

**DELHI TECHNOLOGICAL UNIVERSITY**

**SCHEME OF TEACHING AND EVALUATION**

**MASTER OF TECHNOLOGY IN ENVIRONMENTAL ENGINEERING ( ENE )**

The following alphanumeric coding scheme has been adopted: Core Courses XXXYMN; Elective Courses XXXYCMN  
 XXX abbreviates a particular M. Tech. program, Y – (5 for M. Tech. 1st year, 6 for M. Tech. 2nd year); C – credit of the course (4/3/2); MN – Subject code (Odd number for odd semester and even number for even semester courses)

Semester-I														
	S. No.	Course Code	Course Name	Type/ Area	Cr	L	T	P	CWS	PRS	MTE	ETE	PRE	Total Credits
Group A	1	ENE501	Water Pollution	Core	4	3	0	2	15	25	20	40	-	17
	2	ENE503	Air Pollution & Control	Core	4	3	0	2	15	25	20	40	-	
Group B	3	ENE5401/5403/.....	Elective 1	Elective	4	3/4	0	2/0	15/20	25/0	20/30	40/50	-	
	4	ENE5301/5303/.....	Elective 2	Elective	3	3/2	0	0/2	20/15	0/25	30/20	50/40	-	
	5	ENE5201/5203/...../ UEC5201/5203/.....	Elective 3/University Elective I	Elective	2	2	0	0	20	-	30	50	-	
Semester-II														
	S. No.	Course Code	Course Name	Type/ Area	Cr	L	T	P	CWS	PRS	MTE	ETE	PRE	Total Credits
Group C	1	ENE502	Water Engineering Design	Core	4	3	0	2	15	25	20	40	-	17
	2	ENE504	Solid Waste Management	Core	4	3	0	2	15	25	20	40	-	
Group D	3	ENE5402/5404/5406	Elective 4	Elective	4	3/4	0	2/0	15/20	25/0	20/30	40/50	-	
	4	ENE5302/5304/.....	Elective 5	Elective	3	3	0	0	20	-	30	50	-	
	5	ENE5202/5204/...../ UEC5202/5204/.....	Elective 6/University Elective II	Elective	2	2	0	0	20	-	30	50	-	

Semester-III															
	S. No.	Course Code	Course Name	Type/Area	Cr	L	T	P	CWS	PRS	MTE	ETE	PRE	Total Credits	
	<b>Track 1</b>													<b>12</b>	
<b>Group E</b>	1	ENE651	Research Project	Core	12	0	0	12	0	-	0	100	0		
	<b>Track 2</b>														
	1	ENE601	Major Project I	Core	3						40	60			<b>12</b>
	2	ENE6401/6403/.....	Elective 7	Elective	4	3/4	0	2/0	15/20	25/0	20/30	40/50	-		
	3	ENE6301/6303/.....	Elective 8	Elective	3	3/2	0	0/2	20/15	0/25	30/20	50/40	-		
4	ENE6201/6203/.....	Elective 9	Elective	2	2	0	0	20	-	30	50	-			
Semester-IV															
	S. No.	Course Code	Course Name	Type/Area	Cr	L	T	P	CWS	PRS	MTE	ETE	PRE	Total Credits	
<b>Group F</b>	<b>Track 1</b>														
	1	ENE652	Research Project	Core	12	0	0	12	0	-	0	100	0	<b>12</b>	
	<b>Track 2</b>														
	1	ENE602	Major Project II	Core	12	0	0	12	0	-	0	100	0	<b>12</b>	

