PT. RAVISHANKAR SHUKLA UNIVERSITY

RAIPUR - 492 010, CHHATTISGARH

M Sc Environmental Science

SYLLABUS

SEMESTER EXAMINATION

Effective from July 2022 onwards

Chairman
Prof. Sharad Pandey

External Member (Research Institute) Dr. Shaik Basha

Prof. Krishna Kumar Patra
External member (Academia)

Prof. K. K. Ghosh

Dr. Indrapal Karbhal

M.Sc. ENVIRONMENTAL SCIENCE COURSES

The Environmental Science is a multidisciplinary subject includes chemistry, physics, geology, geography & biology. The teaching and research in the environmental science is urgently required for understanding and controlling the complex environmental issues arising at the local, regional and global scales.

EXAMINATION SCHEME
Semester – I (20 Credits)

Theory (Credit: 16)

Paper Code	Course	Credit	Duration	Internal Assessment	Theory Marks	Total Marks
ENV-101	Fundamental of Ecology and Natural Resources	4	3 Hrs	20	80	100
ENV-102	Instrumental Techniques & Analytical Methods in Environmental Sciences	4	3 Hrs	20	80	100
ENV-103	Environmental Disaster and Risk Management	4	3 Hrs	20	80	100
ENV-104	Solid & Hazardous Waste management	4	3 Hrs	20	80	100

Practical (Credit: 4)

Paper Code	Course	Credit	Duration	Marks
ENV-105	Lab work-1	2	8 Hrs.	100
ENV-106	Lab work-2	2	8 Hrs.	100

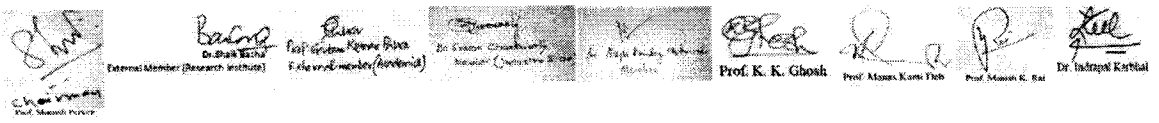
Semester – II (20 Credit)

Theory (Credit: 16)

Paper Code	Course	Credit	Duration	Internal Assessment	Theory Marks	Total Marks
ENV-201	Meteorology and Climatology	4	3 Hrs	20	80	100
ENV-202	Environmental Pollution and Control : Air, Water and Noise	4	3 Hrs	20	80	100
ENV-203	Water and Wastewater Treatment Technologies	4	3 Hrs	20	80	100
ENV-204	Environmental Geosciences	4	3 Hrs	20	80	100

Practical (Credit: 4)

Paper Code	Course	Credit	Duration	Marks
ENV-205	Lab work-1	2	8 Hrs.	100
ENV-206	Lab work-2	2	8 Hrs.	100



Semester – III (20 Credit)

Theory (Credit: 16)

Paper Code	Course	Credit	Duration	Internal Assessment	Theory Marks	Total Marks
ENV-301	Environmental Toxicology	4	3 Hrs	20	80	100
ENV-302	Environmental Microbiology	4	3 Hrs	20	80	100
ENV-303	Environmental Biotechnology	4	3 Hrs	20	80	100
ENV-304	Data Analysis in Environmental Sciences	4	3 Hrs	20	80	100

Practical (Credit: 4)

Paper Code	Course	Credit	Duration	Marks
ENV-305	Lab work-1	2	8 Hrs.	100
ENV-306	Lab work-2	2	8 Hrs.	100

Semester – IV (20 Credit)

Theory (Credit: 16)

Paper Code	Course	Credit	Duration	Internal Assessment	Theory Marks	Total Marks
ENV- 401	Remote Sensing and GIS	4	3 Hrs	20	80	100
ENV- 402	Environmental Economics & Sustainable Development	4	3 Hrs	20	80	100
ENV-403	Environmental Impact Assessment, Environ-mental Audit and Environmental Management System Standards (EIA, EA and EMSS)	4	3 Hrs	20	80	100
ENV-404	Environmental Law and Policy	4	3 Hrs	20	80	100

Practical (Credit: 4)

Paper Code	Course	Credit	Duration	Marks
ENV-405	Dissertation	4	8 Hrs.	100

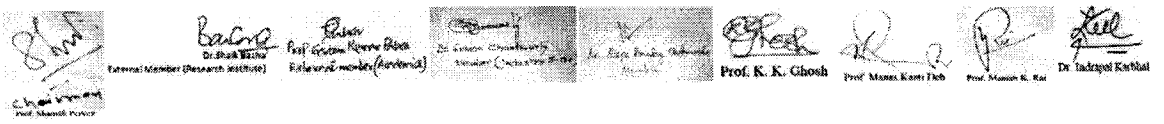
Internal elective paper (Credit: 4)

(i) Food adulteration

(ii) Waste management

External elective paper (Credit: 4)

(i) Renewable, Nonrenewable and Perpetual Resources



(ii) Environmental Disaster and Risk
(iii) Environmental Law, Policies and Society

Semester-I (24 Cr)

Course-1: Fundamentals of Ecology (4 Cr)

Unit-I: Concept of Ecology (1 Cr)

Ecology as an inter-disciplinary science. Origin of life and speciation. Human Ecology and Settlement. History and scope of ecology: autecology, synecology, population, community, ecosystem, biome, tolerance range and limiting factors; Component parts of an ecosystem; Classification of ecosystems; Ecological factors: temperature, light, water; Bio-geo-chemical cycles: Carbon cycle, nitrogen cycle, sulfur cycle, phosphorous cycle; Functional attributes of an Ecosystem :Biological diversity and stability; Biodiversity: Index of diversity and dominance, Biological indices, relationship between species diversity, dominance and stability; Food chain: Trophic levels & ecological pyramid concept; Types of food chain & significance of food chains, pyramid of number, biomass & energy.

Unit-II: Natural Resources (1 Cr)

Classification of natural resources, biotic resources; Renewable and non-renewable resources: Different types of resources and their natural sources. Demographic quotient; rate of consumption and depletion. Value system, equitable resource use. Soil formation and soil erosion; Changes in land use and land cover pattern; conservation of soil and nutrients. Water resources: Distribution, exploitation, depletion of water resources; conservation of water; water use efficiency; water poverty index.

Unit-III: Population Attributes, Population Fluctuation and Population Interaction (1 Cr)

Biotic potential and natality, mortality, survivorship curves, life table, age structure, population growth forms, concept of carrying capacity and environmental resistance; Life history strategies, r and k selection, extrinsic and intrinsic abiotic, biotic, density dependent and independent factors associated with population fluctuation, Models of population growth and interactions: Lotka-Voltera model, Leslie's matrix model; Population interaction like symbiosis, commensalism, parasitism, predation, competition etc.; Ecological Guild Models for single and interacting population, social behavior in animals. Factors affecting change in size of human population: death rate and net population change, migration, fertility, age structure, Human population control; economic development and demography transition, family planning method of birth control, socio-economic methods of controlling human population growth.

Unit-IV: Mineral, Natural and Energy Resources (1 Cr)

Distribution and exploitation; environmental implications of mining; strategies for conservation of mineral resources, land evaluation and suitability, land use/land cover mapping, LU/LC for Environmental Planning.

Renewable and non-renewable resources energy; Alternate and additional sources of energy; depletion of energy resources; Conservation of energy resource; Energy use efficiency. Solar radiation and its technological ways of harvesting; Solar collectors, photovoltaic, solar ponds; Hydroelectric power, Tidal, Ocean Thermal Energy Conversion, Wind, Geothermal Energy, Nuclear energy-fission and fusion, Hydrogen & Fuel cells.

Books & References

1 E. P. Odum, Fundamental of ecology, W.B Sounders, 1971.
2 M. Dash and S. Dash, Fundamentals of ecology, Mc Graw Hill Education, India, 2009.
3 R. T. Wright and B. J. Nebel, Environmental science: Toward A sustainable future, Prentice Hall, 2002.
4 P. Stiling, Ecology: Theories and Applications, Prentice Hall, 2001.
5 C. Faurie, Ecology: Science and Practice, Oxford & IBH, 2001.
6 G. T. Miller, Living in the environment: An introduction to environmental science, Wadsworth Publishers, 1998.
7 J. Turk, Introduction to Environmental Studies, Saunders, 1980.
8 E. J. Kormondy, Concepts of ecology, Prentice Hall, 1996.
9 M. M. Saxena, Applied Environmental Biology, Agrobios, 1990.
10 E. Odum and G. W. Barrett, Fundamentals of Ecology, Brooks Cole, 2004
11 Environment and Natural Resources conservation by Trivedi R.K
12 Dr.M.Anji Reddy Environmental Sciences, BS Publications

Course-2 : Instrumental Techniques & Analytical Methods in Environmental Sciences (4 Cr)

Unit-I: Electrochemical Techniques (1 Cr)

Fundamentals of Environmental Chemistry: Stoichiometry, Gibb's energy, Chemical potential, chemical equilibria, acid base reactions, solubility product, solubility of gases in water, the carbonate system, unsaturated and saturated hydrocarbons, radionuclide's

Idea of pH and buffer, Buffer capacity and ionic strength; Principle and application of pH-metery, Potentiometery, Conductometry, Coulometry, Polarography, Voltammetry (cyclic and anode stripping), Amperometry and Ion Selective Electrodes.

Unit-II: Spectroscopic Techniques (1 Cr)

The basic principle, instrumentation and application of the infrared, FTIR, visible, ultraviolet and Raman and fluorescence spectrometry.

