes | Statements                                                                 | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO1 0 | PO1 1 | PO1 2 | PS O1 | PS O2 | PS O3 |
|-----------------|-----------------------------------------------------------------------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|-------|-------|
| CO1             | Understand the basic concept of nanotechnology and their applications       | 3    | 1    | 2    | 2    | 2    | -    | -    | -    | -    | -     | -     | -     | -     | -     | -     |       |
| CO2             | Understand the various preparation methods of nano materials.               | 3    | 1    | 2    | 2    | 2    | -    | -    | -    | -    | -     | -     | -     | -     | -     | -     |       |
| CO3             | Understand the various instrumental analysis of nano materials.             | 3    | 1    | 2    | 2    | 3    | 1    | 1    | -    | -    | -     | -     | -     | -     | -     | -     |       |
| CO4             | Understand the effect of nano materials to human health.                    | 1    | 1    | 2    | 2    | 1    | 1    | 1    | -    | -    | -     | -     | -     | -     | -     | -     |       |
| CO5             | Understand the nano materials for wastewater treatment applications.        | 3    | 1    | 2    | 2    | -    | 1    | 1    | 3    | -    | -     | -     | -     | -     | -     | -     |       |
| CO6             | Understand the nano materials for energy storage applications.              | 1    | 1    | 1    | 2    | 2    | 2    | 1    | -    | -    | -     | -     | -     | -     | -     | -     |       |
| Overall         |                                                                             | 3    | 1    | 2    | 3    | 2    | 2    | 2    | -    | -    | -     | -     | -     | -     | -     | -     |       |

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
## EV5002  ENVIRONMENTAL SUSTAINABILITY

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### OBJECTIVE
- Students will gain knowledge about valuing environment and economic development without depletion of natural resources.

### UNIT I  VALUING THE ENVIRONMENT

- Valuing the Environment: Concepts, Valuing the Environment: Methods, Property Rights, Externalities, and Environmental Problems

### UNIT II  SUSTAINABLE DEVELOPMENT


### UNIT III  AIR POLLUTION

- Biodiversity, Forest Habitat, Commercially Valuable Species, Stationary-Source Local Air Pollution, Acid Rain and Atmospheric Modification, Transportation

### UNIT IV  WATER POLLUTION

- Water Pollution, Solid Waste and Recycling, Toxic Substances and Hazardous Wastes, Global Warming.

### UNIT V  VISIONS OF FUTURE


### COURSE OUTCOMES:

The students will be able to

- **CO1**: Understand the knowledge of Valuing the Environment and Externalities to Environmental Problems.
- **CO2**: Defining the concept of Sustainable Development
- **CO3**: Understand the knowledge of Biodiversity and air pollution.
- **CO4**: Understand the knowledge of water pollution and its hazards.

### TEXT BOOKS


### REFERENCES

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<tbody>
<tr>
<td>CO1</td>
<td>Understand the knowledge of Valuing the Environment and Externalities to Environmental Problems.</td>
<td>P O1 2 P O2 2 P O3 3 P O4 2 P O5 2 P O6 2 P O7 2 P O8 3 P O9 2 P O10 3 P O11 2 P O12 2 PS O1 2 PS O2 2 PS O3 2</td>
</tr>
<tr>
<td>CO2</td>
<td>Defining the concept of Sustainable Development</td>
<td>2 3 2 3 2 1 2 3 2 2 2 3 3 3 2</td>
</tr>
<tr>
<td>CO3</td>
<td>Understand the knowledge of Biodiversity and air pollution.</td>
<td>3 2 3 3 3 2 1 2 2 1 3 3 2 3 2</td>
</tr>
<tr>
<td>CO4</td>
<td>Understand the knowledge of water pollution and its hazards.</td>
<td>2 2 2 2 2 1 2 3 2 2 3 3 2 2 3 2</td>
</tr>
<tr>
<td>CO5</td>
<td>Understand the Visions of the Future: Development, Poverty, and the Environment.</td>
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<tr>
<td>Over all</td>
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<td>3 3 2 2 1 2 3 3 2 2 3 2 2 2 3</td>
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</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
OBJECTIVES:
- To develop a basic understanding of environmental health and risk assessment and its role within the risk management process.
- To learn about different risk assessment formats and their use in environmental health studies.
- To learn about the different models for environmental risk assessment studies.

UNIT I
Introduction to environmental risk assessment and available methodologies, quantitative risk assessment, Risk assessment steps, rapid risk analysis - comprehensive risk analysis – identification, evaluation and control of risk

UNIT II
Hazard identification and control, Hazard assessment (consequence analysis), probabilistic hazard assessment (Fault tree analysis)

UNIT III
Overall risk contours for different failure scenarios – disaster management plan –emergency planning – onsite and offsite emergency planning, risk management ISO 14000

UNIT IV
Safety measures design in process operations. Accidents modeling – release modeling, toxic release and dispersion modeling, fire and explosion modeling.

UNIT V

TOTAL: 45 PERIODS

COURSE OUTCOMES:
The students will be able to
CO1: Understand the concept of environmental risk assessment
CO2: Understand Hazard identification and control
CO3: Understand disaster management plan
CO4: Understand Safety measures design in process operations.
CO5: Understand the concept of accidents modeling
CO6: Government policies to manage environmental risk

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<td>Understand the concept of environmental risk assessment</td>
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<td>CO2</td>
<td>Understand Hazard identification and control</td>
<td>3</td>
</tr>
<tr>
<td>CO3</td>
<td>Understand disaster management plan</td>
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</tr>
<tr>
<td>CO4</td>
<td>Understand Safety measures design in process operations.</td>
<td>3</td>
</tr>
<tr>
<td>CO5</td>
<td>Understand the concept of accidents modeling</td>
<td>1</td>
</tr>
<tr>
<td>CO6</td>
<td>Government policies to manage environmental risk</td>
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<td>Over all</td>
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</tr>
</tbody>
</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
OBJECTIVE

- The objective of the course is to acquaint the students with current techniques for soil remediation.

