COURSES SCHEME

&

SYLLABUS

FOR

M.TECH.

ENVIRONMENTAL SCIENCE

&

TECHNOLOGY

2015

COURSES SCHEME & SYLLABUS FOR M.TECH.
(ENVIRONMENTAL SCIENCE AND TECHNOLOGY)

SEMESTER – I

SR. NO.	COURSE NO.	TITLE	L	T	P	CR
1	PMA102	RESEARCH METHODOLOGY	2	0	2	3.0
2	PES109	WATER AND WASTEWATER TREATMENT TECHNOLOGIES -1	3	1	2	4.5
3	PES105	ATMOSPHERIC SCIENCES, METEOROLOGY AND CLIMATE CHANGE	3	1	0	3.5
4	PES107	ENVIRONMENTAL SCIENCES	3	1	2	4.5
5	PES106	ENVIRONMENTAL REMOTE SENSING AND GIS ANALYSIS	3	0	2	4.0
6	PES108	SOLID WASTE MANAGEMENT	3	1	0	3.5
TOTAL			**17**	**4**	**8**	**23.0**

SEMESTER – II

SR. NO.	COURSE NO.	TITLE	L	T	P	CR
1	PES204	WATER AND WASTEWATER TREATMENT TECHNOLOGIES-II	3	1	2	4.5
2	PES205	AIR POLLUTION CONTROL ENGINEERING	3	1	2	4.5
3	--	ELECTIVE -I	3/2	1	0/2	3.5
4		ELECTIVE – II	3/2	1	0/2	3.5
5		ELECTIVE –III	3/2	1	0/2	3.5
6		ELECTIVE – IV	3/2	1	0/2	3.5
TOTAL			**18**	**7**	**4**	**23.0**

ELECTIVES**

SR. NO.	COURSE NO.	TITLE	L	T	P	CR
1	PES213	ENVIRONMENTAL SAFETY AND MANAGEMENT	3/2	1	0/2	3.5
2	PES214	ENERGY CONSERVATION AND MANAGEMENT	3/2	1	0/2	3.5
3	PES224	INDUSTRIAL ENVIRONMENT MANAGEMENT SYSTEMS	3/2	1	0/2	3.5
4	PES225	ENVIRONMENTAL LEGISLATION AND IMPACT ASSESSMENT	3/2	1	0/2	3.5
5	PES231	CLEANER TECHNOLOGIES	3/2	1	0/2	3.5

6	PES232	WATER QUALITY MONITORING AND MODELLING	3/2	1	0/2	3.5
7	PES233	AIR QUALITY MONITORING AND MODELLING	3/2	1	0/2	3.5
8	PES241	ENVIRONMENTAL HYDRAULICS AND HYDROLOGY	3/2	1	0/2	3.5
9	PES223	WATERSHED MANAGEMENT	3/2	1	0/2	3.5

****** ELECTIVES ARE OFFERED ON THE BASIS OF PREFERENCES INDICATED BY THE STUDENTS.AN ELECTIVE IS OFFERED ONLY IF THE NUMBER OF STUDENTS REGISTERED IS FIVE OR MORE.

SEMESTER – III

SR. NO.	COURSE NO.	TITLE	L	T	P	CR
1	PES391	SEMINAR	-	-	-	2.0
2	PES392	MINOR PROJECT	-	-	-	4.0
TOTAL			**-**	**-**	**-**	**6.0**

SEMESTER – IV

SR. NO.	COURSE NO.	TITLE	L	T	P	CR
1	PES491	DISSERTATION	-	-	-	12.0
TOTAL			**-**	**-**	**-**	**12.0**

TOTAL CREDITS: 64.0

PMA102: RESEARCH METHODOLOGY

L	T	P	Cr
2	0	2	3.0

Course Objectives: Ability to elaborate the concept of distribution function; ability to distinguish between a discrete and continuous random variable and discuss transformation of one-dimensional, two-dimensional variables; develop potential towards problem solving using analysis of variance techniques; able to compute and interpret Karl Pearson's correlation coefficient and Spearman's rank correlation coefficient. Able to constitute random block design, Latin square design, and derive their probability distributions

Introduction: Nature and objectives of research, Study and formulation of research problem, Scope and formulation of hypothesis, Preparation and presentation of research and project proposals, Selection of thrust research.

Introduction to Statistical Analysis: Measures of Central Tendency and Dispersion, Mean, Median, Mode, Range, Mean deviation, Standard Deviation.

Random Variables and Probability Distribution: Definition, Distributions, Functions, Mathematical Expectation, Binomial, Poisson, Geometric, Negative bionomial, Exponential, Normal and log-normal distributions.

Hypothesis Testing: Tests of Significance based on normal, t and chi-square distributions, Analysis of variance technique.

Linear Regression and Correlation: Linear regression, least square principle and fitted models, Karl Pearson's correlation coefficient, Rank Correlation, Lines of regression.

Design of Experiments: Completely randomized design, Random block design, Latin square design, Statistical analysis and variances of estimates, Analysis of covariance.

Laboratory Work:

Implementation of statistical techniques using statistical packages *viz*., SPSS, Mathematica including evaluation of statistical parameters and data interpretation, Regression Analysis, Covariance, Hypothesis testing and analysis of variance.

Course Learning Outcomes (CLO):

1. Acquiring skills for formulating research problems and hypotheses to be tested, and for the preparation and presentation of research/project proposals.
2. Obtaining the knowledge of probability and data distribution functions and becoming capable of estimating mathematical expectations.
3. Acquiring the skills of regression and correlation analysis, development of statistical models, and calibration, validation and use of the models.
4. Becoming capable of design of experiments for investigations and hypotheses testing relating to research problems and projects.
5. Getting acquainted with the commercially available software packages for the statistical data analysis.

Recommended Books:

1. *Dowdy S, Wearden S and Chilko D. Statistics for Research, Wiley Series (2004).*
2. *Walpole RE, Myers RH, Myers SL. and Ye K. Probability and Statistics for Engineers and Scientists, Pearson Education (2002).*

Evaluation Scheme:

S. No.	Evaluation Elements	Weightage (%)
1.	MST	25
2.	EST	35
3.	Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	40

PES109: WATER AND WASTEWATER TREATMENT TECHNOLOGIES – I

L	T	P	Cr
3	1	2	4.5

Course Objectives: To understand the science and technology of water treatment; to know design, analysis, operation and control of routinely used water treatment units; to know the sampling and analysis techniques required for the monitoring of water treatment plants and for the characterization of the water; and to understand the water quality guidelines, criteria and standards.

