

Department of
Environmental Science & Engineering

Syllabi for:
M.Tech. Environmental Science &
Engineering

Effective from 2012-13



Indian School of Mines
Dhanbad- 826004
Jharkhand, India

COURSE STRUCTURE
FIRST SEMESTER

S. N.	Subject Code	Name of the Course	L-T-P	Cr. hr
1.	AM C 511 01	Advanced Numerical Methods and Applied Statistics	4-0-0	8
2.	ES C 511 01	Ecology and Environmental Microbiology	3-1-0	7
3.	ES C 511 02	Water Supply and Treatment	3-1-0	7
4.	ES C 511 03	Environmental Chemistry	3-1-0	7
5.	ES C 511 04	Principles of Air and Noise Pollution	3-1-0	7
6.		Electives – (Any one)	3-0-0	6
ES E511 01		Environmental Aspects of Mining, Metallurgical and Thermal Industries		
ES E511 02		Environmental Systems Optimisation and Modelling		
ES E511 03		Instrumental Techniques in Environmental Science & Engg.		
ES E511 04		Environmental Geology and Resource Management		
ES E511 05		Environmental Geotechnology		
7.	AM C 512 01	Advanced Numerical Methods and Applied Statistics Practical	0-0-2	2
8.	ES C 512 01	Ecology and Environmental Microbiology Practical	0-0-2	2
9.	ES C 512 02	Environmental Chemistry Practical	0-0-2	2
10.	ES C 512 03	Air and Noise Pollution Practical	0-0-2	2
11.	ES C 516 01	Field and Industrial Visits and Seminar(s)		(02)-
Total Credits			19-4-8	52

SECOND SEMESTER

S.N	Subject Code	Name of the Course	L-T-P	Cr. hr
1.	ES C 521 01	Environmental Laws, Impact Assessment and Auditing	3-1-0	7
2.	ES C 521 02	Wastewater Engineering	3-1-0	7
3.	ES C 521 03	Solid and Hazardous Waste Management and Land Reclamation	3-1-0	7
4.	ES C 521 04	Design of Air Pollution Control Systems	3-1-0	7
5.		Electives – (Any two)	3-0-0	6x2= 12
	ES E 521 01	Remote Sensing and GIS		
	ES E 521 02	Noise Control Engineering		
	ES E 521 03	Environmental Economics and Socio- Economic Planning		
	ES E 521 04	Hazardous Waste and Disaster Management		
	ES E 521 05	Advanced Wastewater Engineering		
	ES E 521 06	Carbon Sequestration and Clean Development Mechanism		
	ES E 521 07	Environmental Aspects of Petroleum Industry		
6.	ES C 522 01	Wastewater Engineering Practical	0-0-2	2
7.	ES C 522 02	Solid and Hazardous Waste Management and Land Reclamation Practical	0-0-2	2
8.	ES C 526 01	Field Visits, Excursions and Seminar(s)		(02)
Total credits			18- 4 - 4	46

THIRD SEMESTER

Sl. No.	Subject Code	Name of the Course	L-T-P	Cr. hr
1.	ES C 536 01	Industrial Training/ Minor Project	0-0-0	4
2.	ES C 534 02	Seminar and Viva voce on Industrial Training/ Minor Project	0-0-0	2
3.	ES C 535 03	Comprehensive Viva-voce (to be conducted at the end of the II Semester, marks to be added while computing III Semester GPA)	0-0-0	4
4.	ES C 538 04	Dissertation (Interim)	0-0-0	15
5.	ES C 534 05	Seminar and Viva-voce on Dissertation	0-0-0	10
6.	ES C 530 06	Evaluation of Teaching Assignment/ Laboratory Development Work etc.	0-0-0	5
Total credits			0-0-0	40

FOURTH SEMESTER

Sl.No.	Subject Code	Name of the Course	L-T-P	Cr. hr
1.	ES C 548 01	Dissertation	0-0-0	20
2.	ES C 544 02	Seminar on Dissertation	0-0-0	5
3.	ES C 545 03	Viva-voce on Dissertation	0-0-0	10
4.	ES C 540 04	Evaluation of Teaching Assignment/ Laboratory Development Work etc.	0-0-0	5
Total credits			0-0-0	40

**AM C511 01: Advanced Numerical Methods and
Applied Statistics [4-0- 0]**

Section A: Advanced Numerical Methods: Review of solution of system of linear simultaneous equation. Solution of tridiagonal system, Ill conditioned system and iterative method to improve accuracy of an Ill conditioned system. Evaluation of double and triple integrals by numerical method and its application, solution of non-linear simultaneous equations, numerical solution of integral equations, Advanced method of interpolation, Spline interpolation, Numerical solution of simultaneous first order ordinary differential equations (ODE) and higher order ODE. Initial and Boundary value problems, Numerical solution of partial differential equations: Laplace and Poisson equation, Heat conduction and wave equations, Writing computer programs of the above methods in F-77.

Section B: Applied Statistics: Review of binomial, negative binomial, Poisson, normal and log normal distributions. Tests of significance for mean, variance, correlation and regression coefficients. χ^2 -test for goodness of fit, attributes and contingency table, F-test, test of proportions, tests of significance under large sample approximations.

Non-parametric tests: Wald-Wolfowitz run test, test of randomness, median test, sign test, Mann-Whitney Wilcoxon U-test.

Time series analysis, introduction to reliability and life testing experiments in engineering problems.

One way and two way analysis of variance, Completely Randomized Design (CRD), Randomized Block Design (RBD), Latin Square Design (LSD).

Books and References

1. Numerical Methods for Scientific & Engg. Computation - MK Jain, SRK Iyenge and RK Jain, 1999
2. Numerical Methods for Mathematics, Science and Engineering - John H Mathews 2000.

