Curriculum and content of the courses: Earth & Environmental Science

Serial No.	Course Title	Credits	Instructor/s	Course Type
Semester iv				
UES 202	Introduction to Earth Systems	2:1	Prosenjit Ghosh	Core
UES 204	Fundamentals of Climate Science	3:0	G. Bala, Arindam, C.	Core
UES 206	Experimental Methods in Environmental Chemistry	1:2	Sudhakar Rao, P. Raghuveer Rao	Core
Semester v				
UES 301	Environmental Hydrology	3:0	V. V. Srinivas	Core
UES 302	Design Principles in Environmental Engineering	2:0	Jayant Modak	Core
UES 303	Introduction to Geochemistry	2:1	Prosenjit Ghosh	Elective
UES 304	Introduction to basic geology	2:1	Sajeev K.	Elective
UES 310	Experimental Methods in Solid Waste Management	1:2	Sudhakar Rao, P. Raghuveer Rao	Elective
Semester vi				
UES 306	Surface and Groundwater Quality	3:0	M. Sekhar	Core
UES 307	Introduction to Solid Earth	3:0	Kusala Rajendran	Elective
UES 308	Landfill Engineering	3:0	G. L. Sivakumar Babu	Elective
UES 309	Wastewater treatment	3:0	H. N. Chanakya	Elective
ST210	Principles and Applications of GIS and Remote Sensing	3:1	T. V. Ramachandra	Elective
Semester vii				
UES 401	Natural Hazards and Their Mitigation	3:0	K. S. Nanjunda Rao & V.V. Srinivas	Core
UES 402	Green Chemistry	3:0	K. R. Prabhu	Elective
AS203	Atmospheric Thermodynamics	3:0	A. Charaborthy and G. S. Bhat	Elective
Semester viii				
UES 403	Solid Waste Management	3:0	J.R.Mudakavi	Elective
AS 216	Introduction to Climate System	3:0	G. Bala	Elective
AS 306	Radiative Transfer in the Atmosphere	3:0	J. Srinivasan and S. K. Sateesh	Elective
ST201	Thermochemical and Biological Energy Recovery from Biomass	2:0	S. Dasappa and H. N. Chanakya	Elective

Semester IV

UES 202: Introduction to Earth Systems (2:1, Core)

Earth Surface features, concept of Geomorphology, Weathering phenomena, Physics and chemistry of Earth's interior, Internal processes, tectonics through time, Geological time scale, Bio-stratigraphy, Early Earth, Rock formation, Rock classification, mineralogy, Basics of crystal symmetry, Composition of Atmosphere and origin of atmosphere, Earth like planetary bodies, Evidence of life in other planet, basics of hydrosphere and its component, physical property of water, Elementary Oceanography, chemical composition of ocean, Evolution of life and its diversification.

Instructor: Prosenjit Ghosh

Suggested Books:

1. Patwardhan PHI, The Dynamic Earth System, Learning Private Limited , New Delhi . ISBN -978-81-203-1496-2
2. Kump, Kasting and Crane, The Earth System, Prentice Hall, ISBN 0-13-142059-3
3. G.R. Thompson and J. Turk, Modern Physical Geology, Saunder College Publishing

UES 204: Fundamentals of Climate Science (3: 0, Core)

Atmospheric structure and composition, Observations and theory of the general circulation of the atmosphere, Global energy balance, Radiative processes in the atmosphere, the greenhouse effect, natural and anthropogenic climate change, waves in the atmosphere, clouds, weather systems, tropical dynamics and monsoons, ocean circulation

Instructors: G. Bala & Arindam C.

Suggested Books:

1 Dennis L. Hartmann, Global Physical Climatology, Academic Press, 1994.
2 Wallace J.M. and Hobbs, P.V., Aytmospheric Sciences: An Introductory survey, Academic Press
3 Peixoto J.P and Oort, A.H., Physcs of Climate. American Institute of Physics, New York.

UES 206: Experimental Methods in Env. Chemistry (1:2, Core)

Characterization of Water Quality - Electrical conductivity, pH, Chlorides, Sulphates, Alkalinity, Hardness,
Characterization of pollutants in water - Estimation using spectroscopic and chromatographic techniques

Determination of dissolved and suspended solids in water samples, Determination of turbidity of water samples
Determination of chlorine in bleaching powder, Determine the optimum dosage of coagulant for coagulation of suspended solids in water sample
Estimation of total coliforms by MPN and Membrane Filtration Method
Soil surface sorption properties - Cation exchange capacity, Organic content, Grain size distribution , Pore water salinity

Instructors: Sudhakar Rao, P. Raghuveer Rao

Suggested books:

1. APHA, Standard methods for the examination of water and wastewater. American Public Health Association, 20th edition, Washington DC, (1999).
2. SP 36 : Part 1 : 1987 Compendium of Indian standards on soil engineering: Part 1 Laboratory testing of soils for civil engineering purposes

Semester V

UES 301 Environmental Hydrology (3:0, Core)
Basic concepts, definition and scope of environmental hydrology, Hydrological cycle and energy budget, Hydro-meteorological processes, Watershed hydrology; Hydrology of forests, wetlands and urban areas, Climate change, Hydrological impacts of environmental change; Hydrogeology, Water quality issues in surface and groundwater.

