

SYLLABUS

FOR

B. TECH. COURSE

IN

ENVIRONMENTAL ENGINEERING



Department of Environmental Science & Engineering
INDIAN SCHOOL OF MINES UNIVERSITY
Dhanbad-826 004 (Jharkhand)

Mathematics-I

[3-1-0]

Calculus-I : Successive differentiation of one variable and Leibnitz theorem, Taylor,s and Maclaurin's expansion of functions of single variable.

Functions of several variables, partial derivatives, Euler's theorem, derivatives of composite and implicit functions, total derivatives, Jacobian's, Taylor's and Maclaurin's expansion of functions of several variables, Maxima and minima of functions of several variables, Lagrange's method of undetermined multipliers. Curvature and asymptotes, concavity, convexity and point of inflection. Curve tracing.

Calculus-II: Improper integrals, convergence of improper integrals, test of convergence, Beta and Gamma functions and its properties, Differentiation under integral sign; differentiation of integrals with constant and variable limits; Leibnitz rule.

Evaluation of double integrals, Change of order of integration, change of coordinates, evaluation of area using double integrals, Evaluation of triple integrals, change of coordinates, evaluation of volumes of solids and curved surfaces using double and triple integrals. Mass, center of gravity, moment of inertia and product of inertia of two and three-dimensional bodies and principal axes.

Trigonometry of complex Number, 3D Geometry and Algebra: Function of complex arguments, Hyperbolic functions and summation of trigonometrical series.

3-D Geometry: Cones, cylinders and conicoids; Central conicoids, normals and conjugate diameters.

Algebra: Convergency and divergency of Infinite series. Comparison test, D' Alembert's ratio test, Raabe's test, logarithmic test, Cauchy's root test. Alternating series; Leibnitz test, absolute and conditional convergence, power series, uniform convergence.

Reference Books:

1. Differential Calculus by B.C. Das and B.N.Mukherjee
2. Integral Calculus by B.C. Das and B.N.Mukherjee
3. Integral Calculus by R.K. Ghosh and K.C. Maity
4. Analytical Solid Geometry by Shanti Narayan
5. Text book of Engineering Mathematics by Debashish Dutta .

Mathematics – II

[3-1-0]

Vector Calculus and Fourier Series:

Vector Calculus: Scalar and vector fields, Level surfaces, Differentiation of vectors, Directional derivatives, gradient, divergence and curl and their physical meaning, vector operators and expansion formulae, Line, surface and volume integrations, Theorems of Green, Stokes and Gauss, Application of vector calculus in engineering problems, orthogonal curvilinear coordinates, expressions of gradient, divergence and curl in curvilinear coordinates.

Fourier Series: Periodic functions, Euler's formulae, Dirichlet's conditions, expansion of even and odd functions, half range Fourier series, Parseval's formula, complex form of Fourier series.

Matrix Theory: Orthogonal, Hermitian, skew-Hermitian and unitary matrices, Elementary row and column transformations, rank and consistency conditions and solution of simultaneous equations, linear dependence and independence of vectors, Linear and orthogonal transformations. Eigen values and Eigen vectors, properties of Eigen values, Cayley-Hamilton theorem, reduction to normal forms, quadratic forms, reduction of quadratic forms to canonical forms, index, signature, Matrix calculus & its applications in solving differential equations.

Differential Equations: Differential equations of first order and higher degree, Linear independence and dependence of functions. Higher order differential equations with constant coefficient, Rules for finding C.F. and P.I., Method of variation of parameter, and method of undermined coefficients, Cauchy and Legendre's linear equations.

Linear differential equations of second order with variable coefficients; change of dependent variable, change of independent variable, linear equations of special types; dependent variable absent, independent variable absent. Simultaneous linear equations with constant coefficients.

Various applications of higher order differential equations in solution of engineering problems.

Partial Differential Equations: Formation of P.D.E, Equations solvable by direct integration, Linear and non-linear equations of first order, Lagrange's equations, and Charpit's method. Homogeneous and non-homogeneous linear P.D.E. with constant coefficients. Rules for finding C.F. & P.I.

Reference Books :

1. Vector Analysis by Lalji Prasad
2. Theory and Problems of Advanced Calculus by M.R. Spiegel (Schaum Series)
3. Theory and Problems of Laplace Transform by M.R. Spiegel (Schaum Series)
4. Higher Engineering Mathematics by B.V. Raman.
5. Advanced Engineering Mathematics by R.K.Jain & S.R.K. Iyenger.
6. A Text Book of Matrices by Shanti Narayan

Physics

[3-1-0]

Thermal Physics: Concepts of distribution of molecular velocities; Distribution laws and statistics-MB, FD and BE, mean free path; Transport phenomena-viscosity, diffusion; thermal conductivity, measurement of thermal conductivity; periodic and aperiodic flow of heat; Wiedemann- Franz law. Heat radiation; black body and black body radiation; Planck's distribution law and its application to classical distribution (Rayleigh-Jeans and Wiens) and total radiation (Stefan-Boltzmann) laws.

Modern Physics: Brief idea of molecular spectra; Rigid rotator, spectra of simple molecules, rotation and rotation-vibration spectra.

Brief idea of wave packet and wave function, Shrodinger equation, Particle in a Box.

Free electron theory; qualitative idea of band theory of solids and Hall effect, Laser and laser systems (He-Ne and Ruby Lasers).

Electromagnetic and Electrical Phenomena in Rocks: Maxwell's field equation, Equation of electromagnetic field, Propagation of electromagnetic waves in different isotropic media, energy of electromagnetic waves, Poynting's theorem & Poynting's vector. Rocks and minerals as dielectrics, electrical conductivity and electrical phenomena in rocks, Piezo-, ferro-, tribo-, and pyro-electricity.

Physics (Practical)

[0-0-3]

Measurement of thermal conductivity of bad conductors, Optical experiments on Diffraction using diffraction grating. Experiments on Semi-conductors – measurement of band gap and Hall effect Experiments using He- Ne Laser – Diffraction Experiments to measure Brewster's angle & find refractive index.

Reference Books :

1. "A Treatise on Heat"- Saha and Srivastava
 2. "Engineering Physics"-B.L.Theraja
 3. "Physics of Rock and Minerals"-Rzhevsky & Novic
 4. Lasers-Ghatak & Thyagarajan
 5. "Solid State Physics"-C Kittel
 6. "Elements of Electromagnetic theory"-M N O Sadiku
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CHEMISTRY

[3-1-0]

Cement: Manufacturing, composition, setting and hardening of cement.

Glass: Types of Glasses, Manufacturing & properties of Glasses.

Polymers: Classification, structure – property relationship, conductive polymers.

Solid Fuels: Structure of coal, classification of coal, Effect of heat on coal, carbonization and pyrolysis. Recovery and purification of by-products obtained from coke ovens; Distillation of coal tar; coal chemicals.

Liquid Fuels: Composition of crude oil, processing of crude oil, distillation, sweetening and cracking (basic concepts), octane number, Cetane number. Additives to improve the quality of diesel and petrol, bio-diesel.

Gaseous Fuels: Characteristics of good fuel; calorific value, theoretical calculations of calorific value of a fuel, natural gas and hydrogen gas.

Phase rule and phase equilibrium diagram: Phase rule; degree of freedom, one and two component systems, temperature and composition diagrams, liquid-liquid and liquid-solid phase diagrams.

Lubricants: General characteristics of lubricants, chemistry of lube oil and greases. Reclamation of lubricants.

Equilibrium: Electrochemistry: Electric potentials at interfaces, electrodes, batteries, electrochemical cells and their applications.

Corrosion: Chemical and electrochemical corrosion, classification, factors affecting corrosion, Form of corrosion and general methods of corrosion prevention.

Chemistry (Practical)

[0-0-3]

List of Experiments: Standards of HCl by Standard Sodium Carbonate solution, Determination of Temporary Hardness of tap water, Estimation of Total Hardness of water, Determination of Iron in Ferrous Ammonium Sulphate solution (Redox titration), Determination of Copper in crystallized Copper Sulphate, Estimation of available Chlorine in Bleaching Powder, Determination of Molecular Weight of Organic Acid by Titration method, Estimation of Sodium Carbonate and bicarbonate in a mixture, To determine the saponification number of an oil, To determine the rate of hydrolysis of methyl /ethyl acetate, To prepare Chrome Alum.

Reference Books :

1. A Textbook of Engineering Chemistry-Sashi Chawla
 2. Applied Chemistry: A Textbook for Engineers and Technologists – H.D.Gesser.
 3. Engineering Chemistry – P.C.Jain & Monika Jain
 4. Engineering Materials – K.G. Budinski & M K Budinski
 5. Engineering Chemistry – B K Sharma
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Engineering Graphics

[1-3-0]

Drawing instruments and their uses; Indian standards for drawing.

Lettering; Types of lines used in engineering graphics: full lines hidden lines, dimension lines, centerlines, section lines construction lines etc.

