12 Environmental Sciences

TRIMESTER WISE DISTRIBUTION OF COURSES

I TRIMESTER

		L	P
ES 500	INTRODUCTION TO ENVIRONMENTAL SCIENCES	3	0
ES 501	ANALYSIS OF AGROECOSYSTEMS	3	0
ES 502/ WST 502	ENVIRONMENTAL POLLUTION	3	0
ES 506	INSTRUMENTAL METHODS OF ENVIRONMENTAL ANALYSIS	2	1
ES 510/ AE 510	SOIL AND WATER CONSERVATION ENGINEERING	3	0
ES 601	BIODIVERSITY	2	0
ES 612	CROP GEOGRAPHY AND ECOLOGY	3	0
ES 691	SEMINAR	1	0

II TRIMESTER

ES 503/ PP 503	GLOBAL CLIMATE CHANGE AND AGRICULTURE	2	1
ES 505/ MB 505	MICROBIAL ECOLOGY	3	1
ES 602	ENVIRONMENTAL IMPACT ASSESSMENT	3	0
ES 603	WASTE MANAGEMENT	2	1
ES 604/ SSAC 604	SOIL ORGANIC MATTER	3	0
ES 605	AGROFORESTRY	2	0
ES 606/ SSAC 606	SOIL AND WATER POLLUTION	2	1
ES 607	ADVANCED ENVIRONMENTAL MONITORING TECHNIQUES	2	2
ES 691	SEMINAR	1	0

III TRIMESTER

ES 504	ENVIRONMENTAL CHEMISTRY	2	2
ES 507	ENVIRONMENTAL MICROBIOLOGY	2	1
ES 508	PERSISTENT ORGANIC POLLUTANTS	2	0

ES 509	BIOFUEL AND ENVIRONMENTAL PROTECTION	2	0
ES 608/ AE 608	RENEWABLE ENERGY CONVERSION SYSTEM	2	1
ES 609	SIMULATION OF ECOLOGICAL PROCESSES	2	1
ES 610	AIR POLLUTION	2	1
ES 611	INTRODUCTION TO ENVIRONMENT LAW AND POLICY	2	0
ES 691	SEMINAR	1	0

Core Courses

M.Sc.: ES 500, ES 502, ES 504

Ph.D.: ES 607, ES 611, ES 612

ENVIRONMENTAL SCIENCES

Major Field : Environmental Sciences

Minor Fields : Ph.D. student shall take two minors (9 credits of course work in each) from any of the other fields outside his/her own.

M.Sc. student shall take one minor (9 credits of course work) from any of the other fields outside his/her own.

DESCRIPTION OF COURSES

ES 500 INTRODUCTION TO ENVIRONMENTAL SCIENCES (3L+0P) I

Objective

To give an overview to the students on the importance of environment in agriculture

Theory

UNIT I

Definitions and concepts in environmental sciences; ecology, ecosystem and environments; components of environment and their interactions

UNIT II

Structure and functions of ecosystems; biotic and abiotic interactions; energy flow and nutrient cycling in different eco-systems- trophic levels, food chain and food webs, primary and secondary productivity; biological building blocks; ecosystems of the world and biogeographic regions; agroclimatic regions; biodiversity – their genesis, utilization, erosion and conservation.

UNIT III

Climate change and climate variability and their impact on agriculture; crop modelling; soil-plant atmospheric interactions; soil and cropping patterns of India; emerging diseases and pests of crops; sustainable agriculture; greenhouse effect; global warming; GHGs emission and mitigation strategies to reduce their emission.

UNIT IV

Environmental pollution- soil, water and air, and their source and sink; impact assessment of environmental pollution on agriculture; evaluation of agroecosystem services; agricultural and non-agricultural wastes and their management

UNIT V

Environmental issues; acts and legislation; generation of biofuels from agricuclture resources; water conservation strategies to improve agricultural productivity

Suggested Readings

Air pollution Control (I-III) by Werner Strans

Concept of Ecology by E.D. Karmandy,

Ecology by E.P.Odum; Oxford and IBM Publishing Co.

Ecology, Environment and Resource Conservation by J.S. Singh, S.P. Singh & S.R. Gupta

Ecology, Principle and Application, J.I. Chapman and M.J. Reiss, Cambridge Press

Environment and Ecology by P.D. Sharma, Oxford & IBH Publicatiob

Environmental and Plant Ecology By J.R.Etherington. Jhon Wiley & Sons

Environmental Science by S.C Santra, New Central book

Global Warming by Sir John Houghton, Cambridge University Press

Principal of ecology in plant production. Eds. T.R. Sinclair and F.P.Gardener, CABI, U.K.

ES 501 ANALYSIS OF AGROECOSYSTEM (3L+0P) I

Objective

To disseminate the knowledge about the concepts related to agro-ecosystems and their role in agriculture.

Theory

UNIT I

Agro-ecosystems; ecological and social attributes; interactions among chemical, physical, biological and socio-economic components of ago-ecosystems

UNIT II

Trophic systems in agriculture; nutrients cycling, carrying capacity, community concepts, competition, biodiversity and complexity

UNIT III

Characteristics, structure and functions of agro-environmental resources (soil, water, climatic factors, living organisms, farm chemicals, rural infrastructure); energy movements; interactions between biotic and abiotic components; properties of various agro-ecosystems; biogeochemical cycles

UNIT IV

Integrated management of agro-ecosystems and their adaptation strategies for sustainable production; sustainable agriculture and its significance; agro-ecological analysis of various agro-ecosystems - productivity, stability, profitability, autonomy and sustainability aspects

UNIT V

Impact assessment of environmental changes on agro-ecosystems; options for sustainable development; ecological assessment of traditional and modern agriculture

Suggested Readings

Agiruclture Ecology by Cox, G.W. Atkins, M.D. 1979. Freeman and Co.

Ecology by E.P.Odum; Oxford and IBM Publishing Co.

Environmental and Plant Ecology By J.R.Etherington. Jhon Wiley & Sons

Principal of ecology in plant production. Eds. T.R. Sinclair and F.P.Gardener, CABI, U.K.

