Department of
Environmental Science & Engineering

Approved Syllabus and Course Content of
M. Tech (Environmental Science & Engineering)
by BOCS held on 27.03.2015

Effective from 2015-16

INDIAN SCHOOL OF MINES
DHANBAD- 826 004, JHARKHAND
## FIRST SEMESTER

<table>
<thead>
<tr>
<th>SI No.</th>
<th>Subject Code</th>
<th>Name of the Course</th>
<th>L  T  P</th>
<th>Total Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>AMC 511 51</td>
<td>Advanced Numerical Methods and Applied Statistics</td>
<td>3-1-0</td>
<td>7</td>
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<tr>
<td>2.</td>
<td>ESC 511 01</td>
<td>Ecology, Biodiversity and Environmental Microbiology</td>
<td>3-1-0</td>
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<tr>
<td>3.</td>
<td>ESC 511 02</td>
<td>Water Supply and Treatment</td>
<td>3-1-0</td>
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<td>4.</td>
<td>ESC 511 03</td>
<td>Environmental Chemistry</td>
<td>3-1-0</td>
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<td>5.</td>
<td>ESC 511 04</td>
<td>Principles of Air and Noise Pollution</td>
<td>3-1-0</td>
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<tr>
<td>6.</td>
<td>Electives – (Any one)</td>
<td>3-0-0</td>
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- ES E 511 01  Environmental Aspects of Industries
- ES E 511 02  Environmental Systems Optimisation and Modelling
- ES E 511 03  Instrumental Techniques in Environmental Analysis
- ES E 511 04  Environmental Geology and Resource Management
- ES E 511 05  Environmental Geotechnology
- ES E 51106  R & R, CSR and Social Impact Assessment
- ES E 51107  Water Management and Conservation

| 7.     | ESC 512 01   | Ecology and Environmental Microbiology Practical | 0-0-2  | 2                  |
| 8.     | ESC 512 02   | Environmental Chemistry Practical | 0-0-2  | 2                  |
| 9.     | ESC 512 03   | Air and Noise Pollution Practical | 0-0-2  | 2                  |
| 10.    | ESC 516 01   | Field and Industrial Visits and Seminar (s) |           | (02)               |

**Total Credits**: 18-5-6  47 + (2)
## SECOND SEMESTER

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<tr>
<th>SI No.</th>
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<tr>
<td>1.</td>
<td>ESC 521 01</td>
<td>Environmental Laws, Impact Assessment and Auditing</td>
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<td>2.</td>
<td>ESC 521 02</td>
<td>Wastewater Engineering</td>
<td>3-1-0</td>
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<td>3.</td>
<td>ESC 521 03</td>
<td>Solid and Hazardous Waste Management and Land Reclamation</td>
<td>3-1-0</td>
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<td>4.</td>
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<td>Design of Air Pollution Control Systems</td>
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<td>ES E 521 01</td>
<td>Remote Sensing and GIS</td>
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<td>ES E 521 02</td>
<td>Noise Control Engineering</td>
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<td>ES E 521 03</td>
<td>Environmental Economics and Socio-Economic Planning</td>
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<td>ES E 521 05</td>
<td>Climate Change and Modeling</td>
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<td>ES E 521 06</td>
<td>Life Cycle Assessment</td>
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<td>ES E 521 07</td>
<td>Environmental Biotechnology</td>
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<td>ES E 521 08</td>
<td>Renewable Energy</td>
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<td>ES E 521 09</td>
<td>Environmental Management System</td>
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<td>Wastewater Engineering Practical</td>
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<td>Solid and Hazardous Waste Management and Land Reclamation Practical</td>
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### THIRD SEMESTER

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<tr>
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<td>ESC 536 01</td>
<td>Industrial Training/ Minor Project Seminar and Viva voce on Industrial Training/ Minor Project</td>
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<td>ESC 535 03</td>
<td>Comprehensive Viva-voce (to be conducted at the end of II Semester, marks to be added while computing III Semester GPA)</td>
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### FOURTH SEMESTER

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<tr>
<td>1.</td>
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</table>
AMC 511 51  Advanced Numerical Methods and Applied Statistics  [3-1- 0]

Part I: Advanced Numerical Methods:

Reference Books:
2. Numerical methods- E. Balagurusamy

Part II: Applied Statistics:

Reference Books:
1. Miller & Freund’s:Probability and Statistics for Engineers (5th ed.)-Richard A. Johnson, PHI.