## LIST OF ELECTIVES

	S.No.	Course Code	Course Name	Type/Area	Cr	L	T	P	CWS	PRS	MTE	ETE	PRE
<b>Elective 1</b>	1	ENE5401	Industrial Wastewater Treatment	Elective	4	3	0	2	15	25	20	40	-
	2	ENE5403	Planning & Design of Environmental Services		4	4	0	0	20	-	30	50	-
	3	ENE5405	Groundwater & Seepage		4	4	0	0	20	-	30	50	-
	S. No.	Course Code	Course Name	Type/Area	Cr	L	T	P	CWS	PRS	MTE	ETE	PRE
<b>Elective 2</b>	1	ENE5301	Environmental Chemistry & Microbiology	Elective	3	2	0	2	15	25	20	40	-
	2	ENE5303	Occupational Safety & Health		3	3	0	0	20	-	30	50	-
	3	ENE5305	Instrumentation		3	2	0	2	15	25	20	40	-
	S. No.	Course Code	Course Name	Type/Area	Cr	L	T	P	CWS	PRS	MTE	ETE	PRE
	1	ENE5201	SEMINAR		2	0	0	2	-	100	-	-	-
<b>Elective 3</b>	2	ENE5203	Advanced Mathematics & Statistics	Elective	2	2	0	0	20	-	30	50	-
	3	ENE5205	Design of Hydraulic Structures		2	2	0	0	20	-	30	50	-
	S. No.	Course Code	Course Name	Type/Area	Cr	L	T	P	CWS	PRS	MTE	ETE	PRE
<b>Elective 4</b>	1	ENE5402	Global Warming & Climate Change	Elective	4	4	0	0	20	-	30	50	-
	2	ENE5404	Waste Containment & Remediation Technology		4	3	0	2	15	25	20	40	-
	3	ENE5406	Environmental Planning & Management		4	4	0	0	20	-	30	50	-
	S. No.	Course Code	Course Name	Type/Area	Cr	L	T	P	CWS	PRS	MTE	ETE	PRE

<b>Elective 5</b>	1	ENE5302	MINOR PROJECT	Elective	3	0	0	-	-	40	-	-	60
	2	ENE5304	Environmental Monitoring & Assessment		3	3	0	0	20	-	30	50	-
	3	ENE5306	Green Technology & Sustainability		3	3	0	0	20	-	30	50	-
	<b>S.No.</b>	<b>Course Code</b>	<b>Course Name</b>	<b>Type/Area</b>	<b>Cr</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>CWS</b>	<b>PRS</b>	<b>MTE</b>	<b>ETE</b>	<b>PRE</b>
<b>Elective 6</b>			Environmental Policy & Law	Elective									
	1	ENE5202			2	2	0	0	20	-	30	50	-
	<b>S.No.</b>	<b>Course Code</b>	<b>Course Name</b>	<b>Type/Area</b>	<b>Cr</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>CWS</b>	<b>PRS</b>	<b>MTE</b>	<b>ETE</b>	<b>PRE</b>
<b>Elective 7</b>	1	ENE6401	Environment Impact Assessment & Audit	Elective	4	4	0	0	20	-	30	50	-
	2	ENE6403	Remote Sensing & GIS		4	3	0	2	15	25	20	40	-
	<b>S.No.</b>	<b>Course Code</b>	<b>Course Name</b>	<b>Type/Area</b>	<b>Cr</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>CWS</b>	<b>PRS</b>	<b>MTE</b>	<b>ETE</b>	<b>PRE</b>
<b>Elective 8</b>	1	ENE6301	Air Quality Modeling	Elective	3	2	0	2	15	25	20	40	-
	2	ENE6303	Life Cycle Assessment		3	3	0	0	20	-	30	50	-
		<b>S.No.</b>	<b>Course Code</b>	<b>Course Name</b>	<b>Type/Area</b>	<b>Cr</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>CWS</b>	<b>PRS</b>	<b>MTE</b>	<b>ETE</b>
<b>Elective 9</b>	1	ENE6201	Hazardous Waste Management	Elective	2	2	0	0	20	-	30	50	-
	2	ENE6203	Bioremediation		2	2	0	0	20	-	30	50	-

## SEMESTER I

### **ENE501      Water Pollution**

Water quality, Detection and measurement of water pollution, stream surveillance, standards and criteria of water quality, water quality management for different uses, Eutrophication and its control strategies, heavy metal pollution and its remediation, Modelling approaches to water quality, River Water quality modelling; modelling in lakes and reservoirs, Modelling of DO in streams, models for microbial decay, Disposal of waste water, Management of Water Pollution