The analysis of Indian agro-ecosystem by Mitchell. R

ES 502/WST 502 ENVIRONMENTAL POLLUTION (3L+0P) I

Objective

To provide the related information on the Environmental Pollutants and their impacts on agriculture and environments

Theory

UNIT I

Introduction to environmental pollution; water borne diseases and their control; biological and chemical indicators of environmental pollution

UNIT II

Sources and types of water pollution; heavy metals in surface and sub-surface waters; pesticide residues in surface and sub-surface waters; phosphates in surface and sub surface waters; uptake of pollutants by plants; radio-active wastes and their safe disposal; sampling and analysis techniques; aquatic plants and their role in pollution control-phytoremediation

UNIT III

Particulate and heavy metal pollution of air; atmospheric pollution from fossil fuels used in vehicles and industry; biofuels for air pollution control; ozone layer and its importance ;echanism of ozone layer depletion and diffusion of CFCs; renewable sources of energy

UNIT IV

Sources and sinks of SOx & NOx in atmosphere; sources and sinks of CO and CO_2 in atmosphere; sources and sinks of CH_4 and nitrous oxide in atmosphere

UNIT V

Solid wastes (crop residues, sludges, food processing industries wastes) and their disposal; sources & nature of soil pollution and their harmful effects; soil and groundwater pollution by nitrates, fluorides and heavy metals

UNIT VI

Anthropogenic influences on terrestrial and aquatic environments and their coping strategies for greater environmental sustainability

UNIT VII

Environmental impact assessment and industrial effluent treatment and their disposal; pollution control in agro-based industries by agri-cycling of their effluent; environmental standards; laws for control of water and air pollution

Suggested Readings

Air pollution Control (I-III) by Werner Strans

Analysis of Air pollutants by Peter O. Warmer

Chemistry in waste reuse by W.J.Cooper

Dictionary of the Environment, Hutchinson Pocket Book Series

Elements in the Environmental Series (Cu, Zn, Od, Hg, Pb) by J.O. Nariagu

Environmental and Pollution Science by lan L.Pepper. Charles P.

Environmental pollution and control by P.A.Vesilind

Environmental Sciences by Nebel

Practical Environmental Analysis by M.Radojesic and V.N.Bashkin

Santra, S.C. 2001. Environmental Science, New Central book

ES 506 INSTRUMENTAL METHODS OF ENVIRONMENTAL ANALYSIS (2L+1P) I

Objective

To impart theoretical and practical knowledge about instrumental techniques used in environmental analysis.

Theory

UNIT I

Basic principles of instrumental analysis, principles of electrometric equipments- EC meter, pH meter, ion meter and polarography

UNIT II

Spectroscopic techniques used in environmental analysis- UV, visible, flame -emission, absorption, Infra red, inductively coupled plasma and mass spectrometry

UNIT III

Chromatographic techniques in environmental analysis – column, thin layer, gas, high pressure, ion chromatography and electrophoresis

UNIT IV

Advanced molecular techniques – Biolog, polymerase chain reaction (PCR)

UNIT V

Other techniques of environmental analysis- Kjeltech, particular sampler, infra red gas analyser, BOD and COD kits, fermention technique – fermentor; Free air carbon dioxide enrichment (FACE) and open top chamber (OTC) techniques

Practicals

Determination of pH and EC, Determination of metals and ion using polarographic analyzer; Heavy metal analysis using AAS; Analysis of group I and II metals using flame photometer; Chromatographic analysis; Microbial activity measurement – Biolog and PCR; Determination of N using Kjeltec; Particulate sampling and analysis; Free air carbon dioxide enrichment studies

Suggested Readings

Environmental instrumentation and analysis handbook by Randy D. Down, Jay H. Lehr

Instrumental Methods Of Analysis, by Willard and Merrit

Methods for Environmental Trace analysis by John R. Dean

Principles of Instrumental Analysis by Douglas A.

ES 510/AE 510 SOIL AND WATER CONSERVATION ENGINEERING (3L+0P) I

Objective

To acquaint and equip with the process of soil and water conservation design of erosion control structures.

Theory

UNIT I

Concepts of soil and water conservation; relevance of soil and water conservation in agriculture; productivity loss due to soil erosion; moisture stress and moisture excess.

UNIT II

Types of soil erosion; mechanics of water erosion of soil; effect of land preparation and cultivation practices on soil erosion; theories of sediment yield and sediment transport; bed load movement; measurement of sediment yield and sediment transport; effective life of dams and water detention structures; effect of soil erosion on the life of multi-purpose river valley projects; soil erosion loss and fertility; erosion in water conveyance systems;

UNIT III

design of channel for erosion control; maximum permissible velocity; hill soil erosion; land slides; mechanics of wind erosion; types of wind erosion and soil movement; wind erosion control measures.

UNIT IV

Analysis of hydrologic data including rainfall, evapotranspiration; watershed characteristics; overland flow; methods of estimation of runoff; peak rate and time distribution of hydrograph; synthetic hydrograph; infiltration process;

UNIT V

Hydrologic evaluation of land treatment; flood routing. Erosion control; design of soil conservation structures; farm ponds and temporary storage reservoirs, drop structures; chute spill ways; temporary storage reservoirs; small earth dams;

UNIT VI

Afforestation and associated agronomic practices; the role of river valley projects; soil conservation department, CADA etc. in undertaking soil and water conservation work.

Suggested Readings

Garde, R.J. and Ranga Raju, K.G. 1977. *Mechanics of Sediment Transport and Alluvial Stream Problems*. Willey Eastern.

Gurmel Singh *et al.* 1994. *Manual of Soil and Water Conservation Practices*. Oxford & IBH.

Hudson, N.1971. *Soil Conservation*. B.T. Batsford Ltd.

Murthy, V.V.N. 1998. *Land and Water Management Engineering*. Kalyani.

USDA 1969. *A Manual on Conservation of Soil and Water*. Oxford & IBH.

ES 601 BIODIVERSITY **(2L+0P) I**

Objective

To impart knowledge and awareness about the evolution mechanism, strength, status, environmental significance, utilization and conservation of biological diversity

Theory

UNIT I

Biodiversity- an overview; level and scale of biodiversity – genetic, species and ecosystem diversity, alpha, beta and gamma diversity; origin of life, organic evolution; genesis of biodiversity; biodiversity changes in space and time; speciation and isolation mechanism.