Principle, instrumentation and application of atomic absorption (i.e. flame, graphite furnace, hydride generation and cold vapor) spectroscopy and atomic emission (i.e. flame, plasma, spark and arc) spectroscopy.

Basic Principle, instrumentation and application of X-ray fluorescence spectroscopy (XRF),

Principle, instrumentation and application of mass spectroscopy, types of mass spectroscopy, fragmentation, ionization and characterization of organic and inorganic materials.

Unit- III: Separation techniques (1 Cr)

Concept and application of separation probes: adsorption, centrifugation, chromatography, crystallization, decantation, demister (vapour), distillation, drying, electrophoresis, elutriation, evaporation, leaching, liquid-liquid extraction, solid phase extraction, flotation, flocculation, filtration, reverse osmosis, dialysis (biochemistry) fractional distillation, fractional freezing, magnetic separation, precipitation, crystallization, sedimentation, sieving, stripping, sublimation, vapour-liquid separation, winnowing and zone refining.

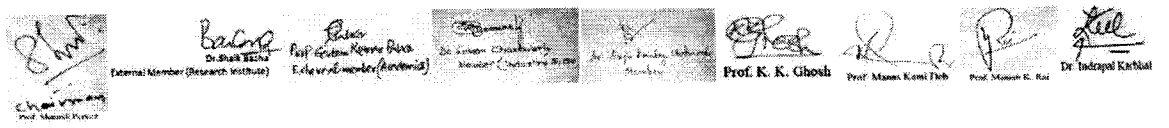
Unit- IV: Chromatography and Miscellaneous methods (1 Cr)

Principle, instrumentation and application of gas, liquid, adsorption, paper, gel, size exclusion, HPLC, TLC, electrophoresis and ion exchange chromatography.

Principle, instrumentation and application of classical analytical methods(i.e. gravimetric, volumetric and thermal methods); Automatic analytical methods and Hybrid analytical methods., nephelometry and turbidimetry.

Books & References

1. G. D. Christian, Analytical Chemistry, 6th Ed, John Wiley & Sons, 2007.
2. H. A. Strobel and W. R. Heineman, Chemical instrumentation: a systematic approach, Wiley, 1989.
3. H. H. Willard, Instrumental methods of analysis, Van Nostrand, 1981.
4. Z. Marczenko and M. Balcerzak, Separation, preconcentration and spectrophotometry in Inorganic Analysis, Elsevier, 2000.
5. E. B. Sandell and H. Ōnishi, Photometric determination of traces of metals, Wiley, 1978.
6. B. Welz and M. Sperling, Atomic Absorption Spectrometry, John Wiley & Sons, 2008
7. Ed Metcalfe, Atomic absorption and emission spectroscopy, J. Wiley, 1987.
8. E. Katz, Quantitative Anallysis Using Chromatographic Techniques, John Wiley & Sons, 2009.
9. J. Rydberg, M. Cox and C. Musikas, Solvent extraction principles and practice, CRC Press, 2004



10. P. J. Haines, Principles of Thermal Analysis and Calorimetry, Royal Society of Chemistry, 2002.
11. E. de Hoffmann and V. Stroobant, Mass Spectrometry: Principles and Applications, John Wiley & Sons, 2007

Course-03: Environmental Disaster and Risk (4 Cr)

Unit-I: Hazard, Risk and Disaster (1 Cr)

Hazard in the Environment, the concepts of hazard, risk and disaster, Human vulnerability to hazard, Disaster trends, complexity in hazard and disaster, Hazard zoning and risk assessment, Environmental Security and Hazards Zoning, hazard zoning maps & preparedness plan. Risk Assessment management: Disaster management cycle, Hazards vs. Risk, Evaluation of Risk, Strategies for Hazard Mitigation: Priorities, Prediction, warning & Public information, Minimizing the probability of hazards, Public policy for hazard management.

Unit-II: Repercussions of Disasters and Hazards (1 Cr)

Economic Damage, Loss of Human and Animal Life, Destruction of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts and Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks of Disease And Epidemics, War and Conflicts

Unit-III: Floods, Cyclones, Tornados and Tsunamis (1 Cr)

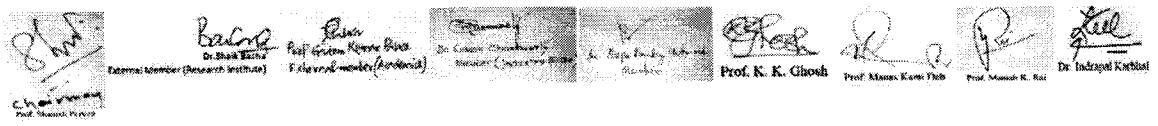
Floods and flood management, causes of excess flows, reduced carrying capacity of rivers, Runoff versus infiltration, sediment load & changing course of rivers, management of floods - strategy, treatment of watersheds, reservoir &detention basis, water spreading , ground water recharge, stream channelization, flood embankments, flood plain zoning, flood forecasting & warning. Regions of flood prone zones in India. Origin of cyclones, tornados and tsunamis, their severity and impacts, coastal hazards mitigation measures.

Unit-IV: Technological hazards: Nature and Definition of Technological Hazards (1 Cr)

Concepts of industrial pollution, nuclear radiation, toxic wastes, dam failures, transport accidents, factory explosions, fires, chemical spills, and technological hazards as a result of the impacts of a natural hazard. Definition of hazardous waste, solid waste generation, concept of solid waste management. Onsite handling and processing, disposal techniques-open dumping, land filling, incineration, composting, potential methods of disposal-utilization, recovery and recycling. The growth of industrial hazard, Some case studies of Technological Disasters like Bhopal gas Tragedy 3 December, 1984, Chernobyl Nuclear accident 1986, Minnamata Japan, Japan's earthquake- tsunami- Fukushima nuclear disaster: 2011

Books and references:

1. Environmental Hazards: assessing risk and reducing hazards, Smith, K. and Petley, D.N. Routledge publication, London.2009, p.383.



2. Atmosphere, weather and climate, a textbook on climatology, Siddhartha, K. Kisalaya Publications Pvt. Ltd. New Delhi, 2000, p. 511
3. Environmental Geology, Valdiya K.S., Tata Mc-Graw Hill, 1987, p.
4. Landslide risk assessment, Lee E.M. and Jones D.K.C., Thomas Telford, 2004, p. 454
5. Environmental Geoscience: interaction between Natural Systems and Man, Strahler, A.N. and S Trahler A.H., Hamilton Publishing Company, California, p.511.
6. The nature of the Environment, Goudie, A., Blackwell Publications, 2001, p.544.
7. Living with Risk: The Geography of Technological Hazards by Susan L. Cutter (Jun 15, 1993)
8. Technological Disasters, P.C. Sinha, Anmol Publications Pvt. Limited, 1998 - 516 pages
9. Earthquakes and Tsunamis in the Past: A Guide to Techniques in Historical Seismology, E. Guidoboni and John E. Ebel, Cambridge University Press, 2009
10. Earth quakes: Bruce A. Bolt
11. Elementary Seismology: Charles F. Richter

Course-4: Solid & Hazardous Waste management (4 Cr)

Unit-I: Solid Waste (1 Cr)

Definition of solid wastes – types of solid wastes – Sources - Industrial, mining, agricultural, municipal solid waste, Construction demolition waste, E-waste and Biomedical waste. Solid waste Problems - impact on environmental health

Unit-II: Functional Elements of Solid Waste Management (1 Cr)

Handling and segregation of wastes at source. Collection and storage of municipal solid wastes; analysis of Collection systems. Transfer stations. Solid waste processing technologies: Mechanical and thermal volume reduction, Biological and chemical techniques for energy and other resource recovery, composting, vermicomposting, fermentational. Incineration of solid wastes. Disposal in landfills: site selection, design, and operation of sanitary landfills; Leachate and landfill gas management; landfill closure and post-closure environmental monitoring; landfill remediation. Regulatory aspects of municipal solid waste management, Plastic waste management.

Unit-III: Hazardous Waste and Management (1 Cr)

Hazardous waste definition. Physical and biological routes of transport of hazardous substances – sources and characterization. Sampling and analysis of hazardous wastes –proximate analysis – survey analysis – directed analysis - handling, collection, storage and transport. Hazardous waste treatment technologies: TSDF concept - Physical, chemical and thermal treatment of hazardous waste: solidification, chemical fixation, encapsulation, pyrolysis and incineration.

Hazardous waste land fills - Site selections, design and operation. HW reduction, recycling and reuse fly ash bricks, Regulatory aspects of HWM/HWM rules.

Unit-IV: Biomedical, Radoactive and E-Waste Management (1 Cr)

Classification, collection, segregation Treatment and disposal. Radioactive waste: Definition, Low level and high level radioactive wastes and their management, Radiation standard by ICRP and AERB Waste characteristics, generation, collection, transport and disposal, regulatory aspects of e waste, Global strategy, recycling. Waste characteristics, generation, collection, transport and disposal, regulatory aspects of e waste, Global strategy, recycling.

Books & References

1. Hazardous waste management Charles A. Wentz. Second edition 1995. McGraw Hill International.
2. Integrated solid waste management George Tchobanoglous, Hilary Theisen&Sammuel A. Vigil.
3. Criteria for hazardous waste landfills – CPCB guidelines 2000.
4. Hazardous waste management by Prof. Anjaneyulu.
5. Environmental Sciences by Daniel B. Botkin and Edward A. Keller, Wiley student, 6th edition- 2009.
6. Standard handbook of Hazardous waste treatment and disposal by Harry M. Freeman, McGraw Hill 1997.