3. Applied Numerical Analysis - CF Gerld and PO Wheatley, 2002.
4. Fundamentals of Applied Statistics – S.C. Gupta and V. K. Kapoor, Sultan Chand & Sons, 2002.
5. Miller & Freunds's Probability and Statistics for Engineers (fifth edition) - Richard A. Johnson.

**ES C511 01: Ecology and Environmental Microbiology
[3-1-0]**

Ecology: 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.

Biogeochemical cycling: C, N, P and S cycle; biological N fixation, nutrient cycling in tropics, Limiting factors, Bio-monitoring, biotic indices, indicator species.

Aquatic ecology: Lentic and lotic habitat, stratification, productivity, community & life form, Wetland, marine and estuarine ecosystem.

Population and community ecology, habitat, ecological niche and ecotone, Ecological successions, Biodiversity: Distribution, measurement enumeration

Ecotoxicology: background, importance & measurement, Ecosystem response to de-oxygenation, Eutrophication, Pesticides & Bio-accumulation.

Ecosystems and the Millennium Development Goals, Landscape ecology

Microbiology: General properties of microorganisms: Environmental importance of microorganisms, classification, Distribution, Enumeration of microbes, Prokaryotic and Eukaryotic cells.

Bacteria: Cell structure, Spore, Morphology and reproductions, Bacterial nutrition, Culture media and culture characteristics, Growth of bacteria, Batch culture, Specific growth rate and doubling time, Continuous culture, Synchronous growth, Effects of environmental factors on growth.

Control of microbes: Physical and chemical methods, Destruction and suppression.

Microbial metabolisms: Anabolism and catabolism, Glycolysis, TCA cycle and ETC, Fermentation and anaerobic respiration, Energy balances (ΔG) – Growth, Substrate Partitioning and theoretical yield, Electron acceptors, Enzymes, Monod and Halden kinetics.

Drinking water microbiology: Stream pollution, Water borne diseases and pathogens, MPN test, Faecal coliform and faecal streptococci, MF techniques, IMViC test.

Air microbiology: Air borne diseases and pathogens.

Soil microbiology: Bio-fertilizer, VAM fungi, N-fixations, Bio-pesticides, Degradation of natural substances, Composting, Bio-energy from waste.

Books and References

1. Fundamentals of Ecology (3rd ed). Eugene P. Odum. WB Saunders Company, Philadelphia (1971).
2. Fundamentals of Ecology- MC Dash. Tata-McGraw Hill, New Delhi (1996).
3. Introduction to Environmental Engg. – G.M.Masters. Prentice Hall of India (1991).
4. Microbiology - Michael J.Pelzer et.al., (5th ed), Tata McGraw Hill, New Delhi (1993).
5. Microbiology for Environmental Scientists and Engineers -Gaudy, AF and Gaudy, ET MGH, New York (1980).

ES C 511 02: Water Supply and Treatment [3-1-0]

Water Resources and Water Supply - Introduction; Rainfall and Run-off; Aquifers properties and ground water flow; Hydrological characteristics of aquifers, porosity, permeability, transmissivity, specific retention, diffusivity. Laws of ground water movement, Darcy's law. Hydraulics:- Flow regimes; Bernoulli's equation; Hazen-williams equation; Flow measurement; Manning's equation.

Aqueducts and Water Pipes; Collection and Distribution of Water; Quality of Water Supply;

Water Treatment Engineering: Demand and water quality management, Overview of water treatment process: theory and application. Sedimentation: type-1 and type-2 settling, settling operation, design and construction of sedimentation tank. Coagulation processes: theory of coagulation, coagulation dose, coagulation practice-- rapid mixing; design consideration. Flocculation processes- design aspects. Water softening- single stage and two stage, re-carbonation, ion exchange. Filtration: Filter hydraulics, filter components, operation and design aspects of slow and rapid sand filters, dual-media filter and mixed media filter. Disinfection- chlorination and other means of disinfection. Removal of dissolved solids. Fluoride, iron and manganese removal. Operation of water distribution net-work systems.

Books and References

1. Water Resources Engineering – Larry W Mays, Wiley Text Books, 2000 .
2. Water Quality and Treatment Handbook -American Water Works Association, McGraw-Hill Pub. 1999.
3. Water Treatment plant Design – American Society of Civil Engineering, McGraw-Hill Publisher, 1997.
4. Water Supply and Sewerage - Steel and McGhee, McGraw Hill NY, latest ed.
5. Manual of Water Supply and Treatment (3rd ed)- Ministry of Urban Development, New Delhi, 1991.

ES C511 03: Environmental Chemistry [3-1-0]

Structure of atmosphere, Properties of Air, Types of Air Pollution Sources: Natural and Anthropogenic Sources, Classification and Chemistry of Major Air Pollutants, Thermodynamics of air pollutants, Atmospheric photochemistry, Chemical and Photochemical Reactions in atmosphere, PAH, VOCs, Acid Rain, Depletion of Stratospheric Ozone. Control of Gaseous Pollutants, Green fuel and their environmental impacts.

Principles and Application of Water Chemistry, Unique Properties of Water, Water Quality Parameters: physico-chemical, biological and bacteriological parameters, Water Quality Criteria and Standards, Water Pollution: Heavy

Metal Pollution and its Abatement, Detergents and Phosphates, Eutrophication, Chemical Methods of Water and Wastewater Treatment, Removal of Dissolved Organics and Inorganics, Removal of Nitrogen and Phosphates, Water disinfection, Xenobiotics

Nature and Importance of Soil, Soil Properties, Acid-Base and Ion-exchange Reactions in Soils, Macro and Micronutrients, Colloidal chemistry of Soils, Fertilizers and Other Soil Amendments, Soil Pollution: Heavy Metals and Radio-nuclides in Soil, Degradation of natural substances, Remediation of Metal Contaminated Soil.