UNIT II

Biogeography- horizontal and vertical distribution of plants, monophylatic and polyphylatic origin of plant species, global and national phytogeographical regions, botanical provinces, dispersal and migration of plants; major centres of origin and domestication of crop plants; exploration and collection of genetic resources; introduction, characterization and utilization of crop genetic resources; status and strength of floristic diversity; hot spots of biodiversity.

UNIT III

Plant nomenclature and classification; major and minor unit of plant classification; binomial and trinomial theory of plant classification; taxonomy of monocotyledons and dicotyledons.

UNIT IV

Genetic erosion and loss of biodiversity – causes and criteria of genetic erosion, levels of genetic erosion; global climate change and loss of biodiversity; biodiversity, bio-productivity and sustainability; biodiversity and life security - food, health, environment and job security

UNIT V

Microbial diversity; species, genetic and molecular diversity indices; diversity and stability of microbial communities; animal diversity; biodiversity and biotechnology; use of microbial biodiversity in environmental pollution control – bioremediation

UNIT VI

Biodiversity conservation- in-situ and ex-situ conservation; biodiversity convention and its law and policy; international Inst.and Agencies working on CBD; cultural, religious, social and environmental aspects of biodiversity.

Suggested Readings

Biodiversity and Global Changes. eds. by O.T. Solbrig et. al., CAB International in association with IUBS,1994.

Biodiversity Implication for Global Food Security. eds. by M.S. Swaminathan and S. Jana, Mac Millan India Limited

Biodiversity, Science and Development: Towards a new Partenership. eds. by Castri ,F. and Younes, T., CAB International ,1996.

Cytology, Genetics and Evolution by P.K. Gupta, Rastoki Publishers, Meerut

Diversity- Special volume for south east asia . vol. 12(3), 1996.

Indian Farming- special volume on Biodiversirt. October, 1993.

Plant Breeding by B.D.Singh, Kalyani Publishers, New Delhi

ES 612 CROP GEOGRAPHY AND ECOLOGY (3L+0P) II

Objective

To impart knowledge about the geographical distribution of crops, their interactions with physical and biological environments and adaptation to diverse agro-climatic conditions

Theory

UNIT I

General principles and scope of crop geography; physical, biological and social factors determining crop distribution; classification and characteristics of edaphic, climatic and biotic environments; agro-climatic and agro-ecological zones; bioclimatic parameters.

UNIT II

Crop domestication and their centers of origin; geographic distribution of crops; agro-ecosystem classification and its structure and function; crop response to diverse environmental stresses e.g. temperature, light, excess and deficit water; properties of agro-ecosystem, their efficiency and interaction between biotic and abiotic components; food chain and food webs; trophic levels and energy flow in various agro-ecosystems.

UNIT III

Thermal and photo-thermal units; relationship and manipulation of developmental physiology of crops; ecological implication of different photosynthetic systems of crop plants; physiological limits of crop yield; net primary productivity; ecological approaches to world food Problems; ecological optimum and efficiency of different crops; resource utilization efficiency of different crops under diverse environments.

UNIT IV

Crop adaptation to diverse environments through natural selection and biological modification; natural biological and anthropogenic adaptation of crops to various abiotic stresses; ecotype concept of crop adaptation and distribution; agricultural region-concept and technique; water, carbon, mineral nutrient and energy dynamics in ecosystems and crop communities.

UNIT V

Ecological analysis of traditional and modern agriculture on the basis of productivity, stability, diversity and sustainability; Agricultural systems of the world and India; surveys and models in crop geography; land use pattern and land use change; ecological/sustainable agricultural production systems.

Suggested Readings

Adaptation of Food Crops to temperature and water stress. Proceeding of an international symposium. Edited by C. George Kue , AVRDC, council of Agriculture, ROC, Taiwan

Ecological implications of dividing plants into groups with distinct photosynthetic production capacities by C.C. Black, Advances in Ecological Research, Academic Press

Productivity, stability, sustainability, equity and autonomy as properties for agro-ecosystem assessment by Gersld G. Marten, Agricultural System 26(1988), 291-316

ES 503/ PP 503 GLOBAL CLIMTE CHANGE AND AGRICULTURE (2L+1P) II

Objective

To impart theoretical and practical knowledge about the evidence, causes and impact of climate change and its adaptation and mitigation options

Theory

UNIT I

Definition and concept of climate change and variability; global warming and dimming; science and politics of climate change and international conventions; evidence, scenario and causes of climate change

UNIT II

Greenhouse gases and mechanism of their production and emission from various agro-ecosystems, source and sinks of GHG; warming potential and contribution of greenhouse gases to global warming, greenhouse effect; monitoring of greenhouse gases

UNIT III

Impact assessment of rise in atmospheric temperature and CO_2 on growth, physiological processes, productivity and quality of different crops, soil health, water availability, insect pest dynamics, crop-weed competition, milk and inland and marine fish production; climate change and loss of biodiversity; spatial and temporal changes in agricultural production in context of climate change.

UNIT IV

Evidence and causes of global dimming; causes of global dimming; impact assessment of global dimming on crop productivity, quality and crop- pest interaction.

UNIT V

Adaptation and mitigation options to climate change; carbon sequestration; modeling climate change and its impact on crops; International summit, conferences, protocols and negotiations on climate change; clean development mechanism; carbon trading, credits, footprints and govt. strategies and policies on climate change management.

Practicals

Measurement of CO_2 from crop fields, Measurement of CH_4 from crop fields, Measurement of N_2O from crop fields, Measurement of O_3 from crop fields, Recent techniques for assessing the impact of high temperature on crops, Recent techniques for assessing the impact of CO_2 fertilization on crops, Recent techniques for assessing the impact of elevated O_3 on crops, Modelling impact of high temperature and CO_2 on crop yield, Modelling impact of high temperature on soil and water, Modelling impact of high CO_2 on soil and water

Suggested Reading

Climate change and clobal crop productivity ed. by K.R. Reddy and H.F. Hodges, CABI Publishing

Climate change Journal

Climate Change: Source, impact and policy, Proceeding of 2nd World Climate Conference. Ed. by J. Jager and H.L. Ferguson, Cambridge University Press, 1993

Global Warming (Fourth edition) by Johm Houghton, Cambridge Press

Greenhouse gas emission from agricultural system, Published by IPCC- USEPA

IPCC Assessment Report 2007

ES 505/MB 505 MICROBIAL ECOLOGY (3L+ IP) II

Objective

To provide the modern concepts of microbial ecology of soil and aquatic environments, microbial interactions and biogeochemical cycling

Theory

UNIT I

Microbial community and its development, Organisms : Bacteria, Fungi, Actinomycetes, Algae, Protozoa, Viruses, Geography and micro- environment of microorganisms, Natural selection, Spatial and temporal distribution, Patterns of micro-organisms.