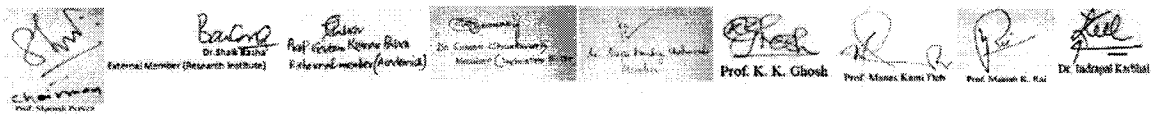
Management of Solid waste in developing countries by FrankFlintoff , WHO regional publications 1976

Course-5: Practical (4 Cr)

1. Determination of pH value in given water samples.
2. Determination of electrical conductivity in given water samples.
3. Determination of total dissolved solids in given water sample.
4. Determination of reduction potential of given water sample.
5. Determination of color value of waste water.
6. Determination of dissolved oxygen in given water sample.
7. Determination of total hardness in given water samples.
8. Determination of calcium hardness in given water samples.
9. Determination of magnesium hardness in given water samples.
10. Determination of total alkalinity in given water samples.
11. Determination of biological oxygen demand in given water samples.
12. Determination of chemical oxygen demand in given water samples.
13. Other advanced practical.

Course-6: Practical (4 Cr)

1. Determination of sodium in water sample by using flame photometer.
2. Determination of potassium in water sample by using flame photometer.
3. Determination of lithium in water sample by using flame photometer.
4. To determine the standard curve with the help of UV – visible spectrophotometer.



5. Determination of the value of slope and intercept of KMnO4.
6. To determine the value of molar absorptivity by using UV visible spectroscopy.
7. Determination of chlorine in water by volhard's method.
8. Determination of iron in given water sample by using UV-VIS spectroscopy.
9. Determination of nitrate in given water sample by titration method.
10. Determination of fluoride in given water sample by titration method.
11. Determination of turbidity in given water sample by using turbidity meter.
12. Determination of ammonium ion in given water sample by titration method.
13. Other advanced practical.

Semester-II (24 Cr)

Course-7 Meteorology and Climatology (4 Cr)

Unit-I: Atmosphere and Earth Science (1Cr)

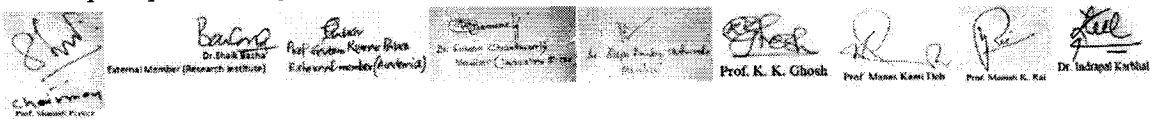
Introducing the Atmosphere, The heterosphere, Subdivisions of the homosphere, the troposphere, atmospheric pressure, Solar radiation, Insolation over the Globe, World Latitudinal zones, Insolation losses in the atmosphere, Long wave radiation, Latitude and the radiation balance, Annual and Daily Cycles of radiation, Man's Impact upon the Earth's Energy Balance, Cosmic particles and Ionizing radiation, The magnetosphere, radiation belts ; Heat flow mechanisms, The Heat Balance Equation, The daily and annual heat balance cycles, Heating and cooling of the soil, Arctic permafrost, Meteorology fundamentals – Pressure, temperature, wind, humidity, radiation, atmospheric stability adiabatic diagrams, turbulence and diffusion. Scales of meteorology. Applications of micrometeorology to vegetated surfaces, urban areas, human beings, animals.

Unit-II: Thermal Environments of the Earth's Surface and Circulation Systems in Atmosphere and Oceans (1Cr)

Introducing the oceans: Composition of Sea water, Density of sea water, Layered structure of Oceans, Energy absorption by water layers, Heating and cooling of lakes and oceans, Sea Surface Temperatures, Sea Ice and its distribution, Daily cycle of air temperature near the ground, Thermal extremes near the ground, The Annual Cycle of Air temperature, Global distribution of air temperatures, Radiation and Heat Environments of High altitudes; Barometric pressure and winds, Idealized circulation on a nonrotating earth, Coriolis effect and the geostrophic wind, Cyclones and anticyclones, The Planetary circulation, Angular momentum transport by air masses, Atmospheric circulation in middle and high latitudes, Heat transport across parallels of latitude, Global patterns of barometric pressure and surface winds, Monsoon winds systems, Local winds, Wind and waves, The causes of ocean currents, The global pattern of ocean currents, Zones of convergence and upwelling, , El Nino, ENSO, The Earth's heat balance, Seasons in India.

Unit –IIII: Atmospheric Energy Releases (1Cr)

Relative humidity and vapor pressure, Absolute and specific humidity, air masses, condensation and adiabatic process, clouds and fog, forms of precipitation, Convective precipitation and thunderstorms, Orographic precipitation, Cyclonic and frontal precipitation, World precipitation regions, Water balance of the atmosphere,



Unit-IV: Man's Impact upon the Atmosphere (1Cr)

Carbon dioxide and oxygen levels in the atmosphere, Man induced changes in Atmospheric temperature, water vapor, clouds, and precipitation, Planned weather modification, Urbanization and balances of radiation and heat, Pollutants in the atmosphere, Inversion and smog, Glacial ice as a recorder of air pollution, Harmful effects of atmospheric pollution, Global effects of particles in the atmosphere, Testimony of the glacial ice layer, Application of meteorological principles to transport and diffusion of pollutants, Scavenging processes, Effects of meteorological parameters on pollutants and vice versa, Wind roses, Topographic effects, concepts of climate change.

Books & References

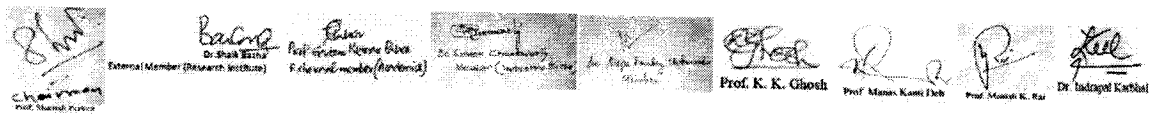
1 Helmis C. G. and Nastos, P. T. (Eds.), Advances in Meteorology, Climatology and Atmospheric Physics, Springer Atmospheric Sciences, 2013.
2 P. V. Hobbs and J. M. Wallace, Atmospheric Science: An Introductory Survey, Academic Press Inc, 2006.
3 C. Booker, The Real Global Warming Disaster, Continuum Publishing Corporation, 2009.
4 A. Goudie, The nature of the environment, Blackwell, 2001.
5 K. S. Valdiya, Environmental Geology, Tata Mc Graw Hill, 1984.
6 Atmosphere, Weather and Climatology: A textbook on climatology, Kisalaya Pub. Pvt. Ltd, New Delhi, 1984.
7 R. G. Barry and R. J. Chorley, Atmosphere, Weather and Climate, Routledge, 2009.
8 J. E. Martin, Introduction to Weather and Climate Science, Cognella Academic Publishing, 2013.
9 J. O. Ayoade, Introduction to Climatology for Tropics, Wiley, 1993.
10 The Atmosphere : An Introduction to Meteorology, Prentice Hall; 12 edition, 20012.

Course-8: Environmental Pollution and Control: Air, Water and Noise (4 Cr)

Unit-I: Air Pollution (1Cr)

Atmosphere and its functions, Physical and chemical properties of atmosphere, natural and anthropogenic sources of atmospheric pollutants, Major and Minor Pollutants in atmosphere (SO_x, NO_x, CO, Pb, PM10, PM2.5, etc.),Gas laws governing the behavior of pollutants in atmosphere, transport and dispersion of pollutants – effect of meteorological and topographical factors, significance of these pollutants and their reactions in the lower and upper atmosphere,, Greenhouses effect, radiative forcing and global warming, Photochemical smog, Oxygen and Ozone chemistry, Ozone layer depletion Acid rain and their impact. History of some major air pollution episodes and case studies of some air polluting industries (thermal power , steel ,aluminum ,cement etc.) ,effect of air pollutants on plants, animals, microorganisms, man, physical structures and materials.

Unit-II: Prevention and Control of Air Pollution (1Cr)



Principles and instruments for measurements of (i) ambient air pollutants concentration and (ii) stack emissions. Indian National Ambient Air Quality Standards. Impact of air pollutants on human health, plants and materials. Acid rain. Dispersion of air pollutants. Mixing height/depth, lapse rates, Gaussian plume model, line source model and area source model. Source-emission inventory, Air quality criteria, Air quality standards(Ambient and Emission Standards), Natural self cleansing properties of the environment, Dilution methods for controlling air pollution from stationary source, Prevention Methods for control of gaseous air pollutants (Combustion ,Absorption and Adsorption), Methods for control of Particulate air pollutants Mechanical device , Filtration , ,Wet scrubber ,Dry Scrubber , Electrostatic precipitator)

Unit-III: Water Pollution (1 Cr)

History of major water pollution episodes, Sources, Classification and types of Water Pollution, characteristics of domestic, municipal, industrial and agricultural wastes – their effects with special reference to oil and detergents, and Heavy metals (mercury, lead, Arsenic cadmium, chromium), pesticides, and other toxic organics and inorganic constituents, Eutrophication and ecological magnification due to water pollution, History of some major water pollution episodes and case studies of some water polluting industries (Sugar and molasses Pulp and Paper Dairy Textile, Food processing, leather etc.)

