MS

(Environmental Sciences)

At

Department of Environmental Sciences

Kohsar University Murree

DEPARTMENT OF ENVIRONMENTAL SCIENCES

KOHSAR UNIVERSITY MURREE

KASHMIR POINT MURREE

2nd BOS MEETING AGENDA

Agenda Item 1	**Request for the approval to launch a 2-year MS Environmental Sciences program by the Department of Environmental Sciences at Kohsar University Murree by SP-2023** We aim to commence minimum 2-year and maximum 4-years MS Environmental Sciences program at Kohsar University Murree (KUM).
Agenda Item 2	**Approval for the scheme of study for MS Environmental Sciences program** The department of Environmental sciences request for the approval of following courses for SP-2023 onwards. **Annex 1.** Relevant document is attached
Agenda Item 3	**Eligibility criteria for MS Environmental Sciences program for SP-2023 onwards** Students seeking admissions in SP-2023 and onwards must have BS Environmental Sciences or BS/MSc in relevant fields (BS Chem, BS Biological Sciences, BS Microbiology, BS Biotechnology, BS Botany, BS Agriculture, BS Bioinformatics) **Annex 2.** Relevant document is attached
Agenda Item 4	**Approval for the Departmental Logo** The department of Environmental sciences request for the approval of departmental logo from the experts. **Annex 3.** Relevant document is attached
Agenda Item 5	**Approval for the Diploma Certification Courses** The department of Environmental sciences request for the approval of following courses for the department of Environmental Sciences Solid Waste Management Water / Soil Testing

	Water Conservation Technologies Apiculture Sericulture Hydroponics **Annex 4.** Relevant document is attached
Agenda Item 6	**Approved title of MS Environmental Sciences Degree** The department of Environmental sciences request for the approval of the title of Degree for MS Environmental Sciences MS Environmental Sciences
Agenda Item 7	Any other agenda with the permission of the Chairperson

Dr. Shahida Shaheen
Head of Department of Environmental Sciences

KOHSAR UNIVERSITY MURREE

A. Approved title of Degree: **MS Environmental Sciences**
B. Department: **Environmental Sciences**

1. Requirement of Program

a) The nomenclature of the degree will be "Masters Studies (MS) in Environmental Science".

b) The MS Degree Program will be of two years duration after four years BS Degree in Environmental Science.

c) The MS degree will be based on course work of 24 credit hours along with a mandatory research thesis/dissertation of 6 credit hours as per HECs' policy guidelines.

d) To support the students in their specialized areas of research work, it is suggested that they should opt for courses of at least 12 credit hours from the list of elective courses in consultation with their supervisors/mentors.

e) The areas of specialization may be offered according to the geographic location of the institutions, availability of the faculty and other facilities.

2. Duration of the program and semester-wise workload

1. **Minimum duration of Program:**
2. **Semester-wise Work load:** Minimum 03 courses (09 Credit Hour), Maximum 04 courses (12 Credit Hour) for a full time student

3. NOC of Professional Councils (To be provided by the Departments, if so desired)

N/A

4. Brief Introduction of Program

The 21st century promises both an exciting time and a challenging world to live in. Many of the most complex challenges will be environmental forcing people to divert their attention towards this field. Meeting these challenges will require problem solving

abilities based in natural, social and management sciences, and other disciplines. Environmental Science is the application of a combination of scientific disciplines to issues and questions regarding environmental and socio-economic problems. Environmental degradation, energy crisis, water scarcity, food security; mitigation and adaptation to climate change impacts are the major areas of concern in today's world. The economy is moving towards "Green or low Carbon Economy" based on Carbon neutrality and valuation of ecosystem services.

Environmental protection and conservation along with alleviation of poverty and sustainable development remained high on the global agenda in UN conferences at Stockholm 1972, Rio 1992, New York 1997, Johannesburg 2002, Bali 2007, Rio 2012 and recently. Environmental pollution, depletion of resources and disintegration of ecological functions are of global, regional and local concerns. To prevent continued environmental degradation and the decline of human society, interactions between human and the environment have to be in harmony. This is achievable through an integrated, holistic approach encompassing natural, social and management sciences with political support and technological, economic and social interventions. This will require qualified and trained human resource.

