ST. JOSEPH'S COLLEGE (AUTONOMOUS)

BENGALURU-27

DEPARTMENT OF ENVIRONMENTAL SCIENCE

SYLLABUS FOR UNDERGRADUATE COURSE

Re-accredited with 'A' GRADE and 3.73/4 CGPA by NAAC
Recognised by UGC as College of Excellence

2015 -16 ONWARDS

SUMMARY OF CREDITS

(*include practical, dissertation, field work, viva etc)*

Total hrs in the semester	Credit	Number of hrs per week	Title	Code number
Semester -I				
60	4	4	Divisions of the Environment	ES 115
33	1	3	Physico-Chemical Analysis of Water	ES 1P1
Semester-II				
60	4	4	Ecology	ES 215
33	1	3	Ecological Methods	ES 2P1
Semester-III				
60	4	4	Environmental Microbiology, Environmental Biotechnology and Biostatistics	ES 315
33	1	3	Environmental Microbiology Environmental Biotechnology and Biostatistics	ES 3P1
Semester-IV				
30	2	2	Natural Resources and Management	ES 415
33	1	3	Basics of Maps; Study and Identification of Natural Resources	ES 4P1

Semester V				
45	3	3	Air, Water and Land Pollution	ES 5115
45	3	3	Environmental Sanitation, Health and Safety and Environmental Toxicology	ES 5215
33	1	3	Meteorology, Air Pollution, Effluent Analysis and Noise Monitoring	ES 5P1
33	1	3	Dissertation (To be submitted in VI semester along with ES 6P2)	ES 5P2
Semester VI				
45	3	3	Environmental Economics, Sustainable Development and Entrepreneurship Development	ES 6115
45	3	3	Town Planning and Environmental Impact Assessment	ES 6215
33	1	3	Soil Analysis	ES 6P1
33	1	3	Dissertation	ES 6P2

SYLLABUS FOR THE SEMESTER PATTERN UNDER AUTONOMY

ACADEMIC YEAR 2015-16 ONWARDS

Vision

Empowering and emancipating students through an understanding of the environment, sustainability and related ethical issues

Mission

Our mission is to develop environmentally conscious citizens who are able to appreciate the environment in its totality. We strive to equip our students with motivation, attitude, sound knowledge, commitment and skills to actively participate, at various levels, in sustainably managing environmental issues

Course Objectives

The following are the year-wise objectives of the course programme:

I Year

I Semester: Theory

- To understand the inseparable nature of the Components of the Abiotic environment-Atmosphere, Hydrosphere and Lithosphere

I Semester: Practical

- To develop the skill for analysing vital parameters of fresh water and interpret the result.

II Semester: Theory

- To understand and appreciate the interrelation existing between Abiotic and Biotic environment.

II Semester: Practical

- To develop the skill to enumerate planktons, carry out primary productivity studies in aquatic and terrestrial ecosystems and community characteristics of plants

II Year

III Semester: Theory

- To understand the harmful and useful role of the microbes in Sanitary Environment
- To apply the Microbial Biotechnology as a tool for Bioremediation.
- To understand the need for Quantification and Analysis of the Biological variables using Bio statistical tools.

III Semester: Practical

- To develop the skill to isolate and identify bacteria and fungi from water and soil
- To develop skill to test bacteriological contamination of potable water
- To use statistical tool to analyse and interpret data

IV Semester: Theory

- To be aware of and to develop concern about the Natural Resources and their Management.

IV Semester: Practical

- To develop skill to identify natural resources such as Minerals, Rocks,Medicinal plants and Endangered Species
- To develop skill to use Topo sheets and interpret topographical features

IV Semester: Open Elective

ES CBCS 415: ENVIRONMENT AND HEALTH

- To understand the role of Environment in human Health
- To understand the need for Environmental sanitation
- To acquire the knowledge of Non-communicable and Communicable diseases
- To acquire the knowledge of Nutrition and Dietetics
- To acquire the knowledge of Occupational health hazards

III Year

V Semester: Theory

- To create awareness and understanding of the sources, effects and control of Air, Water and Land Pollution
- To develop skills to manage the sanitary environment , health and safety
- To have an understanding of toxins and their Testing procedures of toxicity

V Semester: Practical

- To develop the skill to measure vital Meteorological parameters
- To develop the skill to analyse vital parameters of Air and Wastewater
- To develop skill to monitor Ambient Noise

VI Semester: Theory

- To acquire a basic understanding of Town Planning and its implications.
- To acquire an in-depth knowledge in carrying out Environmental Impact Assessment.
- To understand the basics of Environmental Economics systems and acquire skills to manage them sustainably.
- To equip students with the knowledge, attitudes and skills necessary for Environmental Entrepreneurship and to motivate them to venture into entrepreneurship as an alternative career option.

VI Semester: Practical

- To develop the skill to analyse vital parameters of soil and interpret the results.