Scales: representative fractions, reducing and enlarging scales, plain scales, diagonal scales and vernier scales.

Curves used in engineering practice: conic sections, ellipse, parabola, hyperbola, cycloid, epicycloid, hypocycloid, involutes and spiral.

Orthographic projections: First angle and third angle projections, conventions used, orthographic projection of simple solids; Conversion of three-dimensional views to orthographic views.

Isometric projections: of simple solids, isometric views, conversion of orthographic views to isometric views; free hand sketching.

Reference Books :

1. **Engineering Drawing – N D Bhatt**

2. **Engineering Graphics – S C Sharma & Naveen Kumar**
 3. **Engineering Drawing – P S Gill**
 4. **Engineering Drawing with Auto-CAD – Parvez, Khan & Khaliq**
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Manufacturing Processes

[1-3-0]

Carpentry: Classification of timber, seasoning and preservation of wood, description and applications of the various tools used in carpentry, different joints and their practical uses.

Forging: Introduction to Forging, types of tools and their uses, colour representations of different temperature levels, recrystallisation, workability of metals at elevated temperature, safety rules.

Casting: Introduction to foundry, Pattern making, types of casting processes, purpose of runner & riser, applications of casting, defects in casting.

Fitting: Introduction to fitting jobs, fitting tools and their uses, safety rules.

Welding: Welding types, accessories, weldments, safety rules.

Machine Tools: Types of tools, Types of Machine Tools and their specifications, safety rules.

Measurement: Use of vernier etc for product measurement.

Reference Books :

1. **Workshop Technology Part I, II & III – W A J Chapman**
 2. **Workshop Technology Part I & II - Hazra Chowdhury**
 3. **Workshop Technology Part I & II - Raghubanshi**
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Electrical Technology

[3-1-0]

Network theorems (KCL, KVL, Thevenin, Norton, Maximum power transfer) applied to steady-state DC circuit. Single-phase AC circuits and phasor diagrams, series and parallel resonance. Three-phase AC circuits with balanced and unbalanced loads, phasor presentation, measurement of three-phase power by two-wattmeter method.

Single-phase transformer: Construction, types, EMF equation, equivalent circuit, phasor diagram, regulation, efficiency, OC and SC tests.

DC Machines: Construction, types, principle of operation, EMF and torque equation.

DC generator: OCC and external characteristic curves and efficiency.

DC motors: speed-torque characteristics, starting, 3-point starter, speed control and efficiency.

Three-phase induction motor: Construction, types, principle of operation, torque-slip characteristics, starting methods. Introduction to three-phase synchronous motor.

Electrical Technology (Practical)

[0-0-3]

Experiments on Thevenin's theorem, R-L-C series circuit, Single phase power measurement, Characteristics of fluorescent lamp and incandescent lamp, OC and SC tests of single phase transformer, Open-circuit characteristics of DC separately excited generator, External Characteristics of separately excited DC generator, Three-point starter of DC shunt motor, Speed control of DC motor.

Reference books:

1. **Electrical Engineering Fundamentals – V Del Toro**
 2. **Basic Electrical Engineering (Special Indian Edition) – J J Cathey, S A Nasar, P Kumar.**
 3. **Hughes Electrical and Electronic Technology – E Hughes, I M Smith, J Hiley, K Brown.**
 4. **Basic Electrical Engineering – D P Kothari and I J Nagrath.**
 5. **Electric Machinery – A E Fitzgerald, C Kingsley, S D Umans.**
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Electronics Engineering

[3-1-0]

Semiconductor Diodes and Applications – Introduction Characteristics, dc and ac resistances of a diode. Half wave and Full wave rectification. Zener Diodes and then use as regulators, Clippers and Clampers.

Bipolar Junction Transistor – Introduction, Transistor operation CB, CE and CC configuration, dc Biasing, Operating Point, Fixed Bias Circuit, Emitter – Stabilized Bias Circuit. Voltage Divider Bias.

BJT Transistor – Amplification in ac domain, Equivalent transistor model. Hybrid Equivalent model, RC coupled amplifier and its frequency response.

Operational Amplifiers – Introduction, Differential and Common Mode Operation, OPAMP Basics, Practical OPAMP Circuits.

Introduction to Field Effect Transistors and their applications.

Digital Electronics – Review of Basic Gates and Boolean Algebra, Introduction to Combinational Logic Design. Standard Representations of Logical Functions and their simplification. Combinational Logic Design, Half Adder and Full Adders.

Sequential Circuits – Flip flops S-R, J-K and D Application in Ripple Counters.

Electronics Engineering (Practical)

[0-0-3]

1. Study of Electronic Equipment & Components.
2. Study of diode characteristics.
3. Study of regulated power supply.
4. Study of BJT characteristics.
5. Study of op-amp characteristics.
6. Implementation of Boolean algebra using logic gates.
7. Adder Circuits.
8. Flip Flops.

Reference Books:

1. Electronic Device and Circuit Theory - Boylestad & Nashlesky
 2. Digital Principles & Applications - Malvino & Leach
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Engineering Mechanics

[3-1-0]

Fundamentals of Mechanics: Equivalent force system, Equation of equilibrium,

Introduction to Structural mechanics: Force analysis of Frames, Trusses, Shear force, bending moment analysis of Beams.

Friction force analysis: Laws, Sliding and Rolling friction, Screw Jack, Wedge, Belt friction, Collar friction.

Properties of surfaces: First moment of area and the centroid, Second moment and product of areas, Transfer theorem, Polar moment of inertia.

Introduction of variational mechanics,

Kinematics of particles: Velocity and acceleration calculations, Relative motion.

Particle dynamics: Rectilinear translation, Rectangular and cylindrical coordinates.

Energy methods: Conservation of mechanical energy, work-energy equations.

Linear momentum and moment of momentum: Impulse and momentum relations for a particle, Moment of momentum equations for a single particle and for a system of particles.

Introduction to kinematics and kinetics of rigid bodies.

Mechanical vibration of single degree of freedom system.

Reference Books :

1. Vector Mechanics for Engineers – Statics & Dynamics: Beer, Johnston.
2. Engineering Mechanics – Statics & Dynamics: Nelson, Best, McLean.
3. Engineering Mechanics – Statics & Dynamics: Shames, Rao, Pearson.

4. Engineering Mechanics – K.L.Kumar.
 5. Engineering Mechanics – Statics & Dynamics: A.K.Tayal.
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English for Science and Technology

[3-1-0]

Language Resource Development : Using appropriate grammatical lexical forms to express meaning-accuracy, range and appropriacy grammatical lexical exercises.

Reading, Interpreting and Using Written, and Graphic Information: Using (reading and writing) academic texts, articles in technical journals, instruction manuals/laboratory instruction sheets, safety manuals and regulations, and reports; Using maps, graphs, plan diagrams, flow-charts, sketches, tabulated and statistical data.

Writing Appropriately in a Range of Rhetorical Styles i.e. Formal and Informal: Writing instructions, describing objects and processes; defining, narrating, classifying exemplifying, comparing, contrasting, hypothesizing, predicting, concluding, generalizing, restating and reporting; Note making (from books/journals); Writing assignments; summarizing, expanding, paraphrasing; Answering examination questions; Correspondence skills; Interpreting, expressing and negotiating meaning; Creating coherent written texts according to the conventions.

Receiving and Interpreting the Spoken Word: Listening to lectures and speeches, listening to discussions and explanations in tutorials; Note taking (from lectures); Interacting orally in academic, professional and social situation; Understanding interlocutor, creating coherent discourse, and taking appropriate turns in conversation; Negotiating meanings with other (in class room, workshop laboratory, seminar, conference, discussion, interview etc.).

Reference Books :

1. Using English in Science and Technology – R K Singh
 2. Practicing English in Science and Technology - R K Singh
 3. Communication in English : Grammer and Composition - R k Singh
 4. Communication in English for Technical Studies - William, Ray; Ray Rabindranath; and Swales, John—Orient Longman
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Earth System Science

[3-0-0]

AGL [2-0-0]

Space Science: Solar System, Age of the Earth, Origin of Solar system. Meteors and Meteorites.

Earth Dynamics: Interior of the Earth, Composition of the Earth, Seismic waves, Seismograph, Plate Tectonics, Basics of Earthquake , Landslides, Volcanoes.

Geological Oceanography: Sea waves, Tides, Ocean currents, Geological work of seas and oceans, Tsunami and its causes, Warning system and mitigation.

Hydrogeology: Water table, Aquifer, Groundwater fluctuations and groundwater composition, Hydrologic cycle.

Glaciology: Glacier types, Different type of glaciers, Landforms formed by glacier.

Geological bodies and their structures: Rock, Mineral, Batholith, Dyke, Sill, Fold, Fault, Joint, Unconformity

ESE [1-0-0]

Earth's Atmosphere: Structure and composition of atmosphere, Atmospheric circulation, Geological work of wind, Greenhouse effect and global warming, Carbon dioxide sequestration. Steps to maintain clean and pollution free atmosphere with governing laws, precautionary measures against disasters.