ES C 511 01  Ecology, Biodiversity and Environmental Microbiology  [3-1-0]

Biodiversity: Importance, distribution, measurement, and conservation. Impacts of climate change on Biodiversity.

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.

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.


Books and References:

ES C 511 02 Water Supply and Treatment

Water Resources: Aquifers and its properties.

Water Quality: Definitions, Characteristics, and Perspectives: The hydraulic cycle and water quality, physical water-quality Parameters, chemical water-quality parameters, biological water-quality parameters, water quality requirements.

Engineered Systems for Water Purification: Historical overview of water treatment; Water treatment processes: Aeration, solids separation, settling operations, coagulation, softening, filtration, disinfection, dissolved solids removal.

Environmental Engineering Hydraulics Design: Methods of distributing water, distribution reservoirs, distribution systems, distribution system components, capacity and pressure requirements, design of distribution systems, hydraulic analysis of distribution systems, cross – connections in distribution systems, construction of water distribution systems, pumping required for water supply systems.
Books & References:


ES C 511 03 Environmental Chemistry [3-1-0]

Atmospheric chemistry: Chemical components in the atmosphere, tropospheric chemistry, oxidizing capacity of atmosphere, hydroxyl radical, global budgets of CO₂ and methane, tropospheric ozone and NOₓ. Stratospheric chemistry: Chapman mechanism, catalytic losses, aqueous phase chemistry (acid rain formation), greenhouse gas and aerosol chemistry, radiation, effective temperature of earth, radiative forcing, feedback systems.

Aquatic Chemistry: Acids and Bases, titrations, buffers and buffer intensity, chemical equilibrium calculations, pC-pH diagram. Precipitation and dissolution, water softening and water conditioning, Langelier index, solubility diagram, co-existence of phases in equilibrium, Complexation of metal ions and organic complexes in natural water.

Oxidation and reduction reaction stoichiometry, Redox couples, pE-pH diagrams, redox control in natural systems.

Basic concepts of organic chemistry- Aliphatic organic compounds, aromatic compounds, detergents, pesticides, behaviour and fate of organics in the environment. Basic concepts of colloid chemistry.

Soil chemistry: Weathering reactions, structure and surface reactions of clays and oxides, forces at soil-water interfaces.

Books & References:

ES C 511 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, structure of atmosphere and layer classification, energy transfer in atmosphere, geostrophic flow, buoyancy and frictional force, local and general circulation, global climate and micro climate, wind profiles, topographic effects, temperature profiles in atmosphere, stability, inversions, plume behavior, turbulent diffusion, concept of mixing height and determination of stability class application of acoustic sounding (SODAR) technique.

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 modeling – Types and classification of models, purpose of air quality modeling, Box models, Gaussian dispersion model – Assumptions, modifications for ground reflection, line sources and complex terrain. Physics of plume rise, Holland's equation, Briggs equation, etc. Indoor air quality modeling, Features and application of regulatory models.

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 & References:
ELECTIVES

ES E 511 01  Environmental Aspects Industries  [3-0-0]


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


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; petrochemical plants.

R&R, industrial disasters, industrial safety. Environmental laws related to industrial production. Safety audit; Occupational Health & Safety Management System; Risk Assessment, Hazard and Operability Studies (HAZOP) and analysis; Disaster Management.

Books & References:

ES E 511 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 multi-objective 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 & References:


ES E 511 03 Instrumental Techniques in Environmental Analysis [3-0-0]

Basic Concepts for Environmental Analysis: Precision and accuracy, types of errors, titrations, extractions and quality control.

Spectrometry and Photometry: UV-Vis Spectrophotometer, Flame Photometer, Infrared Spectrophotometer, Atomic Absorption Spectrophotometer (AAS), Mass Spectrometry (MS), Fourier transform infrared spectroscopy (FTIR), Nuclear Magnetic Resonance (NMR), Inductively coupled plasma spectrometry (ICPMS).

Chromatography: Basic theory and types of chromatography, Gas Chromatography (GC), High Performance Liquid Chromatography (HPLC), Ion Chromatography (IC).

Ion Selective Electrodes: Operating principle, Primary components, Applications in environmental analysis. Polarography and cyclic voltametry.