UNIT II

Dispersal, Colonization, Succession and the climax, Interspecific competition, Commensalism, Homeostasis, Parasitism, Predation, Proto-cooperation, Symbiosis, Ammensalism.

UNIT III

Microbiology of water bodies, Effect of micro-organisms on animals and plants, Environmental influences on microorganisms, Effect of temperature, aeration, moisture, osmotic pressure, pH, Energy cycle.

UNIT IV

Transformation of phosphorus, sulphur, iron, manganese, magnesium, copper, mercury and arsenic, Mycorrhizal links with plants and their functioning.

UNIT V

Ecology of microbial corrosion, Microbial plasticity, Relevance to microbial ecology, Modeling, Microbial contribution to climatic change, Molecular approaches for measuring the microbial diversity.

Practicals

Sampling and enumeration techniques for micro-organisms, Effect of environmental variables on nitrification, ammonification and microbial growth, Effect of temperature on bacterial interactions, Isolation of nucleic acids from environmental samples, Nitrogen transformations, Microbial corrosion and detection of microbial activities, Symbioses amongst micro-organisms, Synergism and antagonism amongst micro-organisms, Estimation of iron oxidizing and reducing bacteria from soil samples, Isolation of thermophilic, mesophilic and psychrophilic microorganisms from soil samples, Isolation of antibiotic synthesizing microorganisms, Enumeration of sulphur oxidizing and reducing bacteria from soil, Enrichment and isolation of phosphate solubilizing microorganisms from phosphorus deficient and 'P' sufficient soils, Mineralization of phytins by bacteria and fungi, Estimation of phosphorus solubilizing activity of a bacterium and a fungus using different inert phosphorus sources.

Suggested Readings

Maier, R.M. 2009. Environmental Microbiology, Academic Press

Mitchell, R. 1992. Environmental Microbiology, John Wiley and Sons

Paul Eldor, A. 2007. Soil Microbiology, Ecology and Biochemistry, 3rd Edition, Academic Press.

Richard, D. Bargett, The Biology of Soil : A Community and Ecosystem Approach (Biology of Habitats).

Richards, B.N. 1987. Microbes of Terrestrial Ecosystem, Longman.

Subba Rao, N.S. 1986. Soil Microorganisms and Plant Growth. Oxford and IBH Publishing Co.

Sylvia, David M., Fuhrmann, J.A., Hartel, P.T. and Zuberer, D. 2005. Principles and Applications in Soil Microbiology (2nd Edition).

Towner, K.J. and Cockayane, A. 1993. Molecular Methods for Microbial Identification and Typing. Chapman and Hall, London, UK pp 202.

ES 602 ENVIRONMENTAL IMPACT ASSESSMENT (3L+0P) II

Objective

To impart theoretical knowledge about Environment Impact assessment, Life cycle assessment of agriculture related products and processes, Environmental audit and defining the standards for environmental quality assessment and monitoring

Theory

UNIT I

EIA- purpose and aims; key elements of the EIA process and methodologies

UNIT II

Monitoring tools for EIA; EIA administration and practice

UNIT III

Cost and benefits of evaluation of EIA; understanding strengths and limitation of EIA

UNIT IV

EIA standards; risk assessment; potential impact to water and air pollution

UNIT V

Integrated impact assessment; policy; legislative implications; current status of EIA legislation in developing countries

UNIT VI

Undertaking an EIA: case studies for agro-industries

Suggested Readings

Anjanayulu, Y. 2002. *EIA Methodlogies*. BSP BS publication

Environmental limpact assessment Review Jounral, 2000-2005

Lawrence, Dravid P. 2003. *EIA Practical Solutions to Recrurrent problems*

Morgan, R.K. 1988. *EIA- A methodological Perspective* Kluwer Academic Publishers

Smith, L.G. 1993. *Impact Assessment and Sustainable Resource Management*, John Wiley & Sons. New York.

ES 603 WASTE MANAGEMENT (2L+1P) II

Objective

To develop the awareness about the various types of wastes, their disposal and management

Theory

UNIT I

Waste generation; types - collection and factors affecting rate of waste generation; sources of wastes and their classification; landfills and waste dumpsites; solid wastes - domestic, municipal and hazardous; collection and disposal methods; waste management problems- recovery vs disposal

UNIT II

Physical, chemical and biological properties of wastes; hospital and radioactive wastes and their management; incineration and pyrolysis; chemical and biological treatments of wastes

UNIT III

General overview of industrial wastes; impact of wastes on environment - air, water and soil; wastewater collection; sewage and sludge treatment processes and other technologies

UNIT IV

Theory of anaerobic of digestion of organic wastes for fuel and manure; composting and vermi composting techniques; solid and liquid waste utilization in agriculture; application of wastes in

arable lands and their value added products with reference to N,P, K, organic C and other micronutrients and heavy metals; compost application in agriculture

UNIT V

Legislation and regulatory requirements- Case studies in India and Abroad

Practicals

Determination of total solids, volatile solids and ash content; Determination of total microbial count; Determination of coliform count for pathogenic bacteria; Determination of total bacteria leachable and adsorbed on soil samples of the waste dumping site; Determination of particle size and bulk density of the waste sample; Determination of biofuel potential of waste sample; Determination of calorific value of the waste sample; Analysis of methane and carbon dioxide in a gaseous sample; Demonstration of experiment on composting and vermi composting; Visit to a waste management system in Delhi

Suggested Readings

Barton, A.F.M. 1979. Resource Recovery and Recycling. John Wiley Publicaltion

Kastuyama. A.W. *et al*. Solid waste management in the Food Processing Industry, U.S.E.Pj.A.