Biosphere: Origin of life, Evolution of life through ages, Geological time scale, Biodiversity and its conservation.

Natural Resources: Renewable and non-renewable resources, Mineral and fossil fuel resources and their geological setting; Mining of Minerals and conservation, Effect of mining on surface environment.

Reference Books :

1. Earth System Science from biochemical cycles to global changes: Jacobson, M., Charlson, R.J., Rodhe, H., and Orians, G.H., 2002,
 2. Fundamentals of Geophysics - Lowrie, W.
 3. Earth System Science Education for the 21st Century : (<http://esse21.usra.edu>)
 4. Earth's Dynamic Systems – W.Kenneth and Eric H.Christiansen.
 5. Exploring Earth: An introduction to Physical Geology – John P.Davidson.
 6. Holmes Principles of Physical Geology – A. Holmes
 7. A Textbook of Geology – P.K. Mukherjee.
 8. A Text book of Environmental Studies for Undergraduate Courses – Erach Bharucha.
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Global Energy Scenario and Energy Security of India

[3-0-0]

ESE [1-0-0]

Definition of Energy; Primary and Secondary Energy; Difference between Energy, Power and Electricity;
Renewable and Non-Renewable Sources of Energy; The concept and Significance of Renewability;
Social, Economic, Political and Environmental Dimension of Energy;

FME [2-0-0]

Major Types and Sources of Energy at the Global and at the National Level;
Global and Indian Reserves and Resources of Natural Oil and Gas, Coal and Nuclear Minerals:
Potential of Hydroelectric Power, Solar Energy, Wind, Wave and Biomass Based Power and Energy: Globally and in India.
Energy Sources and Power Generation: Thermal, Nuclear, Hydroelectric, Solar, Wind and Wave; General Principles; Relative Merits and Demerits including, Conversion Efficiency, Generation Cost and Environmental Impact: Concepts of Open and Combined Cycles, Co-generation: Clean Coal Initiatives;
Power Transmission and Distribution: General Principles; Demand Side Management;
Social, Political, Economic and Legal Issues Involved in the Generation Transmission Distribution of Power in India:
Current Scenario and Future Prospects of Carbon Sequestration, Coal Gasification and CBM;
Current Scenario and Future Prospects of Solar Power, Hydrogen Power and Fuel Cells;
Energy cum Power Scenario of India vis-à-vis China, South Africa and the USA;
Global Energy Politics.

Reference Books :

1. Non-Conventional Energy Sources, G.D. Rai
 2. A Textbook of Power Plant Engineering, R.K. Rajpur
 3. World Coal Institute Website.
 4. Uranium Information Center Website.
 5. World Energy Council Website.
 6. Integrated Energy Policy, GOI.
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Computer Programming

[3-0-0]

Introduction to Computer Software.
Introduction to Programming, Data Types, Variables, Operators and Expressions, Assignments, Input/Output, Control statements and iterations, Arrays and subscripted variables, String

manipulation, Functions, Recursions, Structures and unions, Pointers, Dynamic memory allocation, Linked structure, File handling, Language preprocessor and Command line arguments.

Introduction to Object Oriented Programming in C++ .

Reference Books :

1. “The C Programming Language” - Brain W. Keringhan and Dennis M.Ritchi
 2. “Programming in ANSI C” - E. Balaguruswamy
 3. “Schaum’s Outline of Programming with C” - Byron Gottifried
 4. ‘Fundamentals of Data Structures in C’ - Ellis Horowitz, Satraj Sahni and Susan Anderson-Freed
 5. ‘Object Oriented Programming in C++’ - E.Balaguruswamy
 6. ‘Object Oriented Programming in C++’ - Robert Lafore
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Value Education, Human Rights and Legislative Procedure

[3-0-0]

Social Values and Individual Attitudes, Work Ethic, Indians Vision of Humanism, Moral and Non-moral Valuation, Standards and Principles, Value Judgments.

Rural Development in India, Co-operative Movement and Rural Development.

Human Rights, UN declaration, Role of various agencies in protection and promotion of Rights.

Indian Constitution, Philosophy of Constitution, Fundamental Rights and Fundamental Duties, Legislature, Executive, and Judiciary: Their Composition, Scope and Activities.

The Legislature: Function of Parliament, Constitution of Parliament, Composition of the Council of the States, Composition of the House of the People, Speaker,

Legislative Procedure: Ordinary Bills, Money Bills, Private Members Bills; Drafting Bills; Moving the Bills, Debate, Voting, Approval of the President/Governor.

Vigilance: Lokpal and Functionaries.

Reference Books :

1. An Introduction to Ethics-Robert E. Dewey and Robert H. Hurlbutt III
 2. Introduction to the Constitution of India-Durga Das Basu
 3. Essay and Reflections-Sarvapalli Radhakrishnan, Mahatma Gandhi
 4. An Autobiography :The story of My Experiments with Truth-M.K.Gandhi,
 5. Human Rights : Questions and Answers-Leah Levin
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THIRD SEMESTER

ESC 13101: Environmental Chemistry

[4-1 -0]

Environmental Chemistry of Water:

The principles and application of aqueous chemistry to the environmental systems. Unique properties of water, Water Quality Parameters: physico-chemical, biological, bacteriological; Xenobiotics; Water Quality Criteria and Standards; Water quality monitoring and management aspects, Chemical methods involved in treating water and wastewater, Removal of dissolved organics and inorganics, Heavy metal pollution and its abatement. Natural water pollution: Eutrophication, Detergents and phosphates, Removal of nitrogen and phosphates, Water disinfection. Significant of water quality parameters.

Atmospheric Chemistry:

Structure and properties of atmosphere, Classification and chemistry of major air pollutants and their control. Types and sources of air pollution-natural, Combustion and other combustion sources. Thermodynamics and kinetics of air pollutants. Atmospheric photochemistry, Chemical and photochemical reactions in atmosphere. Atmospheric pollution due to automobile emissions and its control, Smog, PAH, VOCs, Acid rain, Depletion of stratospheric ozone. Control devices for gaseous pollutants with especial emphasis on adsorption, absorption, mass transfer, condensation, and combustion.

Soil Chemistry:

The nature and importance of soil; Soil in the natural and man-made environment, Soil properties; Acid-Base and Ion-exchange reactions in soils. Macro and Micronutrients; Fertilisers and other soil amendments. Waste and pollutants in soil, Heavy metals and radio-nuclides in soil. Colloidal chemistry of inorganic constituents, clays, OM and soil humus; Absorption in soils - forces and isotherms; Soil as cation and anion exchanger; Degradation of natural substances; Remediation of metal contaminated soil.

Environmental Chemistry of Hazardous Substances:

Classification and characteristics of hazardous substances and wastes, Effects and fate of Hazardous wastes. Reduction, treatment and disposal of hazardous wastes with special reference to chemical treatment. Photolytic reactions.

ESC 13102: Environmental Biology and Ecology

[4-1- 0]

Classification, biomolecules, cell and cell divisions, meristems, simple & complex tissue; tissue systems; primary & secondary growth. Nutrition - autotrophic, pigment systems, chloroplast, light absorption by chlorophyll and transfer of energy; two pigment systems; photosynthetic unit, phosphorylation and electron transport system, C3 & C4 cycle, CAM, factors affecting photosynthesis; Mineral Nutrition in plants; Heterotrophic nutrition. Plant water relationships, diffusion, osmosis, imbibitions, movement of water, uptake of water by roots, the ascent of sap, transpiration, Components of ecosystem; biotic and abiotic factors; Food chain & web; ecological pyramids; ecosystem stability -inertia and resilience. Fragile ecosystem, hot spots. system ecology. Energy flow in ecosystem; recycled pathway. C, N, P and S cycle; biological N fixation, nutrient cycling in tropics. Limiting factors, Bio-monitoring, biotic indices, indicator species. Population and community ecology, habitat, ecological niche and ecotone; ecological successions; biodiversity and indices; Aquatic ecology – Lentic and lotic habitat, stratification, productivity, community & life form, Wetland, marine and estuarine ecosystem. Ecotoxicology - background, importance & measurement. Ecosystem response to de-oxygenation. Eutrophication, Pesticides & Bio-accumulation.

MMR 13101: Mechanical Engineering - I

[3-1-0]

Stress and strain diagram; Elastic constants and their relation; Thermal stresses and strains; Principal stress and Principal planes.

Deflections of beams,

Analysis of stresses in pressure vessels,

Torsion of circular section.

Basic concepts: Degrees of freedom, Kinematic constraints, Linkages, Mechanisms.

Different types of gears, gear trains, reduction ratio and torque assessment, Application of gear boxes.

Basic principles and construction of Governors, Flywheels. Brakes, clutches and dynamometers. Case study based on laboratory setups on the above broad areas.