Unit-IV: Noise Pollution and Control (1 Cr)

Basic properties of sound waves-plane and spherical waves, sound pressure and intensity levels, decibel, effect of meteorological parameters on sound propagation. Noise sources; (machinery noise, pumps; compressors, building and construction equipment, domestic appliances, traffic – vehicular, train, aircraft) effect of noise on human health, noise standards and limit values. Prevention and control of Noise Pollution (sound absorbing materials, reverberation time, acoustic silencers, mufflers, barriers, vibration and impact isolation, anechoic chamber, greenbelt development). Sources, weighting networks, measurement of noise indices (Leq, L10, L90, L50, LDN, TNI).

Books & References

1 N. de Nevers, Air pollution Control Engineering, Mc Graw Hill, 2000.
2 K. Work and C. F Warner, Air Pollution, its origin & Control, New York, 1997.
3 H. Braur and Y. B. G. Verma, Air Pollution Control Equipment, Springer Verlag, 1981.
4 G. Gaur, Air Pollution and its Management, Sarup & Sons, 1997.
5 R. K. Trivedi and P. K. Goel, Air Pollution, Techno-science, 1998.
6 G. Kiely, Environmental Engineering, Tata MC. Graw Hill, 1997.
7 P. K. Goel, Water Pollution , Causes ,effect and Control, New Age International, 2006.
8 S. K. Garg, Sewage Disposal & Air Pollution Engineering, Khana Publisher, 2008.
9 I. J. Higgins and R. Burns, The Chemistry and ecology of pollution, Academic Press, 1975.

10 S. S. Dara, A text book of Environmental Chemistry and Pollution Control, S. Chand, 1993.
11 A. K. De, Environnental Chemistry, New Age International, 2003.
12 J. W. Moore and E. A. Moore, Environmental Chemistry, Academic Press, 1991.
13 T H Y Tebbut, Principal of water quality control, Pergamon Press, 1992.
14 R. K. Trivedy and S. N. Kaul, Advances in Waste water Treatment and Technologies, Vol. II, Global Science, 2000.
15 P. F. Cunniff, Environmental noise pollution, Wiley, 1977.

Course-9: Water and Wastewater Treatment Technologies (4 Cr)

Unit-III: Water Pollutants and Treatment (1 Cr)

Types and Sources, quality of water (water, sewage and industrial wastewater), various stages of water treatment flocculation and coagulation, Sedimentation, Filtration: slow and rapid sand filters, disinfection

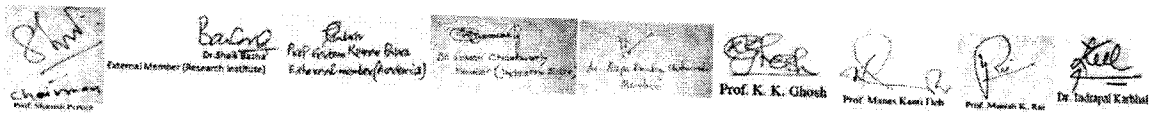
Unit-II: Wastewater Treatment (1 Cr)

Characterization and degree of treatment-Self purification in a stream, characteristics of waste water and treatment plant effluents, Dissolved oxygen, Esturine pollution **Primary treatment**: Screening, Grit removal, Neutralization, Equalization, Coagulation, Flocculation, Sedimentation, Flotation (oil & grease removal), Air stripping **Secondary treatment**-principles of waste treatment, basic kinetic equations, continuous flow treatment models, oxygen requirement in aerobic process, production of sludge. Conventional biological process: Activated Sludge Process (ASP), UASB, Trickling Filters and RBC, ***Nitrogen removal***: Nitrification and denitrification process, phosphorous removal. Low cost wastewater treatment: Aerated lagoons, stabilization ponds, oxidation ditches.

Unit-III: Tertiary Treatment of Wastewater (1 Cr)

Tertiary treatment-ion exchange, Membrane separation Techniques: Brief description of MF, UF, NF membranes. Reverse osmosis principle , Membrane materials , Types of membranes – Plate & frame , tubular, hollow fibre , spiral wound membranes, application of membranes in various industrial applications., ***electro chemical techniques***: electro dialysis, electro coagulation, ***Evaporators***: forced evaporation , Multiple effect evaporators – falling film , raising film , forced circulation , agitated thin film driers. Advanced oxidation process, photo catalysis, Ozonation, Fenton process, Hydrodynamic cavitation.

Unit-IV: Sewage and Industrial Wastewater Treatment and Disposal (1 Cr)



Introduction, importance of sewage, Characteristics of sewage, Sewage treatment and disposal: Grit chamber, Sedimentation tanks, Secondary treatment: Activated sludge process, sludge digestion. Sludge disposal. Septic tank.

Sources, Characteristics, methodology and process for the treatment of industrial wastes of sugar industry- beverage industry- tannery industry- textile mill waste industry- fertilizer plant- steel plant- oil refinery-paper and pulp mill. Legislation, Cleaner technologies: Water conservation, By-product recovery, Zero liquid discharge (ZLD).

Books & References

1. Water Supply and Sanitary Engineering G.S.Bridie & J.S.Brides, Dhanpat Rai & Sons 1993.
2. A treatise on Rural, Municipal, and industrial water management KVSG Murali Krishna
3. Environmental sanitation (Social and Preventive medicine) Dr.P.V. Rama Raju & KVSG Murali Krishna.
4. Waste water engineering, treatment and reuse by Metcalf and eddy, fifth edition, Tata Mc Graw Hill.
5. Municipal and Rural Sanitation-Ehlers,V.M.&Steel,E.W.McGRAW-HILLBook Company,IncV.edition. 1987.

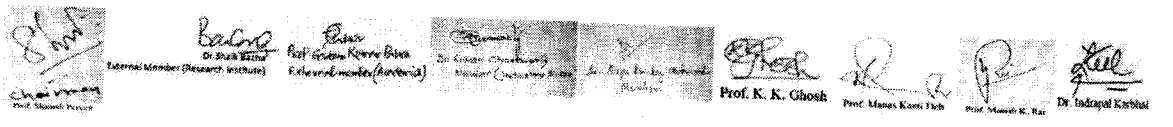
Course-10: Environmental Geosciences (4 Cr)

Unit-I: Fundamentals of Geosciences (1 Cr)

Different spheres in the earth: lithosphere, hydrosphere, atmosphere, biosphere; Primary differentiation and formation of core, mantle, crust, magma generation and formation of igneous rocks: earth dynamic processes: plate tectonics, types of plates, isostasy, geomorphic agents: river, wind, snow, glacier, volcanoes, weathering, erosion, transportation and deposition of earth's materials by running water, wind and glaciers: formation of land forms and sedimentary rocks

Unit-II: Environmental Geochemistry (1 Cr)

Concept of major, trace and rare earth element, Geochemical classification of elements: Abundance of elements in the bulk earth, crust, hydrosphere, atmosphere and biosphere. mobility of trace elements, geochemical cycles, biogeochemical factors in environmental health, human use, trace elements and health, Mineral stability diagrams and controls on the chemistry' of natural waters.



Unit-III: Surface Water Resources and Environment (1 Cr)

Global water balance, ice sheets and fluctuation of sea levels, origin and composition of sea water, hydrological cycle, and its components. Precipitation(Various form of precipitation, interpretation of precipitation data), Evaporation and Evapo-transpiration (Meteorological factors, transpiration, methods of estimating evaporation from land surface using Penman's equation), Infiltration and percolation(Infiltration capacity of soil, Factors influencing infiltration capacity, methods of determining infiltration capacity) Runoff (Duration of runoff, flow rating curves-their determination, adjustment and extension, catchment characteristics and their effects of runoff), climatic factors. Hydrological forecasting: Frequency analysis, probability of the N-year event, series of events, Probability plotting, cyclical nature of hydrological phenomena.

Unit-IV: Ground Water Resources and Environment (1 Cr)

The occurrence of ground water factors of influence, ground water flow, abstraction of ground water, Darcy's law: Darcy's experiment; Fundamental Equation of ground water flow: Generalization of Darcy's law. Aquifer and its types; Confined and Unconfined aquifers; Properties of Aquifer, permeability, porosity. Groundwater occurrence & movement; Ground water levels and Environmental influences. Water conservation-development of watersheds, Rain water harvesting and ground water recharge.

Books and References

1. Environmental Geology: Indian Context by K. S.Valdiya ,Tata Macgraw Hill
2. Environmental Science : E. D. Enger and B. F. Smith
3. Introduction to Geochemistry : Krauskoph K. B.
4. Geology and our environment, Davis, S. N. , Reiton, P. H.& Pestrong, P. Mc.Graw Hill, NY
5. Environmental Geology, Keller, E,.A., Bell &Howell, Columbus, Ohio
6. Physical Geology, Strahler, A. N., John Harper & Row
7. Focus on Environmental Geology, Tank, R.W.Oxford Univ. Press
8. Text Book of Geology, P. K. Mukherjee
9. Environmental geology, Coates, D. R. , John wiley, NY

Course-11: Practical (4 Cr)

1. Determination of pH in given soil sample.
2. Determination of sodium in given soil sample by using flame photometer.
3. Determination of potassium in given soil sample by using flame photometer.
4. Determination of lithium in given soil sample by using flame photometer.
5. Determination of iron content in given soil samples by UV-Visible spectrophotometer.
6. Determination of phosphorus content in given soil samples by UV-Visible spectrophotometer.
7. Determination of sulphate content in given soil samples by UV-Visible spectrophotometer.
8. Determination of boron content in given soil samples by UV-Visible spectrophotometer.