Water – Quality, Standards and Criteria: Physical, chemical and biological water quality; Heavy metals and pesticide pollution; Water quality guidelines, criteria and standards.
Water Treatment Technologies: Treatment of surface waters and ground waters; Water treatment technologies overview; Water treatment plants producing drinking water, process water, soft water, RO water and DM water.
Coagulation/Precipitation, Flocculation and Settling: Coagulation-flocculation; Coagulants and flocculating agents; Flash mixing tanks, flocculation tanks, clari-flocculators and settling tanks.
Filtration Systems: Filtration theory and filter hydraulics; Slow sand filters; Rapid gravity filters; Pressure filters; and Multigrade roughing filters.
Disinfection: Chlorination; Ozonation; Membrane processes for disinfection.
Other Water Treatment Technologies: Ion-exchange process; Adsorption process; membrane processes (nanofiltration and reverse osmosis); Defluoridation units and household level water purification systems.

Laboratory Work:
Optimum pH and optimum dose of coagulants and coagulant aids; Precipitation removal of phosphorous; Breakpoint chlorination and MPN reduction; Adsorption isotherms and adsorption numbers; Ion-exchange resin capacity assessment; Filter hydraulics; Membrane processes for disinfection and TDS reduction.

Course Learning Outcomes (CLO):

1. To be able to acquire scientific and technological understanding on the physico-chemical operations and processes used in the treatment of water and wastewater.
2. To be able to know how to design, analyze, operate and control the routinely used physico-chemical water and wastewater treatment units.
3. To be able to understand the water/wastewater characterization and the treatment units' monitoring required for their design, operation and control, and acquiring the related monitoring and analysis skills.

Recommended Books:

1. *Metcalfe and Eddy Inc., Tchobanglous G, Burton FL, Stensel HD, Wastewater Engineering – Treatment, Disposal and Reuse, Tata McGraw Hill (2007).*
2. *Eckenfelder WW Jr, Industrial Water Pollution Control, MeGraw Hill (2003).*
3. *Weber WJ, Physico-chemical Processes for Water Quality Control, John-Wiley (1999).*
4. *Tebbutt THY, Principles of Water Quality Control, Butter Worth Heinemann (1998)*

Evaluation Scheme:

S. No.	Evaluation Elements	Weightage (%)
1.	MST	25
2.	EST	35
3.	Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	40

PES105: ATMOSPHERIC SCIENCES, METEOROLOGY AND CLIMATE CHANGE

L	T	P	Cr
3	1	0	3.5

Course Objectives: To inculcate fundamental knowledge and understanding of atmospheric sciences; to generate ability to understand effect of meteorological parameters on the dispersion of air pollutants; and to develop awareness of the global air pollution related issues.

Atmosphere Phenomena: Atmosphere and its functions; Profile and composition of atmosphere; Different layers, their characteristics and temperature relationships; Gas laws governing the behaviour of pollutants in atmosphere, natural and anthropogenic sources of atmospheric pollutants; Precipitation and types of storms; Influence of solar radiations on earth atmosphere; Diffuse solar radiations - controlling factors; Distribution of sunshine hours, Weather forecasting and methods.

Meteorology: Micro and Macrometeorology; Fundamental parameters – Pressure, temperature, wind, humidity, radiation, atmospheric stability, turbulence and diffusion; Wind roses, atmospheric stability, inversions, mixing height and topographic effects; Application of meteorological principles to transport and diffusion of pollutants, Scavenging processes; Plume behaviour; Plume rise.

Climate Change: Definition of Climate; Elements of climate; Climatic classifications; Climatic controls; Spatial and temporal patterns of climate parameters in India; Long term changes; Possible causes of climate change- External (Milankovitch variation and Solar activity) and Internal (natural and anthropogenic); Causes and consequences of global warming; ozone hole and consequence of ozone depletion; Montreal protocol; Kyoto protocol and recent conventions; Strategies for conservation of environmental changes induced by CO_2 rise; The concept of carbon sequestration; Clean Development Mechanism (CDM) and its operationalization, modalities and procedures for CDM Project.

Course Learning Outcomes (CLO):

1. To be able to understand of the basic phenomenon of atmospheric sciences
2. To get acquainted with the sources, properties and ill-effects of important air pollutants in ambient (both outdoor and indoor)
3. To be able to use the techniques employed in the monitoring of particulates and gaseous pollutants in ambient air and stack gas
4. To be able to apply to study the effect of meteorological parameters in the dispersion of air pollutants

Recommended Books

1. *Valdia KS, Environmental Geology, Tata-McGraw Hill (1987)*
2. *Boubel RW, Fox DL, Turner DB and Stern AC, Fundamental of Air Pollution, Academic Press (1994)*
3. *Perkins HC, Air Pollution, McGraw-Hill (2004)*
4. *Rao CS, Environmental Pollution Control Engineering, New Age International (2006)*
5. *RaoMN and Rao HVN, Air Pollution, Tata McGraw-Hill (2006)*
6. *De Nevers N, Air Pollution Control and Engineering, Mc Graw Hill (1993)*
7. *van Dam JC, Impacts of Climate Change and Climate Variability on Hydrological Regimes, Cambridge University Press (2003)*

Evaluation Scheme:

S. No.	Evaluation Elements	Weightage (%)
1.	MST	30
2.	EST	45
3.	Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	25

PES107: ENVIRONMENTAL SCIENCES

L	T	P	Cr
3	1	2	4.5

Course Objectives: To provide understanding of basic mechanisms underlying chemical and biological aspects of environmental issues; inculcate concern for one's own surrounding and sustainable living; and develop capacity to act at own individual level to protect and management the environment

Environmental Chemistry: Stratospheric ozone chemistry; Atmospheric aerosol chemistry; Chemistry of greenhouse gases, Chemical reactions in atmosphere; Structure and properties of water; Nutrient and biogeochemical cycling;

Environmental Biology: Water organisms as sources of human health hazards and biological water quality; DO depletion and Eutrophication problems of water; Associations of soil organisms with plants; Role of soil organisms in the soil formation, fertilization, and soil structure and texture maintenance; Biological aerosols; Bioaerosols as sources of human health hazards.