V and VI Semester: Dissertation

To undergo Research Methodology and apply it in Basic and Applied Research in any one of the aspects of Environmental Science

Semester	**I**
Paper Code	**ES 115**
Paper Title	**DIVISIONS OF THE ENVIRONMENT**
Number of teaching hrs per week	**4**
Total number of teaching hours per semester	**60**
Number of credits	**4**

1.0	Environmental Education: Aim – Objectives – Scope.	**1 hour**
2.0	Components of the Environment – their complex interactions and significance.	**1 hour**
3.0	Atmosphere: Evolution of the atmosphere – Principle components – Structure of the atmosphere on the basis of temperature and composition; Significance of Ionosphere - Van Allen Belts; Auroras; Depletion of ozone layer, effects and control measures; Heat budget of the earth; Global warming, effects and control measures.	**10 hours**
3.1	Climatology: Differences between weather and climate – Tropical monsoon climate – Tropical cyclones and their impacts; Weather forecasting and modification – El nino and La nina effect.	**6 hours**
4.0	Hydrosphere: Hydrologic cycle – processes involved and their complex interactions – types of lifting and precipitation – forms of precipitation – Artificial rainfall – Global water balance.	**8 hours**
4.1	Limnology: Definition – Lotic and Lentic environment. Lotic environment: Springs, Stream profile: Potomon and Rhithron.	**4 hours**
4.2	Lentic environment: Ponds, lakes and estuaries – their types.	**4 hours**
4.3	Marine environment: Salinity status of marine environment, acidification of sea water; ocean currents and tides-significance.	**4 hours**
4.4	Ground water: Zonation; Types of wells.	**2 hours**
5.0	Lithosphere: Internal structure of the earth.	**2 hours**
5.1	Endogenic processes: Plate Tectonics – Earthquake and Volcanism – Causes, Effects, and Management.	**4 hours**

5.2	Exogenic processes: River, Sand dunes, Glaciation, Avalanches and Landslides.	**4 hours**
5.3	Petrology: Igneous, Sedimentary and Metamorphic rocks – their formation – types – uses.	**4 hours**
5.4	Pedology: Soil – definition – formation – soil profile. Types – Texture – Structure; pH, and buffering capacity; Cation Exchange Capacity; Soil biota.	**6 hours**

Reference Books

Barry, G.R. and Chorley, J.R. 2003. Atmosphere, Weather and Climate. Routledge, London.

Critchfield, H.J. 1995. General Climatology. Printice Hall of India.

Daji, J.A. 1988. Textbook of Soil Science. Media Promoters and Publishers.

Goldman, C.R. and Horne, A.J. 1983. Limnology. Mc Graw Hill.

Lutgens, F.K. and Tarbuck, E.J. 1982. Atmosphere – Introduction to Meteorology. Prentice Hall Inc.

Menon, P.A. 1989. Our Weather. National Book Trust.

Miller, R.W. and Donahue, R.L.1992. Soils – Introduction to Soils and Plant Growth. Prentice Hall of India.

Miller, Jr. G.T. 1994. Living in the Environment: Principles, Connections and Solutions. Wadsworth Publishing Co.

Nair, B.N. and Thampy, D.M. 1980. Marine Ecology. Macmillan Co. of India.

Rai, M.M. 1981. Principles of Soil Science. Macmillan Co. of India.

Strahler, A.N. and Strahler, A.H. 1973. Environmental Geoscience – Interactions between Natural Systems and Man. John Wiley and Sons.

SEMESTER – I

ES 1P1 PHYSICO-CHEMICAL ANALYSIS OF WATER

Each practical unit is of 3 hours duration

1. Sampling Technique of Water
2. Determination of pH – pH metric method
3. Determination of EC – Conductivity method
4. Estimation of Turbidity-Nephelometric method
5. TS, TSS & TDS- Gravimetric and Filtration method
6. Estimation of Alkalinity – Acidimetric method
7. Estimation of Hardness – EDTA Complexometric method
8. Estimation of Chlorides – Argentometric method
9. Estimation of Dissolved Oxygen –Winkler's method
10. Estimation of Nitrate – Phenoldisulfonic Acid method

Reference Books

Sawyer, C.N. and Mc Carty, P. L. 1978. Chemistry for Environmental Engineering. Mc Graw – Hill International.

Standard Method for Examination of Water and Wastewater. 1989. APHA – AWWA – WPCF

Standard Method for Examination of Water and Wastewater. 1998. APHA – AWWA - WEF

Trivedi, P.K. and Goel, P.K. 1984. Chemical and Biological Methods of Water Pollution Studies. Environmental Publication.

Semester	**II**
Paper Code	**ES 215**
Paper Title	**ECOLOGY**
Number of teaching hrs per week	**4**
Total number of teaching hours per semester	**60**
Number of credits	**4**

1.0	Levels of organization, Ecology: Divisions of Ecology - approaches in studying Ecology.	**2 hours**
2.0	Ecosystems – Characteristics of ecosystems- Structure of the ecosystem -Function of ecosystem- food chain – herbivorous and detritus food chains and food web - bio-magnification; Energy flow in an ecosystem– productivity - trophic levels; Study of pond and crop land ecosystems; homeostasis and feed back mechanisms.	**10 hours**
3.0	Biogeochemical cycles – types – Carbon, Nitrogen, Phosphorus, and Sulphur cycles – anthropogenic influences on these cycles.	**4 hours**
4.0	Community Ecology: Characteristics of a Community; Ecological succession – Primary and Secondary succession – Natural and man-influenced succession, – Hydrarch and Xerarch - Climax vegetation and their theories; Ecotone and Edge effect; Ecological equivalents; Ecotypes and Ecophenes; Ecological indicators.	**10 hours**
5.0	Population Ecology: Definition, Characteristics of Population: Density- Natality – Mortality – Age distribution – Growth form- Population Equilibrium – Biotic potential – Carrying capacity – Dispersal – Dispersion – Population fluctuations – Population regulation – **r** and **K** strategists.	**7 hours**
5.1	Niche concept – Types of niches: Spatial, Trophic and Multidimensional – Niche parameters: Form, Position and Width – Niche Partitioning - Realized and Fundamental Niche.	**5 hours**
5.2	Effect of Climatic (Light, Temperature, Wind and Water), Edaphic, Topographic and Biotic factors on plants; Effect of Light, Temperature Water and Soil on animals.	**10 hours**
5.3	Concept of Limiting Factors: Liebig's Law of Minimum; Shelford's Law of Tolerance and the combined concept.	**3 hours**

6.0	Evolution: Definition – Darwin's postulates - Natural selection – Types –Industrial Melanism - Pesticide resistance.	**5 hours**
6.1	Co-evolution; Mimicry – Batesian and Mullerian mimicry, warning colouration. (isi)	**4 hours**

Reference Books

Agarwal,K.C. 1999.Environmental Biolgogy.Agro Botanica.