Some of the environmental problems are global whose solutions will require international cooperation. Most of them are complex problems whose solution will require people able to grasp the big picture, able to appreciate and deal with complex problems and able to support strategies having long-way of impacts. We do not have many of these kinds of people; and there is a dire need and we anticipate that the academic programs in environmental science are justifying that national need.

5. Objective to offer Program

Objectives

The teaching objectives of the degree programs in Environmental Science are to:

- enable students to learn how to analyze and assess environmental problems, its inter-relationships with other systems of the society;
- equip student with the knowledge and skill necessary for pollution abatement, environmental conservation, management of natural resources and making path to sustainable development; and
- to impart skills to carry out independent scientific and technical research on various

crosscutting aspects of environmental issues.

6. Scope regarding market, social and employment perspective of Program

The Scope

Environmental Science is a decision support science, which has emerged because of convergence of a wide range of disciplines, therefore, its scope is wide as inter and multi-disciplinary field of knowledge. Its ambit is as wide as the environment itself.

Human resources are equipped with knowledge to support decisions, skills needed to mitigate impacts of climate change or adapt necessary measures and attitude to contribute in development of sustainable life style in the society and to develop green economy.

The degree programs are expected to equip the graduates with an ability to understand the linkages between various biophysical and socio-economic components of environment and with an expertise of: demonstration of capabilities to understand the natural and socio- economic processes driving environmental systems; learning of scientific and technical expertise to solve environmental problems by introducing interventions; and development of interactions with stakeholders, managers and policy makers in addressing environmental issues.

TABLE OF CONTENTS

Scheme of Studies for the Two-year MS/MPhil Degree in Environmental Sciences

Semester- I

S.No	Course	Course code	Credit hours
1	Research Methods in Environmental Science	ENV-701	**3**
2	Climate Change Adaptation and Mitigation	ENV-702	**3**

3	Strategic Environmental Assessment	ENV-703	**3**
4	ELECTIVE 1		**3**
Total Credit Hrs.			**12**

Semester- II

S.No	Course	Course	Credit
1	Environmental Analytical Techniques	ENV-704	**3**
2	ELECTIVE 2		**3**
3	ELECTIVE 3		**3**
4	ELECTIVE 4		**3**
3rd & 4th Semesters	Research Work for Thesis		**06**
Total Credit Hrs.			**30**

List of Course

Core Courses of MS/ M.Phil. program:

Titles	**Course Code**	**Credit Hours**
1. Research Methods in Environmental Sciences	ENV-701	3(3-0)
2. Climate Change Adaptation and Mitigation	ENV-702	3(3-0)
3. Strategic Environmental Assessment	ENV-703	3(3-0)
4. Analytical Techniques	ENV-704	3(2-1)

Elective Courses:

Title:	**Course Code**	**Credit Hours**
1. Environmental Chemistry	ENV-705	3(3-0)
2. Applied Environmental Microbiology	ENV-706	3(2-1)
3. Freshwater Ecology / Limnology	ENV-707	3(3-0)
4. Environmental Sociology	ENV-708	3(3-0)
5. Disaster Risk Management	ENV-709	3(3-0)
6. Marine Pollution Management	ENV-710	3(3-0)
7. Epidemiology	ENV-711	3(3-0)
8. Population Dynamics and Environment	ENV-712	3(3-0)
9. Environmental Biotechnology	ENV-713	3(2-1)
10. Wetland Management	ENV-714	3(3-0)

