TEACHING SCHEDULE & STUDY SCHEME

M. TECH. PROGRAMME

(Environmental Science Engineering)

PUNJAB TECHNICAL UNIVERSITY, JALANDHAR

DETAILED SYLLABUS AND OTHER CONDITIONS FOR THE PROPOSED COURSE
M. TECH. ENVIRONMENTAL SCIENCE ENGINEERING

Schedule of Teaching				**Schedule of Examination**				
Lecture	Tutorials (per week)	Total		Time (Hrs.)	Theory Marks	Sessional Marks	Viva	Total
4	0	4	All theory subjects	3	100	50		150
			Project			50	50	100
			Seminar			100		100
			Dissertation			Satisfactory/Not Satisfactory		

SEMESTER-I

ES-501	Remedial Course
ES-502	Physics of Environment
ES-503	Environmental Chemistry
ES-504	Water Pollution and Waste Water Treatment
ES-505	Air Pollution and Control

SEMESTER-II

ES-506	Waste Water Treatment- II
ES-507	Pollution Monitoring Techniques
ES-508	Industrial & Hazardous Waste Management
ES-	Elective-I
ES-	Elective-II

SEMESTER-III

ES-	Elective-III
ES-	Elective-IV
ES-580	Project
ES-590	Seminar

SEMESTER-IV

ES-500	Dissertation

LIST OF ELECTIVES

	ELECTIVE-I
ES-509	Environmental Biotechnology
ES-510	Energy Technology & Alternative Energy Sources
ES-511	Mechanical Vibration & Noise Pollution
ES-512	Hydrology & Water Harvesting
	ELECTIVE-II
ES-513	Energy through Water Utilization
ES-514	Microbial Processes in Environmental Management
ES-515	Fuel Combustion & Vehicular Pollution
ES-516	Soil Chemistry, Pollution & Control
	ELECTIVE-III
ES-517	Environmental Auditing & Impact Assessment
ES-518	Biodegradation & Bioremediation
ES-519	Statistical Methods of Analysis & Simulation
ES-520	Environmental Engg. System Design
	ELECTIVE-IV
ES-521	Environmental Standards & Laws
ES-522	Solid Waste Management
ES-523	Adsorption, Catalyst and Colloidal Engg.
ES-524	Physiology & Toxicology

1ST SEMESTER

ES 501: Remedial Course (only one out of a) & b) below**)**

a) BASICS OF ENGINEERING (For M. Sc. candidates)

The course includes the basic concepts of the engineering disciplines like

1. Electrical/ Engg. : Electricity, Electric conduction, three Phase system, Electrical machinery, Transformers, motors, electric furnaces and other appliances.
2. Electronics: Semiconductor Technology; devices and materials, introduction to chips and microprocessors, power electronics,
3. Mechanical & Production Engg. : Thermodynamic: First, second & third laws, Mechanical properties, steels and engineering alloys, deformation, solidification and machining processes,
4. Civil Engg.: structures, buildings, roads & Bridges, construction materials, cements, concrete & timber; properties, characterization and utilities.
5. Chemical Engg. : Chemical processes, interactions, kinetics & applications, biochemical & biological reactions.
6. Engineering & Technical Drawing

b) BASICS OF APPLIED SCIENCES (For BE/B. Tech candidates)

The course includes the basic concepts of Applied Sciences relevant to Environmental Science & Engg.

1. Environmental Physics: Biophysics, Radiation spectrum and related Physics, Amospheric Physics and ocean science.
2. Environmental Chemistry: Concentration of solutions, ph value, surface phenomenon, chemical, bio-chemical & Biological reactions, chemistry of water, air and soil.
3. Biology: World of living being, Genus & species, nomenaclature, cell, organism, ecosystem Krebs cycle, photosynthesis, Cell mitosis, Population dynamics and habitat destruction

ES 502: Physics of Environment

The course introduces Radiation science, types of nuclear reactors, radiation (units, dose and health effects), radioactive waste control and management, and methods of radioactivity detection.

Physics of Atmospheres and Oceans**.** Fundamental physical processes in atmospheres and oceans. Thermodynamics, condensation, precipitation, hydrostatic balance, stability, convection, radiation, remote sensing, clouds, climate, primitive equations, geostrophic balance, turbulence, waves, hydrodynamic instability, the general circulation, ice age, clouds and Earth's radiation budget, convection and the planetary boundary layer, Earth's middle atmosphere, planetary atmospheres, basic structure of the atmosphere and relevant meteorological considerations; sources of tropospheric air pollutants; atmospheric photosensitivity, ozone layer depletion; causes and remedy.