Leh, F.K.V. and Lak, R.K.C. 1974. Environment and pollution Health effects, Monitoring and control Charles C.Thomas Publisher, U.S.A.

Middlebrroks, E. Joe 1979. Resource Recovery and recycling. John Wiley Publications

Vesilind, P.A. and Pierce, J.J. 1983. Environmental Pollution and contro. Ann Arbor Sciences Publ. Lnc

Wilson, D.G. 1977. Handbook of solid waste management. Marcel Deeker. Incv., Yew York

Wastes recyling and pollution control. HANDBOOK Ed. A.V. Bidgwater and C.J. Mumford, Van Nostrand Reinhold Environmental Engineering series.

ES 604/SSAC604 SOIL ORGANIC MATTER (3L+0P) II

Objective

To teach basic biochemistry of soil organic matter, its composition, fractionation and reactions in soil and its significance in sustenance of soil fertility and environmental quality

Theory

UNIT I

Carbon cycle in nature; carbon stocks of the world and Indian soils; pools, composition, and distribution of organic matter in soil

UNIT II

Biochemistry of the humus formation - theories and pathways for humus synthesis in soil; biochemistry of transformation of N, P and S; organo-metallic interactions and role of chelation in bioavailability of nutrients and pollutant elements

UNIT III

Characterization of humic substances: Extraction, fractionation and purification; elemental analysis, reactive functional groups of humic substances, ion exchange properties, other colloidal properties;

adsorption of organic compounds by clays and role of organic substances in pedogenesis and soil aggregation

UNIT IV

Soil organic matter (SOM) management in tropics; role of crop residues, tillage, land use and crops and cropping systems in SOM management; carbon sequestration - concept, practices and potential of the world and Indian crop lands; soil carbon stocks – issues and priorities for mitigation and sequestration of organic and inorganic carbon in soils,

UNIT V

Environmental issues related to SOM - Green house effect and global warming related to emissions of CO_2, CH_4 and N_2O; organic matter turnover and stabilization in soil - concepts and implications for soil fertility, environmental loads and climate change; soil organic matter dynamics in relation to soil biodiversity in terms of both flora and fauna; carbon transfer model; clean development mechanism – carbon trading; changes in organic carbon turnover in soils - simulation models - Rothamsted Carbon, Century Carbon, Infocrop and DNDC models.

Suggested Readings

Beck, A.J., Jones, K.C., Hayes, M.H.B. and Mingelgrin, U. 1993. Organic *Substance in Soil and Water: Natural Constituents and their influences on Contaminant Behavior*. Royal Society of Chemistry, London.

Gieseking, John E. 1975. *Soil Components*. **Vol. 1.** Organic Components. Springer-Verlag, Berlin.

Magdoff, Fred and Weil, R.R. 2004. *Soil Organic Matter in Sustainable Agriculture*. CRC, Boca Raton.

Mercky, R. and Mulongoy, K. 1991. *Soil Organic Matter Dynamics and Sustainability of Tropical Agriculture.* John Wiley and Sons, New York.

Paul, E.A. 1996. *Soil Microbiology and Biochemistry*. Academic Press, New York.

Pierzinsky, 2002.

Rees, R.M., Ball, B.C., Campbell, C.D. and Watson, C.A. (Editors) 2001. *Sustainable Management of Soil Organic Matter*. CABI Publishing, Oxon, UK.

Stevenson, F.J. 1994. *Humus Chemistry – Genesis, Composition and Re*actions. John Wiley & Sons, New York.

ES 605 AGROFORESTRY **(2L+0P) II**

Objectives

To give an overview to the students on the importance of agroforestry in agriculture and environment

Theory

UNIT I

Agroforestry- its definition, concept, scope and advantage; classification of agroforestry; selection of plant species; plant species interaction; growth & production of tree plant; agroforestry & resource utilization

UNIT II

Agroforestry models for various land use systems; agrisilviculture system, silviagrivulture system, silvipasture system, agrisilvipasture system, regeneration of tree crops

UNIT III

Agroforestry options for sustainable land use; relationships between agro forestry, farm forestry and social forestry; agroforestry research in agricultural research system; environmental education as a tool for sustainable agroforestry

UNIT IV

Agroforestry, biodiversity and sustainability; carbon sequestration through agroforestry; techniques to improve biomass production and climate change mitigation; biofuel production; agroforestry and sustainability

UNIT V

Natural resources and environment management through ecosystem approach; biotic and abiotic components of ecosystem and their linkages; economics of agroforestry system

Suggested Readings

A Text book of Agroforestry by B.S.Chandawat and S.K.Gautam

Agroforestry: Principles and Practices by A.P. Dwivedi

Advances in Agrforestry by L.K. Jha

Agrforestry for Sustainable Land Use by P.Singh, P.S.Pathak and M.M. Roy

Environmental Services of Agroforestry Systems by Florencia Montagnini

Handbook on Agroforestry: Management Practices and Environmental Impact by Lawrence R. Kellimore (Editor)

Potential Application of Agroforestry System from Indian Subcontinent to the Analogous Ecozones of Africa by G.B. Singh (ICAR).

ES 606/SSAC 606 SOIL AND WATER POLLUTION (2L+1P) II

Objective

To teach the students on extent, causes and mitigation of soil and water pollution on global scale and in India

Theory

UNIT I

Soil and water resources of India; Introduction to soil and water pollution; major soil and water problems; status of pollution in India

UNIT II

Sources and cause of soil pollution; types of soil pollution; major soil problems-erosion, salinity, sodicity, pesticide and heavy metal pollution

UNIT III

Physical, chemical and biological characteristics of water; sources and cause of water pollution; point source and non point source pollution; types of pollution in subsurface and surface water; land fill sites and ground water pollution; nitrate, arsenic and fluoride pollution and their control measures.