UNIT I  Introduction


UNIT II  INORGANIC AND ORGANIC GEOCHEMISTRY


UNIT III  CONTAMINANT FATE AND TRANSPORT IN SOIL


UNIT IV  REMEDIATION TECHNOLOGIES


UNIT V  EX SITU TREATMENTS

Ex situ physical/chemical treatments – chemical extraction – solar detoxification – chemical reduction/oxidation – soil washing solidification/stabilization – soil vapour extraction; ex situ thermal treatment – shot gas decontamination thermal desorption plasm arc incineration pyrolysis vitrification

TOTAL: 45 PERIODS

COURSE OUTCOMES:

The students will be able to

CO1: Characterize the soil and classify them.

CO2: Understand many of the basic concepts of pollution, the effects of environmental contamination and the various remediation technologies which may be employed

CO3: Be aware of contamination and degradation caused by various types of urban, industrial and agricultural development

CO4: Will know the transport processes in soil

CO5: Will be familiar with remediation technologies

CO6: Will be able to identify appropriate technology of soil contamination
TEXT BOOKS


REFERENCES

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</thead>
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<tr>
<td>CO1</td>
<td>Characterize the soil and classify them.</td>
<td>PO1  PO2 PO3 PO4 PO5 PO6 PO7 PO8 PO9 PO10 PO11 PO12 PS O1 PS O2 PS O3</td>
</tr>
<tr>
<td>CO2</td>
<td>Understand many of the basic concepts of pollution, the effects of environmental contamination and the various remediation technologies which may be employed</td>
<td>-    -    1  1  2 -    1 -    1 -    - 2    -    -    -</td>
</tr>
<tr>
<td>CO3</td>
<td>be aware of contamination and degradation caused by various types of urban, industrial and agricultural development</td>
<td>-    -    -  2  1 -    2 -    1 -    2  2    -    -    -</td>
</tr>
<tr>
<td>CO4</td>
<td>Will know the transport processes in soil</td>
<td>-    -    -  2  2 -    1 -    1 -    -  1 -    2  2</td>
</tr>
<tr>
<td>CO5</td>
<td>Will be familiar with remediation technologies</td>
<td>-    1    -    -  1 -    1 -    2 -    -    -    -    -</td>
</tr>
<tr>
<td>CO6</td>
<td>Will be able to identify appropriate technology of soil contamination</td>
<td>-    1    1    -  1  2  2  1  1  2    -    1 -    2  2</td>
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<td>Over all</td>
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</tr>
</tbody>
</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
OBJECTIVE

- Students will gain knowledge about occupational health, industrial hygiene, accident prevention techniques and to train them in risk assessment and management.

UNIT I INTRODUCTION


UNIT II OCCUPATIONAL HEALTH AND HYGIENE


UNIT III WORKPLACE SAFETY AND SAFETY SYSTEMS

Features of the satisfactory design of work premises HVAC, ventilation. Safe installation and use of electrical supplies. Fire safety and first aid provision. Significance of human factors in the establishment and effectiveness of safe systems. Safe systems of work for manual handling operations. Control methods to eliminate or reduce the risks arising from the use of work equipment. Requirements for the safe use of display screen equipment. Procedures and precautionary measures necessary when handling hazardous substances. Contingency arrangements for events of serious and imminent danger.

UNIT IV TECHNIQUES OF ENVIRONMENTAL SAFETY


UNIT V EDUCATION AND TRAINING

Requirements for and benefits of the provision of information, instruction, training and supervision. Factors to be considered in the development of effective training programmes. Principles and methods of effective training. Feedback and evaluation mechanism.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

The students will be able to,

CO1: Learn the safety acts, regulations and initiatives.
CO2: Understand the insights of hazards and control measures.
CO3: Study the work place safety and safety systems.
CO4: Appreciate the need of accessing risks.
CO5: Understand the Procedure of investigating accidents.
CO6: Learn the importance of education and training on safety management.
TEXT BOOKS


REFERENCES

**Course Articulation Matrix:**

<table>
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<tr>
<th>Course outcomes</th>
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<tbody>
<tr>
<td></td>
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<td>PO 1</td>
</tr>
<tr>
<td>CO1</td>
<td>Learn the safety acts, regulations and initiatives.</td>
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<tr>
<td>CO2</td>
<td>Understand the insights of hazards and control measures.</td>
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<tr>
<td>CO3</td>
<td>Study the work place safety and safety systems.</td>
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<tr>
<td>CO4</td>
<td>Appreciate the need of accessing risks.</td>
<td>3</td>
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<td>CO5</td>
<td>Understand the Procedure of investigating accidents.</td>
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<tr>
<td>CO6</td>
<td>Learn the importance of education and training on safety management.</td>
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1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
OBJECTIVE

- To enable Students to have knowledge on how to measure process variables, analytical Instrumentation and automatic process controls.

UNIT I

UNIT II
Process Variables Measurement–Temperature systems– Thermocouples, Thermo resistive system, Filled-system thermometers, Radiation thermometry, Location of temperature measuring devices in equipments, Pressure system – Mechanical pressure elements Pressure Transducers and Transmitters, Vacuum measurement, Resonant wire pressure Transducer, Flow system – Differential producers, Variable area flow meters, Velocity, vortex, mass, ultrasonic & other flow meters, positive displacement flow meters, Open – channel flow measurements, Force systems, Strain gauges Humidity Moisture system, Humidity Measurement, Moisture measurement system, Rheological system, Viscosity measurement, Radiation system, Nuclear radiation instrumentation.

UNIT III
Analytical instrumentation – Analysis instruments, Sample conditioning for process analyzers, X-ray Analytical methods, Quadrupole mass spectrometry, Ultra violet Absorption Analysis, Infra red process analyzers, Photometric reaction product analysers, Oxygen analyzers, Oxidation – reduction potential measurements, pH measuring systems, Electrical conductivity and Resistivity measurements, Thermal conductivity, gas analysis, Combustible, Total hydro carbon, and CO analyzer, Chromatography.

UNIT IV

UNIT V
Sensors, Transmitters and control valves - Pressure, Flow, Level, Temperature and Composition sensors, Transmitters, Pneumatic and electronic control valves, Types, Actuator, accessories, Instrumentation symbols and Labels.