Environmental Biochemistry: Bioaccumulation; Biodegradation; Bioremediation; Biomethanation; Environmental degradation of polymers; Bioplastics.

Toxicology and Toxicological Chemistry: Toxicology – Chronic and acute; ADME; Doseresponse concept; Biochemical pathways and reactions associated with toxicants; Evaluation of toxicity;

Laboratory Work:

Analysis of environmental samples by Gravimetry, Titrimetry, DO meter, Conductimeter, Turbidity meter, Spectrophotometer, Flame photometer, AAS, pH/ISE meter, GC; Culturing and microbial enumeration from water/soil samples; Isolation purification and culturing of microorganisms from environmental samples.

Course Learning Outcomes (CLO):

1. Clarity of the basic concepts of structural and functional features of environmental systems
2. Understanding of the soil chemistry, soil pollution and exchange of nutrients in various biogeochemical cycles
3. Learning the significance of biological and biochemical mechanisms associated with functioning of environmental systems
4. Gaining knowledge about the environmental biodegradation and bioremediation
5. Learning of the concept of toxicity and its evaluation

Recommended Books:

1. *Sawyer CN, McCarty PL and Parkin GF, Chemistry for Environmental Engineering and Science, McGraw Hill (2003)*
2. *Shaw IC and Chadwick J, Principles of Environmental Toxicology, Taylor& Francis ltd. (1998)*
3. *Kolwzan B,Adamiak W, Grabas K and Pawelezyk K, Introduction to Environmental Microbiology: Oficyna Wydawnicza Politechniki Wroclaweskiej, Wroclaw (2003)*
4. *Gray NF, Biology of Wastewater Treatment, Imperial College Press (2004)*

Evaluation Scheme:

S. No.	Evaluation Elements	Weightage (%)
1.	MST	25
2.	EST	35
3.	Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	40

PES106: ENVIRONMENTAL REMOTE SENSING AND GIS ANALYSIS

L	T	P	Cr
3	0	2	4.0

Course Objectives: To introduce the fundamentals of remote sensing and geographical information systems and to inculcateability to apply principles and techniques of GIS and remote sensing in hydrology.

Introduction to Principle of Remote Sensing: Definition; Active and passive remote sensing; Aerial and space platforms.

Electromagnetic Radiation: EMR interaction with atmosphere; Atmospheric windows and their significance; Interaction with earth surface materials; Specular and diffuse reflection surfaces, Spectral reflectance curves and spectral signature; Spectral reflectance curves of water, soil and vegetation.

Satellite Programs and Sensors: Classification, description of multi spectral scanning – along and across track scanners; Satellite sensors; Resolution types; Description of sensors in Landsat, SPOT, IRS series.

Satellite Image Interpretation: Basic principles of image interpretation; Visual interpretation; Elements of image interpretation; Digital image processing; Supervised and unsupervised classification.

Introduction to GIS: Components, data types – spatial, attribute and metadata; Raster and vector data and their comparison; Data abstraction, maps and map scale.

Coordinate System: Datum; Geographical coordinate system; Projected coordinate system and their needs: Basic projection types; Polyconic and UTM projections.

Data Input and Editing: Raster and vector data formats; Georeferencing; Data input using scanner and on-screen digitization; Input using xy data; Data editing; Attribute data.

Spatial Analysis: Reclassification, overlaying, buffering, unions, intersections; DEM, DEM analysis, contour and cut-fill analysis; Process modelling using GIS, IDW, spline and kriging; Interpolation techniques

GPS and Keyhole Mark-up Language: Introduction to global positioning system and KML format

Remote Sensing and GIS Applications: LULC Classification; Flood plain mapping and zoning; Ground water studies; Erosion sedimentation studies; Watershed and drainage delineation.

Laboratory Work:

Introduction to various types of remote sensing data; Introduction to image enhancement and classification techniques; Introduction to GIS software and understanding of GIS data and data formats; Preparation of groundwater contours and surfaces using groundwater wells data; Delineation of watershed and drainage pattern using digital elevation models; River shifting studies using remote sensing data and GIS; Flood plain zoning and mapping using remote sensing and GIS.

Course Learning Outcomes (CLO):

1. Gaining fundamental understanding of principles associated with remote sensing and satellite image interpretations.
2. Capacity to interpret coordination, spathial analysis, GIS data and their applications
3. Capacity to extrapolate GIS data of ground water mapping, erosion studies, watershed management and drainage

Recommended Books:

1. *Lillesand T,Kiefer RW andChipman J, Remote Sensing and Image Interpretation, Joh Wiley and Sons,(2007).*
2. *Jensen JR, Introductory Digital Image Processing: A Remote Sensing Perspective, Prentice Hall (1996).*
3. *SchowengerdtRA, Remote Sensing Models and Methods for Image Processing, Academic Press (2007).*
4. *DeMers MN, Fundamentals of Geographical Information Systems, John Wiley & Sons (2009).*

Evaluation Scheme:

S. No.	Evaluation Elements	Weightage (%)
1.	MST	25
2.	EST	45
3.	Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	30

PES108: SOLID WASTE MANAGEMENT

L	T	P	Cr
3	1	0	3.5

Course Objectives: To facilitate understanding of issues and approaches associated with solid, hazardous-solid and special waste management; and facilitate capability to assess legal requirements and strategies associated with management of municipal, hazardous and special solid wastes.

Solid and Hazardous Wastes: Definition, sources and characteristics; Sampling and analysis techniques; Inventorying wastes; Strategies for waste minimization.
Municipal Solid Waste Management: Segregation and recycling and reuse of wastes; Collection, transportation and storage of municipal solid waste; Resource recovery from wastes; waste exchanges; Composting and vermi-composting of wastes; Disposal – siting and design.
Hazardous Waste Treatment and Disposal: Biological and chemical treatment of hazardous wastes; Solidification and stabilization of wastes; Incineration for the treatment and disposal of hazardous wastes; Landfill disposal of hazardous waste; Bioremediation of hazardous waste disposal sites.
Special Waste Management: Biomedical wastes, E-waste.