9. Determination of total organic carbon present in given soil sample by Reverse Titration method.
10. Determination of calcium ion in given soil sample by titration method.
11. Determination of magnesium ion in given soil sample by titration method.
12. Other advanced practical.

Course-12: Practical (4 Cr)

1. Determination of CO_2 concentration level in indoor air by using CO_2 meter.
2. Determination of CO concentration level by using CO meter.
3. To determine the sound level by using sound meter.
4. Determination of weather parameters by Weather & Environmental meter.
5. Collection of PM10 and determine its concentration /distribution in outdoor air.
6. Collection of PM10-2.5 and determine their concentration /distribution in outdoor air.
7. Determination of biological oxygen demand in given water samples.
8. Determination of total organic carbon in given water samples.
9. Determination of productivity in aquatic ecosystem by light and dark bottle method.
10. Determination of total alkalinity in given water samples by titration method.
11. Determination of chemical oxygen demand in given water samples.
12. Other advanced practical.

Semester-III (24 Cr)

Course-13: Environmental Toxicology (4 Cr)

Unit-I: Introducing Toxicology (1 Cr)

History, disciplines and importance of toxicology, Potency and Toxicity, Acute toxicity, chronic toxicity), Hazards ,Risks, Benefit-to-risk-ratio, tolerance limits, Acceptable daily intake, Threshold value. Factors affecting toxicity : Host factor (Age ,species and strain, sex, life stage, health and nutrition, Idiosyncratic toxicity) interaction between chemicals (synergistic, additive and antagonistic).Environmental factors, Physico-chemical properties of toxic substances, route and rate of exposure, Dose, Effect and response, Dose-response curves , & Dose effect relationships (Graded & Quantal response). Statistical concept of toxicity, margin of safety and therapeutic index

Unit-II Translocation of Toxicity (1 Cr)

Absorption, Distribution and Excretion of toxic substances. Absorption: membrane permeability, mechanism of chemical transfer (passive transport, active transport, facilitated transport), absorption (Gastrointestinal, skin, lungs). Distribution: tissue affecting distributions and tissues retention. Excretion: Renal excretion, Biliary excretion and Gastrointestinal. Receptor Concept, Nature of receptors, Theory of toxicant receptor interaction, Mechanism of

action of some Pesticides (organochlorine, carbamate and organophosphate) and heavy metals (lead, arsenic, mercury, cadmium and chromium)

Unit-III: Biotransformation and Bioaccumulation of Toxicants (1 Cr)

Site, Biotransformation reactions, Phase-I (Oxidation, Reduction, Hydrolysis) and Phase- II (Conjugation) reactions and associated enzymes (cytochrome P450 system, cytochrome-b5 system, amine oxidase epoxide hydrolase, esterases and amidases, glutathione-s-transferase),factors(environmental, chemical and organismal) affecting biotransformation of xenobiotics, concept of bioconcentration, bioaccumulation and biomagnifications. Process of accumulation and elimination of toxicants

Unit IV: Toxicity Tests and Safety Evaluation of Chemicals (1 Cr)

Toxicity tests: Types of toxicity test based on number of species(single species ,Multipecies and Ecosystem tests) , based on exposure(single dose and multiple dose) , based on duration of exposure (acute and chronic toxicity test), specific toxicity tests(potentiation, teratogenicity, reproductive ,carcinogenicity, skin, eye tests), safety evaluation of chemicals : introduction and definition of safety, process of risk assessment and safety evaluation programmer (nature of chemical, usage pattern, environmental level & fate, human exposure & effect, monitoring, surveillance and follow-up, decision making)

Books and References

1. Toxicology Vol I ,II and III : Gupta, Metropolitan
2. Experimental toxicology : Anderson & Conning
3. Environmental Pollution and Toxicology: Ray Choudhury & Gupta, Today & Tomorrow Publ.
4. Toxicology, Omkar
5. Toxicology, Sood, Sarup and Sons

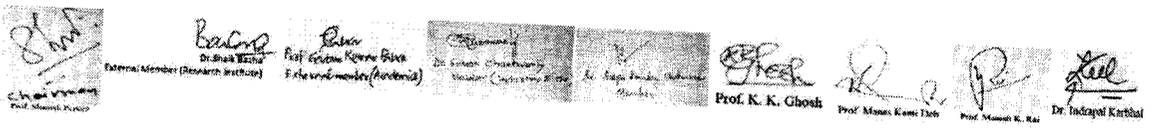
Course-14: Environmental Microbiology (4 Cr)

Unit – I: Fundamentals of Environmental Microbiology (1 Cr)

An over view of microbial diversity (Archaea, Eubacteria, Eukaryotic microbes) cellular organization of bacteria and their types and distribution , microorganisms as component of the environment. Distribution of microbes in air, Allergic disorders by air microflora fungal and pollen allergens. The microbial community in Marine and Fresh water environments. Microbiology of soil – soil habitats, Nutritional types of microorganisms.

Unit- II: Microbial Culture, Enumeration, Growth and Metabolism (1 Cr)

Concept of microbial culture (culture media, culture techniques like enrichment culture, pure, synchronous and continuous culture), Collection and enumeration of aeroallergens. Bacteriological analysis of water, sewage and waste water. Microbial examination of milk & dairy products. Microbial growth (different growth phases, multiplication and kinetics of growth) and microbial metabolism (aerobic, anaerobic, fermentative pathways)



Unit-III: Control of Microorganisms (1 Cr)

Physical agents (temperature, pressure, radiation), chemical agent (bacteriocidal and bacteriostatic compounds, halogens and phenolic) for control of microbes, chemotherapeutic agents (drugs and antibiotics) and their mode of action

Unit-IV: Applied Microbiology

Microbes as biofertilizers, biopesticides and single cell protein, mycorrhiza and their significance, microbial leaching of metals, microorganisms as source of fuel, role of microbes in the synthesis of Alcohols, Antibiotics, Amino acids, dairy products enzymes, vitamin productions and other organic acids, role of microbes in degradation of xenobiotics, microbes for biological treatment of waste water, microbiological biodegradation of Industrial wastes

Books & References:

1. Microbiology – Fundamentals and application R.M. Atlas ,Maxwell-Mcmillan International Ed. 1996
2. Broke –Biology of Microorganisms M.T. Madigan , J.M Martinko and J.Parker ,Prentice Hall International 1998
3. Microbiology -L.M. Prescott, J.P. Harley and D.A. Klein, Tata Mc Graw Hill 2003
4. Fundamentals of Microbiology and immunology, A.K. Banerjee and N. Banerjee ,Central Book Deport 2006
5. Microbiology -Michael J. Pelzer, Tata Mcgraw Hill
6. Microbes, Man and Animals : The Natural History of Microbial Interactions : Linton, A. H. and Burns, R.G. (1982) john Wiley and Sons.
7. Elements of Microbiology : Pelczar, M.J. and Chan ECS, 1981 McGraw Hill.

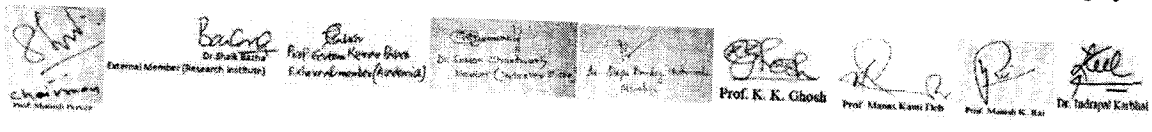
Course-15: Environmental Biotechnology (4 Cr)

Unit-I: Bioremediation (1 Cr)

Scope of bioremediation; types of bioremediation (Natural, solid phase ,slurry phase and bioventing); applications of bioremediation; Bioremediation efficacy testing; Approaches to bioremediation; Role of microbes in biodegradation of xenobiotic compounds:- halocarbons, polychlorinated biphenyls, alkyl benzyl sulfonates and oil mixtures, biodegradation of pesticides, enzyme catalyzed pesticide degradation reactions. Biosorption, Use of bacteria, fungi and algae in biosorption, biomineralisation & bioleaching: Microorganisms involved in Bioleaching of ores, mechanisms of bioleaching, Bioleaching & Metal recovery. Bio indicators, Biomarkers and Biosensors in waste treatment.

Unit-II: Bioremediation of Contaminated Sites, Wastelands and Industrial Wastes (1 Cr)

Bioremediation of contaminated soils (natural attenuation and in-situ subsurface bioremediation) and aquifers (Root Zone Technology and Water Hyacinth – Based Treatment Systems).; bioremediation in aquaculture, Bioremediation of industrial wastes (distillery, pulp and paper, tannery, textile and dye, dairy and food processing). Phytoremediation (phyto-extraction, phyto-



stabilization, phytovolatilaztion, rhizodegradation and rhizofilteration), phytoremediation of inorganic, metallic and organic pollutants in contaminated sites, bioremediation of problematic soil: Coastal saline soil, Alkali soil and mine waste soil; waste land, types of waste land, microbial and earthwormic way of amelioration of waste lands.