COURSE OUTCOMES:
The students will be able to

CO1: Understand different process variables and their measurement units.
CO2: Understand the principle and working of various process variable measuring instruments.
CO3: Understand the principle, working and range of various analytical instruments
CO4: Understand the principle and working of various gas analysis instruments.
CO5: Understand the role of controller in industrial instrumentation.
CO6: Understand the electronic, pneumatic sensors for process variable measurement.
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<td>CO2</td>
<td>Understand the principle and working of various process variable measuring instruments.</td>
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<td>CO3</td>
<td>Understand the principle, working and range of various analytical instruments</td>
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<td>CO4</td>
<td>Understand the principle and working of various gas analysis instruments.</td>
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<td>CO5</td>
<td>Understand the role of controller in industrial instrumentation.</td>
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<td>CO6</td>
<td>Understand the electronic, pneumatic sensors for process variable measurement.</td>
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1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
DESIGN OF EXPERIMENTS

OBJECTIVE

- To introduce the student to the principles and methods of statistical analysis of designed experiments, understand hypothesis testing, perform factorial designs for experiments and model using response surface techniques.

UNIT I

Introduction: Strategy of experimentation, basic principles, guidelines for designing experiments. Simple Comparative Experiments: Basic statistical concepts, sampling and sampling distribution, inferences about the differences in means: Hypothesis testing, Choice of samples size, Confidence intervals, Randomized and paired comparison design.

UNIT II

Experiments with Single Factor: An example, The analysis of variance, Analysis of the fixed effect model, Model adequacy checking, Practical interpretation of results, Sample computer output, Determining sample size, Discovering dispersion effect, The regression approach to the analysis of variance, Non parameteric methods in the analysis of variance, Problems.

UNIT III

Design of Experiments: Introduction, Basic principles: Randomization, Replication, Blocking, Degrees of freedom, Confounding, Design resolution, Metrology considerations for industrial designed experiments, Selection of quality characteristics for industrial experiments. Parameter Estimation

UNIT IV

Response Surface Methods: Introduction, The methods of steepest ascent, Analysis of a second order response surface, Experimental designs for fitting response surfaces: Designs for fitting the first-order model, Designs for fitting the second-order model, Blocking in response surface Computer-generated (Optimal) designs, Mixture experiments, Evolutionary operation, Robust design, Problems

UNIT V


TOTAL: 45 PERIODS

COURSE OUTCOMES:
The students will be able to

CO1: Understand sampling and sampling distribution
CO2: Apply Hypothesis testing with different confidence intervals
CO3: Perform ANOVA and regression analysis
CO4: Perform statistically designed experiments with and without blocking
CO5: Model the given data using Response Surface Methodology
CO6: Perform optimized experimentation like Plackett Burman design, Youden square

TEXT BOOKS


REFERENCES

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|                 |                                                      | PO 1  | PO 2  | PO 3  | PO 4  | PO 5  | PO 6  | PO 7  | PO 8  | PO 9  | PO 10 | PO 11 | PO 12 | PS O1 | PS O2 | PS O3 |
|                 |                                                      | 1     | 1     | 2     | 3     | 2     | -     | 2     | -     | 1     | 1     | 1     | 1     | 2     | 3     | 2     |
| CO2             | Apply Hypothesis testing with different confidence intervals | \[
|                 |                                                      | 1     | 1     | 2     | 1     | 2     | -     | 2     | -     | 1     | 1     | 1     | 1     | 3     | 3     | 2     |
| CO3             | Perform ANOVA and regression analysis                | \[
|                 |                                                      | 1     | 1     | 2     | 3     | 3     | -     | 2     | -     | 1     | 1     | 1     | 1     | 3     | 3     | 2     |
| CO4             | Perform statistically designed experiments with and without blocking | \[
|                 |                                                      | 1     | 1     | 2     | 3     | 3     | -     | 2     | -     | 1     | 1     | 1     | 1     | 3     | 2     | 2     |
| CO5             | Model the given data using Response Surface Methodology | \[
|                 |                                                      | 1     | 1     | 2     | 3     | 3     | -     | 2     | -     | 1     | 1     | 1     | 1     | 2     | 1     | 2     |
| CO6             | Perform optimized experimentation like Plackett Burman design, Youden square | \[
|                 |                                                      | 1     | 1     | 2     | 3     | 3     | -     | 2     | -     | 1     | 1     | 1     | 1     | 3     | 3     | 2     |
| Over all        |                                                      | 1     | 1     | 2     | 3     | 3     | -     | 2     | -     | 1     | 1     | 1     | 1     | 3     | 3     | 2     |

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
OBJECTIVE

Students will gain knowledge about risks involved in working premises and to avoid accidents using prevention methods.

UNIT I


UNIT II

Radiation – tank on fire–flame length – radiation intensity calculation and its effect on plant, people & property radiation – explosion due to over pressure-effects of explosion, risk contour-effects explosion, BLEVE-jet fire-fire ball

UNIT III

Overall risk analysis-generation of metrological data-ignition date-population data consequences analysis and total risk analysis-overall risk contours for different failure scenarios-disaster management plan-emergency planning-n site & off site emergency planning, risk management ISO 140000, EMS models case studies-marketing terminal, gas processing complex, refinery

UNIT IV

Hazard identification safety audits, checklist, what if analysis, vulnerability models event tree analysis, fault tree analysis, Past accident analysis: Fixborough-Mexico-Bhopal analysis.

UNIT V

Hazop-guide words, parameters, derivation-causes-consequences-recommendation, Hazop study-case studies-pumping system-reactor-mass transfer system.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
The students will be able to
CO1: Understand the knowledge of types of risks arising in working environment
CO2: Defining the concept of explosion and its effects
CO3: Understand the knowledge of disaster management.
CO4: Understand the knowledge of checklist and audits
CO5: Will be familiar with hazop and its consequences.
CO6: Will be able to create hazard free working premises

TEXT BOOKS

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<td>CO1</td>
<td>Understand the knowledge of types of risks arising in working environment</td>
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<tr>
<td>CO2</td>
<td>Defining the concept of explosion and its effects</td>
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</tr>
<tr>
<td>CO3</td>
<td>Understand the knowledge of disaster management.</td>
<td>3</td>
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<tr>
<td>CO4</td>
<td>Understand the knowledge of checklist and audits</td>
<td>2</td>
</tr>
<tr>
<td>CO5</td>
<td>Will be familiar with hazop and its consequences.</td>
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</tr>
<tr>
<td>CO6</td>
<td>Will be able to create hazard free working premises</td>
<td>1</td>
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<tr>
<td>Over all</td>
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</tbody>
</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
OBJECTIVE

To make the students aware of environmental legislation and strategies to control pollution,

UNIT I

Environmental legislation and strategies to control pollution, Environmental Legislations in India, Standards and Guidelines, Pollution prevention policy

UNIT II


UNIT III

Factory Act 1987 of India, Occupational health and safety requirements and standards of ILO, Compliance of rules and guidelines of Factory Act applicable to industries, National and international certification scheme.