11. Wildlife and Forest Conservation	ENV-715	3(3-0)
12. Alternative Energy Sources	ENV-716	3(3-0)
13. Remote Sensing & GIS	ENV-717	3(2-1)
14. Environmental Risk Assessment and Management	ENV-7 18	3(2-1)
15. Principles and Applications of Bioremediation	ENV-719	3(3-0)
16. Sustainable Urban Planning and Management	ENV-720	3(3-0)
17. Sustainable Agriculture	ENV-721	3(3-0)
18. Health, Safety and Environmental Management	ENV-722	3(2-1)
19. Energy and Environment	ENV-723	3(3-0)
20. Carbon sequestration and Environment	ENV-724	3(3-0)
21. Advances in Plant Ecology	ENV-725	3(3-0)
22. Biological Conservation	ENV-726	3(2-1)
23. Urban Ecology	ENV-727	3(3-0)
24. Laboratory Management Practices	ENV-728	3(1-2)
25. Restoration Ecology	ENV-729	3(3-0)
26. Gender and Environment	ENV-730	3(3-0)
27. Global Environmental Politics	ENV-731	3(3-0)
28. Coastal Environment and Management	ENV-732	3(3-0)
29. Agrochemicals in the Environment	ENV-733	3(3-0)
30. Remediation Strategies for Contaminated Environment	ENV-734	3(3-0)
31. Treatment and Management of Wastewater	ENV-735	3(3-0)
32. Environmental Application of Nanomaterials	ENV-736	3(3-0)
33. Green Economy	ENV-737	3(3-0)
34. Environmental Education	ENV-738	3(2-1)
35. Polymers and the Environment	ENV-739	3(3-0)
36. Environmental Geology	ENV-740	3(3-0)

SEMESTER 1

RESEARCH METHODS IN ENVIRONMENTAL SCIENCE

Course Code. ENV-701

Credit hours 3 (3-0)

Objectives:

The objective of this course is to equip the students with the skills to undertake a project by planning, designing and defining a research problem; and select indicators and parameters of research and its methodologies.

Course Outlines:

Introduction to Research, Nature of Research, Purpose of Research, Ethics in Research, Types of Research, Tools of Research, Scientific Methods, Techniques & Pre- requisites for Scientific Research, Types of Questions, Types of Relationships, Variables, Hypothesis, Types of Data, Starting a Research Project/Research Proposal, Research Project Conceptualization, Elements of a Research Proposal, Critical Thinking and Developing the Research Question, Defining the Research Problem; Choosing the Research topics, Research Proposal: its importance - A pre-requisite for Research, Research Proposal Writing Techniques, Research Design; Importance of Research Design, Formulation of Research Design Reliability, validity, generalization, Experimental design and use of indicators in research, Tradeoffs in design decisions, Sampling Design; Introduction to sampling design, Logic of Sampling; Concepts and Terminologies, Types of Sampling Designs (Classifying experimental design, factorial design, randomized block design, covariance design, Quasi experimental design) Relationship among pre-post design. Advances in Quasi Experimentation, Survey of Research, Questionnaires construction, How to put things together? Introduction, Objectives, Material and Methods, Review of Literature, Bibliography, Literature Search: Database, Search Engines; Analytical tools in research: qualitative and quantitative methods; Evaluation Research: How to carry out evaluation research, Data Collection: Techniques in data collection: Quantitative & Qualitative Data, Experimental Research, Case Studies, Surveys, Interviews, Questionnaire Data Analysis: Conclusion, Validity - Statistical analyses, Descriptive Statistics (Correlations) Inferential Statistics, Univariate Analysis, Bivariate Analysis, Multivariate Analysis (T-Test, Generalized linear model, Factorial design, randomized block analysis, Analysis of covariance, Regression Analysis), Data Interpretation, Current data interpretation with comparative studies (Inter laboratory comparison), Inference based on findings; Research Presentation Techniques – Data presentation

Recommended Books:

1. *Students project in Environmental Science*, *Harrad,S.*,Batty,h., Diamon, M. and Arhonditsis, G, John and sons Ltd., Chichester, England, 2008.

2. *Designing and Conducting Mixed Methods Research*, Creswell, J. W. & Plano Clark, V.L. Thousand Oaks, Sage CA, USA, 2007.

3. *The Craft of Research* by Wayne C. Booth, 2nd Edition, Univ. of Chicago Press. USA, 2003.

4. *Case Study Research: Design and Methods*, Robert Yin, 3rdEdition, Sage Publishers. USA, 2003.

5. Gliner, J. A., & Morgan, G. A. (2000). *Research methods in applied settings: an integrated approach to design and analysis*. Mahwah, N.J.: Lawrence Erlbaum.

CLIMATE CHANGE ADAPTATION AND MITIGATION

Course Code. ENV-702

Credit hours 3 (3-0)

Objectives:

Climate Change Impacts Adaptation and Mitigation is an interdisciplinary course offered at MS level. The focus of the course is climate change impacts and the human response to climate change, including efforts to adapt to climate change, as well as efforts to avoid or reduce the negative impacts of climate change.