Characteristics of Hazardous Wastes, Classification of Hazardous Wastes, Effects and fate of Hazardous wastes.

Books and References

1. Environmental Chemistry - Stanley E. Manahan, 5th Ed., Lewis Publishers, 1995.
2. Chemistry for Environmental Engineering and Sciences (5th Ed)- - CN Sawyer, PL McCarty and GFParkin, Tata McGraw-Hill ed., New Delhi, 2003.
3. Aquatic Chemistry -W.Stumm & JJ Morgan, John Wiley & Sons, Inc, 3rd Ed., NY-1995.
4. Water Chemistry - V.L.Snoeyine and D.Jenkins, John Wiley and Sons, Inc, NY-1980.
5. Principles and Application of Aquatic Chemistry - FMM Morel & JG Hering, John Wiley & Sons, Inc, NY,1993.

ES C511 04: Principles of Air and Noise Pollution [3-1-0]

Sources of air pollution- stationary and mobile, fugitive emissions, secondary pollutants; Effects of air pollution in regional and global scale, air pollution episodes; Emission factors, inventory and predictions.

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

Air quality monitoring - objectives, time and space variability in air quality; air sampling design, analysis and

interpretation of air pollution data, guidelines of network design in urban and rural areas. Stack monitoring. Air pollution standards and indices.

Dispersion of air pollutants and modelling -- Basic concepts, inversion layer and mixing height, atmospheric stability classes, theory and application of acoustic sounding (SODAR) technique. Box model, The Gaussian dispersion model -- point, area and line sources. Features and application of regulatory models, e.g., screening model, FDM, ISCST-3, Caline-4 and AERMOD Models

Prediction of effective stack height - physics of plume rise, Holland's equation, Briggs equation, etc. modifications of Gaussian dispersion models; indoor air quality models. Air pollution control devices.

Noise Pollution: Basics of acoustics and specification of sound; 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 on health, annoyance rating schemes; special noise environments: Infra-sound, ultrasound, impulsive sound and sonic boom; noise standards and limit values; noise instrumentation and monitoring procedure. Noise indices.

Books and References

1. Environmental Engineering – Arcadio P. Sincero and Gregoria A. Sincero, Prentice Hall of India, 1999.
2. Environmental Pollution Control Engineering- CS Rao, Wiley Eastern Ltd., New Delhi, 1996.
3. Environmental Noise Pollution – PE Cunniff, McGraw Hill, New York, 1987.
4. Handbook of Noise Measurement - APG Peterson & EE Gross PH, Englewood cliffs New Jersey, latest edition.
5. Air Pollution Control Equipment – H. Brauer and Y. B. G. Verma, Berlin Heidelberg, New York, latest edition.

ELECTIVES

ES E511 01 Environmental Aspects of Mining, Metallurgical and Thermal Industries [3-0-0]

Mineral production, history of environmental problems. Mining Methods- Opencast and underground mining. Unit operations: site clearance, drilling, blasting, transportation, reclamation.

Mineral beneficiation and their environmental impacts.

Air pollution, water pollution, noise and air blast, land degradation, subsidence due to mining activities and their control measures. Mining disasters, mine safety and role of DGMS.

Social impacts of mining & its management. R&R Policy.

Mine Closure: Principles, planning, financial provisions, implementation, standards for closure criteria, developing closure plans, progressive and final mine closure.

Environmental laws related to mining environment: Overview; provisions of MMDR Act, MCR and MCDR. EIA of Mining sector, general and specific environmental standards applicable to mining under various laws.

Metallurgical Industries and their Environmental Aspects: Unit operations, sources and management of pollution in integrated steel plants, ferrous and non-ferrous metals.

Thermal Power Plants: Introduction: site selection, layout and unit operations; Fuel and fuel handling -types of fuels, solid, liquid and gaseous. Fuel burning equipments; Pollution control devices- ash handling systems, electrostatic precipitation (ESP) system; Fly ash management and its utilisation. Captive power plants.

Books and References:

1. Environmental Impact of Mining – Down CG and Stocks J. Applied Science Publishers, London, 1978.
2. Environmental Impacts of Mining: Monitoring, Restoration and Control. Lewis Publishers, Boca Raton, 1993.

3. Best Practices Environmental Management in Mining” - EPA (Australia): 1997-2004.
4. Tailings Management - Ritcey GM, Elsevier, 1997.
5. Environmental Management in Mining Areas– Saxena NC, Singh Gurdeep and Ghosh R, (Ed.), Scientific Publishers (India), Jodhpur 2003.

ES E511 02: Environmental System Optimisation and Modelling [3-0-0]

Systems approach - concept and analysis. Problems formulation, model construction and deriving solution from models using LPP. Limitation and Application of LPP to wastewater management systems , to air quality management of non-point source pollution , sensitivity analysis;

Lagrange multipliers- unconstrained and constrained optimisation, limitations of Lagrange’s multipliers. Sequential search algorithms- box algorithm,

Separable and integer programming- application to multiobjective planning. Application of integer programming to municipal solid waste management.

Transportation models. Dynamic programming models- application to land use planning and air pollutant emission control. Present value concepts- optimization over time.

Fate and Transport of contaminants in surface and sub surface environment, Streeter - Phelps model and introduction of various available software’s.

Books and References

1. Operation Research: An Introduction – Hamdy A. Taha, Prentice Hall Pub.
2. Operation Research: Theory & Applications – J.K. Sharma
3. Environmental Systems Optimization- D. A.Haith, 1982, Wiley Sons, NY
4. Handbook of Environmental and Ecological Modelling, Halling-Sorensen B., Nielsen S.N. and Jorgensen S.E., Lewis Publishers Inc., 1995.