Suggested Books:

Andy D. Ward and Stanley W. Trimble, Environmental Hydrology, Lewis Publishers, 2004.
Singh, V.P. (Ed.), Environmental Hydrology, Water Science and Technology Library, Vol. 15, 1995.
Chow,V. T., David R. Maidment, Larry W. Mays, Applied Hydrology, Tata McGraw-Hill Edition, 2010.

V. V. Srinivas

UES 302 Design Principles in Environmental Engineering (2:0, Core)
Laws of conservation: mass, energy and momentum balances
Fundamentals of chemical reaction engineering: thermodynamics, stoichiometry and kinetics of chemical reactions, chemical reactors – stirred tank and plug flow reactors,
Design for waste water treatment processes: physical unit operations such as sedimentation and filtration, chemical and biological treatment processes
Design for air pollution control: gas-liquid interactions, absorption and adsorption processes, particulate emission control

Suggested Books

1. Mackenzie Davis and Susan Masten, Principles of Environmental Engineering, McGraw Hill, 2004.

2. Mackenzie Davis and David Cornwell, Introduction to Environmental Engineering, McGraw Hill, 2006.
3. James Mihelcic and Julie Beth Zimmerman, Environmental Engineering: Fundamentals, sustainability and Design, John Wiley, 2010
4. Frank R. Spellman and Nancy E. Whiting, Environmental Engineer's Mathematics Handbook, CRC Press, 2005

Jayant M. Modak

UES 303 Introduction to Geochemistry: (2:1, Elective)

Geochemical Fundamentals/Chemistry Review , The Elements; basic principles of inorganic chemistry, periodic properties, Thermodynamics and chemical reactions, solubility , Aquatic Chemistry, pH-pE, Biology and redox , Organic Chemistry

High temperature geochemistry - Planetary geochemistry , Age and Origin of the Solar System., Planet formation, differentiation of the Earth, igneous processes, Radiogenic isotope geology/Geochronology

Low temperature geochemistry - The hydrologic cycle and Sedimentary geochemistry, Chemical Processes, Photosynthesis/respiration, Aquatic Microbial Biochemistry in rain, rivers, lakes, estuaries, Chemical weathering, soil formation, geochemistry of clays, The oceans, marine chemistry, primary productivity, Gaia, Marine Sediments: a record of environmental global history, light isotope geochemistry, Global Climate: Present and Future, atmospheric CO

Lab component: will involve exposure to instrumental methods which include a) titration b) chromatography using liquid and gas columns c) analyses of cation and anion using Ion Chromatography, towards chemical analysis of rock samples, measurement of soil moisture contents, geo-chemical characterization of rock samples and determination of CO_2 concentrations in air

Suggested Books

1**. John Victor Walther**, Essentials of Geochemistry, Jones and Bartlett Publishers 2nd Edition, 2009.

2. **R. Gill,** Chemical Fundamentals of Geology, Springer; 2nd edition, 1995.

Prosenjit Ghosh

UES 304 Introduction to Basic Geology (2:1, Elective)

Classification of rocks; Geology of southern India: tectonic concepts; The earth structures and its significance; Shear/suture zones-identification, interpretation and implications, Fluid influence in shear zones; Petrological, geochemical and geochronological: methods, approaches and inferences, origin-exhumation-weathering: the rock cycle, landforms, element mobility and interactions; Linking rocks/mineral chemistry to tectonics with Indian examples.

Laboratory component: Sample preparation of rock specimens, Petrological observation of rock and mineral thin sections

Suggested Books:

1. Ron H. Vernon & Geoffrey Clarke, Principles of Metamorphic Petrology
Cambridge University Press, 2008.
2. Ron H. Vernon, A Practical Guide to Rock Microstructure, Cambridge University Press, 2004.

3. Using Geochemical Data: Evaluation, Presentation, Interpretation , by Hugh R. Rollinson, Longman Publishing Group, 1993.
4. Kent C. Condie, Earth as an Evolving Planetary System, Academic Press; 1st edition, 2004.
5. Earth Structure: An Introduction to Structural Geology and Tectonics by Ben A. Van Der Pluijm & Stephen Marshak, W W Norton & Co Inc.; 2 edition, 2003.
6. Anthony R. Philpotts, Petrography of Igneous and Metamorphic Rocks, Waveland Pr Inc, 2003.
Sajeev K.