ESC 13103 : Applied Thermodynamics

[3-1-0]

Basic thermodynamics: Work and heat transfer, First law of thermodynamics applied to closed and open systems, Second law of thermodynamics, Carnot's propositions, Clausius inequality, entropy principle.

Air standard cycles: Carnot, Otto, diesel and dual cycles; Principle of working of 2 stroke and 4 stroke internal combustion engines, valve timing diagrams and performance testing.

Properties of steam: T-V, P-V, T-S, P-T, H-S diagrams, Mollier diagram.

Steam generators: classification, construction and functioning, mountings and accessories.

Refrigeration Cycles: Basics of air-vapour compression and vapour absorption refrigeration cycles.

Vapour power cycles: Carnot and Rankine cycles, Reheat and regenerative cycles, thermal efficiency and work ratios.

Gas turbine cycles with heat exchanger and regeneration.

AMCP 13101: Methods of Applied Mathematics -I

[4-1-0]

Section A: Analysis of Complex Variables: Limit, continuity and differentiability of function of complex variables, Analytic functions, Cauchy-Reimann's equations and Cauchy' integral theorem, Morera's theorem, Cauchy's Integral formula, Expansion of function of complex variables in Taylor's and Laurent's series, singularities and poles. Residues theorem, contour integration, conformal mappings and its application, Bilinear transformation.

Section B: Special Functions: Solution in series of ordinary differential equations, Solution of Bessel and Legendre equations, recurrence relations and generating function for $J_n(x)$. orthogonal property and Integral representation of $J_n(x)$. Legendre polynomial, Rodrigue's formula, orthogonality properties and generating function for $P_n(x)$. Elliptic integrals and Error function and their properties.

Section C: Laplace Transform and PDE-II: Laplace transform of simple functions, first and second shifting theorems, t-multiplication and t-division theorems; Laplace transforms of derivatives, integrals and periodic functions. Inverse Laplace transform and convolution property. Use of Laplace transform in evaluating complicated and improper integrals and solution of ordinary differential equations related to engineering problems.

Partial Differential Equations: Classification of partial differential equations, solutions of one dimensional wave equation, one dimensional unsteady heat flow equation and two dimensional steady heat flow equation in Cartesian and polar coordinates by variable separable method with reference to Fourier trigonometric series and by Laplace transform technique.

ESC 13201: Environmental Chemistry (Practical)

[0-0-2]

Calibration and Standardisation of pH meter, Conductivity meter, Nephelometer and other water quality monitoring instrument; Determination of pH, Acidity-Alkalinity, Total suspended solids (TSS), Total dissolved solids (TDS), Total hardness and Ca & Mg hardness, Chloride, Sulphate, Nitrate, Oil and grease, DO, BOD, COD, Chlorine demand, Break-point chlorination and Free residual chlorine.

Soil sampling, Description of the soil horizon, Determination of soil pH, Conductivity and Salinity; Organic carbon, Nitrogen and Phosphorus; Sodium and Potassium; CEC, Available sulphur.

Sampling and analysis of inorganic and organic particulates, SO_x, NO_x, NH₃ etc.

Demonstration of UV-VIS Spectrophotometer, Flame photometer, AAS, GC, TOC etc.

ESC 132 02: Environmental Biology and Ecology (Practical)

[0-0-2]

Microscopic study of cell divisions (mitosis and meiosis); Microscopic study of tissue systems; Extraction of photosynthetic pigments; Measurement of water potential; Identification of C₃ and C₄ plants; Measurement of qualitative and quantitative characteristics of plant communities; Ecological sampling of an area (line transect and quadrat methods); Species-area curve method; Field visit of aquatic ecosystem.

ESC 13203: Applied Thermodynamics (Practical)

[0-0-2/2]

Experiments related to Two-stroke and four-stroke IC Engine models, IC Engine performance, boiler performance, vapour compression and vapour absorption refrigeration cycles.

FOURTH SEMESTER

ESC 141 01: Environmental Microbiology [3-1-0]

Classification of microorganisms, Prokaryotic and Eukaryotic cells; General properties, Distribution of microbes, Applied fields of microbiology. Enumeration of microbes. Bacteria - cell structure, spore, morphology, classifications and reproductions.

Environmental importance of Fungi, Algae, Protozoa, Actinomycetes and viruses.

Growth of bacteria, batch culture; specific growth rate and doubling time; continuous culture; synchronous growth. Effects of environmental factors on growth; Bacterial nutrition; culture media and culture characteristics;

Control of microbes by physical agents and chemical methods;

Microbial metabolisms -Anabolism/catabolism; Central metabolism: glycolysis and the TCA cycle; Metabolic pathways of contaminant biodegradation; Metabolic regulation Stoichiometry and Bacterial Energetics - Mass balances, Redox reactions: electron donor/electron acceptor; Redox half-reactions; Energy balances (ΔG) – Growth, Substrate Partitioning and theoretical yield, Electron acceptors, fermentation. Monod and Halden kinetics;

Aerobic and anaerobic respiration; stream pollution; drinking water microbiology; water borne pathogens, MPN test; faecal coliform and faecal streptococci, MF techniques, IMVIC test; Composting; Aeromicrobiology;

Soil microbiology- biofertilizer, VAM fungi, N-fixations, Degradation of natural substances.

ESC 141 02: Fluid Mechanics and Hydraulics [3-1-0]

Properties of fluids: Viscosity; unit, Newton's law of viscosity, Viscosity variation with temperatures, Measurement of viscosity. Pressure and its measurement: absolute, gauge, atmospheric and vacuum pressure; Manometers and mechanical gauges.

Hydrostatic force and surfaces: total pressure and center of pressure for plane, inclined and curved submerged surfaces; pressure on lock gates. Kinematics: types of fluid flow, rate of flow, continuity equation in three dimension, velocity potential and stream function;

Dynamics: equation of motion, Euler's and Bernoulli's equation and their practical applications, Venturimeter, Orifice meter, Pitot tube, Momentum equation and Moment of momentum. Flow through orifices: Introduction, classification of orifices, concept of C_c , C_v , and C_d .

Flow through notches: Introduction, classification of notches – rectangular, triangular, trapezoidal and stepped notches. Flow through pipes: loss of energy in friction, Darcy's and Chezy's equation, minor losses; Hydraulic gradient and total energy line, Pipes in series and parallel, Equivalent pipe, Power transmission through pipes and nozzles. Viscous flow: flow through pipes, flow between two parallel plates, kinetic energy and momentum correction factor. Impacts of jets: force exerted by a jet on stationary, hinged and moving plates, jet propulsion.

ESC 141 03: Geology for Environmental Engineering [4-1-0]

Physical Geology: Branches of geology, Earth- its origin, internal constitution, and age; Atmosphere, hydrosphere, lithosphere and their constituents; Structural features such as folds, faults, unconformities. Plate tectonics; Processes of weathering, Geological agents. earthquakes, volcanoes; Geological work of river, wind, glaciers, seas and ground water; Overview of toposheets and geological maps and contouring.

Mineralogy: Minerals: its properties, Properties of common rock forming minerals. Crystals and crystal systems. Classification of minerals and study of common silicate minerals (Quartz, feldspar, Pyroxene, Mica), sulphide (pyrite, chalcopyrite, galena, Sphalerite) and Oxides (Haematite, Magnetite, Chromite, Pyrolusite, Psilomelane).

Petrology: *Igneous rocks* ; Classification of rocks; Magma- its composition and constitution; Classification and Structure of igneous rocks; Description of some common igneous rocks (Peridotite, Dolerite, Basalt, Granite, Rhyolite). *Sedimentary rocks*: Sedimentation process; Classification and Structure of Sedimentary rocks; Description of some common sedimentary rocks (Conglomerate, Sandstone, Shale, Limestone). *Metamorphic rocks*: Processes of metamorphism; Structures of metamorphic rocks; Description of some common metamorphic rocks (State, Schist, Gneiss, Quartzite, Marble).

Hydrology: Aquifers-types and parameters; Delineation of watershed and its characteristics; Calculation of recharge value; Overview of pumping test studies.

Economic geology: Ore and gangue minerals; Formation of mineral deposits; Mode of occurrence, distribution and uses of some important minerals.

Coal geology: Coal- its composition and origin; Distribution of Indian coals.

Stratigraphy: Geological time scale; Various stratigraphic units of India.

Paleontology: Fossils- their mode of preservation and uses; Geological history, Index fossils.

ESC 141 04 Remote Sensing and GIS

[3-1-0]

Introduction to Remote Sensing: Types of Remote Sensing; Advantages of Remote Sensing; Applications of Remote Sensing ; History of Remote Sensing; Physical basis of Remote Sensing; The Electromagnetic spectrum; Spectral Reflectance Curves; Spectral signatures; Resolution.

Remote Sensing Platforms: Ground, airborne and satellite based platforms; Some important Remote Sensing Satellites.

Sensors: Passive and Active Sensors; Major Remote Sensing Sensors; Satellite band designations and principal applications; Colour / False Colour; Aerial Photography/ Aerial Photo Interpretation.