5. Fundamentals of Atmospheric Modelling, Jacobson Mark Z., Kluwer Academic Press, 2002.
6. An Introduction to Water Quality Modelling, James A. (Ed), (2nd Ed.), 1992.
7. Techniques for Environmental System Analysis - R.H.Pantell Wiley, NY, 2001.
8. System Analysis and Design – RJ Aguilar, Prentice Hall, Englewood Cliffs, N.J., 1993.

ESE 51103: Instrumental Techniques in Environmental Analysis [3-0-0]

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: Spectrochemical methods: 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 oscillographic 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.

Books and References

1. Instrumental Methods of Analysis - HH Willard & LL Dean, John Wiley, 1976
2. Modern Methods of Chemical Analysis - RL Recsok & LD Shields, John Wiley & sons, Inc, 1990
3. Instrumental Methods of Chemical Analysis -GW Ewing, McGraw Hill Book Company, Inc. 1975
4. Modern Methods of Chemical Analysis - RL Pecsok & LD Shields, John Wiley & Sons, Inc. 1986

5. Fundamentals of Molecular Spectroscopy - CN.
Banwell, McGraw Hill, NY, 1990

**ES E 51104: Environmental Geology & Resource
Management [3-0-0]**

Introduction: Introduction to Environmental Geology, The Environmental Crisis – Overview of limited resources, human needs, and waste. Population growth, Sustainability,

Earth materials: The Geologic Cycle – Rock cycle, Physical Properties of Rocks, Soils, Impact of various activities on soil and their management.

Geological Work: Weathering, erosion, transportation, deposition, Geological work of wind and river, Flooding - Magnitude and Frequency, Recurrence, Effects of Urbanization,

Energy and Mineral resources: Fossil Fuels, Energy supply and energy demand, Alternative energy sources, Mineral resources of India.

Geologic Hazards: Landslides -The Human Impact of Landslides, Subsidence, Earthquake Process- Detecting, Locating, and Measuring Earthquakes, Volcanoes - Major types of Volcanoes and their environmental impact.

Water Resources: Watershed characteristics- drainage pattern, Precipitation, Evapotranspiration, Surface Runoff, Groundwater runoff, Hydrological cycle, Types of Aquifers, Water table, Darcy's law, Groundwater Movement & Contamination, Conserving and Managing Water resources, – Rainwater Harvesting. Impact of climate change on water resources.

Books and References

1. Environmental Geology-DR Coates, John Wiely & Sons, NY 1981
2. The State of India's Environment : A Citizen Report - Anil Agarwal, Vol 1&2., 1985
3. Textbook of Soil Science - Biswas and Mukherjee, TMH, New Delhi, 1994.

4. Reclaimed Land, Erosion Control, Soils and Ecology - Martin J Haigh (ed), A Balkema, 2000.
5. Environmental Geology- Indian Context -KS Valdiya.,Tata McGraw Hill, New Delhi, 1987

ES E511 05: Environmental Geotechnology [3-0-0]

Geotechnology and Environment, basics of soil materials, Ground Investigation, Compaction, Shear Strength, Groundwater and Permeability, Permeability and Settlements, Instruments, Waste Disposal by landfill, contaminated land, Derelict land, Tailing Dam, waste materials in geotechnical construction, Application of Geotextiles,

Books and References

1. Environmental Geotechniques, Robert Sarshy, Thomas Telford Books.
2. The Nature and Properties of Soil, Nyle C Brady, Eurasian Publishing House (P) Ltd.
3. Basic and Applied Soil Mechanics II Edition, Gopal Ranjan & A.S.R Rao, New Age Publishers.
4. Geotechnical Engineering, S.K.Gulhati, Manoj K Dutta, McGraw Hill Co.
5. Hydrology - H.M.Ragunath, Wiley Eastern Limited,1990
6. Introduction to Hydrology-W. Viessman (Jr), JW Knapp, GL Lewis & TE Harbaugh, Harper & Row, London, 1977.

AM C512 01: Advanced Numerical Methods and Applied Statistics (Practical) (0-0-2)

Numerical Methods: Solution of tridiagonal system, solution of simultaneous non-linear equations by iteration and Newton Raphson methods. Solution of simultaneous first order ODE. high order ODE by Range-Kutta and Miline's methods, Solution of Laplace and Poisson equations, Solution of heat conduction equations and Solution of wave equations.

Applied Statistics: Practical based on tests of significance for one & two populations case, practical

based on non-parametric tests, practical based on time series, practical based on reliability and life-testing experiments, practical based on CRD, RBD & LSD.

ES C512 01: Ecology and Environmental Microbiology (Practical) (0-0-2)

Environmental Ecology: Measurement of leaf area and calculation of leaf area index (LAI) and leaf area ratio (LAR)

Estimation of moisture contents of leaves and chlorophyll (from grass and tree leaves)

Measurement of productivity by harvest method

Study of root-biomass

Quantitative and qualitative characters of plant communities

Ecological sampling of an area (line transect and quadrat method) "species-area" curve method

Study of vegetation by physiognomic method – biological spectrum method Study of pond ecosystem.

Environmental Microbiology:

Apparatus used for a Microbiological laboratory.

Methods of Sterilisation and Disinfections.

Culture media: Media preparation– Semi-synthetic and Synthetic media. Liquid, Solid and semisolid media, Nutrient agar, PDA media.

Gram staining techniques for detection of gram positive and gram negative bacteria.

Bacteriology of drinking water and domestic sewage -MPN techniques for total coliform, Faecal coliform and Faecal Streptococci (FS), Membrane filtration techniques for faecal coliform and total coliform. IMViC test.

Microbiology of Air: Enumeration of microbes by exposure plate method.

Microbiology of soil: Isolation of microbes by serial dilution methods and colony count by colony counter.

Study of fungi (medium – Rose Bengal agar).