ES 503: Environmental Chemistry

Course topics include the following: Concept of Green Chemistry (1) rates of chemical and biochemical reactions with applications in disinfection and biological treatment; (2) acid-base reactions and the carbonate system with applications in neutralization and pH control; (3) complexation reactions and chelation with applications in chemical coagulation and metals bioavailability; (4) precipitation and dissolution phenomena with applications in iron and phosphate removal and carbonate scaling; (5) oxidation-reduction reactions with applications in metals removal processes (e.g., hexchrome reduction), biochemical reactions and acid mine drainage; (6) a survey of organic chemistry and how organic compounds react and behave in the environment, including principles associated with air-water partitioning, solvent-water partitioning, and sorption phenomena with application in air stripping and adsorption; and (7) a survey of environmental laboratory procedures and analytical techniques in environmental chemistry for both inorganic and organic compounds ; the ozone, oxide of nitrogen, and hydrocarbon chemical cycles; chemistry of toxic organic compounds in the atmosphere gas and aqueous phase chemistry of sulfur dioxide; size distributions, lifetimes, origins and formation mechanisms of aerosols; and control of atmospheric.

Environmental Chemistry Lab.

Analysis of water and waste water for solids , Hardness, Chlorides, pH , Acidity, Alkalinity, Dissolved Oxygen, Residual Chlorine, BOD , COD, MPN.

Analysis of Water for Domestic and Construction purposes. Introduction to analysis of Industrial effluents.

ES 504: Water Pollution & Waste Water Treatment

Water Pollution : Characterisation of Effluents , Effluents Standards.

Physical, Chemical and Biological Characteristics of Waste Water, BOD, COD and TOD – Their estimation and correlation ; BOD progression curve and kinetics , effects of reaction rate constant on short term BOD, determination of BOD rate constants ; Effect of Temperature on BOD ; Nitrification and De- Nitrification and their kinetics. Other primary treatment , Hydrogeology and Groundwater Pollution Properties of major water pollutants, interactions and kinetics. interactions between watersheds and receiving waters, and impacts of wastewater on aquatic ecosystems, such as saprobity, eutrophy, pathogenicity, toxicity, etc..Industrial Water Treatment , Municipal Wastewater Treatment, Municipal Wastewater Treatment

Water Pollution Lab

The major objective of this course is to provide a background in the chemical principles that are particularly important to environmental analytical chemistry. The students learn about the classical and instrumental analytical skills and the application of the techniques to the field in relation with the analysis of environmental sample.

ES 505: Air Pollution and Control

Air Pollution: Micro Metrology and dispersion of pollutants in environment, Fate of Pollutants. Air Pollution Control Technologies: Centrifugal collectors, Electrostatic Precipitators, Bag Filters and Wet Scrubbers. Design and efficiencies, Combustion generated pollution, vehicle emission control. Case Studies.

Air Pollution; Types and strategies for waste minimization, pollution prevention, the concepts of air pollution control design, the regulatory and environmental concerns, which drive the air pollution, control industry. Students are led through the design process from basic theory to practical application and case studies. The sources of air pollution and the available control options are presented and discussed in detail

Air Pollution And Lab

In this course, characteristics and impact of air pollutants, control technology of particulate air pollutants, and aerosol technology are discussed.

2ND SEMESTER

ES 506: Waste Water Treatment- II

Waste Water treatment Systems: Waste Water Collection Systems, Urban Wet Weather Flow, Physio-chemical Process, Activated Sludge and Other Aerobic Suspended Culture Processes, Biological Fixed Filter System, Anaerobic Processing, Natural Treatment and On-site processes, Disinfections and Anti-microbial process, bio-solids and sludge management, Gaseous emissions from waste water facilities, Water Reclamation and reuse; Modeling, Instrumentation, Automation and optimisation of Waste water treatment facilities.

Fate and Effects of Pollutants: Mixing and Transport, Aquatic Sediments, Ground Water Quality, Non-point sources, Fate of Environmental Pollutants. Substratum associated Micro-biotic. Effects of pollution on fresh water organisms. Effects of pollution on Marine organisms.
Thermal Effect. Health Effects Associated with wastewater treatment, disposal and re-use. Administration: Economics, Law.