Digital Image Processing: Pixels and Digital Number; Digital Image Structure; Format of Remote Sensing Data; Image Processing functions: Image Restoration, Image Enhancement, Image Transformation, Image Classification and Analysis; Image interpretation strategies.

Geographic Information System: Introduction; Preparation of thematic map from remote sensing data; Co-ordinate systems; GIS components: Hardware, software and infrastructures; GIS data types: Data Input and Data Processing; DEM/ DTM generation.

Integration of Remote Sensing and GIS techniques and its applications in Environmental Impact Assessment and Management including some case studies.

AMCP 141 01: Numerical and Statistical Methods

[4-0-0]

A. Numerical Methods: Solution of algebraic and transcendental equations by bisection, iteration, false position, secant and Newton-Raphson methods, Generalised Newton's method for multiple roots.

Solution of system of linear simultaneous equations by Gauss elimination, Gauss-Jordan, Crout's triangularisation, Jacobi and Gauss-Seidel methods. Finite differences, Symbolic relations, differences and factorial notation of a polynomial, data smoothing, Interpolation and extrapolation, Newton-Gregory forward and backward, Gauss forward and backward, Stirling, Bessel, Everett, Lagrange and Newton's divided difference formulae; Inverse interpolation by Lagrange's and iterative methods; Cubic splines. Numerical differentiation and integration, Trapezoidal, Simpson's $1/3^{\text{rd}}$, Simpson's $3/8^{\text{th}}$, Weddle and Gaussian quadrature formula.

Numerical solution of first order ordinary differential equations by Taylor's series, Picard's, Euler's, Modified Euler's, Runge-kutta, Adams-Moulton and Milne's methods. Solution of simultaneous first order and second order ordinary differential equations with initial conditions by Taylor's series, Runge-Kutta and Milne's methods. Numerical solution of boundary value problems by finite difference and shooting methods.

B. Statistical Methods: Concept of frequency distribution: Moments, skewness and kurtosis Probability: various approaches of probability-classical, frequency (statistical), subjective and axiomatic. Theorems on probability, conditional probability, independence, Bayes theorem.

Random variable-discrete and continuous. Distribution functions and their properties, Probability mass and density functions, Mathematical expectation, Moment generating function and its properties. Probability distributions: Bernoulli, binomial, negative binomial, Poisson and normal distributions.

Theory of least squares and curve fitting. Correlation – Simple, multiple and partial, regression lines; regression coefficients; multiple and partial regression. Test of significance: Normal test, t-test chi-square test and F-test.

ESC 142 01: Environmental Microbiology (Practical) [0- 0-2]

Apparatus used for a microbiological laboratory; Sterilisation and Disinfections; Media preparation: semi-synthetic, synthetic media and semisolid; culture media – Nutrient agar; Enrichment media preparation; Gram staining.

Bacteriology of drinking water and domestic sewage -MPN techniques for total coliform; Faecal coliform (thermotolerant coliform) MPN test; Faecal Streptococci (FS) MPN test; Membrane filtration techniques for faecal coliform and total coliform; P-A coliform test; Seven hour – coliform test. Microbiology of Air: by exposure plate method; Use of nutrient agar medium, Enumeration and identification of fungal mycelium and spores; Microbiology of soil- Heterotropic bacterial counts by colony counter (Nutrient agar medium); Study of fungi (medium – Rose Bengal agar). Study of microbial activities by CO₂ evolution method (in-situ and Laboratory); Study of fresh water and polluted water algae – (blue green algae, green algae and diatoms only).

ESC 142 02: Fluid Mechanics and Hydraulics (Practical) [0-0-2]

Experiments related to Bernoulli's theorem, Determination of friction losses in pipe flow including Minor losses, Experiments related to flow through orifices, mouthpieces, weir and notches, Calibration of Venturimeter and Pressure gauges; Flow demonstration by Reynolds's experiment, impact of jet, display model of centrifugal pump

ESC 142 03: Geology for Environmental Engineering (Practical) [0-0-2]

Toposheet Analysis; Preparation of drainage map; Study through GPS.

Drawing of strike line & determination of true dip & apparent dip. Study of some common minerals. Study of important igneous, sedimentary and metamorphic rocks. Preparation of watershed map and calculation of TARR value. Water table fluctuation study and pumping test analysis.

AMCP 142 01: Numerical and Statistical Methods (Practical) [0-0-3]

A. Numerical Methods

Numerical solution of non-linear algebraic and transcendental equation by bisection, iteration, false position, secant and Newton Raphson methods.

Numerical solution of a system of linear simultaneous equation by Gauss elimination and Gauss Seidel methods. Interpolation by Lagrange's interpolation formula.

Numerical evaluation of definite integral by Trapezoidal, Simpson's 1/3rd, Simpson's 3/8th, Weddle and Gaussian quadrature formulae.

Numerical solution of first order ordinary differential equation by Euler's, Modified Eulers, second and fourth order Runge-Kutta, Adams-Moulton and Milne's methods.

B. Scope of practice sessions:

Computation of raw moments; central moments, coefficients of variation, coefficients of skewness and kurtosis; fitting of straight line, second degree polynomial (parabola), power curve and exponential curve; computation of product moment correlation; multiple and partial correlation coefficients. Regression coefficients and regression line, plane of regression. Application of tests of significance based on numerical data.

ESC 146 01: Industry and Environment

[0-0-0](1)

Environmental issues related to different industry sectors. Careers in environmental engineering. Environmental awareness programs. Lectures from professional experts. Field trips, and seminars.

ESC 146 02: Land Surveying and Mapping

[0-0-0](4)

Land surveying goals. Principles of land surveying. Distance, elevation, and angular measurement techniques using the state-of-the-art instruments. Leveling and angular measurement instruments. Surveying using traversing and triangulation. Curve surveying, Correlation of surface and subsurface surveys. Land/mine plans development, use of commercial software for mapping and contouring. Analysis of errors during measurement.

ESC 146 03 Industrial Visit / Report

[0-0-0](1)

Visit to different industries like chemical, metallurgy, mining, petroleum and allied industries. Preparation of report and presentation.

FIFTH SEMESTER

ESC 151 01: Air Pollution

[3-1-0]

Fundamentals –physics of atmosphere, stationary and mobile sources, fugitive emission, primary and secondary pollutants.

Effects of air pollution in regional and global scale, air pollution episodes

Emission factor, inventory and predictive equations.

Atmospheric meteorology, wind profiles, turbulent diffusion, topographic effects, separated flows, temperature profiles, stability, inversions, plume behaviour.

Air Quality monitoring: air sampling design, analysis and interpretation of data. Stack monitoring. Air pollution standards and indices. Vehicular pollution, Indoor air quality

ESC 151 02: Water Resource Planning and Management

[4-1-0]

Water Resources: Introduction, hydrological cycle, world water distribution, need for conservation & development of water resources, requirement/water demand for Domestic, industrial hydropower generation, irrigation, navigation & recreation etc.

Hydrological analysis of precipitation: Precipitation, measurement of rainfall, index of wetness, design of rain gauge network, probable maximum precipitation curve, infiltration, infiltration capacity curve, Measurement & estimation of water losses, runoff cycle, runoff coefficients, computation of runoff: rational formulae, unit hydrograph, Bernard's distribution, unit storm method

Streams & reservoir: Stream flow measurement: Notches, weirs, control meters, Venturi-Flumes, Velocity area method, slope area method, capacity elevation curve of river, Types of reservoirs, storage zones, catchment yield & reservoir yield, reservoir capacity mass curve of inflow and outflow, hydrological reservoir routing, reservoir sedimentations and losses, selection of site for a reservoir, economic height of dam

Groundwater hydrology: Aquifers, hydrological properties i.e. porosity, permeability, transmissivity, specific retention, yield etc. measurement of yield, Laws of ground water movement: Darcy's law, Thieme's equilibrium formula, Dupuit's formula etc. Recharging of underground storage, infiltration galleries, infiltration wells, springs, wells

Flood flows and management: Definition & causes of flood, estimation of design flood and flood flows for design of hydraulic structures, flood forecasting techniques: flood routing, inflow-outflow curve, mathematical models etc. Flood control measures

Water resources planning & management: Planning of water resources projects, Engineering economics study, cost benefit analysis, optimization in planning of water resources projects

ESC 151 03: Land Management: Principles and Design

[3-1-0]

Pertinent land characteristics for planning. Land use planning and management for commercial, residential, agricultural, wetland areas etc and regulatory requirements. Impacts of natural and man-made activities on land characteristics and land use planning. Erosion and sedimentation control. Soil transportation and impacts on land use.

Land reclamation principles and requirement, Removal, storage and replacement of topsoil, and subsoil on reclaimed lands. Bonding requirements. Rehabilitation of seriously disturbed lands using physical, chemical and biological methods. Planning for bio-diversity on reclaimed lands. Land use planning models and their limitations.