Study of fresh water and polluted water algae – (Blue green algae, Green algae and Diatoms).

**ES C512 02: Environmental Chemistry (Practical)
(0-0-2)**

Calibration and Standardisation of pH , conductivity; nephelometer and other water quality monitoring instrument; determination of pH, acidity-alkalinity, total suspended solids, total dissolved solids (TDS), total hardness (TSS) and Ca & Mg hardness, chloride, sulphate, nitrate, oil and grease, DO, COD, BOD chlorine demand, break-point chlorination and free residual chlorine.

Soil sampling, description of the soil horizon, determination of soil pH, conductivity and salinity soil 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.

**ES C512 03: Air and Noise Pollution (Practical)
(0-0-2)**

Demonstration of air pollution monitoring instruments; Calibration of HVS by orifice method; Determination of SPM; PM₁₀; SO₂; NO_x and CO in ambient air; 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; Wind rose diagram.

Demonstration of noise pollution monitoring equipment; namely modular precision sound level meter, noise dose meter, human vibration monitoring instrument, audiometer, etc. Noise survey in a multiple noise sources situation in order to develop noise contour diagram for the entire locality. Noise monitoring at residential localities. Frequency spectrum analysis of machine noise. Audiometry survey in order to assess present status of

hearing acuity of the subject. Traffic noise situation monitoring; Human vibration monitoring (whole body as well as hand-arm vibration)S

SECOND SEMESTER

ES C521 01: Environmental Laws, Impact Assessment and Auditing [3-1-0]

Environmental Policies - National and International; International treaties. Carbon management- Kyoto Protocol and Clean Development Mechanism (CDM), Carbon Neutrality.

Environmental Legislations-Acts, Rules, Regulations and Notifications. Environmental standards, Criteria for standard setting.

Framework for EIA; Screening, Scoping and baseline studies; 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.

Environmental audit, objectives, types, features, planning of audits; 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.

Introduction and Formulation of ISO Guidelines in Environmental Management Systems; ISO 14001 Series, Principles; Accreditation Process, Environmental Auditor Criteria, Benefits of EMS; Aspect-Impact Analysis, Continual Improvement, Environmental Performance, Environmental Policy, Vision and Mission, Objective and Target, Environmental Management Planning, Implementing EMS, Plan-Do-Check-Act (PDCA), Preventive and Corrective Action, Internal and External Audits, Documentation, Roles and Responsibilities, Management Reviews & Improvements; Legal and

Regulatory Concerns; Integrating ISO 9000 & ISO 14000. Preparation of ISO Manuals for Industry; Integrating ISO 9000 , ISO 14001 and OHSAS 18001 ; Case Studies Quality Assurance (QA) and Quality Control (QC). Life Cycle Approach. OHSAS 18001.

Books and References

1. Environmental Impact Assessment -Larry, W. Canter (2nd ed), McGraw Hill Inc. Singapore, 1996.
2. Strategic Environmental Assessment - Riki Therirvel, E.Wilson, S.Thompson, D.Heaney, D. Pritchard. Earthscan, London, 1992.
3. Environmental Impact Assessment-Cutting edge for the 21st century - Alan Gilpin, CUP, London, 1994.
4. Environmental Impact Assessment-Theory & Practice - Peter Wathern, Unwin Hynman, Sydeny, 1988.
5. Renewable Energy Environment and Development- Maheswar Dayal Konark Pub. Pvt.Ltd. 1998
6. Planning and Implementation of ISO14001, Environmental Management System- Girdhar Gyani & Amit Lunia Raj Publishiong House, Jaipur, 2000.
7. ISO 14001 Auditing Manual – Gayle Woodside and Patrick Aurrichio, McGraw-Hill.
8. An Introduction to Environmental Audit, R.D.Tripathi, Alpha Publications, 2009.
9. "The ISO: 14000 Handbook" - Joseph Caseio (Ed), Published - CEEM Information Services. 2000
10. INSIDE ISO: 14000 – The Competitive Advantage of Environmental Management - Don Sayre, Vinity Books International, New Delhi, 2001.
11. A Guide to the Implementation of the ISO: 14000 Series on Environmental Management – Ritchie, I and Hayes W, Prentice Hall, New Jersey, 1998.
12. OHSAS & SA Guidelines.

ES C521 02: Wastewater Engineering [3-1-0]

Sewage characteristics, Quantity & Quality, flow rate, treatment flow -sheets. Sewage treatment process, reactor type, hydraulic characteristics, C-diagram. Preliminary

treatment-design and operation of screening and grit chamber. Sedimentation, design and operation PST; Chemical precipitation.

Principle of biological treatment-derivation of bacterial growth kinetics used in designing of wastewater treatment plant. Process design and operation of Activated sludge process and its modification. Bulking and rising sludge. Design of secondary settling tank.

Wastewater treatment for small communities -- Oxidation ditch, extended aeration system, SBR; Process design and operation of mechanically aerated lagoon and Waste stabilization pond system.

Sanitation-- rural sanitation, short term and long term control of insects, rodents, vectors and nuisance; municipal sanitary standards and regulation. Sewage disposal in isolated unsewered areas-- septic tank, cesspools and their effluent disposal methods.

Design and operation of biological nitrification - denitrification system; luxurious phosphorus uptake.

Aerobic attached growth process -Process design and operation of trickling filter, RBC, Biofilter.

Anaerobic treatment: process microbiology and biochemistry; application for treatment of sewage, advantage and disadvantages.

Concept of common effluent treatment plant (CETP).

Floating aquatic plant system and its design and operation.

Sludge characteristics and disposal methods -design and operation of sludge drying bed.

Design and operation of treatment plant. Trouble shooting and trouble free operation.