Unit-III: Biotechnology for Air and water Pollution Abatement (1 Cr)

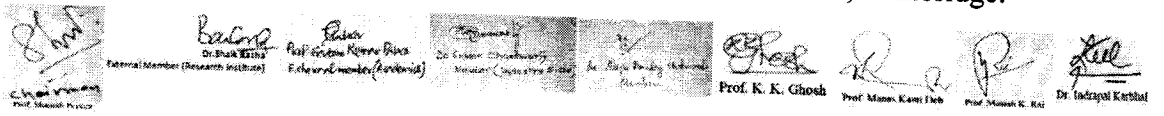
Air Pollution abatement: Bio-scrubber and Bio-filter, Water Pollution Abatement: Aerobic (Activated Sludge Process, Career advanced Activated Sludge Process, Biological Filters ,Rotating Biological Contractors, Fluidized Bed Reactors, Inverse Fluidized and Bed Biofilm Reactor, Expanded Bed Reactor) Anaerobic Biological Treatment (Contact digester, Packed bed or Packed Volume Reactor , Anaerobic baffled digester, Up flow anaerobic sludge blanket reactors), Membrane Bioreactor and Biocatalyst

Unit-IV: Biotechnology for Solid Waste Management (1 Cr)

Potential availability and composition of crop residues and other solid organic wastes. Principles of microbial Composting, Factor influencing composting. Methods of composting (aerobic and anaerobic). Degradation of cellulose, hemicelluloses, chitin, lignin, proteins, fats and waxes) during composting, and end products of composting, Vermicomposting (composting through Earthworms), advantages of vermicomposting over composting. Types of earthworm suitable for vermicomposting. Method of vermicomposting Changes during vermicomposting. Nutrient value of vermicomposts, Effect of vermicomposting on soil fertility and crop productivity, aquatic plant, organic wastes and energy crops for biogas, alcohol and hydrogen production using microorganisms, bioconversion of agricultural, Sewage sludge, Paper waste, sugar mill wastes, tannery sludge) to feed stuffs and fertilizers.

Books & References:

1. Wastewater Engineering Treatment disposal Reuse – Metacalf & Eddy Inc. 4th ed TMGHI ,New Delhi, 2003
2. Environmental Engineering Peavy, HS, Donald RR & G Tchobanoglous MGH Int. Ed. New York 1985
3. Wastewater Treatment for Pollution Control – Soil J Arceivala, Tata Mc Graw Hill 2nd ed. 1998
4. Wastewater Treatment Plants: Planning, Design and Operation- S.R. Qasim, Holt, Rinehart & Winston, 1985
5. Industrial Water Pollution Control – WW Eckenfelder, Jr. McGraw Hill 2nd Edition NY 1989
6. Sewage Disposal and Air Pollution Engineering, S.K. Garg, Khanna Publisher
7. Waste Water Engineering, G.L Karia & R.A Christian ,Prentice Hill Publication,2nd Edition, 2006.
8. Microbial Methods for Environmental Biotechnology: Grainer, J.M. and Lynch, J.M. 1984. Academic Press.
9. Methods in Biotechnology: Hans Peter Schmauder
10. Global environmental Biotechnology: D. L. Wise
11. Basic environmental technology: Jerry A. Nathanson.
12. Basic Biotechnology Ed. Colin Ratledge & B Jorn Kristiasen, Cambridge.



13. Environmental Biotechnology S.K. Agarwal, APH
14. Managing Industrial Pollution S.K. Bhatia, MacMillan
15. Biological and Biotechnological control of insect Pests, Rechcigl and Rechcigl, Lewis
16. Hand book of Bioremediation, Norris et al., Lewis
17. Micro-organism in Action: Lynch & Hobbie
18. Soil Biotechnology: Lynch Blackwel
19. Waste Recycling for energy conversion: Kutand and Hare, Johnwiley and Sons, N Y.
20. Refuse Recycling : Holms, John wiley & Sons, New York

Course-16: Data Analysis in Environmental Sciences (4 Cr)

Unit-I: Fundamentals of Statistics (1Cr)

Population & sample, Variables, Primary and secondary data, Collection of data, Classification and tabulation of data, Need and usefulness of Diagrams & Graphs, Different types of diagrams and graphs. Frequency distribution: Discrete and continuous frequency distribution, sampling methods (random sampling, Stratified random sampling, Systematic sampling), sampling errors, Experimental design: completely randomized block design, randomized block design, Latin square design.

Unit-II: Descriptive Statistics (1 Cr)

Measure of central tendency (Averages), Types of mean: Arithmetic mean, Geometric mean, Harmonic mean; Median, Mode, relation between mean median and mode; Measure of dispersion: Range, Mean deviation & Standard deviation; Skewness and Kurtosis .

Unit-III: Theoretical Probability Distribution (1Cr)

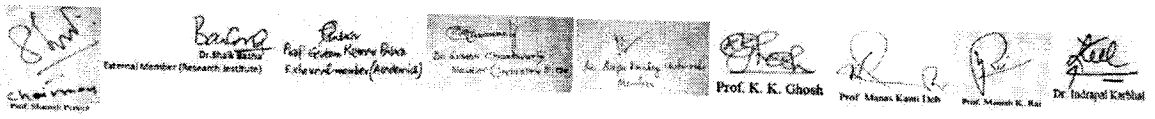
Binomial, Poisson and normal distribution; Testing of Hypothesis: Null and Alternative Hypothesis, level of significance, Student's t distribution and its application, Chi-square(x^2) test & its application.

Unit-IV: Correlation, Regression and ANOVA Analysis (1 Cr)

Types of correlation; simple, partial and multiple correlation, Method of study & testing the significance of correlation coefficient, Rank correlation, Regression analysis: regression equations and regression lines, Properties of regression lines, regression coefficient, testing the significance of regression coefficient. Analysis of variance (ANOVA): One way and two way classification and their applications.

Books and References

1. Walpole, R. and R. Myers (1993). Statistics for Engineers and Scientists, 5th edn. MacMillan, N.Y.
2. Manly (2001) Statistics for environmental science and management, Chapman and Hall / CRC.
3. Statistics : Gupta, Sultan & Chand



4. Fundamental of Statistics: Elhance
5. Biostatics: Mishra & Mishra
6. Statistical Methods: Snedecor and Cochran
7. Introduction to Biostatistics by N. Gurumani, MJB Publisher

Course-17: Practical

1 Sampling of indoor and outdoor aerosols.
2 Detection and determination of trace gases in air.
3 Determination of sound intensity in air.
4 Determination of carbon di-oxide levels in air.
5 Determination of meteorological parameters in air.
6 Determination of ions and metals in aerosols.
7 Determination of toxic elements in air.
8 Determination of Fat in milk sample.
9 Determination of urea in milk sample.
10 Determination of detergent in milk sample.
11 Other advanced practical.

Course-18: Practical

1 Determination of *E.Coli* in water sample by using bactaslide.
2 Determination of *salmonella sp.* in water sample by using bactaslide
3 Determination of *Pseudomonas sp.* in water sample by using bactaslide
4 Analysis of ions with ion chromatography.
5 Analysis of metals with flame photometer.
6 Analysis of metals with AAS.
7 Analysis of the VOCs with gas chromatography.
8 Analysis of H, C, N and O.
9 Analysis of organics with HPLC.
10 Analysis of ions with ion-selective electrodes.
11 Other advance practical.

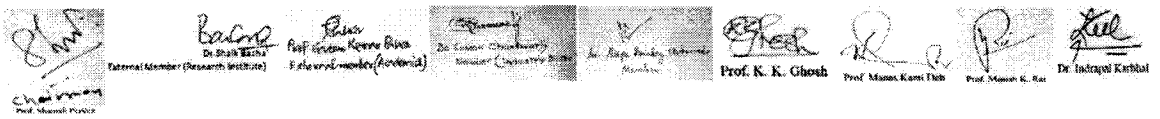
Semester-IV (24 Cr)

Course-19: Remote Sensing and Geographical Information System (4 Cr)

Unit-I: (1 Cr)

Introduction to Remote sensing Science & Technology: Principles of Remote sensing, Physical basis of Remote sensing. The nature and generation of Electromagnetic radiation (EMR). Interaction of EMR with the atmosphere and earth's surface features. Spectral signatures and characteristic spectral reflectance curves for rocks, soil, vegetation and water. Spectral quantities. Far and near infrared and microwave remote sensing.

Unit-II: (1 Cr)



Remote Sensing Observation and Platforms: Air borne and space borne platforms, their relative importance and applications, Orbital geometry. Remote Sensing Satellites. Sensors, Aerial cameras and type of aerial photography, Photo scale and photo elements, Single and multi band scanners MSS sensor and other type of sensors. Aerial Stereo coverage and. Details of sensors on board. Latest Earth resources Satellites viz. LANDSAT 6/7/8, SPOT, IKONOS, IRS,ERS, MODIS, RESOURCESAT, CARTOSAT, GOES,OCEANSAT.
Hyperspectral imaging, RADAR and LIDAR techniques, Indian scenario of remote sensing.

Unit-III: (1 Cr)

Digital image processing: Introduction to digital structure and data recording format sets. Visual Photo-Interpretation Techniques based on Photo elements and Terrain elements, Image Restoration, Enhancement and classifications, Significance of Ground Truths and Training Sets in Image Processing and in automated processing.