UNIT IV

Principles of Environmental impact assessment and audit guidelines and legislature requirements for setting of industrial units in estates/complex. Environmental Pollution monitoring and measurement. Preparatory procedures for EIA study, Evaluation of quality standards of air, water and land environment.

UNIT V

Sampling and analysis techniques, Data interpretations and relationships for the design of treatment facilities, Principles of Environmental Auditing, Cleaner Technologies in Industrial Processes and evaluation of processes Monitoring of, liquid and solid waste management. Case studies: Life cycle assessment

COURSE OUTCOMES:

The students will be able to

CO1: Understand environmental legislation and strategies to control pollution
CO2: Understand standards, guidelines and pollution prevention policy
CO3: Understand the standards for discharge of treated liquid effluent into water bodies and standards for disposal of air emissions
CO4: Understand occupational health and safety requirements
CO5: Understand environmental pollution monitoring and measurement.
CO6: Understand the principles of environmental impact assessment legislature requirements for industrial units in estates/complex

TOTAL: 45 PERIODS
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</tr>
<tr>
<td>CO1</td>
<td>Understand environmental legislation and strategies to control pollution</td>
<td>3 1 1 1 1 1 - - - - - 1 1 1 1</td>
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<tr>
<td>CO2</td>
<td>Understand standards, guidelines and pollution prevention policy</td>
<td>2 1 1 1 1 1 1 - 3 2 1 - - 1 1 1</td>
</tr>
<tr>
<td>CO3</td>
<td>Understand the standards for discharge of treated liquid effluent into water bodies and standards for disposal of air emissions</td>
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</tr>
<tr>
<td>CO4</td>
<td>Understand occupational health and safety requirements</td>
<td>2 1 1 1 - 2 2 1 1 - 1 1 2 2 2</td>
</tr>
<tr>
<td>CO5</td>
<td>Understand environmental pollution monitoring and measurement.</td>
<td>3 2 1 1 1 - 2 2 2 - - - 2 2 2</td>
</tr>
<tr>
<td>CO6</td>
<td>Understand the principles of environmental impact assessment legislature requirements for industrial units in estates/complex</td>
<td>3 2 1 1 - - 2 1 1 1 - 1 1 1 1</td>
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<tr>
<td>Over all</td>
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<td>3 2 1 1 1 1 2 2 1 1 1 2 2 2 2</td>
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</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
OBJECTIVE

- To Introduce The Importance, And Different Approaches Of Cleaner Production In Industries And To Impart Knowledge On Environmental Management Tools Applying Cleaner Production Principle.

UNIT I INTRODUCTION
Sustainable Development – Indicators Of Sustainability – Sustainability Strategies – Barriers To Sustainability – Industrial Activities And Environment – Industrialization And Sustainable Development – Industrial Ecology – Cleaner Production (CP) In Achieving Sustainability – Prevention Versus Control Of Industrial Pollution – Environmental Policies And Legislations – Regulation To Encourage Pollution Prevention And Cleaner Production – Regulatory Versus Market Based Approaches.

UNIT II CLEANER PRODUCTION

UNIT III QUALITATIVE PHASE BEHAVIOUR OF HYDROC CLEANER PRODUCTION PROJECT DEVELOPMENT & IMPLEMENTATION

UNIT IV SUPPORT.INSTURMENTS OF PREVENTION METHODS

UNIT V CASE STUDIES
Industrial Applications Of CP, LCA, EMS And Environmental Audits.

COURSE OUTCOMES:
The students will be able to
CO1: Ability to describe the evolution of corporate environmental management strategies.
CO2: Ability to describe cleaner production measures applicable to different industries
CO3: Ability to conduct energy and material balances for processes as part of a cleaner production assessment.
CO4: Understanding of strategies and technologies for a cleaner industrial production.
CO5: Understanding the relation to the concept of sustainable development.
CO6: To enhance the knowledge on environmental sustainability.
TEXT BOOKS

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<tr>
<td>CO1</td>
<td>Ability to describe the evolution of corporate environmental management strategies.</td>
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<tr>
<td>CO2</td>
<td>Ability to describe cleaner production measures applicable to different industries</td>
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<tr>
<td>CO3</td>
<td>Ability to conduct energy and material balances for processes as part of a cleaner production assessment.</td>
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<tr>
<td>CO4</td>
<td>Understanding of strategies and technologies for a cleaner industrial production.</td>
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<tr>
<td>CO5</td>
<td>Understanding the relation to the concept of sustainable development.</td>
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<tr>
<td>CO6</td>
<td>To enhance the knowledge on environmental sustainability.</td>
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<td>Overall</td>
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CL5028 ENVIRONMENTAL BIOTECHNOLOGY

OBJECTIVE

- The main objective of this course is to impart students an understanding of pollution of environment by air, water and soil responsible for degradation of natural resources and degradation of biodiversity.

UNIT I MICROBES AND METABOLISM

Environmental Biotechnology: Perceptions, Reality, and Applications, microbes in the service of mankind, microbes remediation of contaminated lands and water, microbes in the management of waste water, microbial composting of solid wastes, metabolic pathways of particular relevance to environmental biotechnology, production of cellular, fermentation and respiration

UNIT II POLLUTION AND POLLUTION CONTROL

Classification of pollutants, pollution control strategies, practical toxicity issues, practical applications to pollution control: Bio filters, bio trickling filters, advances in biogas technology, bio scrubbers and other options, process changes in different pollutants generating industries

UNIT III BIOREMEDIATION


UNIT IV BIOTECHNOLOGY REMEDIES FOR ENVIRONMENTAL DAMAGES


UNIT V DNA TECHNOLOGY

Concept of DNA technology - plasmid - cloning of DNA - mutation - construction of microbial strains. Environmental effects and ethics of microbial technology - safety of genetically engineered organisms

TOTAL: 45 PERIODS

COURSE OUTCOMES:

The students will be able to

CO1: Apply the concept of environmental biotechnology and the different types of microbes used
CO2: Classify the different pollutants and identify the appropriate control strategy
CO3: Understand the nature of solid waste pollutants and recognize their remediation through environmental biotechnology techniques
CO4: Gain knowledge on the bioremediation strategies for decontamination and detoxification of environmental systems
CO5: Acquire a knowledge on the basics of DNA, their impact on environment and the ethics of microbial technology

CO6: Get to know the overview of important environmental biotechnologies involved in biotransformation of pollutants and generation of energy and understand the role of environmental biotechnologist and their responsibilities to the environment

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<tr>
<td>CO2</td>
<td>Classify the different pollutants and identify the appropriate control strategy</td>
<td>2 1 2 2 1 3 2 1 2 1 1</td>
</tr>
<tr>
<td>CO3</td>
<td>Understand the nature of solid waste pollutants and recognize their remediation through environmental biotechnology techniques</td>
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<tr>
<td>CO4</td>
<td>Gain knowledge on the bioremediation strategies for decontamination and detoxification of environmental systems</td>
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<td>Over all</td>
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1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
The objective of the course is to provide insights into waste management options by reducing the waste destined for disposal and encouraging the use of waste as a resource for alternate energy production.

UNIT I

UNIT II

UNIT III

UNIT IV Hazardous waste management:

UNIT V
Waste To Energy & Environmental Implications Environmental standards for Waste to Energy Plant operations and gas clean-up. Savings on non-renewable fuel resources.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
The students will
CO1: understand the concept of Waste to Energy
CO2: Be capable of linking legal, technical and management principles for production of energy form waste.
CO3: Learn about the best available technologies for waste to energy.
CO4: Be able analyze case studies for understanding success and failures.
CO5: Develop the skills in the decision making process.
CO6: Know the various sources of waste generation its potential for energy production.
TEXT BOOKS

REFERENCES
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1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
OBJECTIVE
Students will aware of the techniques used for removing contaminants and various technology to control emissions

UNIT I
Introduction to AOP, fundamentals of AOPs for water and wastewater treatment.

UNIT II
Photo induced AOP, UV Photolysis H2O2, UV/O3 processes, Ozonation, Fenton processes, Ultrasound processes and principles of sonochemistry.

UNIT III

UNIT IV
AOP processes for water and wastewater treatment, Photoelectrocatalysis process: photooxidation reactions, photo-initiated oxidations, photomineralization of organic matter in water and air, aqueous systems, sonocatalysis, heterogeneous and homogeneous photocatalysis and kinetic studies, biodegradability and toxicological studies.

UNIT V
Application of AOPs for VOC reduction, biologically toxic or non-degradable and odour treatment, case studies – textile, pharmaceutical and petroleum and petrochemical industries.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
The students will be able to

CO1: Understand the fundamentals of AOP.
CO2: Understand the various AOP methods and its principle.
CO3: Understand the basic mechanism of AOP reaction.
CO4: Understand the fundamentals of semiconductor photolysis.
CO5: Understand the various AOP process for treating organic matter in water.
CO6: Application of AOP in treating non degradable waste.

TEXT BOOKS

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1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
OBJECTIVE

- Students will learn different types of electrochemical reactors, wastewater characteristic, and Electrochemical techniques to treat the gas, liquid and soil pollutant.

UNIT I
Definition and classification of pollutants, Physical and chemical Characteristics of wastewater, method of pollutants analysis role of sensors in environmental pollution. Introduction to Electro chemistry and Electrochemical Engineering. Electrochemical potential- Butler-Volmer, Tafel equation

UNIT II

UNIT III
Comparison of Chemical and Electrochemical Process- Production of hydrogen by water electrolysis, current efficiency, selectivity and energy consumption for electro organic synthesis. Photo-electrochemical cells for conversion of light energy to electrical energy- Photo electrochemical Conversion mechanism. Pollutant treatment using photo electrochemical reactor.

UNIT IV
Electrochemical reactors; two dimensional and three dimensional electrodes; Tank cell- Filter press cell-Packed bed – Fluidized bed electrochemical reactor-Applications; Batch; Continuous Stirred Tank Electrochemical Reactor and Plug flow electrochemical Reactor- Design Equation. Modeling of batch with recirculation, Electro oxidation-Electro coagulation, Application of electrochemical reactors for waste water Treatment.

UNIT V
Materials for electrochemical treatment, electrodes used in different types of industries. Membrane assisted process, electro dialysis and electrochemical ion exchange process, electro osmosis. Membrane assisted electrochemical process for pollutant treatment, Electro winning process.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
The students will be able to

CO1: Understand the Physical and chemical Characteristics of wastewater and their measurement.

CO2: Understand the electrochemical engineering concept to treat the industrial pollutants.

CO3: Understand the various pollutant treatment techniques.

CO4: Understand the various electrochemical reactors for pollutant treatment process.

CO5: Understand the photo electrochemical method for pollutant treatment.

CO6: Understand the membrane based electrochemical process for pollutant treatment.
REFERENCES
## Course Articulation Matrix:

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1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
OPEN ELECTIVE COURSES (OEC)

OE5091 BUSINESS DATA ANALYTICS

OBJECTIVES:
- To understand the basics of business analytics and its life cycle.
- To gain knowledge about fundamental business analytics.
- To learn modeling for uncertainty and statistical inference.
- To understand analytics using Hadoop and Map Reduce frameworks.
- To acquire insight on other analytical frameworks.

UNIT I  OVERVIEW OF BUSINESS ANALYTICS


Suggested Activities:
- Case studies on applications involving business analytics.
- Converting real time decision making problems into hypothesis.
- Group discussion on entrepreneurial opportunities in Business Analytics.

Suggested Evaluation Methods:
- Assignment on business scenario and business analytical life cycle process.
- Group presentation on big data applications with societal need.
- Quiz on case studies.

UNIT II  ESSENTIALS OF BUSINESS ANALYTICS


Suggested Activities:
- Solve numerical problems on basic statistics.
- Explore chart wizard in MS Excel Case using sample real time data for data visualization.
- Use R tool for data visualization.

Suggested Evaluation Methods:
- Assignment on descriptive analytics using benchmark data.
- Quiz on data visualization for univariate, bivariate data.

UNIT III  MODELING UNCERTAINTY AND STATISTICAL INFERENCE


Suggested Activities:
- Solving numerical problems in sampling, probability, probability distributions and hypothesis testing.
- Converting real time decision making problems into hypothesis.