ES 507: Pollution Monitoring Techniques

Measurement and Monitoring of Pollutants: Chemical species, Detection and Occurrence of Indicators Organisms and Pathogens, Geographic Information Systems.

Analytical methods: Gravimetric analysis, volumetric analysis, precipitation methods, oxidation deduction methods.

Instrumental methods: U V I R spectrophotometer, flame photometry, ASS, dispersion & scattering methods, chromatography, polarography, gas chromatography, HIC, IC, mass spectrometry, NMR & ESR spectroscopy, radio activity measurement, x-ray diffraction, thermal analysis techniques: DTA, TGA, DSC.

ES 508: Industrial & Hazardous Waste Management

Industrial Wastes: Agricultural Wastes, Automotive wastes, Wastes from Chemical and Allied Industries, Fermentation Industries, Food Processing Wastes, Waste From electronics and Metal Finishing and Processing, Minerals and Mine Drainage, Waste From Petro-Chemical Industries, Power Production Wastes, Pulp and Paper effluent management, Waste from Pesticides and Herbicides Industries.

Hazardous wastes: Assessment, hazardous waste minimization. Regulations and regulatory trends and treatment or remediation alternatives. Solid waste management options, including recycling in reference to industrial and special wastes. Management and Minimisation of treatment technologies. Storage, Disposal, Remediation.Radio-Active Wastes.

Elective I

ES 509: Environmental Biotechnology

Microbial physiology and its relationship to biodegradation, Definitions, Degrees of biodegradation, Factors needed for biodegradation, Adaptation, "Biodegradability" testing,Oil Industry operations, Crude composition, Hydrocarbon degradation, Stimulating oil degradation, Bioaugmentation, Superbugs, Mixed substrates/ mixed cultures and impact on degradation, Biostimulation, Combination treatment approaches. Surface soil bioremediation, Models, Treatment methods, Solid and slurry phase treatment, Landfarming. Exxon Valdez bioremediation program, Stimulation, Augmentation, Oleophilic fertilizers, Inipol. Composting, Process or product oriented, Municipal, Sewage, Environmental, Hazwates requirements, Low density systems, High density systems, Types of composting, Materials requirements, Process control, Explosives example. Slurry treatment, Advantages, Disadvantages, Lagoons, French limited site, Mixing, Aerobic/anaerobic. In-situ bioremediation, Materials treated, Process control, Delivery systems, UAB, Process control problems, Aerobic, Anaerobic. Halogented compounds, In-situ cometabolism, Bioventing, Biofilters. Liquid phase bioremediation, Bioreactor design, Process control, Activated sludge, PACT, SBR’s, Fixed film reactors, Packed beds. Biomass to fuels, Alcohol, Commodity chemicals, Principle of fermentation, Process design, Economics.

ES 510: Energy Technology & Alternative Energy Sources

Concept of energy, energy requirement, conventional energy sources; fossil fuels, thermal power, hydroelectric power, depleting energy resources, Pollution and energy crisis.
Nuclear Power; fusion and fission, nuclear power reactors, limitations and future.
Non-conventional energy sources; photovoltaic conversion of sunlight into useful electricity, devices and conversion efficiencies, Solar thermal energy, Solar thermal beds, water heaters, solar thermal cookers, Wind energy; future and limitations with regard to India, Tidal wave energy prospects and utilization.

Energy efficient materials and systems. Superconductors; Power generation and transmission, SMES and other environmental friendly and efficient applications.

ES 511: Mechanical Vibrations and Noise Pollution

Brief revision of free and damped vibrations, bi-rank modes vibration absorption, multi degree undamped vibrations, vibration isolation, vibration measuring equipments, Physical characteristics of noise, measurement of noise, permissible limit. vibration reduction technology, standard methods for measurement of noise and vibration, and summary of related regulations are introduced for the students.