Unit-IV: (1 Cr)

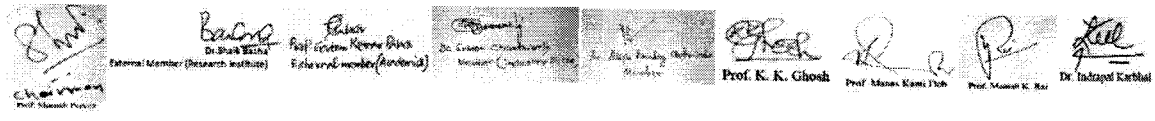
Geographic information system: Introduction, Definition and Terminology, Map Protection and Coordinate system, GIS system hardware, software and infrastructures. Basic components of GIS software. Data structures. Data models, Data acquisition, Data Input and Data processing and management including topology, TIN model, DEM/DTM generation, overlying and Integration and final data product and report generation Integration of Remote sensing and GIS techniques and its applications in land use/land cover and Environmental resource studies

Books and references:

1. Remote Sensing and GIS, Angi Reddy, The Books Syndicate, Hyderabad, 2000
2. Principles of Geographical Information Systems- P. A Burrough and R. A. Mc Donnel, OUP, Oxford, 1998.
3. Remote sensing for Earth Resource-Rao, D. P., AEG Publication, Hyderabad, 1987.
4. Geographical Information System-Kang Tsung Chang, Tata Mc Graw Hill, Publication Edition, 2002
5. Remote Sensing and Its Application –LRA Narayan University Press
6. Remote Sensing and GIS- Basudeb Bhatta Oxford University Press, 09-Oct-2011 - 752 pages
7. Remote Sensing of the environment, John R. Jensen, Dorling Kindersley India, Pvt. Ltd. 2009 - 592 pages
8. Remote sensing and image interpretation, Thomas M. Lillesand, Ralph W. Kiefer, Jonathan W. Chipman –

Course-20: Environmental Economics & Sustainable Development

Unit I: Fundamental of Economics and Environment (1 Cr)
Economics and Environment concepts, role, scope and significance of environmental economics, natural environment, environmental ecology, Eco-Tourism, economics activities and the environment, the market economy, consumer behavior and demand, producer behavior



and supply, consumer and producer surplus, efficiency and perfect competition, imperfect market, market failure and externalities- pecuniary, non-pecuniary or technological, consumption, monopoly and externality, externality and industrial output, approaches to environmental pollution, government policies. Economic growth, Gross National product and the quality of life: Sustainable-earth economy, Economics and Pollution control, Discount factor, Cost-benefit and cost effectiveness analysis

Unit II: Method and Application of Environmental Economics (1Cr)-

Method and Application utility, benefits and costs analysis, concepts of risk and uncertainty, sensitivity analysis, risk analysis, stakeholder behaviors, existence and Bequest values, instruments for environmental control applications – non-compliance fees, tax emissions, economic and the environmental trends, economic growth and welfare, trade and the environment, policy implications.

Unit III: Issues and environmental problems (1Cr) –

Current issues and environmental problems: poverty, population and the environment, environmental degradation in developing countries, biodiversity losses, resource conservation economics of conservation, limits to growth, ecological economics, thermodynamics and the environment, waste recycling, India's development in an ecological perspective, Carbon sequestration and carbon credits, Swachha Bharat Abhiyan. Sustainable Habitat: Green Building, GRIHA Rating Norms.

Unit IV: Concept and strategies of sustainable development, Sustainability of resources (1Cr).

The 17 sustainable development goals (SDGs) to transform our world: No Poverty, Zero Hunger, Good Health and Well-being, Quality Education, Gender Equality, Clean Water and Sanitation, Affordable and Clean Energy, Decent Work and Economic Growth, Industry, Innovation and Infrastructure, Reduced Inequality, Sustainable Cities and Communities, Responsible Consumption and Production, Climate Action, Life Below Water, Life on Land, Peace and Justice Strong Institutions, Partnerships to achieve the Goal.

Reference Book:

1. Hussell, A., Principles of Environmental Economics, Routledge
2. Faber, M & Manstelton, R, 1996, Ecological Economics, Edward Elger Pub.
3. Pearce, D.W & Turner, RK, Economics of Natural Resources & Environment, Harvester
4. Dasgupta, P. & Maler, K., 1998, Environmental & Developmental issues, Basil Blackwell.

Course-21: Environmental Impact Assessment, Environmental Audit and Environmental Management System Standards (EIA, EA and EMSS) (4 Cr)

Unit-I: Origin and Development of EIA (1 Cr)

Nexus between Development and Environment, Comparison between economic and Ecological criteria, Concept of externalities, shared resources, Global commons & carrying capacities. Origin and Development of EIA. Relationship of EIA to sustainable Development. EIA in Project planning & Implementation, EIA process: Evaluation of proposed action,

Scoping, EIA methodologies. Role of GIS in EIA baseline studies. Risk Assessment and Risk Management: Mitigation measures, comparison of alternatives, Reviews and decision making ,compensatory actions, EIA notifications/regulations in India, Green belts: Review of Procedure, Practices and guidelines in India. EIA vs. SEA, Carrying capacity, Cumulative impact assessment.

Unit-II: Case Studies on EIA (1 Cr)

EIA of (a) River valley Projects, (b) Thermal Power Plants, (c) Mining Projects, (d) Integrated Iron and Steel Industries, (e) Cement Industries, (f) Oil Refineries and Petrochemicals, (g)Tourism, (h)Coastal zone Development.

Unit-III: Environmental Audit (1 Cr)

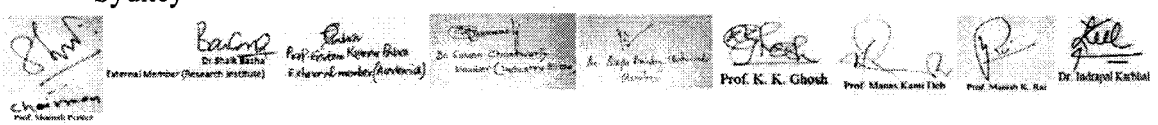
Concept of Environmental Audit, Objectives of Audit, Types of Audit, Audit methodology, Features of effective auditing, Elements of audit process, Program Planning, Organization of auditing Program, Pre-visit data collection, Audit Protocol, On site audit: Data sampling, Inspection, Evaluation and Presentation, Audit report, Action Plan, Management of audit, Waster audits and pollution prevention assessment, Liability audit and site assessment, auditing of EMS, SWOT Analysis (Strength, Weakness, Opportunities and Threats analysis) for EIA, Audit Assessing, Economic & Environmental benefits direct from Environmental Audit, Life Cycle Assessment

Unit-IV: Environmental Management System Standards (1 Cr)

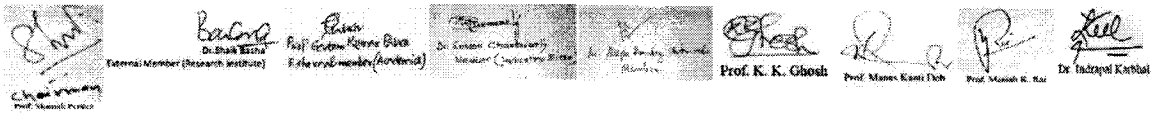
Core elements of EMS, Benefits of EMS, Certification Body Assessment of EMS, Documentation for EMS, EMS standard (ISO9000 & 14000 series): evolution, principles and structure, supporting systems, EMS specification standards & Certification procedures, EMS specification standards:ISO14001, Benefits of Implementing ISO 14001: Indian scenario.

Books and references:

1. Environmental Impact Assessment: Canter, L.W. 1977. Mc Graw Hill, New York
2. Environmental Impact Assessment Methodologies: Anjaneyulu Y. and Minickam V., BS Publications, Hyderabad
3. Manual of Environmental Impact Evaluation-Rosen JJ 1976 Prentice Hall
4. A practical guide to Environmental Impact Assessment, Erickson, P.A., Academic Press
5. Environmental Impact Analysis Hand book Rao & Woolen (eds) 1980 Mc Graw Hill
6. Environmental Quality Management: Bindu N Lohani 1984, South Asia Publ.
7. Environmental Impact Assessment: Alan Gilpin 1995, Cambridge Univ. Press
8. Manual of Environmental Impact Evaluation-Sharma, J. Rosen. Prentice Hall
9. Current documents on guidelines of EIA, MOEF, Govt. of India.
10. Strategic Environmental Assessment. R. Therirvel, E. Wilson, S. Thampson, D. Heany & D. Pritchard.
11. Environmental Impact Assessment- Cutting edge by 21st century- Cutting edge by Alan Gilpin, Cup, London
12. Environmental Impact Assessment & Practice- Theory, P. Wathem, U. Hynman, Sydney



13. A Practical Guide to Environmental Impact Assessment – Paul A Erickson Academic Press
14 Planning and Implementation of ISO 14001, Environmental Management system- Gyani & Amit Lunia, Girdhar Raj Publ, House Jaipur.
15. A guide to the implementation of the ISO 14000 series on Environmental Management- Ritchie I and Hayes co Prentic Hall, New Delhi .
16. Environmental Management, Kulkarni, V. and Ramachandra, T.V., TERI press, New Delhi, 2009
17. Uberoi, N.K. (2010). Environmental Management, Excel Books, New Delhi.
18. ISO 14004 – Environmental management systems : General guidelines on principles, systems and supporting techniques (ISO 14004 : 1996 (E)).
19. Environmental management systems : Specification with guidance for use (ISO 14001 : 1996b (E)). (International organization for standardization – Switzerland).
20. Handbook of environmental management and technology : Gwendolyn Holmes, Ben Ramnarine Singh, Louis Theodore.
21. Environmental Impact Assessment, L. W. Canter, Mc Graw Hill Publication, New York.