Suggested Evaluation Methods:
- Assignments on hypothesis testing.
- Group presentation on real time applications involving data sampling and hypothesis testing.
UNIT IV  ANALYTICS USING HADOOP AND MAPREDUCE FRAMEWORK


Suggested Activities:
- Practical – Install and configure Hadoop.
- Practical – Use web based tools to monitor Hadoop setup.
- Practical – Design and develop MapReduce tasks for word count, searching involving text corpus etc.

Suggested Evaluation Methods:
- Evaluation of the practical implementations.
- Quizzes on topics like HDFS and extensions to MapReduce.

UNIT V  OTHER DATA ANALYTICAL FRAMEWORKS

Overview of Application development Languages for Hadoop – PigLatin – Hive – Hive Query Language (HQL) – Introduction to Pentaho, JAQL – Introduction to Apache: Sqoop, Drill and Spark, Cloudera Impala – Introduction to NoSQL Databases – Hbase and MongoDB.

Suggested Activities:
- Practical – Installation of NoSQL database like MongoDB.
- Practical – Demonstration on Sharding in MongoDB.
- Practical – Install and run Pig
- Practical – Write PigLatin scripts to sort, group, join, project, and filter data.
- Design and develop algorithms to be executed in MapReduce involving numerical methods for analytics.

Suggested Evaluation Methods:
- Mini Project (Group) – Real time data collection, saving in NoSQL, implement analytical techniques using Map-Reduce Tasks and Result Projection.

OUTCOMES:
On completion of the course, the student will be able to:
- Identify the real world business problems and model with analytical solutions.
- Solve analytical problem with relevant mathematics background knowledge.
- Convert any real world decision making problem to hypothesis and apply suitable statistical testing.
- Write and Demonstrate simple applications involving analytics using Hadoop and MapReduce
- Use open source frameworks for modeling and storing data.
- Apply suitable visualization technique using R for visualizing voluminous data.

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OBJECTIVES:
- Summarize basics of industrial safety
- Describe fundamentals of maintenance engineering
- Explain wear and corrosion
- Illustrate fault tracing
- Identify preventive and periodic maintenance

UNIT I INTRODUCTION
Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc. Safety color codes. Fire prevention and firefighting, equipment and methods.

UNIT II FUNDAMENTALS OF MAINTENANCE ENGINEERING
Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

UNIT III WEAR AND CORROSION AND THEIR PREVENTION

UNIT IV FAULT TRACING
Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment’s like, i. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.

UNIT V PERIODIC AND PREVENTIVE MAINTENANCE
Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance

OUTCOMES:
CO1: Ability to summarize basics of industrial safety
CO2: Ability to describe fundamentals of maintenance engineering
CO3: Ability to explain wear and corrosion
CO4: Ability to illustrate fault tracing
CO5: Ability to identify preventive and periodic maintenance

TOTAL: 45 PERIODS
REFERENCES:

OE5093 OPERATIONS RESEARCH LT P C
3 0 0 3

OBJECTIVES:
- Solve linear programming problem and solve using graphical method.
- Solve LPP using simplex method
- Solve transportation , assignment problems
- Solve project management problems
- Solve scheduling problems

UNIT I LINEAR PROGRAMMING
Introduction to Operations Research – assumptions of linear programming problems - Formulations of linear programming problem – Graphical method

UNIT II ADVANCES IN LINEAR PROGRAMMING
Solutions to LPP using simplex algorithm- Revised simplex method - primal dual relationships – Dual simplex algorithm - Sensitivity analysis

UNIT III NETWORK ANALYSIS – I
Transportation problems -Northwest corner rule, least cost method,Voges’s approximation method - Assignment problem -Hungarian algorithm

UNIT IV NETWORK ANALYSIS – II
Shortest path problem: Dijkstra’s algorithms, Floyds algorithm, systematic method -CPM/PERT

UNIT V NETWORK ANALYSIS – III
Scheduling and sequencing - single server and multiple server models - deterministic inventory models - Probabilistic inventory control models

TOTAL: 45 PERIODS

OUTCOMES:
CO1: To formulate linear programming problem and solve using graphical method.
CO2: To solve LPP using simplex method
CO3: To formulate and solve transportation, assignment problems
CO4: To solve project management problems
CO5: To solve scheduling problems

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OE5094  
COST MANAGEMENT OF ENGINEERING PROJECTS  
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OBJECTIVES:  
- Summarize the costing concepts and their role in decision making  
- Infer the project management concepts and their various aspects in selection  
- Interpret costing concepts with project execution  
- Develop knowledge of costing techniques in service sector and various budgetary control techniques  
- Illustrate with quantitative techniques in cost management  

UNIT I  
INTRODUCTION TO COSTING CONCEPTS  
9  
Objectives of a Costing System; Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost; Creation of a Database for operational control.  

UNIT II  
INTRODUCTION TO PROJECT MANAGEMENT  
9  
Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomerate of technical and nontechnical activities, Detailed Engineering activities, Pre project execution main clearances and documents, Project team: Role of each member, Importance Project site: Data required with significance, Project contracts.  

UNIT III  
PROJECT EXECUTION AND COSTING CONCEPTS  
9  
Project execution Project cost control, Bar charts and Network diagram, Project commissioning: mechanical and process, Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis, Various decision-making problems, Pricing strategies: Pareto Analysis, Target costing, Life Cycle Costing.  

UNIT IV  
COSTING OF SERVICE SECTOR AND BUDGETERY CONTROL  
9  
Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis, Budgetary Control: Flexible Budgets; Performance budgets; Zero-based budgets.  

UNIT V  
QUANTITATIVE TECHNIQUES FOR COST MANAGEMENT  
9  
Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Learning Curve Theory.  

TOTAL: 45 PERIODS
OUTCOMES
CO1 – Understand the costing concepts and their role in decision making
CO2 – Understand the project management concepts and their various aspects in selection
CO3 – Interpret costing concepts with project execution
CO4 – Gain knowledge of costing techniques in service sector and various budgetary control techniques
CO5 – Become familiar with quantitative techniques in cost management

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REFERENCES:
2. Charles T. Horngren and George Foster, Advanced Management Accounting, 1988

OE5095  COMPOSITE MATERIALS  L T P C

OBJECTIVES:
- Summarize the characteristics of composite materials and effect of reinforcement in composite materials.
- Identify the various reinforcements used in composite materials.
- Compare the manufacturing process of metal matrix composites.
- Understand the manufacturing processes of polymer matrix composites.
- Analyze the strength of composite materials.