Total Organic Carbon Analysis: Operating principle and primary components

Books & References:

ES E 511 04  Environmental Geology & Resource Management  [3-0-0]

Introduction to Environmental Geology: Scope and applications of Environmental Geology, the environmental crisis, Overview of limited resources, population growth.

Earth materials: The rock cycle, physical properties of rocks, soils, Impact of various activities on soil and their management.

Geological work: Weathering and erosion, transportation, deposition. Geological work of wind and river.

Flooding: Magnitude and frequency, recurrence interval, impact on urbanization.

Energy and mineral resources: Fossil fuels, energy supply and energy demand, alternative sources of energy, mineral resources of India.

Geologic Hazards: Landslides - The human impacts of landslides, subsidence, Earthquake process- Detecting, locating and measuring earthquakes, volcanoes - Major types of Volcanoes and their environmental impacts.

Water Resources: Watershed characteristics - Drainage Pattern, precipitation, evapotranspiration, surface runoff, groundwater runoff, and hydrological cycle. Groundwater movement & contamination: Types of aquifer, water table, Darcy’s Law, conserving and managing water resources, rainwater harvesting, impact of climate change on water resources.

Books & References:
5. Environmental Geology - Indian Context –KS Valdiya, TMH Delhi, 1987

ES E 511 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 & References:
ES E 511 06  R & R, CSR and Social Impact Assessment  [3-0-0]

Specific case studies from various sectors including mining.

Boos & References:

ES E 511 07  Water Management and Conservation  [3-0-0]

Ground water resources and its management: Groundwater management strategies.
Rainwater Harvesting: Introduction, basic components of rainwater harvesting, Catchment Areas (Rooftop, Land surface catchment etc.), design of Collection Devices & Conveyance Systems; advantages & disadvantages; design of rainwater harvesting structure, safety consideration, development cost; material requirements, effectiveness of technology, future development.
Direct (surface, sub-surface) and indirect (induced) techniques of artificial recharge, planning of artificial recharge projects, artificial recharge techniques and design, monitoring, mechanism for artificial recharge projects, case histories of artificial recharge in India. Artificial recharging of groundwater and use of domestic and industrial waste waters. General Guidelines for the evaluation of groundwater recharge projects with case studies. Diagnosis and control of rivers and streams stresses, siltation and pollution problems from watershed. Problems, Restoration, Conservation of rivers and lakes, National lake conservation plan. River linking and hydro power projects.

Books & References:
1. Water Resources Engineering- Larry W. Mays, John Wiley and Sons
ES C 512 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 chlorophyll and moisture contents of leaves (from grass and tree leaves); measurement of productivity by harvest method; estimation 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.


ES C 512 02  Environmental Chemistry (Practical)  (0-0-2)

Calibration of pH meter by two points method. Determination of chloride, nitrate, sulphate, alkalinity, acidity, total hardness, colour, turbidity, metals and metalloids, and sodium concentration.
Soil sampling, determination of soil pH, conductivity, salinity, organic carbon, nitrogen, phosphorus, sodium, potassium, and cation exchange capacity of soil.
Demonstration of UV-VIS spectrophotometer, Flame photometer, AAS, GC, TOC and HPLC.

ES C 512 03  Air and Noise Pollution (Practical)  (0-0-2)

Demonstration of air pollution monitoring instruments; Calibration of HVS by orifice method; Determination of SPM; PM$_{10}$; SO$_2$; ammonia and NO$_x$ in ambient air; Respirable dust monitoring by RDS and FPM; Demonstration of stack monitoring kits; Demonstration of Indoor air quality CO, VOC and aerosol monitors; Determination of atmospheric stability class using portable anemometers; Development of 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).
SECOND SEMESTER

ES C 521 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.

Environmental Clearance; Forest clearance; Consent to Establish & Consent to Operate; Environmental conservation plan for endangered flora and fauna; The Mines and Minerals (Development and Regulations) Act.

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.

Introduction to ISO 14001 series, OHSAS 18001; case studies.

Books & References:
11. OHSAS & SA Guidelines.
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.


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, de-nitrification system; luxurious phosphorus uptake.

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


Books & References:
Solid and Hazardous Waste Management: Municipal solid waste management: Engineering principles; sources, nature and characteristics; quantitative and qualitative; Solid waste problems: Industrial (Ash dyke, Sedimentation), mining (OB dump, Tailing Dam), 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.