Legal Requirements: Municipal solid waste rules; Hazardous waste rules; Biomedical waste rules; E-waste rules; Rules related to recycled plastics, used batteries, flyash, etc.

Laboratory Work:
Biodegradable and combustible fraction of the solid waste/sludges and their calorific values; thermal, chemical and biological sludge stabilization; municipal solid waste sampling, segregation and analysis; Incineration ash analysis; Autoclaved material testing; E-waste processing; Composting and Vermicomposting.

Course Learning Outcomes (CLO):

1. Understanding and appreciating the environmental pollution and nuisance potential of municipal solid waste and of special category wastes.
2. Become aware of the regulatory requirements applicable to the handling and management of municipal solid wastes and special category wastes.
3. Acquiring the knowledge of procedures, practices and technologies of management and handling (collection, reception, storage, treatment/processing, transportation and disposal) of solid wastes.

Recommended Books:

1. *Pichtel J, Waste Management Practices: Municipal, Industrial and Hazardous, CRC Press (2005)*
2. *Kreith F and Tchobanoglous G, Handbook of Solid Waste Management, McGraw Hill (2002)*
3. *LaGrega M, Buckingham P and Evans J, Hazardous Waste Management, McGraw Hill (1994)*
4. *Freeman H, Standard Handbook for Hazardous Waste Management, McGraw Hill (1989)*
5. *Pollution Control Acts, Rules and Notifications Issued There under: Pollution Control Law Series, Central Pollution Control Board, New Delhi (1986)*

Evaluation Scheme:

S. No.	Evaluation Elements	Weightage (%)
1.	MST	30
2.	EST	45

PES204: WATER AND WASTEWATER TREATMENT TECHNOLOGIES – II

L	T	P	Cr
3	1	2	4.5

Course Objectives: To understand the science and technologies of wastewater treatment processes and operations. To know the design, analysis, operation and control of the routinely used wastewater treatment units. To understand the sampling and analytical techniques required for the wastewater characterization and for the monitoring of the wastewater treatment plants. To acquire knowledge on the facilities and provisions required for the handling and management of the wastewater treatment sludges.

Wastewater Characteristics and Effluent Standards: Physical, chemical and biological parameters of water pollution; DO, BOD and BOD kinetics; Nutrients; Effluent standards.

Overview of Wastewater Treatment Technologies: Preliminary, primary, secondary and tertiary treatment technologies.

Preliminary Treatment: Screens; Grit removal facilities; Effluent sumps and pumps; and Equalization tanks.

Primary Treatment: Neutralization and precipitation; Primary and secondary sedimentation tanks; Membrane filtration processes; Roughing filters.

Biological Treatment: Activated sludge process and its modifications including SBR; Trickling filters and RBC units; SAF, FAB and MBBR technologies; UASB reactors and its modifications; Waste stabilization pond systems and its modifications.

Other Treatment Technologies: Advanced oxidation processes; Biological nutrient removal; Filtration and chlorination; Membrane processes for TDS reduction.

Laboratory Work:
DO, BOD and COD measurements**;** BOD kinetic parameters; MLSS, MLVSS and SVI; ASP kinetic parameters; Biogas generation potential; Biodegradable fraction assessment; Settling column tests for primary and secondary clarifiers; Fenton/photocatalytic treatment process.

Course Learning Outcomes:

1. Acquire scientific and technological understanding on biological wastewater treatment processes
2. Knowing how to design, analysis, operate and control the routinely used biological wastewater treatment units
3. Understanding the wastewater characterization and the biological treatment units monitoring required for their design, operation and control, and acquiring the related monitoring and analysis skills.
4. Understanding the facilities and provisions required for the handling and management of the wastewater treatment sludge.

Recommended Books:

1. *Metcalf, Eddy, Tchobanoglous, G., Burton, F.L., Stensel, H.D., Wastewater. Engineering – Treatment, Disposal and Reuse, Tata McGrawHill (2002).*
2. *Eckenfelder WW Jr., Industrial Water Pollution Control, McGrawHill (2003).*
3. *Biological Wastewater Treatment, Edited Volume Series, IWA (2008).*

Evaluation Scheme:

S. No.	Evaluation Elements	Weightage (%)
1.	MST	25
2.	EST	35
3.	Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	40

PES205: AIR POLLUTION CONTROL ENGINEERING

L	T	P	Cr
3	1	2	4.5

Course Objectives: To facilitate understanding of the principles underlying designing of industrial ventilation systems and mechanical devices used for particulate and gaseous emission control from various sources. To acquire basic knowledge in management strategies for the control of air pollution.

Introduction: Role and scope of air pollution control engineering, Principles of fluid flow, Boundary layer theory, Energy transfer in fluid flow, Fluid flow measurement, Dynamics of particles in fluid, Properties of particles, Collection efficiencies of particles, Source reduction (Fuel substitution, Fuel pretreatment, Process modifications), Emission standards.

Design of Industrial Ventilation Systems: Component of Ventilation systems, Air pollution control systems, Hood specifications and design, Duct specifications and design, Blowers, stacks.

Particulate Emission Control: Stoke's law, Basic principles, Design and operation of settling chambers (Both laminar and turbulent flow), Cyclone and multiclones, Scrubbers, Bag houses and Electrostatic precipitators, Collection efficiency and Pressure drop calculations across air pollution control devices.

Gaseous Emissions Control: Basic principles, Design and operation of scrubbers for gaseous pollutant removal, Adsorption columns and condensation devices.

Control of Mobile Sources: Control of crank case emissions, Evaporative emissions control, Air fuel ratio, Alternative fuels, Automobile emission control, Catalytic convertors, Gasoline and diesel powered vehicles.

Air Pollution Mitigation Measures: Green belt design, Management strategies for air pollution abatement.