Sources and characteristics of industrial wastewater, effects on environment. Standards related to industrial wastewater. Waste volume reduction, waste strength reduction, neutralization, equalization and proportioning. Advanced wastewater treatment. Industry specific wastewater treatment for chloro-alkali, electroplating, distillery, tannery, pulp and paper, fertilizer, etc. Treatment

technology of coal washery and coke oven effluents. Acid mine drainage: occurrence, effects and treatment technologies.

Books and References

1. Wastewater Engineering: Treatment, disposal, Reuse - Metcalf & Eddy Inc. 4th ed. TMGHI, New Delhi, 2003.
2. Environmental Engineering- Peavy, HS, Donald RR & G. Tchobanoglous, MGH Int. Ed. New York, 1985.
3. Wastewater Treatment for Pollution Control - Soli J Arceivala, Tata McGraw Hill, 2nd ed. 1998
4. Wastewater Treatment Plants: Planning, Design and Operation- S.R..Qasim, Holt, Rinehart & Winston, NY, 1985
5. Industrial Water Pollution Control –WW Eckenfelder, Jr., McGraw -Hill , 2nd Edition, NY 1989

ES C521 03: Solid & Hazardous Waste Management & Land Reclamation [3-1-0]

Solid and Hazardous Waste Management: Municipal solid waste management: Engineering principles; Sources, nature and characteristics; quantitative and qualitative; Solid waste problems: Industrial, mining, refineries and petrochemical plants, agricultural and domestic (urban) wastes. Hydrologic aspects of solid waste. Regulatory aspects of solid waste management.

Solid waste disposal: Sanitary landfill planning, site selection, design and operation, equipment, costs, Aerobic 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.

Biomedical waste categorization, generation, collection, transport, treatment and disposal.

Hazardous waste – landmark episodes, classification, generation. Guidelines for HWM. Regulatory framework in the USA, EU and India, Basal Convention and other

international statistics. Treatment and disposal; remediation of contaminated sites.

Land Reclamation: Reclamation planning -pre-project land use planning, post project land use monitoring; physical reclamation-regrading and recontouring, terracing, slope preparation, segregation and burial of toxic substances, reclamation alternatives, reclamation equipment, scheduling and costs.

Factors affecting plant establishment. Soil characteristics: physical, chemical and biological; soil amendments; selection of species, ecological succession theory, top soil conservation, mine spoil evaluation, nitrogen fixation, mycorrhiza, financial aspects of reclamation.

Current bioremediation practice and application; factors influencing bioremediation, bioremediation system and process, In situ bioremediation.

Books and References

1. Solid Waste: Engineering Principles & Management Issues- G.Tchobanoglous, GH. Theisen & R. Eliassen, McGraw Hill Int. Ed. Singapore, 1977.
2. Environmental Engineering - HS Peavy, DR Rowe & G Tchobanoglous, McGraw-Hill Int. Ed., Singapore, 1985.
3. Quarry Reclamation - NJ Coppin and A.D.Bradshaw, Mining Journal Books, London,1982
4. Hazardous Waste Management (2nd ed) - Lagrega, MD, PL Buchingham & JC Evans, McGraw Hill, NY, 2001.
5. Bioremediation Principles – Eweis, JB, Ergas SJ, Chang DYP and Schroeder ED, McGraw-Hill, Singapore, 1998.

ES C 521 04: Design of Air Pollution Control Systems [3-1-0]

Review of general principles of air pollution control.
Design and operation of gravity settling chambers, cyclones,

Design and operation of wet dust scrubbers – column scrubbers, jet scrubbers, vortex scrubbers, rotating disc scrubbers, and venturi scrubbers.

Design and operation of fabric filters.

Design and operation of electrostatic precipitators design and operation of mist separators- baffled mist separators, pressure separators.

Dust control and abatement measures in mines; role of green belts.

Control devices for gaseous pollutants with special emphasis on adsorption, absorption, mass transfer, condensation, and combustion. Fuel and Flue gas desulphurization, sulphur recovery,

Control of motor vehicle emissions; Indoor air pollution control. Operation and maintenance of control equipment

Economics and trends of air pollution control.

Books and Reference

1. Air Pollution Control Equipment - H.Brauer & YBG Verma, Springer-Verlag, Berlin Heidelberg, NY, latest Ed.
2. Environmental Pollution Control Engineering - C.S.Rao, Wiley Eastern Ltd., New Delhi, 1996.
3. Air Pollution- Its Origin and Control - Kenneth Work and Cecil F. Warner, IEP, New York, latest Ed.
4. Air Pollution Control Engineering - Noel de Nevers, McGraw Hill, Singapore, 1995.

Air Pollution Control in Industries, Vol. 1 & 2 – T. K. Ray, Technip Books International, 2003.

ELECTIVES

ES E521 01: Remote Sensing and GIS [3-0-0]

Introduction , Types , Application and importance of Remote Sensing; Physics 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 GIS and Remote Sensing – Application of Remote Sensing and GIS – Water resources – Urban Analysis – Watershed Management – Resources Information Systems.

Global Positioning System – an introduction.

Books and Reference:

1. Remote Sensing and GIS - Anji Reddy M., The Book Syndicate, Hyderabad, 2000.
2. Principles of Geographical Information Systems - P A Burrough and R. A. McDonnell, OUP, Oxford, 1998.
3. Remote Sensing for Earth Resource- Rao, D.P., AEG Publication, Hyderabad, 1987.
4. Geographic Information System- Kang Tsung Chang, Tata Mc Graw Hill, Publication Edition, 2002.

ES E 521 02: Noise Control Engineering [3-0-0]

Noise measurement techniques and analysis: Worksite, ambient and road transport. Noise prediction and modelling, noise impact assessment: Scultz Fractional Impact method; Value function curves. Noise abatement measures - Sound absorption, Acoustic barrier, Vibration

Isolation, Vibration damping, Muffling, personal protector and green belt--principles and design considerations. Noise pollution and management in Mines, Washeries, Power plants, Fertilizer plants, Cement plants, etc. Human Vibration- whole body vibration problems in opencast mines, health effects and control measures.