Beck, W.S., Liem, K. F. and Simpson, G. G. 1991. Life – Introduction to Biology. Harper Collins Publications.

Chapman, J.L. Reiss, M. J. 1995. Ecology – Principles and Applications. Cambridge University Press.

Dash, M. C. 2001. Fundamentals of Ecology. Tata McGraw-Hill Publishing Co.

Kormondy, E. J.1996. Concepts of Ecology. Prentice Hall of India.

Odum, E.P. 1971 Fundamentals of Ecology. W.B. Saunders Co.

Ricklefs, R. E. and Miller, 1999. Ecology. W.H. Freeman and Co.

Raven, P.H. and Johnson, G. B. 1995. Biology. Wm. C. Brown Publications.

Smith,T.M.andSmith,R.L.2007.Elements of Ecology.PearsonEducation

Taylor, T. J., Green, N. P. O. and Stout, G.W. 1998. Biological Science Soper, R. (ed.). Cambridge University Press.

Wallace, R. A. 1990. Biology – The World of Life. Harper Collins Publications.

SEMESTER – II

ES 2P1 ECOLOGICAL METHODS

Each practical unit is of 3 hours duration

1. Sampling technique of Planktons (2 units)
2. Quantitative estimation of planktons–Sedgwick-Rafter method.
3. Quantitative estimation of zooplankton Sedgwick-Rafter method.
4. Determination of organic pollution – Palmer's Algal Pollution index.
5. Estimation of Primary Productivity of a pond – Light and Dark bottle method.
6. Estimation of Primary Productivity of algae – Chlorophyll method.
7. Estimation of Primary Productivity of grasses – Harvest method.
8. Study of plant community - Quadrat method.
9. Identification of Ecological Indicators.

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Reference Books

Michael, P. 1986. Ecological Methods for Field and Laboratory Investigations. Tata Mc Graw-Hill Publishing Co. Ltd.

Rolan, R. G. 1973. Laboratory and Field Investigations in General Ecology. Macmillan Co.

Standard Method for Examination of Water and Wastewater. 1989. APHA – AWWA – WPCF.

Subrahmanyam, N. S. and Sambamurty, A. V. S. S. 2000. Ecology. Narosa Publishing House.

Trivedi, P.K. and Goel, P.K. 1984. Chemical and Biological Methods of Water Pollution Studies. Environmental Publications.

Semester	**III**
Paper Code	**ES 315**
Paper Title	**ENVIRONMENTAL MICROBIOLOGY, ENVIRONMENTAL BIOTECHNOLOGY AND BIOSTATISTICS**
Number of teaching hrs per week	**4**
Total number of teaching hours per semester	**60**
Number of credits	**4**

1.0	Environmental Microbiology: Environmental Determinants; Temperature, Radiation, Pressure, Salinity, pH and Water Activity.	**7 hours**
2.0	Air Microbiology: Air borne Infections – Causative Microbes - Control Measures; Sick Building Syndrome; Droplet infection.	**4 hours**
2.1	Aquatic Microbiology: Water borne Diseases –Disinfection of water for potable purposes.	**4 hours**
2.2	Soil Microbiology: Rhizosphere and Rhizoplane Microflora – Composting; Biodegradation of DDT, PCBs and Plastics; Bioleaching of Heavy Metals – Copper, Iron and Uranium.	**6 hours**
2.3	Bioremediation of Xenobiotic Pollutants: Testing for Effects on Microorganisms – Bioremediation Efficacy Testing – Side Effect Testing. Approaches to Bioremediation: Environmental Modification and Microbial Seeding –Bioremediation: Contaminated Soils, Aquifers, Marine Oil slick and Air Pollutants; Biosensors.	**6 hours**
2.4	Genetically Engineered Species and Pest Control; Biotechnology and Biodiversity; Salient features of Guidelines and Policy of GMOs in India.	**3 hours**
3.0	Biostatistics: Definition – Functions and Limitations of Statistics.	**2 hours**
3.1	Diagrammatic Representation of Data: Line Diagram - Bar diagram – Pie Diagram; Graphical Representation of Data: Histogram, Frequency Polygon, Ogive.	**5 hours**
3.2	Sampling Techniques: Methods of Sampling – Random Sampling methods – Non-random Sampling Methods – Sampling and Non-sampling Errors.	**3 hours**
3.3	Measures of Central Tendency: Arithmetic mean, Geometric mean – Median – Mode.	**5 hours**

3.4	Measures of Dispersion: Range, Standard Deviation and Coefficient of Variation.	**4 hours**
3.5	Correlation: Scatter Diagram. Karl Pearson Coefficient of Correlation and Spearman's Rank Correlation.	**4 hours**
3.6	Test of Significance: Null hypothesis – Alternative hypothesis – Errors in Testing Hypothesis – Levels of Significance – Student's 't' test.	**7 hours**

Reference Books

Agarwal , S.K. 1998. Environmental Biotechnology. APH Publishing Corporation.

Atlas, R. M. and Bartha, R. 1998. Microbial Ecology – Fundamentals and Applications. Benjamin/Cummings Science Publishing.