Course Outline:

Introduction, types and their climatic effects, modeling of climate change, types of climate change models. Climate Change and Wetlands: impacts, adaptation and mitigation. Basic understanding of the physical science of climate change, Climate change impacts and the human response to climate change. Adaptation to climate change, natural and anthropogenic drivers and direct observations of recent climate change. Potential adaptation strategies in different sectors. Climate change impacts and adaptation practices for ecosystems, Land use, water resources, society and human health, Climate change mitigation strategies, Carbon sequestration, Transition to carbon neutral energy sources, Geo-engineering as well as measures to increase energy efficiency. Climate change policy and social change, International climate change negotiations, regulatory instruments, voluntary agreements and social change. Climate change and food production, climate change and its effects on Pakistan's agriculture, water resources, forests, etc.

Recommended Books:

1. Adaptation to climate change /Mark Pelling. Abingdon, Oxon, England; New York Routledge, c 2010.

2. Dow, Kirstin, 1963 The atlas of climate change mapping the world's greatest challenge/Kirstin Dow and Thomas E. Downing. London Earth scan, 2011.

3. Climate Change Causes, Effects, and Solutions, 1stEdition, Hardy, J. T., John Wiley & Sons, 2003.

4. *Global Warming -The Complete Briefing* by John T. Houghton.(3rd edition) Cambridge University Press, 2004.

5. *Climate Impact and Adaptation Assessment* A Guide to the IPCC Approach, Earth scan Publication Ltd, London, 2005.

6. *Climate Change - Causes, Effects, and Solutions*, Hardy, J.T., John Wiley & Sons, 2003.

7. IPCC Assessment Reports on Climate Change

8. Botkin D. & Keller E., 2000. *Environmental Science: Earth as Living Planet.* 8th ed. John Wiley and Sons.

9. Cunningham W.P., & Saigo, B.W., 2001. *Environmental Science*, 6th Ed. Mc-Graw Hill

STRATEGIC ENVIRONMENTAL ASSESSMENT (SEA)

Course Code: ENV-703

Credit hours 3 (3-0)

Objectives:

SEA is a rapidly evolving field around the World. The objective of this course is to explain theory, practice and methodology strategic environmental assessment. After completing this course, the students will be able to: 1. appreciate the relationship between SEA and environmental planning processes.

2. obtain a practical understanding of SEA methods and approaches.

3. develop and awareness of SEA effectiveness and performance requirements.

Course Outlines:

Environmental Assessment Introduction and concepts, Week 5-8: Methods and tools for EA, Strategic Environmental Assessment: Key concepts. Week 10: SEA legislation and process, Regulatory and planning framework of SEA and Implementation, SEA Tools and Techniques, SEA case studies: examples from a wide spectrum of sectors; SEA case studies for Water and SEA case studies for Waste, Future directions: Cumulative impact assessment, Sustainability assessment.

Recommended Books:

1. A Practical Guide to the Strategic Environmental Assessment Directive (2005)

2. Sheate, W.R. *et al* (2004) Implementing the SEA Directive. Sectoral Challenges and Opportunities for the UK and EU, *European Environment*, Vol 14 (2), 73-93

3. SEA and Integration of the Environment into Strategic Decision-Making: Report to EC (2001)

SEMESTER 2

ENVIRONMENTAL ANALYTICAL TECHNIQUES

Course Code. ENV-704

Credit hours 3(2-1)

Objectives:

The objective of this course is to impart skills and techniques necessary for measurement of different environmental pollutants. This course will enable the students to carryout monitoring and evaluation.

Course Outline:

Introduction; Principles of physical, chemical and Microbiological analysis of environmental pollutants, Sampling Procedure for the examination of Water, Wastewater, Air and Solid Waste; sampling rules, Sample collection and preservation. Laboratory Techniques, Field Monitoring for parameters of importance causing environmental pollution. Environmental Chemical Analysis; Principles for Instrumental Techniques using Spectroscopy, Chromatography, Microscopy and X-Ray Diffraction analyses etc. Assessment and Interpretation of Results using Statistical Tools.