#### **Suggested Books:**

1. Manahan, Environmental Chemistry, CRC Press Book
2. Sawyer, McCarty, and Parkin, Environmental Engineering, McGraw-Hill
3. Berry WK, Water Pollution, CBS Publishers

### **ENE503      Air Pollution & Control**

Definition, Sources of air pollution, air pollution measurement, estimation of air pollution sources, effects of air pollution. air quality standards. air pollution meteorology, dispersion of air pollutants. air pollution control equipment: settling chambers. Inertial devices, electrostatic precipitator, scrubbers, fitters, adsorption devices, combustion devices, condensation devices, Basics of acoustics, sound power, sound intensity, sound pressure level, measurement of noise, noise mapping, noise standards, health effects of noise, basic knowledge about noise models, noise control methods.

#### **Suggested Books:**

1. Rao CS, Air Pollution and Control, New Age International Pvt Ltd
  2. Rao and Rao, Air Pollution Control Engineering, McGraw Hill Education
- Nathanson JA, Basic Environmental Technology: Water Supply, Waste management and Pollution Control, Fifth Edition PHI

### **ENE5401      Industrial Wastewater Treatment**

Theories of waste water treatments, combined treatment of raw industrial waste with domestic sewage, volume reduction, strength reduction, Discharge of completely treated waste to Municipal Sewer, discharge of raw waste to stream, standards for discharge of treated wastewater, characteristics and treatment of wastes from the apparel industry, Food processing industries, Material industries, Chemical industries, Energy industries CETP-case studies.

#### **Suggested Books:**

1. Patwardhan AD, Industrial wastewater treatment, PHI Learning Pvt. Ltd.
2. Karia GL & Christian RA Wastewater Treatment, PHI Learning Pvt. Ltd.
3. Arundel J, Sewage and Industrial effluent treatment, Blackwell Science

### **ENE5403 Planning & Design of Environmental Services**

Environment and Human-Activity: Resource, pollution, re-use & management; Land-Use Planning & Management; Water plan optimization & allocation; Design of conveyance system for source and fugitive, Design of cyclone and cyclone scrubbers, venture-scrubbers, packed towers and fabric filters. Design of control for volatile organic carbon compounds; Management of private and public managed utilities, management of water supply and sewerage schemes, Environmental objectives and targets, utilities equipment maintenance and preventive maintenance.

#### **Suggested Books:**

1. Gilbert MM, Introduction to Environmental Engineering and Science, Prentice-Hall of India Pvt. Ltd.
2. Canter, Environmental Impact Assessment, McGraw-Hill
3. Rao & Rao, Air Pollution, Tata McGraw Hill

### **ENE5405 Groundwater & Seepage**

Darcy's law General hydro-dynamic equations, flow nets in isotropic and anisotropic medium. Steady and unsteady flow through confined and non-confined aquifers, Schwartz Christoffel transformation and its application for ground water and seepage problems. Multiple well system, partially penetrating wells, image wells, mutual interference of wells. Storage and exploration of ground water, design, construction and maintenance of wells. Ground water recharge and run off. Water quality, budgeting, simulation of ground water basin. Application of remote sensing for ground water.

#### **Suggested Books:**

1. Cushman & Tartakovsky, The Handbook of groundwater Engineering, CRC Press
2. Milton Edward Harr, Groundwater and Seepage, McGraw-Hill
3. Delleur JW, Handbook of Groundwater Engineering, CRC Press

### **ENE5301 Environmental Chemistry & Microbiology**

Hydrological cycle, unique properties of water, principles of equilibrium chemistry, pH, oxidation-reduction and their application; chemistry of pollution due to detergents, pesticides, polymers, trace organics, metals, hydrocarbons, and

radioactive compounds; chemistry of ozone depletion, smog formation; greenhouse effect; morphology of bacteria, fungi, algae; pure and mixed cultures; microbial growth and dynamics; biodegradation and basic principles of microbial transformation of organic matter; acclimatization of wastes and microbial inhibition mechanisms; Role of microbes in wastewater treatment; Microbiology applied to bio scrubbers and bio filters, bioremediation of contaminated sites-case study.