Reclamation and ecological restoration of degraded land: Physical/technical reclamation: Top soil management- inventory, removal, transportation, preservation and redistribution; monitoring of top soil quality, shelf life of topsoil; slope stability and drainage, estimation of soil erosion, sediment load and design of sedimentation pond. Soil amendment, mulches and coir mats; principles of ecological restoration, SERI guidelines; factors affecting plant establishment and growth. Mine soil characteristics: physical, chemical and biological; programmes and planning of vegetation cover development; establishment of grass-legume cover; application of Bio-fertilizer. Monitoring and aftercare of restored site; evaluation of restoration success and indicator parameters. Reclamation equipments and cost.


Mine Tailings Management: Reclamion of tailings impoundments etc.

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

Books & References:

Introduction: General principles of air pollution control, aerosols – Size distribution of aerosols, physical and chemical properties, and particle dynamics – Terminal settling velocity, slip correction factor, stopping distance and removal mechanism.

Control device for Particulates: Types and classification of control device for particulates, design aspects of control device, selection criteria, concepts of removal efficiency and calculation basics of flue gas and control device. Design and operation of gravity settling chambers, efficiency of settling chambers using plug flow and mixed flow models. Cyclone separators: Concept, types and cut diameter, design equations, and pressure drop. Design and operation of fabric filters, ESP, wet dust scrubber.

Control device for gaseous pollutants: Absorption – Types, two-film theory, mechanism, concept of equilibrium curve, application of mass balance, design of L/G, diameter and height of tower. Application of adsorption and condensation for control of pollutants and their design. Thermal incinerators – principles, types, design equations using energy balance approach, SCR and SNCR.

Industrial Air Pollution Control: Dust control and abatement measures in mines; role of green belts. Thermal power plants: Control principle to improve overall thermal efficiency, Fuel and flue gas desulphurization, FBC, control of NOx, concept of IGCC and CCS. Control of motor vehicle emissions; Indoor air pollution control.

Books & References:

ELECTIVES

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


Electromagnetic Radiation, terms and definitions, laws of radiation, EM spectrum, interaction between EM radiation and matter, reflection, absorption and transmission, interaction between EM radiation and atmosphere, atmospheric windows.

Remote Sensing systems – Active and passive systems, imaging and non-imaging systems, concept of resolutions in RS – Spatial, spectral, radiometric and temporal; Orbits and remote sensing platforms for earth observation, earth observation satellites (LANDSAT, SPOT, IRS, IKONOS, world view and sensors for stereo data (MOMS, CARTOSAT)) and their characteristics. Satellite imaging modes and geometric errors; image quality & structures.


Integration of Remote Sensing and GIS: Environmental Applications, Suitability Analysis, Risk Analysis, Hazard Analysis etc.

Fundamental Concepts of GPS: Types of GPS, GPS Satellite, Applications of GPS in resource surveys, mapping and navigations.

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


Ground vibration and air blast, environmental and health effects; strategic control, abatement measures and noise exposure.

Books & References:

ES E 521 03  Environmental Economics and Socio-Economic Planning  [3-0-0]

Environmental Economics: Economy and environment - The historical development of environmental economics; circular economy and 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.

Books & References:


ES E521 04 Advanced Wastewater Engineering [3-0-0]


Ion Exchange: Fundamentals of ion exchange, types of ion exchange resins, general characterization of ion exchange resins, theory and application of ion exchange.

Advanced Oxidation Process: Theory of advanced oxidation, technologies used to produce hydroxyl radicals, applications.

Sludge handling and disposal: Sludge processing steps- Preliminary operations, thickening, stabilization, conditioning, dewatering, heat drying and thermal reduction. Aerobic and anaerobic sludge digestion microbiology and design, land application of sludge and design consideration. Sludge storage, land application of domestic sewage and ground water recharge.

Books & References:

5. Biological Wastewater Treatment: Theory and Application - CLP Grady, and HC Lim, Marcel Dikker, NY, 1980.
ES E 521 05 Climate Change and Modeling (3-0-0)

Introduction to Climate system; Global energy balance, assessment, MAGICC energy balance model.

Causes of climate change, climate feedback mechanisms, Climate modeling: importance and significance, types of models, history of climate models, sensitivity, parameterization.