Baker, K. H. and Herson, D. S. 1994. Bioremediation. McGraw-Hill Inc.

Bitton, G. 1994. Wastewater Microbiology. Wiley-Liss Inc.

Chatterji, A.K. 2002. Introduction to Environmental Biotechnology. Prentice-Hall of India Pvt. Ltd.

Forester, C. F. 1985. Biotechnology and Wastewater Treatment. Cambridge University Press.

Khan, I. A. and Khanum, A. 1994. Fundamentals of Biostatistics. Ukaaz Publications.

Kothari,C.R.2008.Research Methodology- Methods and Techniques. Revised Ed., New Age International Publ., Bangalore

McCarty, P.L. 2001 Environmental Biotechnology: Principles and Applications.

McGraw Hill International Editions.

Mitchel, R. (ed.) 1992. Environmental Microbiology. Wiley-Liss Inc.

Pelczar, M. J., Chan, E. C. S. and Krieg, N. R. 1993. Microbiology – Concepts and Applications. McGraw-Hill Book Co.

Southey, C., Kaushik, N. and Trivedi, R.K. (Eds). 2001. Detergents and the Environment. Tata McGraw-Hill Publishing Co. Ltd.

Thakur, I.S. 2006 Environmental Biotechnology: Basic Concepts and Applications. I. K. International Pvt. Ltd.

SEMESTER III

ES 3P1 ENVIRONMENTAL MICROBIOLOGY, ENVIRONMENTAL BIOTECHNOLOGY AND BIOSTATISTICS

Each practical unit is of 3 hours duration

1. Isolation of Bacteria from Water/Wastewater – Serial Dilution Technique.
2. Identification of Bacteria – Gram Staining.
3. Isolation of Fungi from Soils – Pour Plate method.
4. Identification of Fungi – Lactophenol Cotton Blue Staining.
5. Study of Root Nodule Bacteria – Gram Staining.
6. Study of Endomycorrhiza (VAM), Coralloid roots and Lichens.
7. Estimation of Coliform Group of Bacteria – MPN Technique.
8. Estimation of Coliform Group of Bacteria – MF Technique.
9. Computation of Standard Deviation – Micrometry
10. Positive and Negative Correlation - Verification of Beer's Law.

Reference Books

Aneja, K. R. 1996. Experiments in Microbiology, Plant Pathology, Tissue Culture and Mushroom Cultivation. Wishwa Prakashan.

Benson, H. J. 1998. Microbiological Applications – Laboratory Manual in General Microbiology. McGraw-Hill Publications.

Bhattacharyya, B. N. 1993. Experiments with Microorganisms. Emkay Publications.

Standard Method for Examination of Water and Wastewater. 1989. APHA – AWWA – WPCF.

Standard Method for Examination of Water and Wastewater. 1998. APHA – AWWA – WEF.

Semester	**IV**
Paper Code	**ES 415**
Paper Title	**NATURAL RESOURCES AND MANAGEMENT**
Number of teaching hrs per week	**2**
Total number of teaching hours per semester	**30**
Number of credits	**2**

1.0	Natural Resources: Definition, Classification of natural resources based on utility potential. Interrelations among various natural resources (synergies and trade-offs). Land use patterns of India.	**2 hours**
2.0	Water budget of India - Dams: Impact on environment – alternatives; Droughts and Floods: Causes and Control Strategies – Watershed Management; Rain Water Harvesting; River linking.	**5 hours**
3.0	Forest Resources: Importance of Forestry – Types of Forests – Impacts of Deforestation; - Forest Fires and their Control; Forest conservation: Sacred Groves – Joint Forest Management; Chipko and Appiko Movements; Forest Rights Act - Minor Forest Products; Ecotourism and its impacts.	**5 hours**
4.0	Biodiversity and Wildlife: Definition – Levels of Biodiversity; Values of Biodiversity, Endemic species, Biodiversity Hotspots; Threats to Biodiversity, Endangered species; Red Data Book; Conservation - *In-situ*– Protected areas – Sanctuaries - National Parks — Biosphere Reserves - Project Tiger; Community Conserved Areas – case studies on Black Buck, Snow leopard, Amur falcon, Sarus Crane. *Ex-situ:* Captive breeding, Zoos, Cryopreservation. Bio-piracy; Biodiversity Bill, 2000. – Wild life Protection Act, 1972. Grasslands of India – issues and conservation. (BR)	**10 hours**
5.0	Energy Resources: Definition - Classification of energy resources; Conventional: Hydel, Fossil fuels, Nuclear energy and their impacts. Non-conventional: Solar, Wind, Tidal, Microhydel.	**4 hours**
6.0	Mineral resources**:** Mining and Quarrying and their impacts; Ecological conflicts of mineral extraction; Desertification and Soil erosion: Causes – Types – Impacts – Control measures.	**4 hours**

Reference Books

Abbasi, S.A. and Abbasi, N. 2001. Renewable Energy Sources and their Environmental Impact. Prentice-Hall of India Pvt. Ltd.

Agarwala, V.P 1985. Forests in India – Environmental and Production Frontiers. Oxford and IBH Publishing Co.

Beck, W.S., Liem, K. F. and Simpson, G. G. 1991. Life – Introduction to Biology. Harper Collins Publications.

Dayal, M. 1989. Renewable energy – Environment and Development Konark Publishers.

Fernandes, W., Menon, G. And Viegas, P. 1988. Forest Environment and Tribal Economy. Indian Social Institute.

Gadgil,Madhav and Seshagirirao,P.R.1998.Nutturing Biodiversity An Indian Agenda.CEE Publ. Ahmedabad.

Goel,R. S. (Ed),. 1993.Environmental impacts of water resources. Tata Mc Graw Hill Publishing Co.