ESC 151 04: Soil Mechanics for Environmental Engineering [3-0-0]

Soil, Complexity of soil nature, formation, regional deposits, solid-water-air relationships and index properties.

Classification of soil, soil structure and clay minerals, soil compaction, consolidation, effective stress, capillarity and permeability, seepage through soils, flownets, drainage and dewatering.

Soil mechanics applications in slopes, factor of safety. Site investigation and subsoil exploration. Measuring instruments. Application of soil mechanics in environmental engineering.

ACC 151 04: Instrumentation Methods for Environmental Analysis [3-1-0]

Treatment of data in quantitative analysis: Accuracy, Precision, Standard deviation, and types of Errors, minimization of error, significant figures, criteria for rejection of data.

Principles of instrumentation; advantages, applications, and limitations of the following analytical techniques: Spectrophotometry, FTIR, NMR, Atomic absorption and Emission spectrophotometry, Flame photometry, Fluorimetry, Nephelometry, Inductively coupled plasma spectrometry and MS.

Electrochemical methods: Polarography, Pulse polarography, Ion selective electrodes, Oscilloscopic Polarography, Cyclic voltametry, Anodic Stripping Voltametry.

Chromatography: Classification, general ideas about adsorption, partition, and column chromatography, paper and thin layer chromatography. Gas chromatography, High performance liquid chromatography (HPLC), Ion chromatography. Physical & biological methods of monitoring.

ESC 152 01: Air Pollution (Practical) [0-0-2]

Calibration of HVS, RDS by orifice method; Determination of SPM, PM₁₀, SO₂, NO_x and CO in ambient air; Preparation of Wind Rose Diagram; Respirable dust monitoring by GDS, RDS and RAM; Elemental analysis of particulate matter; SO₃ in ambient air by lead candle method; Demonstration of stack monitoring kits; Demonstration and Data analysis of SODAR.

ESC 152 04: Soil Mechanics for Environmental Engineering (Practical) [0-0-2]

Practical related to Moisture Content, Atterberg's limit test, Density and Specific Gravity, Particle Size analysis, Falling Head and Constant Head Permeability Tests, Compaction Tests, Consolidation Tests, Triaxial Tests.

ACC 152 04: Instrumental Methods for Environmental Analysis (Practical) [0-0-2/2]

Estimation of iron by Vis-spectrophotometer (including plotting of calibration curve using least square method), Detection of PAH by FTIR, Estimation of Na, K, Ca by flame photometer, Conductometric titration, Potentiometric titration, Determination of distribution coefficient of I₂ in water and CCl₄, Estimation of free chlorine in water.

SIXTH SEMESTER

ESC 161 01: Municipal Wastewater Engineering [3-1-0]

Introduction, domestic sewage flow, characteristics and sources, method of sampling, types of sewer system, hydraulic design of sewers, construction and testing of sewer lines, sewer materials, joints and appurtenances, sewage pumping and pumping stations, maintenance of sewerage system; Wastewater treatment -physical unit process, preliminary treatment design and operation of screening, communicators, flow equalisation, grit chamber; design and operation of PST, aeration system, oxygen transfer, factors affecting oxygen transfer, types of aerators, removal of VOCs by aeration; Chemical unit process: Biological treatment: Operation and design aspects of ASP and its modifications; design and operation of oxidation ditch, trickling filter, RBC, Aerated lagoons and waste stabilization ponds, UASB and hybrid bioreactors, SBRs, Design of secondary settling tank; Aquatic plant system, constructed Wetlands Sludge handling and disposal, design of sludge drying bed. Disposal and reuse- dilution, self-purification of streams, land irrigation and sewage farming, wastewaters reuse, ground water recharge; and vermiculture, Standards of disposal into natural water courses and on land, Indian Standards. CETP design, operation and maintenance aspects.

ESC 161 02: Air Pollution Control [3-1-0]

Review of general principles of air pollution control. Design of Stack. Design of Hood and Duct. Control of particulate matter : Design and operation of Gravity Settling Chambers, Cyclones, Wet Scrubber, Electrostatic Precipitators and Fabric Filters. Dust control and abatement measures– dust suppression, dust extraction and dust consolidation. Design of control devices for gaseous pollutants with special emphasis on adsorption, absorption, mass transfer, condensation and combustion Control of motor vehicle emissions. Indoor air pollution control. Economics of pollution control.

ESC 161 03: Solid Waste Management [3-1-0]

Municipal Solid Waste Management - Engineering principles, sources, nature and characteristics; quantitative and qualitative aspects; Solid waste problems - Industrial, Mining, Agricultural and Domestic (urban) wastes. Hydrological aspects of solid waste. Regulatory aspects of solid waste management. Solid waste disposal - Sanitary landfill planning, site selection, design and operation, equipment, costs, landfill stabilization. Biological oxidation. Composting, optimum conditions for composting Pyrolysis; Incineration: waste characterization, combustion calculation, unit operations, supply of air, products of combustion, furnace temperature, furnace calculation, storage of refuse, waste reduction and environmental control. Industry specific solid waste management: Agriculture, Process industry, Mineral and Metallurgical industry, Disposal of industrial and mill tailings, Resource and energy recovery; Recycling of solid waste.

ESC 161 04: Environmental Policy and Legislation [3-1-0]

Environmental Policies - National and International trends, Changes in global perspective, International treaties. National Policies: National Environmental Policy, National Forest Policy, National Water Policy, Rehabilitation and Resettlement Policy; Evolution of environmental legislation in India, Legal provisions for environmental protection; various Acts, Rules and Regulations. Notifications issued under various Acts and Rules. Environmental standards, Criteria for Standards setting. Public Liability Insurance Act and legal aspects relating to hazardous and toxic substances.

ESC 161 05: Water Quality and Treatment

[3-1-0]

Water Supply Engineering: Sources of water: Alternative sources, i.e., rain, surface and ground water, Water quality parameters: physical, chemical and biological parameters, water quality requirements, and Indian standards; Water Demand: Design flows, design periods, and design population, Factors affecting water consumption, variations in water demand, design capacities for various water supply components;

Assessment of yield and development of the sources and intake works; Transmission of Water: Hydraulics of conduits, selection of pipe materials and joints, Distribution of Water: Methods of distributing water, distribution system components, distribution reservoirs, capacity and pressure requirements, design of distribution systems, hydraulic analysis of distribution systems, Pumps and pumping stations required for water supply systems, Plumbing design for buildings.

Water Treatment Engineering: Overview of water treatment process, theory and application, Sedimentation: type-I, type-II, type III and type IV settling, settling operation, design and construction of sedimentation tank. Coagulation processes: theory of coagulation, coagulant dose, slow rapid mixing; design consideration, Flocculation processes- design aspects, Filtration: Filter hydraulics, filter components, operation and design aspects of slow and rapid sand filters, Pressure filter, Dual-media filter and mixed media filter. Disinfection- chlorination and other methods of disinfection, Water softening- single stage and two stage, Recarbonation, Ion exchange, Removal of dissolved solids, Fluoride, Iron and Manganese removal, Nitrogen & Phosphorous removal.

ESC 162 01: Municipal Wastewater Engineering (Practical)

[0-0-2]

Pre – and post chlorination, analysis of sewage, Determination of MLSS, MLVSS, SVI,; sludge settling characteristics curve, BOD₅: TKN ratio, nitrifer fraction, Jar-test, Total coliform, FS & FC in raw sewage.

ESC 162 03: Solid Waste Management (Practical)

[0-0-2]

Sample preparation; sampling techniques; coning and quartering method; overburden and other wastes sampling. Profile sampling, site description; estimation of rooting depth and litter-fall. Determination of coarse fraction,; pH & buffered pH, KCl & CaCl₂ solution; EC & Ece; exchangeable Na & K; non-exchangeable K & HNO₃-soluble-K. ESP and SAR. neralisable -N and total nitrogen in profile samples. CEC. Determination of organic matter and organic carbon C:N ratio; Determination of plant available P and total P; Determination of P-fixing characteristics of OB samples; in OB samples of different depth and observe any variation with respect to depths. DTPA -extractable micronutrients and trace elements in OB samples; Determination of Microbial activity by CO₂ evolution method in laboratory.

ESC 162 05: Water Quality and Treatment

[0-0-2]

Determination of water quality parameters: pH , colour, conductivity, acidity-alkalinity, turbidity, hardness, TSS, TDS, Chlorides, Nitrate, sulphate, DO, chlorine demand, break point chlorination, free residual chlorine. Jar test experiments, settling studies, determination of heavy metals, determination of trace elements

MSC 16351: Managerial Economics

[0-0-0] (4)

Concept and context; Demand Analysis and Supply Analysis; Quantitative Demand Analysis and Revenue Analysis; Cost and Production Function; Price and Output Determination by the Firm and Industry under various market structures, e.g., Perfect Competition, Monopoly; Monopolistic Competition; Oligopoly; Business Cycle; National Income Measurement; Theories of Income Determination; Saving-Investment Analysis.