UNIT IV

Microbial pollution in water, their sources and common water born diseases; Transmission and control of water borne diseases

UNIT V

Impact of modern trends of agriculture on pollution; effect of soil and water pollution on agriculture and soil health; characteristics of domestic, municipal and industrial effluents; merits and demerits of their utilization in agriculture

UNIT VI

Physical, chemical and biological remediation of soil and water pollution; wastewater treatment; integrated nutrient management;

UNIT VII

Laws and legislation for soil and water pollution, permissible limits of pollutants in soil and water

Practicals

Introduction to limnological studies, Determination of nitrate and phosphate in soil and waters; Determination of EC, pH ,alkalinity, free CO_2; Estimation of residual chlorine in water, fluoride in water; Determination of calcium, magnesium and hardness of water, dissolved oxygen in water; Determination of minor metallic elements in soil and water; Measurement of Coliform, MPN, B.O.D./COD in natural and waste waters

Suggested Readings

Ciaccio, Leonard L. 1971. Water and water pollution Handbook vol. 1 to 4. Marcel Deeker Inc., New York.

Environmental and Pollution Science by Ian L. Pepper, Charles P. Gerba and Mark L.Brusseau, Academic Press 2nd Ed., 2006

Mark J. Hammer and Mark J. Hammer(Jr) 1998. Water and Wastewater Technology 3rd edition. Prentice Hall of India

Novotny, V. and Chesters, G. 1981. Handbook of Non-point Pollu-tion (Sources and Management). Van Nostrand Reinhold Co., New York.

Standard Methods of Water and Wastewater Analysis, APHA, WPCF, N.Y.2003

Water Resources of India by K.L.Rao

Winkler, M. 1981. Biological Treatment of waste water. Ellis Horward Ltd.

ES 607 ADVANCED ENVIRONMENTAL MONITORING TECHNIQUES (2L+2P) II

Objective

To impart the theoretical and practical knowledge of advanced environmental monitoring techniques

Theory

UNIT I

Design of environment quality monitoring programs; monitoring methods, their strength and weakness.

UNIT II

In-situ / Ex-situ monitoring techniques for physical (sediment yield, runoff) and chemical (chemical erosion, salinization/sodification, heavy metal contamination), degradation of soil / water resources at field / catchment scales

UNIT III

Application of spectro-photometric / chromatographic / microscopic and molecular techniques for monitoring inorganic and organic pollutants, pesticide residues, green house gases, microbial biomasss/ diversity / community structure and phylogeny

UNIT IV

Spatio-temporal environmental resource / degradation mapping with remote sensing tools/ techniques; use of GIS, GPS & DSS systems; integration of multi-source and multi scale data

UNIT V

Computer intelligent processing technologies for analyzing environmental data

Practicals

Design of small scale environmental quality monitoring programs; Design of large scale environmental quality monitoring programs; In-situ erosion and run-off measuring techniques for catchments; Demonstration of an automated weather data acquisition system; Sample preparation for elemental analysis by AAS; Sample preparation for elemental analysis by spectrophotometer; Analysis of metals by AAS, Analysis of green house gases by GC; Techniques of estimating TOC in biodegradable wastes; Microscopic techniques for analysis of environmental samples; Microbial community structure analysis using chromatography; Molecular analysis of microbes by PCR; Molecular analysis of microbes by gel documentation techniques, Soil use mapping with remote sensing; Land use mapping with remote sensing,; Environmental monitoring with GIS systems; Environmental monitoring with GPS systems; Application of spatial decision support systems for monitoring large scale productivity declines; Application of decision support systems for sustainable development; Computer intelligent processing technologies analyzing environmental data.

Suggested Books for Study

Fundamentals of Remote Sensing , George Joseph D

Instrumental methods of analysis, Willard, Merritt, Dean and Settle; CBS publishers and distributors.

Instrumental methods of Chemical analysis, Chatwal and Anand; Himalaya Publishing House, Bombay.

Modern methods of Chemical analysis, Pooksok and Willium

Remote Sensing and Image Interpretation, Thomas M. Lillesand, , Ralph W. Kiefer, Jonathan W. Chipman

ES 504 ENVIRONMENTAL CHEMISTRY (2L+2P) III

Objective

To provide the theoretical and practical knowledge about the Environmental Chemistry and related atmospheric phenomenon

Theory

UNIT I

Introduction, concept and scope of Environmental Chemistry; chemistry of solutions and principles of thermodynamic processes

UNIT II

Basic photochemistry, atmospheric radiation chemistry, photo and radiolytic scavengers and their transformation and nuclear transformation

UNIT III

Acid – Base theory, PAN and atmosphere, classification and nature of environmental pollutants; mechanism of organic reactions and isomerism

UNIT IV

Hydrological cycle in the environment; Oxygen cycle in the environment, Phosphate, Sulphur and Nitrogen cycles in the environment

UNIT V

Chemistry of fossil fuels, chemistry of CFC and Ozone depleting substances and hydrosols

UNIT VI

Chemistry of metals & non-metals with reference to agriculture; chemical toxicology with reference to metals and- non-metals

UNIT VII

Analytical techniques and methodology for detecting major pollutants; chemistry of agrobased-industrial wastes

Practicals

Qualitative organic analysis and detection of functional groups (Alcoholic, Phenolic, Carboxylic acid, Aldehyde and Ketones etc.); Detection of N, P, K, S and Halogens in water and soil samples; Estimation of solution by volumetric & gravimetric analysis; Qualitative and quantitative polyvalent metal analysis; Detection of heavy metals in soil, water and air; Separation of organic components by chromatography; Analytical techniques for environmental pollutant; Analysis of pollutant with GLC & spectrophotometer

Suggested Readings

Chemistry of Atmosphere by P.S.Sindhu

Environmental Chemistry by A.K. De

Environmental Chemistry by J.W.MooreThe Chemistry of our Environment by R.I.A.Horne

Inorganic Chemistry by Cotton & Wilkinson

Inorganic Chemistry P.L.Soni

Organic Chemistry by I.L.Finar vol. 1 and 2

Organic Chemistry by Morrison Boyd

Physical Chemisstry by Atlkin

Physical Chemistry by S.Gladstone

ES 507 ENVIRONMENTAL MICROBIOLOGY (2L+1P) III

Objective

To impart theoretical and practical knowledge about defining the important microbes involved in environmental microbiology, methodologies used to monitor the microbes and their activities and the effects of these microbes in environmental microbiology

Theory

UNIT I

Environmental microbiology at the end of second millennium; environmental microbiology; International dimension

UNIT II

Environmental determinants governing the existence of microbes in the terrestrial; aquatic and extreme environments

UNIT III

Bioindicators – their relevance and utility in assessing/monitoring the degree/status of environmental degradation

UNIT IV

Microbial transport and bioaugmentation; biodegradation and bioremediation; biocorrosion and biofouling; microorganisms and metal pollutants

UNIT V

Microbial risk assessment of water and food; monitoring and molecular methods in Environmental Microbiology

UNIT VI

Emerging technologies in environmental microbiology and its application; bioreporters, biosensors, and microprobes; micobial fuel cell

UNIT VII

Intellectual property rights.