Lab work:

Analyses of Water, wastewater, air and solid wastes for pollutant determination; Instrumental analyses using Spectroscopy, Chromatography, Microscopy and X-Ray Diffraction analyses etc. Data Interpretation using Statistical Tools

Recommended Books:

1. *Environmental Engineering Laboratory*. Ahmed, K.A one Publishers Lahore, Pakistan, 1998.

2. *Standard Methods for Examination of Water and Wastewater*. L. S. Clesceri, A. E. Greenberg, A. D. Eaton. 20th Edition. APHA publisher, USA, 1998.

ELECTIVE COURSE ENVIRONMENTAL CHEMISTRY

Course Code. ENV-705

Credit hours 3 (3-0) Objectives:

This course is designed to provide knowledge about different chemical process occurring in the environment, various physical and chemical methods to minimize pollution and adverse effects of various pollutants on human health and toxicity.

Course Outline:

Chemistry of atmosphere, Major layers in atmosphere, Temperature changes in the atmosphere, units to describe atmospheric chemistry, Chemical reactions in the atmosphere

sources, Effects of following pollutant on human health Carbon dioxide, Nitrogen oxides, Sulfur dioxide, Volatile organic compounds, automobile pollutants

Industrial smog, Photochemical smog, production of hydroxyl radical, their reaction with hydrocarbons, Indoor air pollution various indoor air pollutants, particulates, chemistry of ground level air pollution, Production of ozone in the stratosphere catalytic destruction of ozone, Hydroxyl Radical cycle, NO cycle, the chlorine cycle, Null cycles, Effects of ozone depletion on human health and environment, Green chemistry its principles, Water pollution, Types of water pollutants oxidation Reduction reactions in aqueous systems, Suspended solids and sediments, Dissolved solids, Toxic organic compounds, pesticides,

organochlorine insecticides, carbamates, accumulation in biological systems. Biomagnification and Biodegradation, Toxic heavy metals and their Bioaccumulation.

Recommended Books:

1. Environmental Chemistry. Ibanez, J.G., Hemandez-Esparaz, M., Doria- Serrano, C., Fregoso-Infante, A. and Singh, M.M., Springer, Germany.2008.
2. Principles of Environmental Chemistry, Girard, lE., 1stEdition. Jones and Barlett, USA, 2005.
3. Environmental Chemistry. Baird Collin and Michael Cann. W.H. Freeman and Company, New York USA. 2008.

APPLIED MICROBIOLOGY

Course Code. ENV-706

Credit hours 3(2-1)

Objectives:

The course is designed to disseminate the best available information about the genetics, biochemical and Environmental agriculture related properties of the microorganisms and their possible exploitation in the production of food, vaccines , fermented products, antibiotics, diseases resistant crops, Bioremediation, Solid waste treatment and other similar areas in the most efficient and economic manner.

Course Outline:

Fermentation Technology: Stages of fermentation process, Isolation, screening, preservation and improvement of industrial microorganisms, Media formulation, Sterilization, Inoculum development- The range of fermentation process, Submerged, Solid state fermentation, The chronological development of the fermentation industry, The component parts of a fermentation, process Continuous culture, Fed- Batch culture, Chemo stat culture, *Process Engineering:* Bioreactor- Design, Operation, Cell Harvesting, and Disruption, Product

recovery and Purification, Instrumentation and Process Control, Types of bioreactors, *Fermentation Products:* Alcohols, Alcoholic beverages, Organic acids, Polysaccharides, antibiotics, Vitamins, Fermented Foods, Organic acids, *Environmental Aspects:* Mineral leaching with bacteria, microorganisms involved in the sulfide mineral leaching, chemistry of sulfide mineral oxidation by bacteria, exploitation of bacterial sulfide mineral oxidation, dump and heap leaching, In-situ bacterial leaching of ore, mineral concentrate-leaching utilization of bacterially generated solvents, heavy metal pollutants removal by bioaccumulation, Degradation of toxic wastes, mechanisms of detoxification, biotechnological remedies, waste recovery, single cell protein, biogas technology, *Bioremediation:* Microbial control of environmental pollution, Transport and fate, Biodegradation, microbial activities and Environmental effects on biodegradation, Transform of metal pollutants, Phytoremediation: Mechanisms involving removal of hazardous compounds and heavy metals from soil and water.