**Suggested Books:**

1. Manahan, Environmental Chemistry, CRC Press
2. Gilbert MM, Introduction to Environmental Engineering and Science, Prentice-Hall of India Pvt.Ltd
3. Pelczar, Textbook of Microbiology, McGraw-Hill Education

**ENE5303 Occupational Safety & Health**

Definition; Occupational Health and Environmental Safety Management – Principles practices. Common Occupational diseases: Occupational Health Management Services at the work place; ILO and EPA Standards; Industrial Hygiene; Element of training cycle, Assessment of needs; Chemical Hazard;Evaluation and control of basic hazards; Ergonomic Hazards; Bureau of Indian standards on safety and health 14489 - 1998 and 15001 – 2000, OSHA, Process Safety Management (PSM) as per OSHA, PSM principles, OHSAS – 18001, EPA Standards, Performance measurements to determine effectiveness of PSM. Importance of Industrial safety, role of safety department, Safety committee and Function.

**Suggested Books:**

1. Kohn J and Friend MA, Fundamentals of Occupational Safety and Health, Government Institutes Inc.,USA
2. Reese CD, Occupational Health and Safety Management: A Practical Approach (Third Edition)
3. Kelloway, Montgomery, and Francis, Management of Occupational Health and Safety, Nelson College Indigenous Press, 2013

**ENE5305 Instrumentation**

The Significance and Application of Measurement; Functional Elements of Generalized Measuring System; Classification of Measuring Instruments, Standards of Measurement and its classification; Management of Data in quantitative analysis: Accuracy, precision, types of errors, Minimization of error, statistical analysis and curve fittings; Spectro-analytical Methods; Chromatographic Methods; Electro Analytical Methods; Continuous Monitoring instruments and their principles: NDIR for CO, Chemiluminescence analysis for NO<sub>x</sub> and fluorescence analysis for

SO<sub>2</sub>

**Suggested Books:**

1. Khandpur RS, Handbook of Analytical Instruments, McGraw-Hill, 2007
2. Fritschen L, Environmental instrumentation, Springer New York
3. Down RD, Lehr JH, Environmental Instrumentation and Analysis Handbook

**ENE5201 Seminar**

**ENE5203 Advanced Mathematics & Statistics**

Numerical Methods - Partial differential equations, Newton-Raphson method, Finite difference, finite element, method of characteristics, different methods, Successive over relaxation methods. Optimization – classification and importance in Environmental Studies. Single and multivariable optimization without and with constraints. Linear Programming – different methods, linear approximation of non-linear optimization. Statistics - Significance Tests, Frequency Distribution, Characteristics of Distributions, Method of Least Squares and Regression, Multiple Regression. Probability – Concepts, Methods, Binomial, Poisson and Normal distribution, Risk and uncertainty analysis.

**ENE5205 Design of Hydraulic Structures**

Project planning site investigations, choice of type of dams. Cost benefit studies; Non-overflow dams: Gravity, Arch and buttress type, Rock fill and earthen dams, their design, stress analysis, stress concentration around openings; Different types of spillways and energy dissipaters, their design. Preparation and protection of foundation for dams. Model analysis of Hydraulic structures. Instrumentation in dams. Temperature control in concrete dams.

**Suggested Books:**

1. Keshri DN, Analysis and Design of Hydraulic Structures, JBC Press
2. Balasubramanya N, Hydraulic Structures & Irrigation Design Drawing, Sapna Book House

**SEMESTER II**

**ENE502 Water Engineering Design**

Sources of water, necessity of treatment, Critical Water quality parameters, water quality guidelines and standards; Principles and design of aeration systems – two film theory, water in air system, air in water system. Intake structures – Different types, design criteria. Principles of sedimentation; design criteria and design of settling tanks. Principle of Coagulation and Flocculation- coagulation theory, design criteria and numerical examples. Filtration - theory of



granular media filtration; Classification of filters; Adsorption; Disinfection; Water Softening; Fluoridation and defluorination; Ion Exchange-processes; Membrane Processes, Reverse osmosis; Ultrafiltration; Electrodialysis; distribution: design of various components of the distribution system. Design of the units of Water Treatment Plant