SEVENTH SEMESTER

ESC 171 01: Environmental Impact Assessment

[3-1-0]

Sustainable Development. Framework for Environmental Impact Assessment. Screening, Scoping and Baseline Studies, Significance and Importance of Impacts, Impact prediction, Mitigation aspects, Assessment of alternatives, Public Hearing, Decision Making. Techniques for assessment of impacts on physical resources, ecological resources, human use values and quality of life values.

Impact assessment methodologies -various methods, their applicability. Strategic Environmental Assessment. Cumulative impact assessment. Risk and uncertainty in EIA. Environmental Management Planning. Disaster management planning.

ESC 171 02: Industrial Waste water Treatment

[3-1-0]

Sources and characteristics of industrial wastewater; effect on environment, management- volume reduction, neutralization, equalization and proportioning, heavy metals removal, adsorption, ion exchange, design and operation of RO process, stripping towers (ammonia stripping), activated carbon column; treatment and disposal of sludge. Wastewater treatment methodology for specific industries - chlor-alkali, electroplating, distillery, dairy, tannery, pulp and paper, textile, dye, fertilizer, refinery, pharmaceutical, iron & steel, coke ovens, coal washeries, mine wastewater including acid mine drainage; Industrial complexing for zero pollution attainment, Common effluent treatment plant (CETP): design, operation and maintenance aspects.

ESC 171 03: Design of Environmental System

[3-1-0]

Air: Design of air pollution control devices.

Land: Design of tailings dams.

Design of overburden dump.

Design of landfill sites.

Water: Design concept of Effluent Treatment Plant's & Wastewater Treatment Plant's.

ESC 171 04: Noise: Fundamentals and Control

[3-1-0]

Basics of acoustics: Sound power, Sound intensity and Sound pressure levels; Plane, Point and Line sources, Multiple sources; Outdoor and indoor noise propagation; Psycho-acoustics and noise criteria, Effects of noise: Annoyance rating schemes and value function curves; Special noise environments. Noise standards and indices.

Noise monitoring: worksite, ambient and road transport.

Machine vibration – monitoring and analysis.

Noise Control measures - Sound Absorption, Acoustic Barrier, Vibration Isolation, Vibration Damping, Muffling, Personal Protector and Green Belt - principles and design. Noise pollution and management in Mines, Power plants, Fertiliser plants, Cement plants, etc.

Human Vibration- whole body vibration problems in surface mines, health effects and control measures.

Ground vibration and air blast - Environmental and health effects, strategic control and abatement measures.

Elective papers

ESE 171 05: Environmental Toxicology & Health

[3-0-0]

Behaviour of chemicals in the environment: physical and chemical properties, transformation and degradation process; Distribution of toxic chemicals in air, water, sediments, soil and biota; Routes and mechanisms of toxicant entry into organisms; Distribution of toxicants within organisms; Biotransformation of toxicant within organisms; Elimination of toxicants from organisms. Infections – Salmonella; Intoxications – Botulism, Staphylococcus aureus, Clostridium perfringens; Non-bacterial parasites - tapeworms-beef, pork, fish; Roundworms-Trichinosis; Chemical Hazards-additives, pesticide residues, toxic metals.

Control of food and waterborne diseases: Introduction to major disease-causing microorganisms in the environment and their transmission through water, food, and air. Description of the organisms, pathogenesis, clinical disease, reservoirs, modes of transmission, and epidemiology. Transport, survival, and fate of pathogens in the environment; the concept of indicator organisms as surrogates for pathogens; and the removal and inactivation of pathogens and indicators by water and wastewater treatment processes. Examples of the public health impact of environmental transmission routes of these pathogens in developed and developing countries.

ESE 171 06: Hazardous and Biomedical Waste Management

[3-0-0]

Hazardous Wastes: Landmark episodes, classification, generation, guidelines of HWM, Regulatory frame work., Basal Convention and other international statistics Monitoring of critical parameters/provide risk-analysis. HAZON, HAZOP, Consequence Analysis. Faculty and eventry analysis. Emergency Management: Indian and foreign legislation in respect of the above. Case studies, leakage, explosion, oil-spills and fire of hazardous chemical storage. Leakage in atomic reactor plants,

Hazardous Chemicals: Toxic chemicals, flammable chemicals, pesticides, explosives, reactive substances, Cyanide wastes, water-soluble chemical compounds of heavy metals, & toxic metals. Hydrocarbons, point pigment dyes, oil emulsion tars, phenols, asbestos, acid/alkaline slurry, Physical properties, and chemical composition and lethal dose and concentration on human life flora and fauna. Storage, collection, transport,

Hazardous Waste Treatment: waste reduction, neutralization, Incineration, combustion and Pyrolysis, unit operations, supply of air, products of combustion, furnace temperature, furnace calculation, and environmental control, disposal. Precautions in collection, reception, treatment, transport, storage, and disposal, and import procedure for environmental surveillance

Biomedical Waste: categorization, generation, collection, transport, treatment and disposal. Radioactive wastes generated during mining, processing of atomic minerals, and in atomic reactors, and disposal of spent fuel rods. Treatment and disposal; remediation of contaminated sites.

ESE 171 07: Occupational Health and Safety

[3-0-0]

Occupational Health and Safety concern and problems. National and international protocols and concerns, policies and legislation.

Ergonomics; Stress-strain concept; Assessment of human capabilities and limitations; Human Physiological Work Capacity and its evaluation.

Sources of work stress (a) intrinsic to the jobs, (b) work environmental stressors like heat & humidity, noise & vibration, dust, illumination, etc.; Methodologies for evaluating different types of stresses.

Human Error and Accidents: Different Classification of Human Error, Theories of Accident Causation, Human Error Audit. Accident analysis.

Education and Training in Occupational Hygiene.

Need to evolve an integrated Occupational Health and Safety Programme for specific industries.

Occupational Health & Safety Management Systems (OHSAS - 18001): Legal and other requirements; Overview; Planning, hazard identification and risk assessment; Occupation Health and Safety Policy; OH & SMS Documentation; Emergency Preparedness and Response

ESE 171 08: Environmental Economics

[3-0-0]

Economy and Environment -the historical development of environmental economics; circular economy, sustainable economy. Economics of Pollution: optimal level of pollution, market achievement of optimal pollution, Taxation and optimal pollution, Environmental standards, Taxes and subsidies, Marketable pollution permits, Measuring environmental damage -Total economic volume and valuation methodology, pollution control policy in mixed economics. Environmental Values Ethics; discounting the future, alternative to adjusting discounting rates.

Economics of Natural Resources;-Renewable resources, Extinction of species, Optimal use of exhaustible resources Measuring and mitigating natural resource scarcity. Development and Environment;- Development, Preservation and conservation, Irreversibility and sustainability, Environment and the developing countries. Carrying capacity based development planning. Cost Benefit Analysis of Environmental Change; Appraisal of Sustainable development Projects; Principles of Cost Allocation, Preventive, Punitive and social costs.

ESC 172 01: Environmental Impact Assessment (Practical)

[0-0-2/2]

Exercises on Screening, Scoping, Prediction, Identification and Evaluation of Impacts.

Case studies related to EIA.

Arranging Mock Public Hearings related to EIA case studies.

ESC 172 02: Industrial Wastewater Treatment (Practical)

[0-0-2/2]

Analysis of specific pollutants in different types of industrial wastewater, design of activated carbon column, coagulation and flocculation test.

ESC 17204: Noise: Fundamentals and Control (Practical)

[0-0-2/2]

Demonstration of noise pollution monitoring instrument, Noise survey and development of noise profile in a multiple noise sources situation, Ambient noise monitoring, Frequency noise monitoring of machine noise, Audiometry survey for assessing hearing acuity, Traffic noise monitoring, Human vibration (whole body vibration) monitoring

HSS 173 45: Social and Ethical Issues in Engineering

[0-0-0](2)

Introduction to Ethical Theories and Ethical Analysis

Engineering as a Profession: a) some history; b) The workplace in which Engineering is situated;

c) Ethical Standards of the Profession, the Codes of Ethics.

Professional Ethics in relation to Law, Common Morality, and the Market.

Ethical Responsibility, Loyalty: critical and uncritical

The standard of reasonable care

The Engineer's Perspective alongside the Business Manager's Perspective

Professional dissent and whistle blowing.

Honesty, sharing and withholding information, confidentiality, secrecy.

Conflict of interest, Bribery, Extortion, Grease, Gifts

Managing risk to Humans and the Environment

How Government/ the Legal System influences Engineering Practice.

Design, Innovation, and Emerging Technologies, especially Disruptive Technologies, e.g, Information Technology, Nanotechnology, etc.