Gupta, R.K., Dabral, B.G., Homji,V. M. M. and Puri, G. S. 2000. Forest Ecology. Vol. 3. Oxford and IBH Publishing Co.

ICAR. 1992. Handbook of Agriculture.

Kumar,U and Asija, M.J. 2003 Biodiversity, Principles and Conservation Agrobios (India).

Owen, O. S. 1980. Natural Resources Conservation – An Ecological Approach. Mcmillan Publishing Co. Inc.

Rao, S. M. 1990. Introduction to Social Forestry. Oxford and IBH Publishing Co.

Ristinen, R.A. and Kraushaar, J.J. 1999. Energy and the Environment. John Wiley and Sons Inc.

Santra,S.C.2001.Environmental Science.Ist Ed.,New Central Book Agency.Kolkata.

Sharma, V.K. 1985. Water Resource Planning and Management. Himalaya Publishing House. Bombay.

Subrahamanyam, N. S. and Sambamurthy, A. V. S. S. 2000. Ecology. Narosa Publishing House.

Trivedi, P. R. and Raj, G. 1992. Environmental Energy Resources. Akashdeep Publishing House.

Varma, A. and Behera, B. 2003. Green Energy – Biomass Processing and Technology. Capital Publishing Co.

Wallace, R. A. 1990. Biology – The World of Life. Harper Collins Publications. 1

SEMESTER IV

ES 4P1 BASICS OF MAPS; IDENTIFICATION OF NATURAL RESOURCES

Each practical unit is of 3 hours duration

1. Index properties of Minerals.
2. Identification of Major Rock Forming Minerals.
3. Index properties of Rocks
4. Identification of Rocks.
5. Identification of medicinal plants of Karnataka.
6. Identification of endangered flora and fauna of India.
7. Introduction to Mapping.
8. Properties of Maps
    i. Direction and Scale
    ii. Latitude & Longitude
    iii. Grid References
    iv. Conventional signs and symbols.
9. Representation of Relief.
10. Study of Drainage Pattern and settlement Pattern

Reference Books

Ahuja, J. S., Virk, M. J. S., et.al., 1993. Map Education. Survey of India.

Sathyanarayanswami, B. S. 1985. Engineering Geology – Laboratory Manual. Eurasia Publishing House Pvt. Ltd.

Semester	**V**

Semester	**IV**
Paper Code	**ES CBCS 415**
Paper Title	**ENVIRONMENT AND HEALTH**
Number of teaching hrs per week	**2**
Total number of teaching hours per semester	**30**
Number of credits	**2**

1.1	Dimensions of health- Physical, mental and social health; Spiritual health. Disease triangle. Health Justice.	**5 hours**
2.1	Aero-allergens: Dust mites- Pollens.	**15 hours**
2.2	Water borne endemic disease: Fluorosis , Arsenic poisoning and Methemoglobinemia.	
2.3	Soil borne endemic disease: Melioidosis.	
2.4	Vector borne diseases: Plauge and Malaria; emerging diseases: Dengue, Chikungunya, Zika, Ebola, Swine Flu, Bird Flu, Severe Acute Respiratory Syndrome (SARS), *Middle East Respiratory Syndrome* (MERS); Zoonosis- Leptospirosis; Kyasanur forest disease (KFD) and Toxoplasmosis.	
2.5	Drug safeties: Thalidomide Tragedy; Antibiotic stewardship; New Delhi *Antibiotic-Resistant superbug*.	
2.6	Environmental Sanitation and Hygiene: Safe disposal of human excreta; Solid waste disposal; Sanitation value chain.	
3.0	Malnutrition: Vitamin deficiency diseases and Mineral deficiency diseases; Folic acid requirement during pregnancy; Food Safety- Adulterants and preservatives; Pesticide Toxicity: Endosulfan and DDT; Genetically Modified Food.	**5 hours**
4.0	Occupational health: Sick Building Syndrome; Noise and Radiation; Stress and Fatigue; Carpal tunnel syndrome (CTS) Methyl mercury and cerebral palsy; Synergistic effect; Cigarette smoking and pregnancy complications - Cigarettes and Other Tobacco Products (Prohibition of Advertisement and Regulation of Trade and Commerce, Production, Supply and Distribution) Act, 2003.	**5 hours**

Reference Books

Bedi and Yashpal. 1971. Handbook of Hygiene and Public Health. Atma Ram &Sons, Delhi.

Park.k 2009.Park's Textbook of Preventive and Social Medicine, 20th Edition.Misc Publ.

Paper Code	**ES 5115**
Paper Title	**AIR, WATER AND LAND POLLUTION**
Number of teaching hrs per week	**3**
Total number of teaching hours per semester	**45**
Number of credits	**3**