**Suggested Books:**

1. Davis ML, Water and Wastewater Engineering: Design Principles and Practice, McGraw Hill
2. Metcalf & Eddy Inc., Wastewater Engineering: Treatment and Reuse, McGraw Hill
3. Garg SK, Water Supply Engineering: Environmental Engineering - Vol. I, Khanna Publisher

**ENE504 Solid Waste Management**

Definition; Sources; Composition & Properties of Municipal solid waste. Handling & Separation of solid waste, Municipal Waste (Management & Handling Rules, 2000), Integrated solid waste management (SWM) System, Hierarchical approach for SWM; Solid waste generation; Solid Waste Collection & Transportation; Waste handling and separation; Methods of Disposal of Municipal Solid Waste; Landfills: Site selection, Site preparation, Generation, & Control of Landfill gases; Movement & control of leachate; landfill design; Long term post closure plan, Groundwater monitoring during & after closure; Transformation and recycling of waste materials; Composting; Recovery of bioenergy from organic waste. Thermal Conversion Technologies: Incineration, Pyrolysis & Gasification Systems.

**Suggested Books:**

1. Kreith F and Tchobanoglous G, Handbook of Solid Waste Management, McGraw Hill
2. McBean, Rovers, and Farquhar Solid Waste Landfill Engineering and Design, Prentice Hall Ptr

**ENE5402 Global warming & Climate Change**

Introduction to Climate Change , Climate feedback, Green-House Effect, Green House Gases (GHGs) and their Emission Sources, Quantification of CO<sub>2</sub> Emission, Indicators of global warming, Global Warming Potential (GWP) of GHGs, Modelling Climate change, Ozone layer depletion and its control, Impacts of climate change – Global and India, Temperature Rise, Sea Level rise, Coastal Erosion and landslides, Coastal Flooding, Kyoto Protocol – Importance, Significance and its role in Climate Change, Carbon Trading - Mechanisms , Various Models (European, Indian) Global and Indian Scenario, Clean Development Mechanisms – Various Projects related to CO<sub>2</sub> Emission Reduction, Carbon Sequestration – Conventional and non-conventional techniques, Role of Countries and Citizens in Global Warming.

**Suggested Books:**

1. Drake F, Global Warming: The Science of Climate Change - 1st Edition, CRC Press
2. Romm JJ, Climate Change: What Everyone Needs to Know, Oxford University Press

**ENE5404 Waste Containment & Remediation Technology**

Sources of subsurface contamination, Mechanisms of Soil contamination; Physical-chemical and biological interactions in soils; Effect of contamination on geotechnical properties; Waste disposal on land, Site selection, Leachate and Gas Generation, Waste characterization, waste containment principles; Types of Landfills, natural attenuation landfill, Containment landfills, liner material and design of landfill elements; Landfill construction, operation and performance monitoring. Environmental monitoring around landfills; Detection, control and remediation of subsurface contamination, Various types of barrier systems; Reclamation of contaminated sites-Case Studies.

**Suggested Books:**

1. Reddy KR, Geoenvironmental Engineering: Site Remediation, Waste Containment, and Emerging Waste Management Technologies, Wiley Publisher
2. Yong RN, Geoenvironmental Engineering, Thomas Telford Ltd.
3. Kreith F and Tchobanoglous G, Handbook of Solid Waste Management, McGraw-Hill Education

**ENE5406 Environmental Planning & Management**

Environment and Sustainable Development - carrying capacity, relationship with quality of life, carrying capacity and resource utilization. Engineering Methodology in Planning and its Limitations – carrying capacity based short and long-term regional planning. Environmental Protection - Economic development and social welfare consideration in socio economic developmental policies and planning. Total cost of development and environmental protection cost. Case studies on Regional carrying capacity. Engineering Economics – Value Engineering, Time Value of Money, Cash Flows, Budgeting and Accounting. Environmental Economics: Introduction, economic tools for evaluation, Green GDP, Cleaner development mechanisms and their applications. Environmental Audit – methods, procedure, reporting and case studies.