Laboratory Work:

Field visits; Particulate collection efficiencies calculation in centrifugal separator; Efficiency calculation in gaseous removal devices like wet scrubbers; Fume hood design; Stack Monitoring; Measurement of vehicular emissions; Adsorption

Course Learning Outcomes (CLO):

1. Gaining knowledge of air pollution control systems including source reduction and air pollution abatement strategies
2. Learning the designing and operational difficulties of various air pollution control devices for the removal of particulates and gaseous pollutants from both stationary as well as mobile sources
3. Understanding the sources of air pollution and the remedial measures required for the air pollution control

Recommended Books:

1. *Flagan RC and Seinfeld JH, Fundamentals of Air Pollution Engineering, Prentice Hall (1988).*
2. *Boubel RW, Fox DL, Turner B and Stern AC, Fundamental of Air Pollution, Academic Press (1994).*
3. *Perkins HC, Air Pollution, McGraw Hill (2004).*
4. *Rao CS, Environmental Pollution Control Engineering, New Age International (2006).*
5. *Rao MN and Rao HVN, Air Pollution, Tata McGraw Hill (2006).*

Evaluation Scheme:

S. No.	Evaluation Elements	Weightage (%)
1.	MST	25
2.	EST	35
3.	Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	40

PES213: ENVIRONMENTAL SAFETY AND MANAGEMENT

L	T	P	Cr
2	1	2	3.5

Course Objectives: To understand the methods of identification, classification and characterization of different hazardous materials and wastes; to know about the rules and regulations pertaining to the handling and management of hazardous materials and wastes; to understand the occupational health and safety management systems and their essential elements; and to impart awareness on noise pollution and control and on personal protection equipment.
Hazardous Materials: Definition and classification; Material safety data sheets; Handling of hazardous materials.
Regulations: Rules and regulations pertaining to the management and handling of hazardous chemicals; Hazardous wastes; Biomedical wastes; Hazardous microorganisms; Genetically engineered organisms or cells; Municipal solid wastes; E-wastes; Batteries and plastics. **Hazard Identification**: Assessment of risk; Risk management; OSHAS 18001 and Occupational health and safety management systems.
Principles of Accident Prevention: Accident recording; Analysis; Investigation and reporting; On-site and off-site emergency preparedness and response plans; Rules and regulations dealing with chemical accidents.
Protection from Hazardous Materials: Personal protective equipment and clothing; Fire safety; Noise and vibrations; Principles of noise control.
Safety Management: Notification of sites; Safety reports; safety audits.

Laboratory Work:
Material safety data sheets; On-site and off-site emergency plans; Environmental risk analysis; Safety audits; preparation of safety reports and notification of sites.

Course Learning Outcomes (CLO):
1. Understanding of the methods of identification, classification and characterization of different hazardous materials and wastes
2. Knowledge of the rules and regulations pertaining to the handling and management of hazardous materials and wastes
3. Ability of hazards identification and risk assessment, and development of emergency preparedness and response plans and programs
4. Knowledge of the occupational health and safety management systems and their essential elements.
5. Aware of the noise pollution problems and personal protection equipment.

Recommended Books/Web Links:

1. *Central Pollution Control Boards. Pollution Control Acts; Rules and Notifications Issued Thereunder. Pollution Control Law Series (PCLS/02/2006)*
2. *Gustin JF, Safety Management: A Guide to Facility Managers; Taylor & Francis (2003)*
3. *http://moef.nic.in/modules/rules-and-regulations*

Evaluation Scheme:

S. No.	Evaluation Elements	Weightage (%)
1.	MST	20
2.	EST	40
3.	Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	40

PES214: ENERGY CONSERVATION AND MANAGEMENT

L	T	P	Cr
2	1	2	3.5

Course Objectives: To understand and appreciate the energy crisis and environmental concerns associated with the energy management, and the importance of energy conservation; to know the techniques of energy analysis and the associated energy efficient technologies for the routinely used thermal and electrical energy systems; and to acquire the knowledge and the basic skills for energy monitoring, energy bench marking, energy action planning and energy auditing

Introduction: Non-renewable energy resources, and new and renewable energy resources; Energy technologies; Energy crisis and environmental concerns; Principles of energy conservation and management. Potential areas of energy conservation in industries, Agriculture and municipal area.
Energy Efficient Technologies in Thermal Systems: Fuels and combustion; Boilers and turbines; DG sets; Circulating cooling water systems; Steam system and condensate systems and insulation; Heat exchangers; Multiple effect evaporations; Furnaces; and Waste heat recovery systems.
Energy Efficient Technologies in Electrical Systems: Electrical motors and drives; Pumps, Fans and Blowers; Air compressors and compressed air systems; Buildings and space heating and lighting systems; HVAC systems.
Energy Management: Supply side and demand side management; Energy monitoring, monitoring and auditing; Energy management systems; Energy conservation methods.
Energy Policy and Legislation: Energy policy; Energy conservation act, 2001; Energy managers and energy auditors; Energy labelling and energy standards.

Laboratory Work:
Energy monitoring; Boiler energy efficiency assessment, EnergyPlus Simulation soft software.

Course Learning Outcomes (CLO):
1. To able to understand the energy crisis, and of environmental and sustainability concerns associated with the energy management.
2. To appreciate the importance of energy conservation and having the knowledge of energy conservation strategies and methods.
3. To be able to understand Energy Management Systems (EnMS) and their essential elements.
4. To aware of the Energy Conservation Act, 2001, and of the legal energy requirements applicable to the routinely used thermal and electrical energy systems Aware

Recommended Books:

1. *Practical guide to energy conservation – a ready reckoner on energy conservation measures; Petroleum Conservation Research Association (2009).*
2. *Indian Energy Board-2012; World Energy Council.*
3. *White LC, Industrial Energy Management and Utilization; Hemisphere Publishers; (1988).*
4. *Eastop TD and Croft DR, Energy Efficiency for Engineers and Technologists; Longman - Scientific and TechnicalSeries (1988).*

Evaluation Scheme:

S. No.	Evaluation Elements	Weightage (%)
1.	MST	20
2.	EST	40
3.	Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	40

PES224: INDUSTRIAL ENVIRONMENT MANAGEMENT SYSTEMS

L	T	P	Cr
3	1	0	3.5

Course Objectives: To acquire the skills and understand the techniques for the identification and evaluation of environmental aspects of an organization's activities, products and services; to understand the environmental management systems and their essential elements.; and to acquire the knowledge and skills needed for the establishment, documentation, implementation, maintenance, and auditing of Environmental Management Systems

Introduction: Industrial systems; Resource consumption, waste generation and environmental pollution; Legal environmental requirements applicable to industrial facilities; Environmental functions of industrial facilities.