Engineering and Sustainable Development,

Issues associated with Globalization

EIGHTH SEMESTER

ESC 181 01: Environmental Auditing

[3-1-0]

Concepts of Environmental Audit, Objectives of Audit. Types of Audits; Features of Effective Auditing; Programme Planning; Organisation of Auditing Programme, Pre-visit data collection, Audit Protocol; Onsite Audit; Data Sampling - Inspections - Evaluation and Presentation; Exit Interview; Audit Report - Action Plan - Management of Audits; Waste Management Contractor Audits; Life Cycle Approach (LCA).

Introduction; Principles & elements of successful environmental management; ISO principles; EMS; Creating an Environmental Management System in line with ISO: 14000; Benefits of an Environmental Management System; Principles & elements of successful Environmental Management: Leadership, Environmental Management Planning, Implementing an Environmental Management System, measurement & evaluations required for an Environmental Management System, Environmental Management Reviews & Improvements; Legal and Regulatory Concerns; Integrating ISO 9000 & ISO 14000.

ESC 181 02: Environmental Modeling

[3-1-0]

Classification of models for environmental system.

Air quality models—atmospheric stability and turbulence; gaussian plume model and modifications; numerical models, urban diffusion models, calibration and sensitivity analysis. Configuration and application of recently used air pollution models.

Transport and fate of pollution in aquatic systems; river, estuarine and lake hydrodynamics; stratification and eutrophication of lakes; dissolved oxygen model for streams; temperature models. Transport and fate of pollutants in soils and ground water.

Noise modeling: configuration and application of commonly used models.

ESC 18103: Risk Assessment and Disaster Management

[3-1-0]

Perception of Risk: Theories and Human Adjustment.

Environmental Risk assessment: Introduction, identification of potential hazards, assessment of the risk, consequence analysis, hazard identification methods: check list, hazard and operability studies (HAZOP), hazard analysis methods, failure modes and effect analysis, hazard indices, models, regulatory priorities.

Natural Disasters: flood, earthquake, cyclones, forest fires, nuclear, mining disasters.

Emergency response systems, disaster prevention and mitigation.

ESC 181 04: Industrial Environmental Issues: Case Studies

[3-1-0]

Brief description of typical unit operations in extractive, chemical, manufacturing, processing, agricultural, biological and pharmaceutical industries. Land, water and air related environmental issues/case studies for different industries. Field visits and guest lectures from professionals.

ELECTIVE PAPERS

ESE 181 05: Energy and Environment

[3-0-0]

Energy: Definition and various forms, Sources and properties. Energy transfer, conversion and storage.

Hydel Energy: Potential resources, Production and requirement, Common features of conventional Hydro power installations, Socio- economic issues- case studies.

Fossil Base Energy: Fossil fuel types, Combustion kinetics and thermodynamics, Emission control in combustion process, Clean combustion technologies (CCTs).

Biomass Energy: Definitions, Chemical and Physical properties, Thermal conversion to heat and electricity, Resources and production, Socio- economic and environment impacts.

Fuel cells, Mechanism and efficiency

Solar energy: Potential & production, solar cells, Solar thermal energy power generation

Wind Energy: Potential and production, Conversion mechanism to electrical energy.

Geothermal energy, Tidal Energy and conversion to electrical energy.

Environmental portion, Global warming, Environmental changes, etc.

ESE 181 06: Environmental Geotechnology

[3-0-0]

Development of soil mechanics, importance, associated problems and applications, interdisciplinary nature of geotechnical engg. Consolidation of Soils, Shear Strength of Soils, Stability of Slopes, Stress Distribution of Soils, Earth Pressure.

Ground Improvement Technique: Stabilization of soil, Reinforced earth geotextile, geomembrane

Rock Engineering, principle of rock slope design, rock strength properties & measurement, mechanism of joint formation, discontinuities, ground vibrations, Site investigations, failures, stabilization, applications.

Soil Water: Occurrence of ground water, water table, capillary water, soil structure, pore pressure and effective stress, permeability and of soils, flow of water through soils. Coefficient of permeability and its determination in lab and field, quick sand phenomenon, factors affecting permeability, flow nets and its construction, seepage through earthen embankments, piping and protective filters.

ESE 181 07: Environmental Biotechnology

[3-0-0]

Introduction, scope and importance; production of non-conventional fuels- methane, hydrogen, alcohols and algal hydrocarbons. Energy Utilization: cellular respiration, carbohydrate metabolism to other compounds, Glycolysis, fermentation, Krebs's cycle, ETS; phosphorylation, ATP, factors affecting respiration. Mining and metal biotechnology: Microbial transformation, accumulation and concentration of metals, metal leaching, extraction and future prospects. Microorganisms as food- SCP, Biological control- microbial control of plants, plant pests, pathogens and insects. Microorganisms and microbial products. Industrial microbiology General account: maintenance of stock cultures, culture collection centers/microbial gene banks, inoculum build up, industrial substrates, design of a bioreactor, batch and continuous fermentation and solid substrate fermentation. Immobilization technologies. Exploitation of Microorganisms for soil fertility: Biological nitrogen fixation and biofertiliser phosphate solubilization, VAM fungi and crop productivity.

ESE 181 08: Human System Engineering

[3-0-0]

Stress and strain concept and scope of Human System Engineering.

Assessment of human capabilities and limitation as information receiver, information processor and action taker.

Anatomical characteristics, strengths and circadian rhythms.

Human Physiological Work Capacity and its Evaluation.

Sources of Work Stress (a) Intrinsic to the Jobs, (b) Work Environmental Stressors like Heat & Humidity, Noise & Vibration, Dust, Illumination, etc.; Methodologies for evaluating different types of stresses.

Human Error and Accidents: different classification of human error, theories of accident causation, Human Error Audit. Accident Analysis.

Work system design through Human System Design

ESC 188 01: Design Project

[0-0-6]

Perform integrated and open-ended analysis and design of an environmental system with consideration of land, water and air pollution. Economic analysis of alternate developed scenarios. Requires comprehensive written report and oral presentation.

ESC 181 05: Rehabilitation and Resettlement Issues

[0-0-0] (2)

Social impacts of industrial and developmental activities. Quality of life concept- and its use in development planning. Social surveys and socio-economic data generation. Social cost of environmental pollution. Rehabilitation and resettlement of project affected people. Laws related to social development. Policies and guidelines of rehabilitation planning, Corporate social accountability/responsibility. Specific case studies from various sectors including mining.

CAPSULE COURSE OFFERED TO OTHER DEPARTMENTS.

(III Semester)

Environmental Science and Engineering

[3-0-0]

Environmental issues – National & global; sustainable development, global warming, IPCC emission scenarios.

Land Environment: Landscape analysis; land use planning & management.

Air pollution: air quality criteria & standards, air quality monitoring and assessment, design of air pollution control equipment. Noise pollution.

Water pollution: availability, water pollutants, water quality criteria & standards; microbiology and epidemiology, water treatment processes and management.

Wastewater Engineering –primary, secondary and tertiary treatment processes, common effluent treatment plants (CETPs).

Ground water: aquifers, hydraulic gradient, fate and transport of contaminants in ground water.

Solid waste: Solid waste management & resource recovery, source reduction, collection & transfer, composting, conversion of waste-to-energy, landfill design.

Hazardous wastes- legislation, storage, transportation, & disposal of hazardous waste

Biological environment: Ecology & ecosystem; biodiversity & its conservation; design of green belts, biological reclamation

Societal environment; socio-economic impacts, population and economic growth, resettlement & rehabilitation policies;

Text books:

Introduction to Environmental Sc. & Engineering – GM Masters (2004)- PHI.

Environmental Science and Engineering – J. G. Henry & G.W. Henke Prentice Hall INT Edition, NJ, USA, 1996 (2nd Ed.)

Environmental Engineering – HW Peavy, DR Rowe & G Tchobanoglous, McGraw- Hill Int (1998).

Environmental Engineering – Gerard Kiely, McGraw- Hill Int (1998).

(VI Semester)

Environmental Legislation, EIA and Auditing

[3-0-0]

Environmental Policies - National and International trends, International treaties. Legal provisions for environmental protection: various Acts, Rules and Regulations. Notifications issued under various Acts and Rules. Environmental standards, Criteria for standard setting.

Framework for Environmental Impact Assessment. Screening, Scoping and baseline studies, Public Hearing/Consultation. Environmental Management Planning.

Environmental Auditing, Features & Effective Auditing, Auditing Process, Environmental Statement, Environmental Auditing System

Text books:

Renewable Energy Environment and Development-Maheswar Dayal Konark Pub. Pvt.Ltd. 1998

Planning and Implementation of ISO14001, Environmental Management System- Girdhar Gyani & Amit Lunia Raj Publishing House, Jaipur, 2000.

“The ISO: 14000 Handbook” - Joseph Caseio (Ed), Published - CEEM Information Services. 2000

INSIDE ISO: 14000 – The Competitive Advantage of Environmental Management - Don Sayre, Vinity Books International, New Delhi, 2001.

A Guide to the Implementation of the ISO: 14000 Series on Environmental Management – Ritchie, I and Hayes W, Prentice Hall, New Jersey, 1998