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

Books and References:

1. Industrial Noise Control and Acoustics – Randall F Barron, Marcel Dekker, Inc., New York, 2003.
2. Engineering Noise Control: Theory and Practice – David Bies et. al., Routledge Publishers, 2003 .
3. Vibrations – Balakumar Balachandran and Edward B. Magrab, Thomson Asia Pte. Ltd., Singapore, 2003.
4. Vibrations from Blasting – by David Siskind, 2000.
5. Noise control: Principles and Practice - Bruel & Kjaer, 2nd ed. B & K Pub., Denmark, 1986.

ES E521 03: Environmental Economics and Socio-Economic Planning [3-0-0]

Environmental Economics : Economy and Environment -the historical development of environmental economics; The circular economy, The sustainable economy. Economics of Pollution;-The optimal level of pollution, The 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.

Socio-economic Planning: Importance of Socio-economic development planning. Social indicators and their importance; 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.

Corporate Social Responsibility (CSR), different models; Social Accountability (SA) 8000; Certification.

Books and References:

1. Values for the Environment: A Guide to Economic Approach – Winpeny JT, Overseas Development Institute, London, HMOS, 1991.
2. Economic Analysis of Environmental Impacts – Dixon, John, A, Scura LF, Carpenter RA and Sherman PB, Earthscan Publications Ltd., London 1995.
3. Environmental Assessment Source Book (Vol – 1)- World Bank, Environment Department, Washington DC, The World bank, 1991.
4. Valuing the Environment – Barde J and Pearce DW (ed), Earthscan Publication, London, 1991.

ESE521 04: Hazardous Materials and Disaster Management [3-0-0]

Hazardous Waste: Cyanide wastes, water-soluble chemical compounds of heavy metals, & toxic metals. Hydrocarbons, point pigment dyes, oil emulsion tars, phenols, asbestos, acid/alkaline slurry, etc. Physical properties, and chemical composition and lethal dose and concentration on human life flora and fauna. Precautions in collection, reception, treatment, transport, storage, and disposal, and import procedure for environmental surveillance. Radioactive wastes generated during

mining, processing of atomic minerals, and in atomic reactors, and disposal of spent fuel rods.

Hazardous Chemicals: Toxic chemicals, flammable chemicals, pesticides, explosives, reactive substances, physical and chemical characteristics, precautions in manufacture, storage and transport, preparation of safety report. Hazardous micro-organisms-bacteria, fungi, parasites and viral viruses.

Disaster Management; Disasters: Natural- Earthquake, flood, volcanic eruption, cyclones, tornado. Man-made- Failure of dams, leakage, explosion, oil-spills and fire of hazardous chemical storage. Leakage in atomic reactor plants. Mining disaster. Monitoring of critical parameters/provide risk-analysis. Hozon, HAZOP, Consequence Analysis. Faculty and eventry analysis. Emergency Management: Indian and foreign legislation's in respect of the above. Case studies.

Books and References:

1. Standard Handbook of Hazardous Waste Treatment and Disposal – Freeman, HW, McGraw Hill, NY, 1989.
2. Hazardous Waste Management Engineering – Martin EJ & Johnson JH, Van Nostrand-Reinhold, NY, 1987.
3. Hazardous Waste Management (2nd ed) – Wentz, CA, McGraw Hill , NY, 1995.
4. Solid Waste Management – Mantell, CL, John Wiley, NY, 1975.

ES E521 05: Advanced Wastewater Engineering [3-0-0]

Principles of reactor design; flow pattern in reactors, estimation of dispersion number. Kinetics of plug flow and completely mixed flow reactor. Microbiology and bioenergetics of waste degradation, modelling and application of biological process employed in wastewater engineering. Growth kinetics determination for inhibitory substrate.

CASP; Sequencing batch reactor (SBR) for carbon oxidation and biological nutrient removal, modelling of SBR for treating inhibitory and non-inhibitory substrate; anaerobic SBR, GAC-SBR. High rate algal pond system; Removal of toxic compounds and refractory organics; removal of dissolved organic substances. Phosphorous removal mechanism. Application of phostrip, Bardenpho and phoredox process. Combined N and P removal by A2/O, Bardenpho, UCT and VIP process.

Design of natural treatment and on-site process- Soil based system (like slow rate, rapid infiltration and overland flow). Special emphasis on site evaluation and selection, crop selection, crop characteristics, distribution method and design parameters. Design and operation of constructed wetland (reed beds). Constructed reed beds for small wastewater treatment works, polishing wastewater effluents.

Sludge handling and disposal; Design and operation of sludge thickener. Stabilization of sludge- anaerobic digestion, single stage and two stage; process design. Aerobic sludge digestion – process microbiology and design. Conditioning of sludge. Land application of sludge and design consideration. Sludge storage, land application of domestic sewage and ground water recharge. Wastewater reclamation and reuse. Sustainable sewage treatment.

Books and References

1. Wastewater Engineering: Treatment, Disposal, Reuse - Metcalf & Eddy Inc. 4th ed. TMGH, New Delhi, 2003.
2. Wastewater Treatment for Pollution Control - Soli J. Arceivala, Tata McGraw Hill, 2nd ed, 1998.
3. Wastewater Treatment Plants: Planning, Design & Operation- S.R.Qasim, Holt, Rinehart & Winston, NY, 1985.
4. Wastewater Treatment – DW Sunderstorm and H.E. Klei, PH, Englewood Cliffs, NJ, 1979.
5. Biological Wastewater Treatment: Theory and Application - CLP Grady & HC Lim, Marcel Dikker, NY, 1980.