**Suggested Books:**

1. McDonough and Braungart, Cradle to Cradle: Remaking the Way We make Things, North Point Press
2. Smith S, Environmental Economics, Oxford University Press

**ENE5302     Minor Project**

**ENE5304     Environmental Monitoring & Assessment**

Introduction to multi-media sampling techniques and analytical methods for evaluation outdoor/indoor air, soil/surfaces, and water; environmental science and industrial hygiene approaches for anticipating, recognizing, evaluating, and controlling hazards, with the primary focus on recognition and evaluation of contaminants, including data interpretation for risk reduction and regulatory compliance; environmental investigative techniques, instrument selection, and quality control, documentation, calibration, and sample management.

**Suggested Books:**

1. Cohrssen, Draggan, and Morrison, Environmental Monitoring, Assessment, and Management, Praeger Publisher, 1987
2. Shukla and Srivastava, Methodology of Environmental Monitoring and Assessment, Commonwealth Publishers

**ENE5306     Green Technology & Sustainability**

Introduction of Green protocol: Need, Goal and Limitation of Green Technology, Principles of Green Technology with their explanations and examples. Green Innovation & Sustainability: Criteria for choosing appropriate green energy technologies, life cycle cost; the emerging trends – process/product innovation, technological/environmental leap-frogging; Eco/green technologies for addressing the problems of Water, Energy, Health, Agriculture and Biodiversity- WEHAB (eco-restoration/ phyto-remediation, ecological sanitation, renewable energy technologies, industrial ecology, agroecology and other appropriate green technologies); design for sustainability; Environmental reporting and ISO 14001; climate change business and ISO 14064; green financing; financial initiative by UNEP; green energy management; green product management.

**Suggested Books:**

1. Sivasubramanian V, Environmental Sustainability Using Green Technologies, CRC Press
2. Arceivala SJ, Green Technologies, Tata McGraw Hill 2014

3. Sharma SK, Green Chemistry for Environmental Sustainability, CRC Press

**ENE5202 Environmental Policy & Law**

Introduction to environmental laws in India; Constitutional provisions, Stockholm conference; Bhopal gas tragedy; Rio conference. General principles in Environmental law: Precautionary principle; Polluter pays principle; Sustainable development; Overview of legislations and basic concepts; Water Act, 1974; Water Cess Act, 1977; Legal framework on Air pollution: Air Act,1981; Environment Act, 1986; Rules and guidelines under Environment Act.

**Suggested Books:**

1. Bishnoi, Malik, and Garg Introductory Text of Environmental Policies and Laws, Kalyani Publishers 2002
2. Trivedy RK, Handbook of Environmental Laws, Acts, Guidelines, Compliances & Standards, BPV Publications
3. Leelakrishnan P, Environmental Law in India, Butterworths India

**SEMESTER III**

**ENE651 Research Track I**

**ENE601 Project-1**

**ENE6401 Environmental Impact Assessment**

Definition and history of environmental impact assessment, related law necessary for EIA, Objectives of Environmental Impact Assessment, Process for EIA, TOR, IEE, Components of EIA Reports; Tools for assessment of environmental impacts: checklist, networks, matrices, overlays, baseline study, scoping & scales, network overlays, index methods. Planning of environmental Factors; Prediction and assessment of impacts on air and noise; soil and land use; water quantity and quality; Mitigation and Monitoring process for environmental impact assessment; Environmental Auditing, Impact Analysis of hydropower projects.

