

## SYLLABUS

### Ph.D Course Work (Environmental Science)

Total Credits: 16

**Paper I: ESP- 101 (Compulsory Paper) Research Methodology**

**Credit – 04**

#### **Unit- I**

##### **Laboratory safety measures and personal protection practices**

Steps in research : Selection and formulation of research problem, design formulation of hypothesis, review of literature, Data Collection, processing of data, presentation of data editing, presentation of research finding.

**Structuring the Report:** Chapter format, pagination, presenting footnotes and figure legends, abbreviations, presentation of tables and figures, Referencing, Documentation – use and format of appendices – indexing.

#### **Unit- II**

**Research Report :**Types of research reports, steps in drafting reports, editing the final draft

**Analysis of Data :**Chi Square Test, S.D., S.E.,ANOVA

**Basic of Environmental Monitoring &Assessment:**Air, Water, Soil.

**Paper II: Optional (Any one from ESP : 102-110)**

**Credit - 04**

**ESP 102: Bio- remediation &Ecological Agriculture**

#### **Unit – I**

Microbial Bioremediation and Phytoremediation of degraded ecosystem, Genetically modified bioremediators, Environmental concerns of Genetically modified bioremediators, Commercial Bioremediation projects. A critical review on emerging trends in Bioremediation.

#### **Unit -II**

Ecological agriculture Problems related to use of conventional chemical fertilizers, synthetic pesticides, excessive water use, and high energy input in agriculture, organic, fertilizers, biofertilizers, slow/controlled release fertilizers, stabilized fertilizers, customized fertilizers, vermiculture, biopesticides, biogradable pesticides, water and energy conservation methods in agriculture, Organic farming, A critical review of emerging trends in ecological agriculture.

**Prof. Rana Pratap Singh**

## **ESP – 103: Environmental Microbiology**

### **Unit - I**

Bacterial photosynthesis : oxygenic and anoxygenic photosynthesis, photosystems and electron transport systems, photophosphorylation, Membrane transport system; Active/passive nutrient transport system.

### **Unit–II**

Extremophiles, concept of stress and stress tolerance, Signalling biomolecules, Free oxygen radicals. Radical induced oxidative stress, Antioxidants, UV – induced damage to DNA, photorepair, Dark repair and SOS inducible mechanisms.

**Prof. D.P. Singh**

## **ESP – 104: Microbial Ecology**

### **Unit-I**

Micoorganisms in ecosystems, Microbial succession, Microbial antagonists and their role in suppression of pathogenic forms, Biopesticides, microbial interaction, antibiosis, fungistasis, Use of botanicals as pesticides, Mycorrhizae and their role, seed bacterization, Microbiology of air, soil and water, N<sub>2</sub> fixing microorganism, process of root nodulation in leguminous crops and their role in N<sub>2</sub> fixation, concept of population and community dynamics, Integrated management of pathogenic forms, soil paterurization, seed bacterzation, effect of environmental determinants on microbes.

### **Unit-II**

Methods of inoculation and isolation of microbes. Types of sterilization, nutrient media and their composition, Methods to find out occurrence, abundance and frequency of microbes, colony diameter technique, method of pure culture, preservation of microbial culture, methods related to antibiosis and fungistasis, techniques of isolation of VAM, Isolation of air, soil and water microorganisms, methods related to physic-chemical characterstics of soil and water Microbial taxonomy.

**Prof. S.K. Dwivedi**

## **ESP- 105: Microbial Enzymes and Bioremediation**

### **Unit – I**

**Microbiological Techniques :** Aseptic techniques: (Physical, Chemical Methods) – Isolation and pure culture Techniques –Staining (Simple, Grams, Capsule, Spore and Acid fast staining)-Preservation Technique.

**Microbial culture studies :** Culturing of different types of microorganism ( bacteria, yeast, fungi) used in the production of commercially important products; Formulation of culture media; Estimation of biomass (dry weight); kinetics of microbial growth, substrate utilization and product formation.

### **Unit – II**

**Enzyme Isolation and Assays of Enzyme Activity :** Extraction of commercially important enzymes from natural sources; Development of enzyme assays; quantification of enzyme activity and specific activity. Estimation of Michaelis Menten parameters, Effect of pH and temperature on enzyme activity, kinetics of inhibition.

**Enzyme Immobilization and Bioremediation :** Technique of cell and enzyme immobilization matrix entrapment, ionic and cross linking, column packing; Application of Immobilisation - enzymes and cell for bioconversion processes: Aerobic and anaerobic biological processes for stabilization of solid/liquid wastes; Bioremediation.

**Bioprocess Techniques:** Bioremediation – Solid State fermentation- Submerged fermentation. Design of fermentation media, Strain improvement- Downstream processing of industrial products, various types of microbial and enzyme reactors; Instrumentation in bioreactors.