Course-22: Environmental Law, Policies and Society (4 Cr)

Unit-I: Water, Air, Forest and Wildlife act (1 Cr)

Constitution of Central and State Pollution Control Boards, Power ,Function and responsibility of Central and State Boards (Objectives, Area of jurisdiction, responsibility of an industry, power and function of state and central Government, Cognizance of offence, Penalties and Punishment), Brief account of The Forest Act 1927 ,Forest conservation Act. 1980: Objective and Jurisdiction, Responsibility of Industry. Wildlife Protection Act 1972 Authorities under the Act. Wild life Advisory Boards and their functions, Detection and prevention of offences. Cognizance of offences, the wildlife (protection) Amendment Act. 1991

Unit-II: The Environment Protection Act 1986 (1 Cr)

Necessity and Scope of the Environmental Protection Act, Powers of the Central Government , Parallel Provisions with the water and the Air act, The Public Liability
Insurance Act 1991, Important rules & notification under the Environment Protection Act 1986 : Public Hearing notification 1997 , Biomedical waste (Handling and Disposal) rules 1998. Recycled plastic manufacture and usage rules 1999 , Municipal Solid Waste (Management and Handling) Rules 2000 ,The Noise Pollution (Regulation and Control) Rules 2000 , , Environmental Impact Assessment Notification 2006 , e-wastes Management and Handling Rules 201, Coastal Regulation Zones (CRZ) 1991 amended from time to time.

Unit-III: Environmental Policies (1 Cr)

Environment and constitutional provisions in India, National & International Trend. Changes in Global Prospective, International Treaties, Brief Note on Stockholm Conference 1972 , , Nairobi Declaration, Rio (Brazil) conference 1992, Rio+5 and the Rio+10, Rio+20, Kyoto Protocol, National Forest Policy, 1988, National Water Policy, 2002, National Environmental Policy, 2006, Johannesburg Conference 2002 National Authorities: Green Tribunal ,Global environmental issues and International policies relating to control Global warming, Ozone depletion, hazardous waste, CITES etc. Role of UN authorities in protection of Global Environment, Multinational authorities and agreements, Environmental Movements in India.

Unit-IV: Society and Environmental Ethics (1 Cr)

Human impact on the Earth, Hunting and Gathering Society, Agriculture Society, Industrial Society, Sustainable -Earth Society: Concept of throw-away and sustainable -Earth Society, our future society; Environmental Ethics: Ethics and moral, ethics of Throw-away & Sustainable-Earth Society, Ethical guidelines.

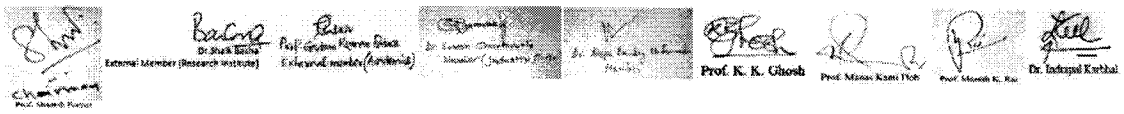
Books and References

1. Hand Book of Environment, Forest and Wild life laws in India, WPSI, Natraj
2. Pollution Control Acts, rules and Notifications issued under CPCB, New Delhi

3. Environmental Laws, New Perspectives, K. C. Agrawal, Nidhi Publisher, Bikaner
4. Wildlife of India, Conservation and Management, K. C. Agrawal, Nidhi Publisher
5. Environmental laws in India, Gurdip Singh, Quality Law Books
7. The Economics of the Environment, Oates W.E.
8. Kanchan Chopra, et al., Ecological Economics and Sustainable Development
9. Economy and the Environment, Goodstein
10. Sumi Krishna : Environmental Politics, Peoples' Lives and Developmental Choices, Sage, New Delhi, 1996
11. Cone J.D., Hayes S.C., Environmental Problems / Behavioral Solutions (1980) California
12. Declaration of The Stockholm Conference, Rio
13. Constitution of India [Referred articles from Part-III, Part-IV and Part-IV-A].

Course-23 Dissertation (8 Cr)

Review or case studies on detection, determination, mapping, sources and control of environmental contaminants.



Elective courses

FOOD ADULTERATION

Courses

UNIT-I: **Food chemistry**

Chemistry of Food, Introduction to Food Processing & Preservation, Technologies of Milk & Milk Products, Introduction to Food Microbiology, Processing & Preservation of Fruits & Vegetables, Processing Technology of Meat & Meat Products, Cereals, Food Packaging, Cereals & Legume Processing, Food Additives, Processing Technology of Beverages, Preservative, Jam, Jellies & Marmalade, Fermentation & Unfermented Products, Food Adulteration, Team Management, Project & Case Study, Industrial Training.

UNIT-II: **Adulteration, preservatives and colouring agents**

Adulteration, Chemical preservatives, Colouring matters, Baking powder and baking-powder chemicals, adulteration of specific foods (i.e. Beverages, Alcoholic, Non-alcoholic, Canned vegetables, Cereal products, Breakfast foods, Flour, Cocoa and chocolate, Coffee and tea, Condimental sauces, Dairy products, Butter, Cheese, Cream, Milk, Edible fats and oils, Flavouring extracts, Fruit products, Meat preparations, Spices, Sugars, sirups,Vinegar, etc.

UNIT-III: **Characterization of food preservatives and colors**

Detection of salicylic acid, Detection of benzoic acid, Detection-of boric acid and borax, Detection of formaldehyde, Detection of saccharin, Detection of coal-tar dyes, Detection of copper, Detection of turmeric, Detection of caramel

UNIT-IV: **Characterization of adulterants in major foods**

Detection and determination of adulterants (pesticides, POPs & others) in cereals, seeds, vegetables, fruits, milk, butter and dairy products, meats, chicken, coffee and tea, spices, Condimental sauces, flavoring agents, oils.

Books

1. Introduction to Food Analysis. S.S. Nielsen, 1998. Aspen Publishers - The best general overview of food analysis techniques currently available. (Required).
2. Food Analysis: Theory and Practice. Y. Pomeranz and C.E. Meloan, Chapman and Hall - General overview of food analysis techniques (Useful)
3. Food Analysis: Principles and Techniques. D.W. Gruenwedel and J.R. Whitaker, Marcel Dekker - General overview of food analysis techniques (Useful)
4. Analytical Chemistry of Foods. C.S. James, Blackie Academic and Professional - General overview of food analysis techniques (Useful)
5. Official Methods Of Analysis, Association of Official Analytical Chemists - Officially recognized methods of analysis for many food components (Very Useful - Available in my office).

WASTE MANAGEMENT

Courses

UNIT-I: Domestic waste

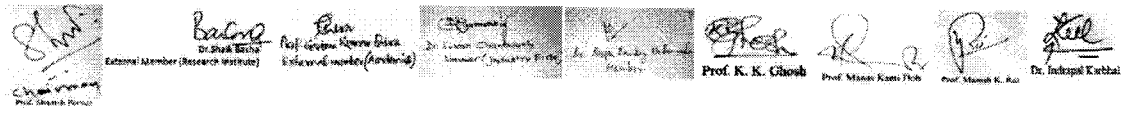
Definitions
The Earth environment
Conservation and use of resources
Value of resources: economic, ecological and aesthetic
Damage being caused by urbanization
The impact of humans
Sewage and it's treatment
Characteristics of Sewage
Components of Sewage –solids, organic material, industrial waste
Decomposition of Sewage
The nitrogen cycle
Classification of Sewerage Systems
Storm Water Systems and Management
Dry Rubbish
Nature of Refuse
Placement and protection of nins
Trade waste
Refuse Collection Systems
Refuse Collection vehicles
Salvage materials
Safe disposal of household chemicals

UNIT-II: Street Cleaning & Disposal of Refuse

Types of Street Refuse
Methods of street cleaning –gritting, sanding, sweeping, washing, etc
Cleaning storm water pits
Managing snow
Refuse disposal-separation, controlled tipping, combustion, pulverization, etc
Refuse for fertilizer
Methods of Refuse Sorting –screening, magnetic, hand sorting
Types of incinerators
Vacuum systems for refuse collection –Garchey system, gandillon
Harvesting energy from combustion

UNIT-III: Industrial Waste & recycling

Types of industrial pollution
The greenhouse effect
Ozone depletion
Nuclear power
Nuclear fission
Mining nuclear fuel
Uranium enrichment



Gas Diffusion
Gas centrifuge
Nuclear waste
Transporting nuclear waste
Reprocessing
Health risks of nuclear waste
Scope and nature of recycling
Rubbish tips (dumps)
Recycling plastics
Recycling metals
Recycling glass
Recycling paper
Recycling rubber
Actions by individuals (at home or work) –reducing, reusing and recycling waste

UNIT-IV: Water Quality & Treatment

Industrial effluent
Pricing control compared with direct control
Types of water impurities
Scope of purification
Managing water for public supply
Water treatment methods
Purification methods –sedimentation, filtration, disinfection, aeration, screening,etc
Recycling sewage water
Recycling waste water
Reed bed treatment
Improving water quality from any source –physical, chemical, biological impurities
Water borne diseases

Books

1 M. Georgacarakos, Guide to waste management including information on recycling, landfills, sustainability, composting, and ways to protect the environment, Webster's Digital Services, USA, 2011.
2 A. S. Weinberg, D. N. Pellow, A. Schnaiberg, Urban recycling and the search for sustainable community development, Princeton University Press, 2000.
3 L. F. Diaz, M. de Bertoldi, W. Bidlingmaier, Compost Science and Technology, Elsevier, 2007.
4 S. R. Rao, Resource recovery and recycling from metallurgical wastes, Elsevier, 2006.
5 M.H. van Agteren, Sytze Keuning, Jan Oosterhaven, Handbook on Biodegradation and Biological Treatment of Hazardous Organic Compounds, Springer; 1998.