UES 310 Experimental Methods in Solid Waste Management (1:2)

Solid waste characterization - Water leach test, Toxicity Characteristic Leach Procedure

Pollutant sorption capacity characterization – Kinetics & adsorption isotherms, Distribution coefficients

Pollutant transport – Column experiments to evaluate transport and partitioning in vadose and saturated zones, Diffusion coefficients

Laboratory determination of soil permeability for contaminant flow

Chemical solidification of contaminated wastes-Lime and cement stabilization, Leaching and compressive strength measurements

Suggested Books:

1. US EPA publication SW-846: Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, 1996.
2. BIS Compendium on Engineering Properties of Soils

Instructors: Sudhakar Rao, P. Raghuveer Rao

Semester VI

UES 306 Surface and Groundwater Quality (3:0, Core)

Hydrologic Cycle, Water and chemical budgets; Sources and types of water pollution, Water quality standards, Fate and transport in aquatic systems, Rivers and streams, Lakes & Reservoirs, Wetlands, Estuaries. Groundwater flow and geologic controls on flow, Vadose zone hydrology, Contaminant transport in groundwater, Modeling environment.

Suggested Books:

1. Chin, D. A., Water quality engineering in natural systems. Willey InterScience, 2006.

2. Bedient, P.B., Rifai, H.S.,Newell, C.J., Ground Water Contamination: Transport and Remediation. Prentice Hall, Englewood Cliffs, NJ, USA. 1994.

M. Sekhar

UES 307 Introduction to Solid Earth (3:0, Elective)

History of the Earth: Introduction to Earth history, origin of the Earth and solar system; origin and evolution of life, mass extinctions, interpretation of the geological record of Earth history; measurement of geological time, historical development of concepts.

The dynamic Earth: Introduction to the dynamic Earth, Gravity and Magnetic fields, thermal structure and heat flow, Radioactivity, internal structure of the earth. Continental drift and plate tectonics, earthquakes, volcanoes, mountain-building processes; igneous and metamorphic processes; surface processes, erosion, soil, and sediment formation, important morphological features on the earth, interactions among the lithospheric, hydrospheric, atmospheric, and biospheric systems.

Suggested Books:

1. C.M.R. Fowler, The solid earth: An introduction to Global Geophysics, Cambridge University Press, 2005.
2. Philip Keary and Frederick Vine, Global Tectonics, Blackwell Science, 1996.
3. Raymond Siever, John Grotzinger, and Tom Jordan, W. H. Freeman; Understanding Earth, Frank Press, Fourth Edition, 2003.

Kusala Rajendran

UES 308 Landfill Engineering (2:0, Elective)

Physico-chemical and engineering properties of soil, Ground water flow and contaminant transport, Criteria for landfill site location, Design of landfill components such as liners, covers, leachate collection and removal, Gas generation and management, Principles and methods of monitoring ground water quality and quantity, End uses of landfill sites, Risk assessment approaches, Contaminated site characterization and remediation technologies, Environmental laws and regulations

Suggested Books:

1. Rowe, R. Kerry, Quigley, Robert M., Brachman, Richard W. I., and Booker, John R. Barrier Systems for Waste Disposal Facilities , 2nd ed., Spon Press, Taylor & Francis Group, London, 2004.
2. Sharma, H.D., and Reddy, K.R., Geoenvironmental Engineering: Site Remediation, Waste Containment and Emerging Waste Management Technologies, John Wiley & Sons, Inc., Hoboken, New Jersey, 2004.
3. Tchobanoglous, Theisen and Vigil, Integrated Solid Waste Management - Engineering Principles and Management Issues, McGraw Hill 1993.

G. L. Siva kumar Babu

UES 309 Wastewater Treatment (3:0, Elective)

Wastewater generation patterns /sources - quantification and quality issues, Pathogens and microbiological risks from wastewater.

Pollution Indicators - physical, chemical, biological and microbiological.

Water Testing - Physico-chemical properties, Biological and microbiological characteristics.

Microbial Metabolism with respect to waste water remediation and water treatment,
Organic Matter Removal-Anaerobic and Aerobic methods, Modeling activated sludge processes.
Nitrogen, Phosphorus and Pathogen removal from wastewater, Aquatic and water Toxicity and toxicology, Physico-chemical basis and processes for aeration, mixing, settling, microbial killing processes.
Sludge physical properties, settling properties, characterization, remediation, treatment and disposal.
Membrane Bio-reactors, Anaerobic Wastewater Treatment reactor designs, Hybrid reactors, Biofilm Reactors, Anaerobic biofilm reactors.
Micro-biological and Phyto-remediation techniques.
Grey and black water recycling, needs, Ground water pollution, sources and mechanisms, sustainability issues, in-situ and ex-situ bioremediation.