Practicals

Isolation and characterization of micro-organsims from environmental samples; Evaluation of environmental parameters that influences the microbial growth; Measurement of microbial activity in environmental samples; Substrate utilization patterns in environmental isolates; Measurement of biodegradation capacity of microorganisms; Soil enzyme assays; Extraction of quorum sensing molecules from plant pathogens; Detection of quorum sensing molecules in Plant microbe interaction; Biofuel production from different substrates; Impact of radiation on soil biodiversity.

Suggested Readings

Environmental Microbiology by R.M.Maier

Environmental Microbiology By. R. M. Maier

Laboratory Manual in general Microbiology by H. J. Benson

Laboratory Manual in general Microbiology by H.J.Benson

Manual of environmental Microbiology by Hurst et al.

Microbial Ecology : Fundamentals and Applications by R.M.Atlas/R.Bartha

Microelectrodes: their use in microbial ecology. Advances in Microbial

ES 508 PERSISTENT ORGANIC POLLUTANTS (2L+0P) III

Objective

To understand the nature, properties and environmental implications of persistent organic pollutants

Theory

UNIT I

Definitons, origin, properties and classification of persistent organic pollutants

UNIT II

Dynamics and interaction of poly nuclear aromatic hydrocarbons (PAH) in the environment

UNIT III

Dynamics and interaction of poly chlorobiphenyls, furans and dioxins in the environment; dynamics and interaction of persistent pesticides in the environment

UNIT V

Bioremediation of persistent organic pollutants; disposal and decontamination of persistent organic pollutants

UNIT VI

Monitoring of persistent organic pollutants; legislation and treaties to control persistent organic pollutants in the environment

Suggested Readings

Persistent organic pollutants by Claes Beraes, Alnqvist and Wiksell

Persistent organic pollutants: Environmental Behavior and pathways for Hurman exposure by: Stvard Harrad, Kluwer, Academic publication, 2001

Poly aromatic hydrocarbons- Biological oxidations by Muller, R and F.Lingens, Springer. Berlin Acidellberg. New York.

Persistent Organic Pollutants in Asia, Volume 7: Sources, Distributions, Transport and Fate An Li (Editor), Shinsuke Tanabe (Editor), Guibin Jiang (Editor), John P. Giesy (Editor), Paul S.K. Lam (Editor)

Persistent Organic Pollutants, by Harrad and Stuart

ES 509 BIOFUEL AND ENVIRONMENTAL PROTECTION (2L+0P) III

Objective

To impart theoretical and practical knowledge about bio-fuels and their potential role for providing environmental protection and energy security

Theory

UNIT I

Overview of world fossil fuels production, demand, supply and environmental consequences; Introduction to biofuels and its environmental benefits; production scenario and policy in India and other countries

UNIT II

Resources for biofuel production including energy crop, biomass waste, agri-residues and algae

UNIT III

Phyto-chemistry of various biofuel crops; processes of bio diesel, ethanol, hydrogen and biogas production

UNIT IV

Biodiesel production potential of crops and trees, their management and cost-benefit assessment; Ethanol and hydrogen production potential; limitations and advantages from different feedstocks and cost-benefit analysis.

UNIT V

Biogas production technology from farm domestic, municipal and industrial waste and its environmental benefits

UNIT VI

Biophysical technologies for energy production from biomass; Carbon sequestration and pollution abatement potential of bio fuels

Suggested Readings

Agriculture as a Producter and Consumer of Energy Edited by J.Outlaw. K.Collins, J.Duffield CABi July 2005

Biofuels: production, application and development, Edited by Alan Scragg, CABI, Cambridge Univrsity press 2009

Bicatalysts and Bioenergy Edited by Ching T.Hou and Jei-Fu Shaw, Willey, Ajohn Willey and Sons, INC Publication 2008

Biofuels, Implications for the feed industry, Edited by Jannes Doppenberg and Piet van der aar Wageningen Academic Publishers 2007

Proceedings of the First World Conference of Energy and Industry James and James (Sciences Publislhers) Ltd. May 2001.

Success and Visions for Bioenergy: Thermal processing of biomass for bioenergy, biofuels and bioproducts, Edited by A.V.Bridgwater CPL Press, Septemebr, 2007

ES 608/AE 608 RENEWABLE ENERGY CONVERSION SYSTEMS (2L+1P) III

Objective

Engineering concepts on renewable energy conversions and uses.

Theory

UNIT I

Energy cycle of the earth, Energy flow and storage, Renewable energy sources,

UNIT II

Thermodynamics of energy conversion, Conversion systems of solar energy, wind energy, biomass energy, hydraulic energy etc.

UNIT III

Concepts of hybrid and integrated energy conversion systems,

UNIT IV

Applications and economics of different renewable energy systems in agriculture.

Practicals

Experiments on concepts and processes mentioned in theory.

Suggested Readings

Boyle Godfrey. 1996. Renewable Energy: Power for Sustainable Future. Oxford Univ. Press.

Culp, A.W. 1991. Principles of Energy Conservation. Tata McGraw Hill.

Duffle, J.A. and Beckman, W.A. 1991. Solar Engineering of Thermal Processes. John Wiley.

Garg, H.P. and Prakash, J.1997. Solar Energy - Fundamental and Application. Tata McGraw Hill.

Grewal, N.S., Ahluwalia, S., Singh, S. and Singh, G. 1997. Hand Book of Biogas Technology. Solar Energy Fundamentals and Applications. TMH New Delhi.