1.0	Air Pollution: Definition – Sources – Classification of Air pollutants.	**1 hour**
1.1	Effect of Air Pollution on Biosphere: Effect on human, Plants and Materials.	**4 hours**
1.2	Meteorology of Air Pollution: Atmospheric Stability – Temperature Inversions – Plume Behaviour.	**2 hours**
1.3	Control of Air Pollution: Settling Chambers, Inertial Separators, Cyclones, Filters, Electrostatic Precipitators and Scrubbers.	**6 hours**
1.4	Salient features of Air Pollution (Prevention and Control) Act, 1986; Ambient Air Quality Standards.	**2 hours**
2.0	Water Pollution: Definition, Sources and Classification of Water Pollutants.	**2 hours**
2.1	Heavy Metal Pollution: Causes, Effects and Control Measures with reference to Lead and Mercury.	**2 hours**
2.2	Pesticide Pollution: Causes, Effects and Control Measures with reference to Organo-chlorine pesticides.	**2 hours**
2.3	Thermal Pollution: Causes, Effects and Control Measures.	**2 hours**
2.4	Oil Pollution: Causes, Effects and Control Measures.	**2 hours**
2.5	Sewage Treatment: Aerobic and Anaerobic methods – Preliminary and Primary treatment – Screens, Grit Chamber, Equalisation Tank and Clarifier; Secondary Treatment – Activated Sludge Process and Tricking filters; oxidation pond; oxidation ditch; septic tank and Upflow anaerobic digester. Tertiary treatment: Chlorination; Reverse Osmosis.	**9 hours**
2.6	Treatment of Industrial Effluents: Dairy and Electroplating industry.	**4 hours**
2.7	Salient features of Water Pollution (Prevention and Control) Act, 1974; Drinking Water Quality Standards.	**2 hours**
3.1	Land Pollution: Sources and Classification of Land Pollutants.	**1 hour**
3.2	Reclamation of Contaminated Soils: Phyto-remediation-Chemo-remediation;Reclamation of Saline, Alkaline and Water-logged Soils.	**4 hours**

Reference Books

Bhatia, S.C. 2003. Managing Industrial Pollution. Macmillan India Ltd.

Crites,R. and George,T.1998.Small and Decentralised Wastewater Management Systems.WCB McGraw Hill, Boston.

Chhatwal, G. R., Mehra, M. C., Katyal, T., Satake, K., Katyal, M. and Nagahiro, T. 1989. Environmental Noise Pollution and its Control. Anmol Publications.

Das,R.C. 2008 Environmental Science- Principles and Practices.I Ed., Printice Hall of India,New Delhi.

Duggal, K. N. 1985. Elements of Public Health Engineering. S. Chand and Co. Ltd.

Metcalf and Eddy, Inc. Revised by Tchobanoglous, G. and Burton. 1991. Wastewater Engineering – Treatment, Disposal and Reuse.McGraw Hill Inc.

Perkins, H. C. 1974. Air Pollution. Mc Graw – Hill Kogakusha Ltd.

Rao M. N. and Dutta A. K. 1987. Wastewater Treatment. Oxford – IBH Publishing Co.

Rao, M. N. and Rao, H. V. N. 1988. Air Pollution. Tata McGraw – Hill Publishing Co. Ltd.

Santra,C.S.2001.Environmental Science. Ist Ed.,New Central Book Agency

Smith, W. J. (ed.). 1983. The Control of Oil Pollution. Graham and Trotman Publishers.

Stern, A. C. 1986. Air pollution Vol. I – VIII. Academic Press Inc.

SEMESTER – V

ES 5P1 METEOROLOGY, AIR ANALYSIS, EFFLUENT ANALYSIS AND NOISE MEASUREMENT

Each practical is of three hours duration

I METEOROLOGICAL PARAMETERS

1. Temperature, Humidity, Pressure and Precipitation.
2. Wind Direction, Speed and Wind Rose.

II AIR POLLUTION ANALYSIS

1. Estimation of SPM – High Volume Air Sampler method.
2. Estimation of SO2 – West and Gaeke method.

III EFFLUENT ANALYSIS

1. Estimation of Iron – Phenanthroline method.
2. Estimation of Chromium – Diphenyl Carbazide method.
3. Estimation of Copper – Neocuproine method.
4. Estimation of BOD – Dilution method.
5. Estimation of COD – Dichromate Refluxion method

IV NOISE MEASUREMENT

1. Measurement of Noise – Noise-level Meter.

Reference Books

Donn, W. L. 1975. Meteorology. McGraw – Hill Book Co.

Harrison, R. M. and Perry, R. 1986. Handbook of Air Pollution Analysis. Chapman and Hall.

Kazt, M. 1969. Measurement of Air Pollutants. WHO.

NEERI Manual. 1982. Air Quality Monitoring. NEERI Publications.

Sawyer, C.N. and Mc Carty, P. L. 1978. Chemistry for Environmental Engineering. Mc Graw – Hill International.

Stern, A. C. 1986. Air pollution Vol. I – VIII. Academic Press Inc.

Standard Method for Examination of Water and Wastewater. 1989. APHA – AWWA– WPCF.

Standard Method for Examination of Water and Wastewater. 1998. APHA – AWWA – WPCF.

Semester	**V**
Paper Code	**ES 5215**
Paper Title	**ENVIRONMENTAL SANITATION, HEALTH AND SAFETY AND ENVIRONMENTAL TOXICOLOGY**
Number of teaching hrs per week	**3**
Total number of teaching hours per semester	**45**
Number of credits	**3**

1.1	Solid Waste Management and Disposal: Definition – Sources – Types; On-site handling, Storage and processing – Collection – Transfer and Transportation – Processing – Recovery of materials and Disposal. Plastic Management Rules,2011.	**8 hours**
1.2	Disposal of Hazardous Wastes — Hazardous Waste Management and Handling Rules, 1989 – Biomedical Waste (Management and Handling) Rules, 1998.	**4 hours**
1.3	Effect of Radiation on man – Dosimetry – Geiger-Muller Counter – Liquid Scintillation counter.	**4 hours**
1.4	Noise Pollution: Sources – measurements – Effect on man – Control measures and Guidelines.	**5 hours**
1.5	Occupational health: Occupational environment-Physical, Chemical and Biological hazards; Occupational pneumoconiosis: Asbestosis, Anthracosis, Bagassosis, Byssinosis, Silicosis - Preventive measures- Salient features of The Factories Act,1948 and The Employees State Insurance Act, 1948; Status of occupational health in India.	**5 hours**
2.1	Environmental Toxicology: Terminologies – Environmental pollutants; Contaminants, Toxicants – No Effect Level – Safety – Risks – Acceptable Daily Intake – Virtual Safety.	**3 hours**
2.2	Toxicity: Definition – Objective and Experimental Design of Acute, Sub acute and Chronic toxicity tests: Selection of Species – Route of Administration – Dosage and Number of Animals – Observation and Examination – Evaluation of Data.	**4 hours**
2.3	Dose-Response Relationships – Types; Bioassay –Objectives of Static and Continuous test procedures; LD50, LC50, TLV, ED and TI.	**4 hours**
2.4	Categories of Toxic Effects: Local and Systemic – Reversible and Irreversible – Immediate and Delayed – Morphological and Biochemical-Allergic and Idiosyncratic reactions; Teratogenic, Reproductive, Carcinogenic and Mutagenic effects.	**8 hours**