Suggested Books:

1. APHA, Standard methods for the examination of water and wastewater. American Public Health Association, 20th edition, Washington DC, 1999.
2. Metcalf & Eddy Incorporation, Wastewater engineering, treatment and re-use. Revised by George Tchobanoglous, Franklin, L. Burton and H. David Stensel, Tata McGraw-Hill Publishing Company limited, New Delhi., 2003.

Hoysall Chanakya

Semester VII

UES 401 Natural Hazards and Their Mitigation (3:0, Core)

Definitions and basic concepts, different kinds of hazards and their causes, Geologic Hazards: Earthquakes, causes of earthquakes and their effects, plate tectonics, seismic waves, measures of size of earthquakes, earthquake resistant design concepts; Slope instability and landslides, causes of landslides, principles of stability analysis, remedial and corrective measures for slope stabilisation, Climatic Hazards: Floods, causes of flooding, regional flood frequency analysis, flood control measures, flood routing, flood forecasting and warning systems; Droughts, causes and types of droughts, effects of drought, hazard assessment and decision making; Use of GIS in natural hazard assessment, mitigation and management.

Suggested Books:

1. Donald Hyndman and David Hyndman, Natural Hazards and Disasters, Brooks/Cole Cengage Learning, 2008
2. Edward Bryant, Natural Hazards, Cambridge University Press, 2005
3. J Michael Duncan and Stephan G Wright, Soil Strength and Slope Stability, John Wiley & Sons, Inc, 2005.
4. Amr S Elnashai and Luigi Di Sarno, Fundamentals of Earthquake Engineering, John Wiley & Sons, Inc, 2008

K. S. Nanjunda Rao, V. V. Srinivas

UES 402 Green Chemistry (3:0, Elective)

Introduction and principles of green chemistry, Tools of green chemistry-alternative starting material, alternative target/product, Process analytical chemistry, Evaluation of methods to design safer chemicals, Reaction types, yield and atom economy, Examples of green chemistry, Solid acids and bases as catalysts, Organocatalysis, Catalysis and Green chemistry, Catalysis in novel reaction media, Enatoselective catalysis, Future trends in green chemistry.

Suggested Books:

1. Paul T. Anastas and John C. Warner, Green Chemistry: Theory and Practice. Oxford University Press, 2000.
2. William McDonough and Michael Braungart, Cradle to Cradle: Remaking the Way We Make Things. New York: North Point Press, 2002.
3. Paul T. Anastas and John C. Warner, Green Chemistry: Theory and Practice. Oxford University Press, 2000.
4. William McDonough and Michael Braungart, Cradle to Cradle: Remaking the Way We Make Things. New York: North Point Press, 2002.
5. Roger A. Sheldon, Isabel Arends, and Ulf Hansfeld, Green Chemistry and Catalysis.Wiley-VCJ Verlag GmbH & Co. KGaA. Weinreim, Germany, 2007

K. R. Prabhu

Semester VIII

UES 403 Solid Waste Management (3:0, Elective)

Classification and characterization of solid wastes, The RCR (recover, recycle and reuse) principle, Handling and treatment of MSW (municipal solid waste), Biological treatment, Thermal treatment, Landfill, Integrated waste management, Sludge generation from treatment of industrial waste waters, Physico-chemical characterization of sludge, Sludge handling, treatment and disposal options, Siting, operation and maintenance of Toxic Substances Disposal Facilities (TSDFs), Surface and ground water control, Closure and post closure care of land-fills, Treatment of hazardous wastes: Air stripping, Soil vapour extraction, Carbon absorption, Steam stripping, Stabilization and solidification, Thermal methods – combustion, liquid injection incinerators, Biological methods – conventional treatment, In-situ bio-remediation

Toxicology and risk assessment: Toxic effects, dose-response relationships, carcinogens, ecotoxicology, risk, exposure and toxicity assessment, risk characterization, ecological risk assessment.

Environmental, legal and public health aspects of solid waste management

Suggested Books:

1. F.McDougall, P.White, M.Franke and P.Hindle, Integrated Solid Waste Management- Life Cycle inventory, Blackwell Publishing, 2001.
2. Charles A.Wentz, Hazardous Waste Management, McGraw-Hill International Editions, Singapur, 1989
3. G.Kiely, Environmental Engineering, Mc-Graw Hill International Edition, 1998.
4. Dawson and Mercer,Hazardous Waste Management –John Wiley, 1981
5. Lagrega M.D., Buckingham P.L., and Evans J.C., Hazardous Waste Management , McGraw Hill International Edition. (1994)