UNIT I  INTRODUCTION  9
Definition – Classification and characteristics of Composite materials - Advantages and application of composites - Functional requirements of reinforcement and matrix - Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.

UNIT II REINFORCEMENTS  9
Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers - Properties and applications of whiskers, particle reinforcements - Mechanical Behavior of composites: Rule of mixtures, Inverse rule of mixtures - Isostrain and Isostress conditions.

UNIT III MANUFACTURING OF METAL MATRIX COMPOSITES  9
UNIT IV  MANUFACTURING OF POLYMER MATRIX COMPOSITES

UNIT V  STRENGTH
Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygrothermal failure. Laminate first play failure-insight strength; Laminate strength- ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations.

TOTAL: 45 PERIODS

OUTCOMES:
- CO1 - Know the characteristics of composite materials and effect of reinforcement in composite materials.
- CO2 – Know the various reinforcements used in composite materials.
- CO3 – Understand the manufacturing processes of metal matrix composites.
- CO4 – Understand the manufacturing processes of polymer matrix composites.
- CO5 – Analyze the strength of composite materials.

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REFERENCES:
OBJECTIVES:
- Interpret the various types of wastes from which energy can be generated
- Develop knowledge on biomass pyrolysis process and its applications
- Develop knowledge on various types of biomass gasifiers and their operations
- Invent knowledge on biomass combustors and its applications on generating energy
- Summarize the principles of bio-energy systems and their features

UNIT I INTRODUCTION TO EXTRACTION OF ENERGY FROM WASTE
Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors

UNIT II BIOMASS PYROLYSIS
Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.

UNIT III BIOMASS GASIFICATION

UNIT IV BIOMASS COMBUSTION
Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

UNIT V BIO ENERGY
Properties of biogas (Calorific value and composition), Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production -Urban waste to energy conversion - Biomass energy programme in India.

TOTAL: 45 PERIODS

OUTCOMES:
CO1 – Understand the various types of wastes from which energy can be generated
CO2 – Gain knowledge on biomass pyrolysis process and its applications
CO3 – Develop knowledge on various types of biomass gasifiers and their operations
CO4 – Gain knowledge on biomass combustors and its applications on generating energy
CO5 – Understand the principles of bio-energy systems and their features

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AUDIT COURSES (AC)

AX5091  ENGLISH FOR RESEARCH PAPER WRITING  L T P C

2 0 0 0

OBJECTIVES

- Teach how to improve writing skills and level of readability
- Tell about what to write in each section
- Summarize the skills needed when writing a Title
- Infer the skills needed when writing the Conclusion
- Ensure the quality of paper at very first-time submission

UNIT I  INTRODUCTION TO RESEARCH PAPER WRITING  6
Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

UNIT II  PRESENTATION SKILLS  6

UNIT III  TITLE WRITING SKILLS  6
Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check

UNIT IV  RESULT WRITING SKILLS  6
Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions

UNIT V  VERIFICATION SKILLS  6
Useful phrases, checking Plagiarism, how to ensure paper is as good as it could possibly be the first-time submission

TOTAL: 30 PERIODS

OUTCOMES

CO1 – Understand that how to improve your writing skills and level of readability
CO2 – Learn about what to write in each section
CO3 – Understand the skills needed when writing a Title
CO4 – Understand the skills needed when writing the Conclusion
CO5 – Ensure the good quality of paper at very first-time submission

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OBJECTIVES

- Summarize basics of disaster
- Explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- Illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- Describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- Develop the strengths and weaknesses of disaster management approaches

UNIT I   INTRODUCTION 6
Disaster: Definition, Factors and Significance; Difference between Hazard And Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

UNIT II   REPERCUSSIONS OF DISASTERS AND HAZARDS 6

UNIT III   DISASTER PRONE AREAS IN INDIA 6
Study of Seismic Zones: Areas Prone To Floods and Droughts, Landslides And Avalanches; Areas Prone To Cyclonic and Coastal Hazards with Special Reference To Tsunami; Post-Disaster Diseases and Epidemics

UNIT IV   DISASTER PREPAREDNESS AND MANAGEMENT 6
Preparedness: Monitoring Of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological And Other Agencies, Media Reports: Governmental and Community Preparedness.

UNIT V   RISK ASSESSMENT 6
Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People’s Participation in Risk Assessment. Strategies for Survival

TOTAL: 30 PERIODS

OUTCOMES

CO1: Ability to summarize basics of disaster
CO2: Ability to explain critical understanding of key concepts in disaster risk reduction and humanitarian response.
CO3: Ability to illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
CO4: Ability to describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
CO5: Ability to develop the strengths and weaknesses of disaster management approaches

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AX5093 SANSKRIT FOR TECHNICAL KNOWLEDGE L T P C 2 0 0 0

OBJECTIVES
- Illustrate the basic sanskrit language.
- Recognize sanskrit, the scientific language in the world.
- Appraise learning of sanskrit to improve brain functioning.
- Relate sanskrit to develop the logic in mathematics, science & other subjects enhancing the memory power.
- Extract huge knowledge from ancient literature.

UNIT I ALPHABETS 6
Alphabets in Sanskrit

UNIT II TENSES AND SENTENCES 6
Past/Present/Future Tense - Simple Sentences

UNIT III ORDER AND ROOTS 6
Order - Introduction of roots

UNIT IV SANSKRIT LITERATURE 6
Technical information about Sanskrit Literature

UNIT V TECHNICAL CONCEPTS OF ENGINEERING 6
Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics

TOTAL: 30 PERIODS

OUTCOMES
- CO1 - Understanding basic Sanskrit language.
- CO2 - Write sentences.
- CO3 - Know the order and roots of Sanskrit.
- CO4 - Know about technical information about Sanskrit literature.
- CO5 - Understand the technical concepts of Engineering.