**Suggested Books:**

1. Glasson J, Introduction to Environmental Impact Assessment, Routledge Publishers 2012 (4<sup>th</sup> Edition)
2. Canter L, Environmental Impact Assessment, McGraw Hill 2014

3. Noble B, Introduction to Environmental Impact Assessment: A Guide to Principles and Practice, Oxford University Press 2015
4. Shrivastava AK, Environment Impact Assessment, APH Publishing Corporation

### **ENE6403 Remote Sensing & GIS**

Fundamentals of Remote Sensing, Ideal Remote Sensing System, Types of Sensors, Remote Sensing Satellite – IRS and INSAT specifications, Applications of remote sensing, Digital image processing and image interpretation, GIS: Principles and applications, Components of GIS, GIS Data and Types, Sources of data, Global Positioning System (GPS), Integration of Remote Sensing and GIS, Optimal Routing of Solid wastes using GIS – Case Study. Environmental Siting of Industries and Zoning Atlas Development. Modelling of Water Distribution System using GIS – Case Study. Sustainable Urban Development Planning using GIS. Environmental Degradation Assessment using RS and GIS. Ground water vulnerability modelling using GIS.

#### **Suggested Books:**

1. Campbell JB, Introduction to Remote Sensing, Guilford Press
2. DeMers MN, Fundamentals of Geographic Information Systems, John Wiley & Sons 2008 (4<sup>th</sup> edition)
3. Reddy MA, Text Book of Remote Sensing and Geographical Information Systems BS Publication

### **ENE6301 Air Quality Modelling**

Introduction to air pollution models. Approaches to model formulation. Criteria for model selection, Application of air pollution models, Air pollution meteorology – meteorological parameters, stability classification, plume rise, plume behaviour, dispersion parameters. Emission factor, factors affecting vehicular emissions, Basic diffusion equation, deterministic, numerical and statistical models. Introduction to boundary layer, turbulence. Physical modelling approach, stochastic modelling approach to air pollution dispersion, Theory of Gaussian plume model and its application. Introduction to indoor air quality models, Case studies.

#### **Suggested Books:**

1. Gordon G, Prentice Hall System Simulation
2. Peavy and Rowe, Environmental Engineering, TMH publications
3. Pal AS, Air Pollution Meteorology and Dispersion, Oxford University Press

### **ENE6303 Life Cycle Assessment**

The fundamental concepts related to interaction of industrial and environmental/ecological systems, sustainability

challenges facing the current generation, and systems-based approaches required to create sustainable solutions for society; systems-based, trans-disciplinary approach to sustainability, problems in sustainability and appropriate solutions based on scientific research, applied science, social and economic issues; life cycle inventory (LCI) and life cycle impact assessment (LCIA) including the social and economic dimensions. The application of life cycle assessment methodology using appropriate case studies

**Suggested Books:**

1. Hauschild, Rosenbaum, and Olsen, Life Cycle Assessment: Theory and Practice, Springer Publisher
2. Schenck R and White P, Environmental Life Cycle Assessment: Measuring the environmental performance of products, American Centre for LCA
3. Curran MA, Life Cycle Assessment Handbook: A Guide for Environmentally Sustainable Products, Wiley-Publishers.

**ENE6201 Hazardous Waste Management**

Hazardous waste management: Definition and characteristics, Sources and categorization, Treatment technologies: Physico-chemical, thermal, biological, sea and land disposal, Hazardous Waste (Management & Handling) Rules, Basel convention; Waste destruction technologies, Waste concentration technologies, TSDF; cradle to grave approach, Solidification and Stabilization Technologies, Biological Treatment, Storage and Disposal of radioactive waste

**Suggested Books:**

1. LaGrega, Buckingham, and Evans Hazardous Waste Management, Waveland Pr Inc. 2010
2. Rao MN and Sultana R, Solid and hazardous waste management, Elsevier Publisher 2017

**ENE6203 Bioremediation**

Basic principles of chemical and biological degradation of toxic chemicals, application of the remedial technologies in natural environments; occurrence and ecological significance of toxic organic chemicals; chemistry of contaminants, kinetics and mechanisms of degradation (chemical and biological); current technologies of bioremediation of contaminated soils and water.

**Suggested Books:**

1. Alexander M, Biodegradation and bioremediation, Elsevier Publisher 1999

2. Wise D, Bioremediation of Contaminated Soils, CRC Press 2000

**SEMESTER IV**

**Track 1\***

**ENE652**    Research Project

**Track 2**