Environmental Aspects: Process mapping approach for the identification of environmental aspects of industrial activities; Core industrial activities and environmental aspects; Support industrial activities and environmental aspects; Significant environmental aspects.

Management of Environmental Aspects: Waste minimization through source reduction; Waste recycling and reuse; By-products and resources recovery from wastes; Waste treatment and disposal; Overview of waste treatment technologies; pollution prevention programs.

Environmental Management System (EMS) Approach: Basic concepts of EMS approach; Essential elements of an EMS and ISO 14001; ISO 14000 series of standards and their relevance to EMS and to the environmental performance improvement.

Development; Implementation and Maintenance of EMS: EMS development and implementation project and plan; ISO 14004 standard; Identification of significant environmental aspects; Formulation of environmental policy and setting of environmental objectives and targets; Environmental management programs; Operational controls.

EMS Auditing: EMS auditing; and audit program and procedures; ISO 19011 and environmental auditing; Audit activities and audit reports.

Course Learning Outcomes (CLO):

1. To be able to identify and evaluate environmental aspects of an organization's activities, products and services
2. To be able to understand legal and other environmental requirements applicable to organizations
3. To be able to understand Environmental Management System (EMS) approach and knowing the essential elements of an EMS
4. To be able to establish, document, implement, maintain and improve EMS in organizations

Recommended Books:

1. *Freeman H, Industrial Pollution Prevention Handbook; McGraw-Hill Professional (1994).*
2. *Edwards AJ, ISO 14001: Environmental Certification Step by Step; Butterworth-Henemann (2004).*
3. *Stapleton PJ, Glover MA and Davis SP, Environmental Management Systems: An Implementation Guide to Small and Medium-sized Industries; NSF International (2001).*
4. *ISO 14004: 2004 - Environmental management systems – General guidelines on principles; systems and support techniques.*
5. *ISO 19011: 2011- Guidelines for auditing management systems.*

6. *ISO 17021: 2011 - Conformity assessment — Requirements for bodies providing audit and certification of management systems.*

Evaluation Scheme:

S. No.	Evaluation Elements	Weightage (%)
1.	MST	30
2.	EST	45
3.	Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	25

PES225: ENVIRONMENT LEGISLATION AND IMPACT ASSESSMENT

L	T	P	Cr
3	1	0	3.5

Course Objectives: To provide an overview on environmental legislation and acts applicable for environmental pollution; to facilitate understanding on role of pollution control boards and their procedure; and to facilitate understanding of various aspects related to EIA processes.

Definition of Terms: Conventions and protocols; Policy; law; acts and rules; Administrative and legal interpretations; Codes and specifications.

Overview of Environmental Legislation: Overview of Indian environmental law; Pollution control boards – Powers; functions and Procedures.

Provisions of Water Act; Water-cess Act; Air Act; Environmental Protection Act; Public Liability Insurance Act as Applicable to Industry: Provisions relating to Environmental clearance; Environmental sampling, analysis and reporting of results; Environmental standards; Overview of other key environmental regulations- Municipal solid waste rules; Biomedical waste rules; Hazardous waste, microorganisms, and chemicals rules;

Legal Aspects of EIA: EIA notification; Environmental clearance process - Screening; scoping; public consultation and appraisal; Objectives and scope of EIA; EIA process flow chart.

Project and the Environment Description: Environmental feasibility analysis; Baseline studies; and environmental data collection: Methods of Impact analysis- checklists; matrices; networks; overlays etc.,

EMP (Environmental Management Plan) and EIA Documentation: Principles and Elements of approach; identification and mitigation of environmental impacts: types and structure of EIA documents.

Course Learning Outcomes (CLO):

1. Becoming aware of the environmental legislation, environmental policies of the country and of the international environmental conventions and protocols.
2. Knowing the environmental regulations applicable to the industry and other organizations with significant environmental aspects
3. Knowing about the environmental requirements applicable to the environmental impact assessment, and about the environmental clearance process of developmental projects.
4. Understanding the methods and tools of identification, prediction and evaluation of environmental impacts of developmental projects.

Recommended Books:

1. *CPCB, Pollution Control Law Series - PCL/2/2001; Central Pollution Control Board (http://envfor.nic.in/cpcb/cpcb.html)*
2. *Jain R and Clark A, Environmental Technology Assessment and Policy; Ellis Harwood (1989)*
3. *EIA notification, Gazette Notification: SO 1533 dated 14-09-2006; MOEF. GOI (2006).*

Evaluation Scheme:

S. No.	Evaluation Elements	Weightage (%)
1.	MST	30
2.	EST	45
3.	Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	25

PES231: CLEANER TECHNOLOGIES

L T P Cr
3 1 0 3.5

Course Objectives: To provide acquaintance with modern cleaner production processes and emerging energy technologies; and to facilitate understanding of the need and application of green and renewable technologies for sustainable development of the society

Introduction: Industrialization and sustainable development; Cleaner production (CP) in achieving sustainability; Clean development mechanism (CDM); Source reduction techniques - Raw material substitution; Process modification and equipment optimization; Product design; Reuse and recycling strategies; Resources and by-product recovery from wastes; Treatment and disposal; Pollution prevention programs.

Cleaner Production: Overview of CP Assessment Steps and Skills; Basic analysis of material and energy flows; Green procurement; Identifying and reducing losses; New and low waste technologies; Product modification; Good housekeeping; CP audits.

Green Design: Green buildings - benefits and challenges; public policies and market-driven initiatives; Effective green specifications; Energy efficient design; Passive solar design; Green power; Green materials and Leadership in Energy and Environmental Design (LEED)

Renewable and Emerging Energy Technologies: Introduction to renewable energy technologies- Solar; wind; tidal; biomass; hydropower; geothermal energy technologies; Emerging concepts; Biomolecules and energy; Fuel cells; Fourth generation energy systems.