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REFERENCES
1. “Abhyaspustakam” – Dr. Vishwas, Samskrita-Bharti Publication, New Delhi
2. “Teach Yourself Sanskrit” Prathama Deeksha-Vempati Kutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication
OBJECTIVES
Students will be able to
• Understand value of education and self-development
• Imbibe good values in students
• Let the should know about the importance of character

UNIT I
Values and self-development—Social values and individual attitudes.
Workethics, Indian vision of humanism. Moral and non-moral valuation. Standards and principles. Value judgements

UNIT II
Truthfulness, Cleanliness. Honesty, Humanity. Power of faith, National Unity. Patriotism. Love for nature, 
Discipline

UNIT III
Personality and Behavior Development—Soul and Scientific attitude. Positive Thinking. Integrity and 
Universal brotherhood and religious tolerance. True friendship. Happiness Vs suffering, love for truth. 

UNIT IV
Character and Competence—Holy books vs Blind faith. Self-management and Good health. Science of 
reincarnation. Equality, Nonviolence, Humility, Role of Women. All religions and same message. Mind 
your Mind, Self-control. Honesty, Studying effectively.

OUTCOMES
Students will be able to
• Knowledge of self-development.
• Learn the importance of Human values.
• Developing the over all personality.

Suggested reading
Press, New Delhi
OBJECTIVES
Students will be able to:
- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- To address the growth of Indian opinion regarding modern Indian intellectuals’ constitutional role and entitlement to civil and economic rights as well as the emergence nationhood in the early years of Indian nationalism.
- To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.

UNIT I HISTORY OF MAKING OF THE INDIAN CONSTITUTION:
History, Drafting Committee, (Composition & Working)

UNIT II PHILOSOPHY OF THE INDIAN CONSTITUTION:
Preamble, Salient Features

UNIT III CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES:

UNIT IV ORGANS OF GOVERNANCE:
Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.

UNIT V LOCAL ADMINISTRATION:

UNIT VI ELECTION COMMISSION:
Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners - Institute and Bodies for the welfare of SC/ST/OBC and women.

OUTCOMES
Students will be able to:
- Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
- Discuss the intellectual origin of the framework of argument that informed the conceptualization of social reform sliding to revolution in India.
- Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
- Discuss the passage of the Hindu Code Bill of 1956.

Suggested reading
1. The Constitution of India, 1950 (Bare Act), Government Publication.
OBJECTIVES
Students will be able to:
• Review existing evidence on there view topic to inform programme design and policy
• Making under taken by the DfID, other agencies and researchers.
• Identify critical evidence gaps to guide the development.

UNIT I INTRODUCTION AND METHODOLOGY:
Aims and rationale, Policy background, Conceptual framework and terminology - Theories of learning, Curriculum, Teacher education - Conceptual framework, Research questions - Overview of methodology and Searching.

UNIT II THEMATIC OVERVIEW
Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries - Curriculum, Teacher education.

UNIT III EVIDENCE ON THE EFFECTIVENESS OF PEDAGOGICAL PRACTICES
Methodology for the in depth stage: quality assessment of included studies - How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? - Theory of change - Strength and nature of the body of evidence for effective pedagogical practices - Pedagogic theory and pedagogical approaches - Teachers’ attitudes and beliefs and Pedagogic strategies.

UNIT IV PROFESSIONAL DEVELOPMENT
Professional development: alignment with classroom practices and follow up support - Peer support - Support from the head teacher and the community - Curriculum and assessment - Barriers to learning: limited resources and large class sizes.

UNIT V RESEARCH GAPS AND FUTURE DIRECTIONS
Research design – Contexts – Pedagogy - Teacher education - Curriculum and assessment - Dissemination and research impact.

TOTAL: 30 PERIODS

OUTCOMES
Students will be able to understand:
• What pedagogical practices are being used by teachers in formal and informal classrooms in developing countries?
• What is the evidence on the effectiveness of pedagogical practices, in what conditions, and with what population of learners?
• How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?
**Suggested reading**

**AX5097**

**STRESS MANAGEMENT BY YOGA**

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**OBJECTIVES**
- To achieve overall health of body and mind
- To overcome stress

**UNIT I**
Definitions of Eight parts of yoga.(Ashtanga)

**UNIT II**
Yam and Niyam - Do’s and Don’t’sin life - i) Ahinsa, satya, astheya, bramhacharya and aparigraha, ii) Ahinsa, satya, astheya, bramhacharya and aparigraha.

**UNIT III**
Asan and Pranayam - Various yog poses and their benefits for mind & body - Regularization of breathing techniques and its effects-Types of pranayam

**TOTAL: 30 PERIODS**

**OUTCOMES**
Students will be able to:
- Develop healthy mind in a healthy body thus improving social health also
- Improve efficiency

**SUGGESTED READING**
1. ‘YogicAsanasforGroupTarining-Part-I”:JanardanSwamiYogabhyasiMandal, Nagpur
2. “Rajayogaorconquering the Internal Nature” by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata
OBJECTIVES

- To learn to achieve the highest goal happily
- To become a person with stable mind, pleasing personality and determination
- To a waken wisdom in students

UNIT I
Neetishatakam-holistic development of personality - Verses- 19,20,21,22 (wisdom) - Verses- 29,31,32 (pride & heroism) – Verses- 26,28,63,65 (virtue) - Verses- 52,53,59 (don't's) - Verses- 71,73,75,78 (do's)

UNIT II
Approach to day to day work and duties - Shrimad BhagwadGeeta: Chapter 2-Verses 41, 47,48 - Chapter 3-Verses 13, 21, 27, 35 Chapter 6-Verses 5,13,17,23, 35 - Chapter 18-Verses 45, 46, 48.

UNIT III
Statements of basic knowledge - Shrimad BhagadGeeta: Chapter2-Verses 56, 62, 68 Chapter 12 - Verses 13, 14, 15, 16,17, 18 -Personality of role model - shrimadbhagwadgeeta - Chapter2-Verses 17, Chapter 3-Verses 36,37,42 - Chapter 4-Verses 18, 38,39 Chapter18 – Verses 37,38,63

OUTCOMES
Students will be able to

- Study of Shrimad- Bhagwad- Geeta will help the student in developing his personality and achieve the highest goal in life
- The person who has studied Geeta will lead the nation and man kind to peace and prosperity
- Study of Neetishatakam will help in developing versatile personality of students.

Suggested reading
1. Gopinath, Rashtriya Sanskrit Sansthanam P, Bharthiari’s Three Satakam, Niti-sringar-vairagya, New Delhi,2010