**ES E 521 06 Carbon Foot Prints and Clean
Development Mechanism (3-0-0)**

Climate Change Mitigation: Way and means, Concept of Carbon Sequestration. Carbon Sequestration projects, Carbon Sequestration Modalities and Procedures. Global Carbon Cycle: Stocks and Fluxes of Carbon in terrestrial and marine ecosystems and anthropogenic impact. Policy Perspective: UNFCCC, Role and Function of IPCC, Kyoto Protocol and its implication on Developed and developing countries, function of Kyoto Protocol.

Clean Development Mechanism (CDM) and its operation, modalities and procedures for CDM Project. Forestry Perspective: Source or Sink of Carbon, Measuring of Carbon Dioxide. The Climate Mitigation potential of Forest and its evaluation, Land use, Land use Change and Forestry (LULUCF), Evolution of LULUCF in CDM.

Emissions trading of clean development mechanism (CDM), Difficulties with the CDM, Financial issues with the CDM, prototype carbon funds (PCF), Carbon Credits and it's trading, carbon finance, and evaluation of Carbon Credit of solar energy systems. Emissions trading under different article, Carbon foot prints.

Books and References

1. Carbon Capture: Sequestration and Storage (Issues in Environmental Science and Technology), by R E Hester and R M Harrison.
2. Carbon Capture and Sequestration Integrating Technology, Monitoring, Regulation by Elizabeth Wilson and David Gerard.
3. Climate Change and the Kyoto Protocol: The Role of Institutions and Instruments to Control Global Change by Michael Faure Joyeeta Gupta Andries and Nentjes.
4. Voluntary Carbon Markets by Ricardo Bayon Amanda Hawn and Katherine Hamilton.

**ES E 521 07 Environmental Aspects of Petroleum
Industry [3-0-0]**

Petroleum Industry: Production and consumption of the oil and gas, Unit operations involved in exploration and production of petroleum and natural gas; Major environmental problems in on-land and off-shore exploration; Oil Industry Safety Directorate (OISD); Standard guidelines; Environmental impacts; Dow and Toxicity index, Vapour Cloud Explosions (VCE), Boiling Liquid Vapour Cloud Explosion (BLEVE). Disaster management, Spill Response Program, . Hazard and Operability Studies (HAZOP) and analysis; Disaster Management.

Environmental laws related to oil and gas exploration and production. Safety audit; Occupational Health & Safety Management System; Stress management, Ergonomics.

PRACTICALS

ES C522 01: Wastewater Engineering (Practical) (0-0-2)

Determination of chlorine demand, break-point chlorination and free residual chlorine; Na and K in sewage sample, wastewater and natural water; Determination of Nitrate-nitrogen ($\text{NO}_3\text{-N}$) concentration in domestic sewage, wastewater, surface water sample and underground water sample. Determine chloride, acidity and alkalinity of raw sewage, wastewater, natural surface water and compare the results MLSS and MLVSS. Sludge Volume Index (SVI) and development of sludge settling characteristics curve and design of PST based on settling curve. Determine TS, TSS, TDS and settleable solids in domestic sewage. Calculation of inorganic and organic portions.

Determination of BOD_5 :TKN ratio and comment on the treatment process for biological removal of nitrogen. Derive the COD: BOD_5 ratio and use the same data for BOD_5 :TKN ratio estimation.. Jar-Test of filtered domestic wastewater and determination of optimum dose on the basis of COD and turbidity removal. Calculation of dose requirements in Kg/m^3 of water. Estimation of total coliform, FS and FC in raw domestic sewage.

ES C522 02: Solid and Hazardous Waste Management & Land Reclamation (Practical) (0-0-2)

Sample preparation; sampling techniques; coning and quartering method; overburden and other wastes sampling. Profile sampling, Characterisation of Solid Waste, Proximate Analysis and Ultimate Analysis, Calorific Value; Determination of coarse fraction,; pH & buffered pH, KCl & CaCl₂ solution; EC & CEC; exchangeable Na & K; non-exchangeable K & HNO₃-soluble-K. ESP and SAR. mineralisable -N and total nitrogen in profile samples. Determination of organic matter and organic carbon C:N ratio; Determination of plant available P and total P; DTPA -extractable micronutrients and trace elements in OB samples; Leachate Analysis.

THIRD SEMESTER PROJECT WORK [40 Cr.]

A candidate after passing the qualifying examination shall undertake an Industrial training / Minor project work under the supervision of a faculty member of the ESE. An interim report on dissertation topic has also to be submitted and will be evaluated by an Examination Board constituted for this purpose.

Sl.No	Subject Code	Name of the Course	Credit hours
1.	ES C 536 01	Industrial Training/ Minor Project	4
2.	ES C 534 02	Seminar and Viva-voce on Industrial Training/ Minor Project	2
3.	ES C 535 03	Comprehensive Viva-voce (to be conducted at the end of II Semester, marks to be added while computing III Semester GPA)	4
4.	ES C 538 04	Dissertation (Interim)	15
5.	ES C 534 05	Seminar and Viva-voce on Dissertation	10
6.	ES C 530 06	Evaluation of Teaching Assignment/ Laboratory Development Work etc.	05
Total			40

FOURTH SEMESTER PROJECT WORK [40 CR.]

On the completion of dissertation work each student has to submit for examination, a dissertation embodying the result of the research work carried out by him/her. The viva-voce examination will be conducted by a Board of Examiners to be constituted by ISM.

Sl.No	Subject Code	Name of the Course	Credit hours
1.	ES C 548 01	Dissertation	20
2.	ES C 544 02	Seminar on Dissertation	5
3.	ES C 545 03	Viva-voce on Dissertation	10
4.	ES C 540 04	Evaluation of Teaching Assignment/ Laboratory Development Work etc.	5
Total			40