Course Learning Outcomes (CLO):

1. Able to understand basic concepts in source reduction and waste management
2. Capable of utilizing steps and skills in designing technically viable cleaner production systems
3. Able to examine and evaluate present and future advancements in emerging and renewable energy technologies

Recommended Books:

1. *Kirkwood RC and Longley, AJ(Eds.), Clean Technology and the Environment, Chapman & Hall, London (1995).*
2. *World Bank Group; Pollution Prevention and Abatement Handbook – Towards Cleaner Production, World Bank and UNEP; Washington DC (1998).*
3. *Modak P, Visvanathan C and Parasnis M, Cleaner Production Audit, Course Material on Cleaner Production and Waste Minimization; United Nations Industrial Development Organization (UNIDP) (1995).*
4. *Rao S and Parulekar BB, Energy Technology: Non-conventional; Renewable and Conventional; Khanna Pub. (2005).*

Evaluation Scheme:

S. No.	Evaluation Elements	Weightage (%)
1.	MST	30
2.	EST	45
3.	Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	25

PES232: WATER QUALITY MONITORING AND MODELLING

L	T	P	Cr
2	1	2	3.5

Course Objectives: To facilitate understanding of water quality guidelines, criteria and standards, and water quality index; understanding and implementation of water quality programs; to acquire knowledge of the water quality modelling, sampling and analysis; and to provide exposure to the conventionally used water quality models

Water Quality and Parameters: Physical; chemical and biological water quality parameters; General parameters; Biological water quality and fecal coliform count; Solids; Biodegradable and non-biodegradable organic matter; Nutrients; Heavy metals; and pesticides and recalcitrant/toxic organic compounds.

Water Quality Monitoring: Surface water and groundwater quality; Water quality standards and effluent standards; Water quality criteria and guidelines; Classification of water bodies; water quality monitoring programs; Water sampling and analysis techniques; Water quality index and use specific water quality index.

Water Quality Modelling: Introduction to water quality modelling; Modelling of Lakes and reservoirs; Rivers and streams; and Groundwater modelling; Modelling for common water quality parameters: DO; temperature; suspended solids; algae; nutrients; coliforms and toxics; Calibration; validation and use of water quality models (DO-BOD models; solute transport models; nutrients and eutrophication models; and toxic substances and sediments models). **Conventional Water Quality Models:** QUAL2E – QUAL2K; BASINS and WASP7.

Laboratory Work:

Water quality monitoring programs; Development and use of water quality indices; Use of water quality modelling softwares.

Course Learning Outcomes (CLO):

1. To be able to use the knowledge of water quality guidelines, criteria and standards, and water quality index
2. To be able to understand the water quality programs and their implementation including the water sampling and analysis
3. To be able to use water sampling and analysis techniques, water quality data analysis and WQI calculations
4. To be able to understand of water quality modelling and exposure to some of the conventionally used water quality models.

Recommended Books:

1. *Bartram J (Ed.), Water quality monitoring: A practical guide to the design and implementation of freshwater quality studies and monitoring programs, Taylor & Francis (2012).*
2. *Manivanan R, Water quality modelling: rivers, streams and estuaries, New India Publishing Agency (2008).*
3. *Chapra SC, Surface water quality modelling, Waveland press (2008).*
4. *Thomann RV and Mueller JA, Principles of surface water quality modelling and control, Harper & Row (1987).*

Evaluation Scheme:

S. No.	Evaluation Elements	Weightage (%)
1.	MST	20
2.	EST	40
3.	Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	40

PES233: AIR QUALITY MONITORING AND MODELLING

L	T	P	Cr
2	1	2	3.5

Course Objectives: To facilitate acquiring basic skills of sampling and analytical techniques in air quality monitoring; and understanding of the air quality modelling and simulation techniques

Introduction: Overview of current air quality trends and challenges; Basic concepts; applications and importance of air quality Monitoring; Iso-kinetic sampling; Precision and accuracy of monitoring; Air Quality Guidelines and Standards.

Sampling and Monitoring Air Matrices: Scope; Purpose and Objectives of Air Quality Monitoring Programme; Preliminary information required for planning an air quality survey; Guidelines for planning a survey; Site Selection; Design of an air quality surveillance network; Period; frequency and duration of sampling; Averaging times.

Sampling Techniques: Ambient air quality monitoring – High volume sampler; Fine dust samplers; Gaseous monitoring kit; Stack monitoring – Flue gas analyzer; stack monitoring kits; orsat apparatus; Tail pipe emissions monitoring; Noise monitoring; Indoor air quality monitoring; On-line monitoring; Preservation; storage and transportation of environmental samples.

Analytical Techniques: Preparation of samples for analysis; Gravimetry; titrimetry; potentiometry (including ion analyzers); Colorimetry (UV-visible spectrometry); Metals and heavy metal detection techniques; Interpretation of Data; Air Quality Assessment and Reporting.

Air Quality Modelling: Basic Components of an Air Quality Simulation Model; Parameters of Air Pollution Meteorology; Steady-state; Non-Steady-state and Grid Meteorological Modelling; Dispersion and Receptor modelling techniques; Gaussian plume model; Pasquilli's stability classification; Modelling softwares; Validation of Models; Applications of Modelling; Air Pollution Forecast Models.

Laboratory Work:

SO_x analysis by West and Geake method; NO_x analysis by Jacobs and Hochheiser method; Stack monitoring; Tail pipe emissions monitoring; Preparation and analysis of samples in AAS and IC; Measurement of indoor air quality; Noise monitoring; Air modelling softwares - ISCST3; Aermod, Calroads, Calpuff, etc.

Course Learning Outcomes (CLO):

1. Learning of the techniques employed in the monitoring of particulates and gaseous pollutants in ambient air and stack gas
2. Gaining knowledge about modelling of air quality through the use of different softwares.