Mittal, K.M. 1985. Biomass Systems: Principles & Applications. New Age International.

ES 609 SIMULATION OF ECOLOGICAL PROCESSES (2L+ 1P) III

Objective

To impart the theoretical and practical knowledge of using simulation models on crop-environment interactions.

Theory

Unit I

Fundamentals of dynamic simulation, systems, models and simulation.

UNIT II

Descriptive and explanatory models, modelling techniques steps, states, rates and driving variables, feedbacks and relational diagrams.

UNIT III

Numerical integration, introduction to FST language.

UNIT IV

Modeling crop env. & crop pest interactions, soil water, nitrogen and balance, introduction to a simple crop ecological model, applications of simulation modelling in environmental impact assessment & green house gas emission ,

UNIT V

Data requirements & limitations of modeling; modeling crop-environment and pest interaction, soil, water, nitrogen and C balance; assessing crop growth, scheduling and management practices and water use planning through simulation tools.

Practicals

Scheduling planting and harvesting of crops; Drawing relational diagrams; Applying numerical integration techniques; Fitting probability distribution functions; Hands on model validation through statistical indices; FST programming language; Hands on to InfoCrop model; Assessing crop growth through InfoCrop model; Hands on to USAR model, Crop rotation & water use planning through USAR model.

Suggested Readings

Agriculture Ecology- Cox, G. W., Atkins, M. D. 1979. Freeman & Co.

Ecology – O.P. Odum, Oxford & IBM Publishing Co.

Environmental & Plant Ecology – Etherington, J. R., John Wiley Sons.

Principle of ecology in plant production. Eds. T.R. Sinclair & F.P. Gardener, CABI, UK

The analysis of Indian agro-ecosystem- Mitchell, R.

ES 610 AIR POLLUTION (2L+IP) III

Objective

To impart theoretical and practical knowledge about the air pollution and pollutants, their sources and formation in the air, effects on crop plants and control measures,

Theory

UNIT I

An overview of air pollution course; air quality, contamination, pollution, and source of various air pollutants; physical and chemical properties of air pollutants

UNIT II

Classification of air pollutants (primary/secondary /photochemical air pollutants); Physical monitoring of gaseous pollutants and SPM; chemical synthesis of photochemical smog; dispersion and transport of air pollutants

UNIT III

An introduction to air pollution biology; mode of entrance of pollutants into plans; effect of air pollution on vegetation and animal; factors affecting plant response to air pollutants; mode and mechanism of plant-pollutants interaction; defense mechanism against gaseous pollutants in plants; toxicity/injury/symptoms of air pollutants on plants

UNIT IV

Biological (physiological, biochemical and structural) effects of air pollutants (SO_2, HF, PAN &O_3) and on vegetation; effect of different air pollutants on crop growth and yield; mode of air pollutants interaction and their individual and combined effects on vegetation; tolerant and susceptible plant species; Heavy metal pollution, their source and sinks, movements, uptake and biological effects on crops; heavy metal tolerance in plants, adaptation of plant species to heavy metals; phytoremediation of heavy metals.

UNIT V

Volatile organic compounds as an air pollutants; acid rain and its effects on vegetation; vegetation as a biological indicator for air pollution; physical, biological and legal control of air pollution and air pollution law; land use planning for polluted areas.

Practicals

Sampling of gaseous pollutants from atmosphere; Measurement of mass concentration of SPM in the air; Measurement of SO_2, NOx and O_3 concentration in ambient air; Measuring techniques crop response to gaseous air pollutants; Measurement of chlorophyll and carotenoids in plants; Measurement of protein and carbohydrate in plants; Diagnosis of air pollutants effects on vegetation.

Suggested Readings

Air Pollution by A.C. Stern, Academic Press

Air Pollution Control Theory by Martin Crawford, M.C. Craw Hill Publ. Co.

Analysis of Air Pollution by O. Warner, John Wiley & Sons

Atmospheric Motion and Air Pollution by R.A. Dobbins, John Wiley & Sons

Effect of Air Pollution on Plants Edited by T.A. Mansfield, Cambridge University Press, London

Encyclopedia of Environmental Air Pollution by G.R. Chhatwal, Vol. I,II,III, Anmol Publishers (P) Ltd. New Delhi

Environmental Pollution and Control by P.A. Vesilind and J.J. Pierce, Am. Arbor Society

Plant Stress from Air Pollution by M. Threshow and F.K. Anderson, John Weiley & Sons

ES 611 INTRODUCTION TO ENVIRONMENTAL LAW AND POLICY (2L+0P) III

Objective

To disseminate the knowledge of law and policy for environmental protection

Theory

UNIT I

Environmental law and the Indian constitution; the Environment Protection Act 1986 and Draft National Environmental Policy 2006

UNIT II

Laws for resource utilization; pollution control act (air, water, noise); waste management; forest conservation act and Wildlife Protection Act; wildlife trade and trafficking; policy dialogues for protection of different species

UNIT III

Right to environment as human right; fundamental principles governing international environmental law; environmental security, rights and duties under international environmental law; International conventions and negotiations

UNIT IV

International and national organizations and environmental institutions for the protection of environment

UNIT V

Nature and origin of negotiations; MEAs (Multiateral Environmental Agreements) and dispute settlement mechanism; Cartegena protocol and transboundry movement of GMOs/LMOs; biosecurity and biosafety issues

Suggested Readings

Bedi, Ranbir Singh and Bedi, A.S. 2002. *Encyclopaedia of Environment & Pollution Laws*, Orient Law House.

Desai, Bharat 1994. *Environmental Laws of India: Basic Documents,* Lancers Books.

Leelakrishnan, P. *Environmental Law in India*, LexisNexis Butterworths Wadhwa Nagpur.

Shyam Divan, Armin Rosencranz. Environmental Law and Policy in India: Cases, Materials and Statutes, Oxford University Press (2002).

Singh, Ram Babu and Misra, Suresh 1996. *Environmental Law in India: Issues and Responses*, Concept Publishing Co.

Thakur, Kailash 1997. *Environmental Protection Law and Policy in India*, Deep & Deep Publications.

Tiwari, A.K. 2006. *Environmental Laws in India: Contribution of the Supreme Court*, Deep & Deep Publications.