ES 512: Hydrology & Water Harvesting

Water, Nature & Properties, Water Sources their Management, Ground Water, Movement Nature, Geological Activity, Streams & Drainage, Depositional Features, Glacier, Ocean, Topography & Circulation Shaping,

Water Harvesting, Canals, Barrage & Dams, Environmental Impacts & Economics, Rain Water Management, Rain Water Harvesting Techniques,

Atmospheric Water, Water Estates & Heat, Cloud, Foe, Thunder Storms, Orographic Precipitation, Global Balances of Energy & Water, Pollution Dome & Plume,

ELECTIVE II

ES 513: ENERGY THROUGH WASTE UTILIZATION

Bioenergy: Future Supplyin Developing Countries, Energy Planning, Energy Technologies and Development, Observations on Producer Gas Development with Particular Reference to Thailand, Biomass Utilization in India, Stoves and Kilns, A Study of Ethanol Production in Kenya, The Economics of Bioenergy in Developing Countries, Aforestation and Public Participation, Bioenergy Research and Development in Developing countries.

Energy by Rice Husk utilization, Energy Conversion Considerations, Burning in a Controlled Atmosphere, Destructive Distillation, Pyrolysis, Gasification – Producer Gas, Other Chemicals, Thermochemical and Biochemical Processes, Physical and Chemical Characteristics of Rice Husk, Use of Rice Husk as Fuel, Processes Using Husk as an Energy Source, Equipment and Machinery to Convert Rice-Husk to Energy and for other related Functions.

ES 514: MICROBIAL PROCESSES IN ENVIRONMENTAL MANAGEMENT

Some general and important reactions carried out by heterotrophic and autotrophic microorganisms in relation to environmental science. General roles of microorganisms in environmental science. General responses of microorganisms to changing environmental conditions. Direct physical and chemical effects, fine control, coarse control, morphological & genotypic changes. Relevant considerations in using microorganisms for bioremediation in the environment. Discuss considerations relating to the type of microorganisms to be used and how best to use them, contingency planning and containment. Considerations in monitoring the progress of bioremediation: safety & security precautions, chemical analyses, microbial analyses involving immunological detection, lipid profiling, BIOLOG, gene probing, variations of PCR, reporter genes, various measurements of microbial activity, toxicity monitoring using different organisms. Factors that affect biodegradation: proximity to substrates, coping with large and hydrophobic substrates, coping with dilute nutrient, pollutant uptake, nature of pollutant recalcitrance, structural constraints to biodegradation, co-metabolic requirements, mixed substrate utilization and its environmental significance. General discussion on the three essential elements in bioremediation - microorganisms, environment & pollutants. Microbial degradation of selected aromatic and aliphatic chlorinated and non-chlorinated hydrocarbons. Detailed biochemistry (and some genetics) of selected catabolic enzymes and pathways, in particular dioxygenases and monooxygenases involved in the degradation of aromatic compounds. Various microbial dechlorination reactions. Peroxidases and their role in lignin biodegradation. Polymer metabolism: demonstrate with a prototype substrate, eg. Cellulose, xylan or pectin.

ES 515: Fuels, Combustion and Vehicular Pollution

Solid, Liquid and Gaseous Fuels. Stored and Unstored Fuels. Bio- solar fuels, Fuels from Organic Wastes. Conventional and Alternate fuel for Stationary and Mobile combustion systems. Basic Combustion calculations, Equilibrium calculations.

Adiabatic Flame Temperature, Chemical Kinetics and Steady state combustion.

Sources and nature of combustion generated pollution and their effects. Emissions from stationary combustion sources.

Vehicular emissions types of Engines and their working, emission composition and technologies for emission reduction, vehicular pollution standards and their prevention, Instrumentation and Control.

ES 516: Soil Chemistry, Pollution & control

Soil Science & Remediation Technologies, The objective of this course is to provide an understanding of soil structure, mechanics, physics, chemistry, and microbiology. These fundamentals are then applied to the migration of contaminants in soil and the evaluation and design of soil remediation technologies.

Soil Science Laboratory: Discusses basic physical, chemical, and biological properties of soils. Soil formation, clay mineralogy, organic matter and cation exchange capacity are included. Current environmental problems of soil pollution are also covered.

ELECTIVE III

ES 517: Environmental Auditing & Impact Assessment

Course topics include: (1) A review of the environmental risk assessment process; (2) A review of environmental auditing procedures, including an introduction to ISO 14000 and its impact on the environmental auditing process; (3) Overview of federal requirements relating to environmental assessments and impact statements; and (4) a project involving the conducting of an actual audit of a facility.