Reference Books

Ballantyne,B.,Marrs,T and Turner,P (eds.)1993.General and Applied Toxicology. Macmillan Press Ltd.

Bhattacharya.S. 2011. Environmental Toxicology. I Ed., Books and Allied (P) Ltd.Kolkata.

Davis, M. L. and Cornwell, D. A. 1991. Introduction to Environmental Engineering.Mc Graw – Hill International.

Francis, C. W. and Auerbach, S. I. 1983. Environment and Solid Wastes. Butterworth Publishers.

Grover, V. I., Guha, B. K., Hogland, W. and McRae, S. G. (eds.) 2000. Solid Waste Management. Oxford – IBH Publishing Co. Pvt. Ltd.

Mishra, P. C. 1989. Soil Pollution and Soil Organisms. Ashish Publishing House.

Pandey, K. and Shukla, J. P. 1989. Elements of Toxicology. Radha Publications.

Park,K.1995.Preventive and Social Medicine. Banarsidas Bhanot Publications. Permeggiani,L(ed.) 1983. Encyclopaedia of Occupational Health and Safety. Vol 1&2 . ILO, Geneva.

Prasad, S. N. and Kashyap, V. 1991. Introduction to Toxicology. S. Chand and Co. Ltd.

Santra, S.C. 2001. Environmental Science, New Central Book Agency (P) Ltd. Schilling,R.S.F. (ed.) 1986. Occupational Health Practice. Butterworths.

Tchobanoglous, G., Theisen, H. and Eliassen, R. 1977. Solid Wastes – EngineeringPrinciples and Management Issues. Mc Graw – Hill Publications.

Theodore, L. 1990. Air Pollution Control and Waste Incineration for Hospital and Other Medical Facilities. Van Nostrand Reinhold Publishers.

SEMESTER V
DISSERTATION

Dissertation work replaces one practical paper in the semester V (ES 5P2) and one practical paper in the semester VI (ES 6P2)

Time allotted is 3 hours per week in each of these semesters

Each candidate is required to take up a Project Work in applied aspects as a partial fulfillment of the course.

Candidates may work either individually or in a group (maximum of 5 students).The group size is at the discretion of the allotted Project Guide. Dissertation reports are to be submitted to the department individually towards the end of the semester VI for evaluation.

Semester	**VI**
Paper Code	**ES 6115**
Paper Title	**ENVIRONMENTAL ECONOMICS, SUSTAINABLE DEVELOPMENT AND ENTREPRENEURSHIP DEVELOPMENT**
Number of teaching hrs per week	**3**
Total number of teaching hours per semester	**45**
Number of credits	**3**

1.0	Environment Economics: Definition – Limiting factors in using natural resources - Economic growth and development.	**2 hours**
1.1	Neoclassical Economic Paradigm –Environmental Goods and Services; free goods and economic goods; Environmental quality as a public good; Negative externalities and market failure.	**5 hours**
1.2	Fundamentals of Cost Benefit analysis; A case study.	**4 hours**
1.3	Natural Resource Economics – Concepts of Natural Resource; use; Objectives of natural resource management; Concept of Entropy. Resource scarcity – Malthusian theory of population; Theory of diminishing return.	**4 hours**
1.4	The Common's Theme- Tragedy of commons.	**1 hour**
1.5	Economic Models for Pollution Control – Market Model for Water Pollution Control; Carbon trading.	**5 hours**
2.0	Sustainable Development - Definitions and Goals. Ecological footprints.	**4 hours**
2.1	Sustainable development: Sustainable Agriculture, Sustainable Forestry; Sustainable Energy and Sustainable Transportation; Corporate response to sustainable development.	**10 hours**
3.0	Entrepreneurship Development: Concept of Entrepreneur and Entrepreneurship: Definitions for Entrepreneur and Entrepreneurship-Qualities of an Entrepreneur-Functions of Entrepreneurs-Classification of Entrepreneurs-Women Entrepreneurs Schumpeter's view on Entrepreneur-Entrepreneurial Guidance-Common Entrepreneurial Traits-Factors motivating new Entrepreneurs-Traits of Successful Entrepreneurs-Scope and Opportunities for Environmental Entrepreneurs-Case studies.	**10 hours**

Reference Books

Callon,S.J. and Thomas,J.M. 2000.Environmental Economics and Management Theory, Policy and Applications. Dryden Press.

Charantimath,M.P.2006EntrepreneurshipDevelopment–Small Business Enterprises. Ist Ed., Pearson Education.

Dollinger, M. J. 2006. Entrepreneurship Strategies and Resources, III Ed., Pearson Education.

Gadgil, M. and Guha, R. 1998. Fissured Land. Oxford University Press

Ian Wills 2007 Economics and the Environment. Allen &Unwin, NSW.