**Dr. Shikha**

## **ESP-106: Waste Management and Energy Generation Technologies**

### **Unit-I**

**Waste treatment and its management:** Definition-Sources, Type, Compositions, Properties of Waste-Municipal Solid Waste, Industrial Waste-Physical, Chemical and Biological Property- Collection – Transfer Stations –Waste Minimization and Recycling; Waste to energy conversion processes-Biological, Chemical and Thermo chemical processes, Reduction, reuse and recycling, resources recovery and utilization. Environmental Impacts. Definition & Identification of Hazardous Waste – Sources and Nature of Hazardous Waste – Impact on Environment –Waste Site –Disposal of Hazardous Waste, Underground Storage Tanks Construction, Installation & Closure.

## **Unit-II**

**Energy Generation from Waste :** Types – Biochemical Conversion – Sources of energy Generation – Industrial Waste, Agro Residues –Anaerobic Digestion – Biogas Production-Types of Biogas Plant; Thermochemical Conversion – Sources of Energy Generation- Gasification – Types of Gasifiers – Briquetting – Industrial Applciation of Gasifiers-Utilization and Advantages of Briquetting – Environment Benefits of Biochemical and Thermochemical Conversion; Fuels from biomass (Biogas, Biofuels and Biohydrogen); Overview on Processes involved, and from biomass (Biogas, Biofuels and Biohydrogen); Overview on Processes involved, and applications.

**Dr. Richa Kothari**

## **ESP – 107:Environmental Impact Assessment and Air Pollution**

### **Unit – I**

Origin and development of EIA, National environmental policy and statutory requirements of EIA, objectives of EIA, Methodology of EIA; categorization and evaluation criteria; prediction and assessment of impact, interaction between environmental components and impacts. Alternate strategies and mitigation measures, environmental monitoring and audit. Case studies: river projects: oil refineries and petrochemicals etc.

### **Unit – II**

Sources and diffusion of SO<sub>2</sub>, CO, NO<sub>x</sub> smoke, particulates in air. Sampling techniques: analysis of different gases and solid particulates, effect of air Pollution on human health, control techniques, air quality criteria and case study. Levels of air pollution in India. Air pollution standards in India.

Physico Chemical Properties of Ground water & Surface wate Impact assessment of organic/inorganic water pollutants and their management.

Meteorological Fundamentals. Adiabatic process, plume Behaviour, Effects of Meteorological parameters on Transport and Diffusion, Pollutant Concentration variation. Wind rose.

**Dr. Narendra Kumar**

## **ESP – 108: Water Resources – Management and Modeling Techniques**

### **Unit – I**

Water Resources – Surface and subsurface, quantity estimation techniques, river basins and watersheds in catchment planning, wetlands, estuaries and lakes, water resources of India, principles of water resource management.

### **Unit – II**

Water quality models, fundamentals of water quality modeling, completely mixed system, concept of continuously stirred tank reactors (CSTR), mass balance approach, different type of loading, dissolved oxygen modes, Streeter Phelps equation for point and distributed sources; eutrophication models for lakes and flowing water.

**Dr. Venkatesh Dutta**

## **ESP-109: Wastewater and Solid waste Treatment Technologies**

### **Unit I**

**Water and wastewater treatment:** primary, secondary, tertiary and advanced treatment. Solid Waste: Origin, characteristics, Quantity and Analysis; Problems of Solid Wastes; Storage, collection, transportation of solid wastes; Legislation for solid waste. Treatment of solid wastes: composting, vermicomposting, anaerobic digestion; reuse and resource recovery the solid waste; disposal of solid waste.

### **Unit II**

Introduction of nanotechnology, basics for nanotechnology, methods for the synthesis of nano materials, instrumental characterization of nanomaterials. Application of nanotechnology for remediation of pollutants from water. Pollutant removal process: Fenton and advanced Fenton process, photo-catalysis, ozonolysis, and adsorption; adverse impact of nanomaterials on the environment.

**Dr. Jiwan Singh**

## **ESP-110: Plant Microbe Interaction for Sustainable Agriculture**

### **Unit I**

Rhizosphere as unique habitat, Beneficial Soil Microbes- PGPR, PGPF, Mechanism of Action of Beneficial Soil Microbes- Nutrient Acquisition, Biocontrol, Rhizoremediation, Stress Management.

## **Unit II**

Application of Beneficial Soil Microbes in field, Production of biofertilizers and biopesticides, Application of bioinoculants in field, Current scenario of bioinoculants at global level, Constraints in development & application of bioinoculants, Remediation of wastelands using beneficial soil microbes.

**Prof. Naveen Kumar Arora**

**Paper- ESP – 111: Presentation and Review of Literature.**

**(CP) – 04 Credits**

**Paper – ESP – 112: Presentation of Synopsis**

**(CP) – 04 Credits**

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**Total – 16 Credits**