ES 518: Biodegradation and Bioremediation

Aerobic Transformation of Aromatic Compounds, Anaerobic Transformation of Aromatic Compounds, Transformation of Halogenated Organic Compounds, Anaerobic Dehalogenation, Aerobic Transformation of Halogenated Cpds, Transformation of Nitroaromatic Compounds, Microbial Transformation of Heavy Metals, Evolution of New Metabolic Pathways, Predicting Biodegradation, Thermodynamics of Biotransformations, Kinetics of Biotransformation, Bioavailability Considerations

ES 519: Statistical Methods of Analysis & Simulation

This course presents topics in statistics needed for statistical analysis and modeling of air, water and other environmental systems. It also presents the methodology for developing the statistical models themselves. Several relevant case studies are presented.

The lab work shall be on modeling and simulation on environment related problems.

ES 520: Environmental Engineering Systems Design

In this design course students select an environmental problem requiring resolution and proposes a comprehensive solution. The solution proposed must meet all technical standards and regulatory guidelines. Completion of a work schedule detailing tasks to be performed during the detailed design and evaluation phase of the project course. Selection of an environmental problem based on the student's current or previous background/experience is strongly encouraged. Performance of the detailed technical design for all hardware components of the project; Preparation of all required software i.e. completion of all required regulatory documents; a prESntation of the final design including details of the economics of the proposed design as well as technical specifications and completed regulatory work.

ELECTIVE IV

ES 521: Environmental Standards and Laws

Principles and practices of environmental planning and policy are introduced. Topics covered in this course are environmental policies of national and local governments, programs for financing environmental policies, development of environmental technologies and environmental industry, efficient enforcement of environmental regulations and management, and international environmental treaties.

This course presents case law and regulations relating to all areas of environmental compliance needed by the practicing environmental engineer. Provisions of ISO 14000,

ES 522: Solid Waste Management

Ecology and Environment, Principles of ecology and of ecosystem process, description, and measurement, with emphasis on ecosystem health assessment, Sources of Solid Wastes,

Urban Solid Waste: Nature & Characterization, Disposal Recycling & Threats. Biomedical Waste, Hospital Waste Disposal, Solid waste Processing, Thermal Volume Reduction, Manual Component Separation, Land Filling with Solid waste, Design & Operation of Landfills.

Industrial biodegradable and non-biodegradable, Management of Agro industrial Wastes, Agricultural Crop residues, Forest Residues, and Fruit Factory Byproducts. Animal Waste and their recycling and vermiculture,

ES 523:Adsorption, Catalyst & Colloidal Engg

Introduction to Adsorption Engineering, Porous Adsorbents, Adsorption Equilibrium, Diffusion in Porous Particles, Kinetics of Adsorption in a Vessel, Kinetics of Adsorption in a Column – Chromatographic Analysis, Kinetics of Adsorption in a Column – Breakthrough Curves, Heat Effects in Adsorption Column, Regeneration of Spent Adsorbent, Chromatographic Seperation, Pressure Swing Adsorption, Adsorption for Energy Transport.

ES 524: Physiology and toxicology

Occupational Safety and Health Administration; A brief survey of human anatomy, physiology and pathology of the lungs, skin, ears and eyes within the context of potential industrial pathogens, Comfortable working environmental conditions, chemical irritants or physical hazards; Identification and evaluation of industrial hazards including solvents, particulates, dermatoses, industrial noise, radiation, temperature extremes, ergonomically incompatible equipment and biological hazards; Techniques for the control of hazards including ventilation, protective equipment, noise reduction strategies, principles of ergonomic design and product substitutions; and Case studies in designing and implementing an industrial hygiene program for various types of industries.

ES 580: Project

The students will be required to take up the project work on an environment related problem preferably the one selected for graduate seminar. This work may be extended for the major project work of fourth semester.

ES 590: Seminar

Students will be required to deliver a seminar on topic relevant to environmental aspects/problems of industries and /or rural, semi-urban or urban areas.

4TH SEMESTER

ES 500: Project Dissertation

Today's environmentalist is faced with numerous environmental issues, all of which must be managed simultaneously. For any one environmental problem within a business or manufacturing setting, there are a number of possible technical approaches to controlling or eliminating that problem. The environmental manager for that business must select the best technical option from among many. This project dissertation is to be undertaken in collaboration with an industry, Government Organization, research establishment or a lab.