Recommended Books:

1. *Borrego C and Ana IM,Air Pollution Modelling and its Application; Springer (2008).*
2. *Tiwary A and Colls J, Air Pollution: Measurement; Modelling and Mitigation; Spon Press (2002).*
3. *Khare M, Air Pollution – Monitoring; Modelling; Health and Control; InTech Publishers (2012).*

4. *Brebbia CA,Power H and Tirabassi T, Air Pollution V: Modelling; Monitoring and Management; InTech (1997).*
5. *Zannetti P, Air Quality Modelling - Theories; Methodologies; Computational Techniques; and Available Databases and Software: Volume IV - Advances and Updates; EnviroComp Institute (2010).*

Evaluation Scheme:

S. No.	Evaluation Elements	Weightage (%)
1.	MST	20
2.	EST	40
3.	Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	40

PES241: ENVIRONMENTAL HYDRAULICS AND HYDROLOGY

L	T	P	Cr
3	1	0	3.5

Course Objectives: To facilitate understanding of hydrological aspects of water resources; Understanding the principles of need based activities such as pumps, mixers related to water; and to develop competence to propose effective convergence and design features of water supply projects

Introduction: Hydrological cycle; Water and climate change; Scope of hydrology.

Pipe Flow and Water Distribution System: Flow through pipes, hydraulic gradient and total energy line; Parallel, compound and equivalent pipes; Design of water distribution networks by Hardy Cross Method.

Open Channel Flow and Sewer Design: Types of flow in channels, most economical sections, Specific energy diagram; Hydraulic gradelines; Hydraulic jump; Hydraulic elements of sewers and design of sewers.

Hydraulic Design: Hydraulic design of water and waste water treatment plants; Design of systems for disposal on land and for underground injection.

Pumps and Pumping Stations: Pumps and their classification; Pump performance curves, system head capacity curves and pump selection; Valves and flow measurement devices; and Pumping stations and their design.

Aeration and Mixing: Aeration and mixing equipment, diffused aeration systems, air transfer calculations

Hydrology: Precipitation/rainfall and measurement; Hydrological data analysis and storm water estimation – SCS technique, hydrograph, rational method; Storm sewer design; Ground water movement and governing equations; Yield determination of wells; and ground water recharging.

Course Learning Outcomes (CLO):

1. To be able to apply fluid mechanics to water supply and sewerage systems, to water and wastewater treatment plants, and to air pollution control systems
2. To be able to apply knowledge on the facilities and provisions (pumps, blowers, mixers, flow measurement devices) required for the handling of fluids (water, wastewater and gaseous emissions)
3. To be able to use techniques and skills on fluid flow measurement and quantification
4. To be able to apply concepts of fluid mechanics to storm water handling and management

Recommended Books:

1. *Chow VT, MaidmentDR and MaysLW, Applied hydrology, Tata McGraw Hill, New Delhi (2010).*
2. *McGhee, Water supply and sewerage, McGraw Hill, New Delhi (1991).*
3. *Wurbs RA and James WP, Water resources engineering, PHI New Delhi (2002).*
4. *Nathanson, JA, Basic environmental technology, PHE, New Delhi (2003).*

Evaluation Scheme:

S. No.	Evaluation Elements	Weightage (%)
1.	MST	30
2.	EST	45
3.	Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	25

PES223: WATERSHED MANAGEMENT

L	T	P	Cr
2	1	2	3.5

Course Objectives: To provide guidance on direction for assessment and development of water potential of regimes; to facilitate understanding of approaches for maintenance of watershed based ecosystem and to develop ability to apply theories underlying the solutions for practical problems of watershed.

Introduction: Concept of watershed development; Objectives, need, integrated and multidisciplinary approach.

Characteristics of Watershed: Size; Shape; Physiography; Slope, Climate, Drainage, Land Use; Vegetation; Geology and Soils; Soils; Hydrology and Hydrogeology; Socio-Economic Characteristics; Basic Data On Watersheds.

Erosion and Measures to Control Erosion: Erosion - Types; Factors affecting and effects of Erosion; Estimation of soil loss due to erosion (universal soil loss equation); Erosion control measures: Contour techniques; Ploughing; Furrowing; Terracing; Gully control; Rockfill; Dams; Brushwood dam; Gabion.

Water Harvesting: Rainwater harvesting; catchment harvesting; Harvesting structures; Soil moisture conservation; Check dams; Artificial recharge; Farm ponds; Percolation tanks. **Land Management**: Land use and land capability; Classification; Management of forest, Agricultural, grass land and wild land; Reclamation of saline and alkaline soils.

Ecosystem Management: Role of ecosystem; Crop husbandry; Soil enrichment; inter-mixed and strip cropping; Cropping pattern; Sustainable agriculture; Biomass management; Dry land agriculture; Silvipasture; Horticulture; Social forestry and afforestation.

Water Bodies and Aquatic Ecosystems: Influence of ponding on water quality; Thermal stratification and mixing; Eutrophication and water weeds; Sediment-water interactions; Effects of waste disposal and pollution; Fate of pollutants discharged into water bodies; Self cleansing capacities of water bodies.

Human Interventions for Water Quality Management: People participation; Preparation of action plans; administrative requirements; Management of catchments/watersheds and prevention of pollution; Flood control; Wetlands and constructed wetlands; Control of weeds and nutrient removal; River basin management system; Satluj river action plan; Ganga action plan.

Laboratory Work:

Permeability; Percolation and leaching studies; Rainfall and storm data analysis; surface run off and hydrograph analysis; Vegetation analysis (productivity; dominance and diversity analysis).

Course Learning Outcomes (CLO):

1. Acquiring capabilities to demarcate and characterize watersheds
2. Acquiring the capabilities to analyze the watersheds and understand the issues and concerns associated with them, and to frame the watershed management objectives
3. Enabling to understand and analyze the hydrological and remote sensing data
4. Having knowledge of the best management practices for the sustainable management of watershed

Recommended Books:

1. *Nathanson JA, Basic Environmental Technology. Prentice-Hall (2002).*
2. *Murthy JVS, Watershed Management, New Age International (1998)*
3. *Awurbs R andJames WP, Water Resources Engineering, Prentice Hall (2001)*
4. *Murthy VVN, Land and Water Management, Kalyani Publications (2009)*
5. *Majumdar DK, Irrigation and Water Management, Prentice Hall (2000)*

Evaluation Scheme:

S. No.	Evaluation Elements	Weightage (%)
1.	MST	20
2.	EST	40
3.	Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	40