Hanley, N., Shogren, J.F. and White, B. 1997. Enviornmental Economics in Theory and Practice. MacMillan.

Hisrich,D.R.,Peters,P.M.and Shepherd,A.D. 2007.entrepreneurship. 6th Ed.,Tata McGraw-Hill Publ.Co. Ltd.

Karpagam, M. 2006. Environmental Economics.Revised Ed., Sterling Publishers.

Kumar,P.(ed.)2005. Economics of Environment and Development.Ane Books.

Mankiw,N.G.2001 Principles of Economics. II Ed., Thomson.

Murthy,C.V.S 2002 Small Scale Industries and Entrepreneurial Development. Himalaya Publishing House.

Ramakrishnan, P.S. 2001 Ecology and Sustainable Development, National Book Trust.

Schumacher, E.F. 1977. Small is Beautiful. Abacus – Sphere Books.

Subhashini,M.2010. Economics of Environment. PHI Learning Pvt.Ltd.

Thomas,W.Z. and Norman,S.M.2005. Essentials of Entrepreneurship and Small Business Management.IV th Ed.,Pearson Printice Hall.

Welford, R.1996.Corporate Environmental Management. Systems and Strategies.Universities Press (India) Ltd.

SEMESTER – VI
ES 6P2 SOIL ANALYSIS
Each practical unit is of 3 hours duration

1. Sampling Techniques of Soil.
2. Determination of Moisture Content – Oven Dry method.
3. Determination of Water Holding Capacity – Imbibition method.
4. Determination of pH – pH metric method.
5. Estimation of Lime Content – Back Titration method.
6. Estimation of Calcium and Magnesium – EDTA method.
7. Estimation of Organic matter – Walkley and Black method.
8. Estimation of Organic Nitrogen – Kjeldahl method.
9. Estimation of Phosphorus – Vanadomolybdate method.
10. Estimation of Potassium – Flame Photometric method.

Reference Books

Baruah, T. C. and Barthakur, H. P. 1997. Textbook of Soil Analysis. Vikas Publishing House Pvt. Ltd.

Daji, J.A. 1988. Textbook of Soil Science. Media Promoters and Publishers.

Firman, E. B. 1964. Chemistry of Soils. Oxford IBH Publishing Co.

Jackson, M. L. 1973. Soil – Chemical Analysis. Prentice Hall Publications.

Miller, R. W. and Donahue, R. L. 1992. Soils – Introduction to Soils and Plant Growth. Prentice Hall of India.

Rowell, T.L. 1994. Soil Sciences – Methods and Applications. Longman Scientific and Technical.

Semester	**VI**
Paper Code	**ES 6215**
Paper Title	**TOWN PLANNING AND ENVIRONMENTAL IMPACT ASSESSMENT**
Number of teaching hrs per week	**3**
Total number of teaching hours per semester	**45**
Number of credits	**3**

1.0	Town Planning: Concepts of Planning- Aims, Objectives and Principles of Town Planning.	**5 hours**
1.1	Growth of Cities and towns: Origin - types of growth - stages of growth - methods of growth (origin and direction).	**2 hours**
1.2	Zoning: Importance – Classification Industries: Selection of Sites for Industries. Transportation: Means – Requirements of an Ideal City Road; Traffic Management.	**5 hours**
1.3	Re-planning the Existing Towns: Need – Objectives – Data Collection – Urban Renewal – Advantages of Urban Renewal; Ecocities.	**2 hours**
1.4	Village Planning: Need — Village- Types; Principles of Village planning.	**2 hours**
2.0	Environmental Impact Assessment: General Aspects of an EIA –Environmental Regulations - EIA An Overview - Utilities Of EIA- Scope, Public Participation; Methods of Impact Identification – Baseline data, Matrices, Checklists and Networks; Impact Prediction. Case Studies: Industry, Mining and Multipurpose Dams.	**23 hours**
3.0	Environmental Audit: Aim and Objectives; Elements of Environmental audit; Environmental Audit Statement Notification, 1992 (Amended, 1993).	**5 hours**

Reference Books

Baldwin, J. H. 1988. Environmental Planning and Management. International Book Distributors.

Barthwal, R.R.2009. Environmental Impact Assessment. New Age International publication.

Canter, L. W. 1996. Environmental Impact Assessment. McGraw Hill Inc.

Hiraskar, G. K. 2000. Fundamentals of Town Planning. Dhanpat Rai Publications.

O'Riordran, T. and Truner, R. K. 1983. Annotated Reader in Environmental Planning and Management. Pergamon Press Ltd.

Rao, P.S.B. and Rao, P.M. (eds). 2001. Environment Management and Audit. Deep and Deep Publications Pvt. Ltd.

Rau, J. G. and Wooten, D. C. 1980. Environmental Impact Analysis Handbook. McGraw Hill.

Santra, S.C. 2001. Environmental Science, New Central Book Agency (P) Ltd.

Shrivastava, A.K. 2003. Environment Impact Assessment. APH Publishing Corporation.

Trivedi, P.R. 2004. Environmental Impact Assessment. APH Publishing Corporation.

SEMESTER VI
DISSERTATION

Dissertation work replaces one practical paper in the semester V (ES 5P2) and one practical paper in the semester VI (ES 6P2)

Time allotted is 3 hours per week in each of these semesters

Each candidate is required to take up a Project Work in applied aspects as a partial fulfillment of the course.

Candidates may work either individually or in a group (maximum of 5 students).The group size is at the discretion of the allotted Project Guide. Dissertation reports are to be submitted to the department individually towards the end of the semester VI for evaluation.