Energy balance models: Energy balance models and glacial cycles, box models, convective adjustment, radiative-convective models, two dimensional models, models of intermediate complexity, general circulation modeling of the atmosphere, ocean, and cryosphere, land surface modeling.

Modeling of atmospheric chemistry, coupled modeling, working with climate models, climate model evaluation, climate model predictions and policy, volcanic eruptions; detection and attribution of anthropogenic forcing.

Books & References:

ES E 521 06 Life Cycle Assessment [3-0-0]

Introduction of LCA, benefits of conducting LCA, limitation of conducting LCA.

Components of LCA: Goal and scope, functional unit, system boundaries, data quality, critical review process.

Inventory analysis: Data collection, defining system boundaries, calculation procedures, validation of data, relating data, allocation and recycling.

Impact assessment: Category definition, classification, characterisation, valuation/weighting.

Interpretation: Identification of significant environmental issues, evaluation, conclusions and recommendations.

Applications of LCA: Solid waste management, cement industry, water management, mining sector etc.

Books and Reference:
ES E 521 07  Environmental Biotechnology  [3-0-0]

Introduction to environmental biotechnology, cell genetic material, Nucleic acid-based methods of analysis- Extraction of nucleic acids from environmental samples, Polymerase chain reaction- Steps of PCR, design of primers, PCR detection of specific and universal genes, RT-PCR, real-time PCR, Recombinant DNA techniques- Cloning, metagenomics, sequence analysis, comparative genomics.

Bacterial genetic recombination, recombinant DNA technology, applications in environmental engineering.

Bioremediation for soil environment- Biotechnologies for ex-situ and in-situ, remediation of soil, phytoremediation technology for soil decontamination.


Bioremediation for air environment- atmospheric environment for microorganisms, microbial degradation of contaminants in gas phase, Biological filtration processes for decontamination of air stream, Bioscrubbers.

Books & References:

ES E 521 08  Renewable Energy  [3-0-0]


Wind Energy and its Utilization: Wind energy scenario in India, properties of wind, wind velocity and wind rose diagram, estimation of power in wind; Types of wind turbines, characteristics, construction of wind mills; Aerodynamic considerations of wind mill design, wind stream profile, rotor blade profile and cross section; Drive system-gears, wind electric generators, regulating and control systems for wind mills; Performance evaluation and recent technologies of wind energy conversion system; Wind energy potential estimation and site selection; wind farms, cost estimation of the energy from wind energy conversion system.

Solar Energy and Its Utilization: Solar radiation spectrum; The Photo Voltaic effect; Spectral response; p-n junction; different types; characteristics; temperature effect; Photovoltaic modules; Battery storage; Charge regulators, Solar thermal collectors applications: solar ponds; dryers; distillation; solar cooker. Passive Solar design.

References

ES E 521 09 Environmental Management System [3-0-0]

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). OHSAS 18001.

Books and References:
6. OHSAS & SA Guidelines.

PRACTICALS

ES C 522 01 Wastewater Engineering (Practical) (0-0-2)


ES C 522 02 Solid and Hazardous Waste Management & Land Reclamation (Practical) (0-0-2)

Sample preparation; sampling techniques; conning and quartering method; overburden and other wastes sampling. Profile sampling. Characterisation of Solid Waste, Proximate 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; Analysis of toxic elements. 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.

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

<table>
<thead>
<tr>
<th>SI No.</th>
<th>Subject Code</th>
<th>Name of the Course</th>
<th>Total Credit Hours</th>
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<td>ESC 544 02</td>
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<tr>
<td>3.</td>
<td>ESC 545 03</td>
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<td>ESC 540 04</td>
<td>Evaluation of Teaching Assignment/ Laboratory Development Work etc.</td>
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<td><strong>Total</strong></td>
<td><strong>40</strong></td>
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</tbody>
</table>
The department envisions that Environmental Science is a multidisciplinary subject combining ecosystem processes and human activities. The understanding of knowledge and skills acquired through studying Environmental Science is critical to the attainment of sustainable development for sound environmental management. Mission. The mission of the Department is to make people aware of the hazards of environmental pollution and offer viable solutions to these problems. The challenges of 21st century would require advance research and activities in the field of Environmental Sciences and Engineering. It is, therefore, necessary to develop the research facilities in order to cope with future demands. The department is engaged in multidisciplinary research.