Lab work:

Production of Fermented Food Tempeh, Water analysis, Isolation and screening of metal resistant bacteria, Isolation and screening of metal resistant fungi, Demonstration of Fermenter, Sterilization Techniques, Identification of microbes.

Recommended Books:

1. Glazer, A. N. 2007. *Microbial Biotechnology: Fundamentals of Applied Microbiology.* 2nd Ed. Hiroshi Nikaido, Cambridge University Press, New York, USA.

2. Patrick, K. J. 2004 .*Environmental Microbiology Principles and Applications.* Biological Sciences Department, University of Cincinnati, Cincinnati, Ohio, USA

FRESHWATER ECOLOGY

Course Code. ENV-707

Credit hours 3 (3-0)

Objectives:

The objective of this course is to train the students for ecological analysis of freshwater habitats in terms of identification of flora and fauna and the interactions among them. At the end of the course, the students are expected to acquire the techniques for study of freshwater habitats.

Course Outline:

Hydrology and Physiography of various types of freshwater systems, Chemistry of various freshwater systems and associated organisms, Physical relationships, Movement of light, heat

and chemicals in water, Hydrology and Physiography of groundwater and wetland habitats, Physiography of lakes and reservoirs, Types of aquatic organisms: Cyanobacteria, Eukaryotic Algae, Aquatic fungi, Protozoa, Non-vascular plants and vascular plants, Animals: Porifera, Cnidaria, Platyhelminthes and Nemertea, Gastrotricha, Ŕotifera, Nematoda, Mollusca, Annelida, Bryozoa, Tardigrada, Arthropoda, Fishes, Tetrapods; Biodiversity of freshwaters, Measures of diversity, temporal and spatial factors, short term factors influencing local distribution, Invasions of Nonnative species, extinction, Chemicals in freshwater, Redox potential, potential energy and chemical transformations, Distribution of dissolved oxygen in environment, transformations of carbon, fermentation, methanogenesis, Nitrogen, Sulfur, Phosphorus and other Nutrients, Effects of toxic chemicals and other pollutants on aquatic ecosystems, Fish Ecology, Freshwater Ecosystems: Groundwater Ecosystems, Streams, Lakes and Reservoirs, Wetlands.

Recommended Books:

1. Lampert, W. and Sommer, U., 2007. Limno-ecology: The Ecology of Lakes and Streams. Oxford University Press, New York.
2. Dodds, W.K., 2002. Freshwater Ecology: Concepts and Env. Applications. Academic Press. London.
3. Dodds, W.K. and Whiles, M.R., 2002. Freshwater Ecology: Concepts and Environmental Applications of Limnology. 2nd Ed. Academic Press. London.

ENVIRONMENTAL SOCIOLOGY

Course Code. ENV-708

Credit hours 3 (3-0)

Objectives:

Environmental sociology is the sociological study of societal-environmental interactions, although the focus of the field is on relationship between society and environment in general and the social factors that cause environmental problems in particular. After completing this course the students will be able to explore the various forms of interaction between human society and the environment, focusing on the social dimensions of the surrounding natural and human-made environments.

Course Outlines:

Foundations of Environmental Sociology; Human Dimensions of Environmental Change; Environmental Justice and Social Stratification; Social Dimensions of Environmental Disasters; Consumer Society, Rotating topic seminars in Environmental Sociology should also be included.

Recommended Books:

1. Gottlieb, Robert. 2005. *Forcing the Spring: The Transformation of the American Environmental Movement*. Washington, D.C.: Island Press.

2. Guha, Ramachandra. 2000. *Environmentalism: A Global History*. New York: Longman.

DISASTER RISK MANAGEMENT

Course Code. ENV-709

Credit hours 3 (3-0)

Objectives:

This course will provide know how in dealing with natural calamities and their management by encompassing the field of hazard and disaster studies. It discusses a wide range of aspects, i.e., assessment of factors, which put societies in vulnerable situations to the disaster management continuum. To underline the importance of disasters in socio-economic development, this course also aims to assess the consequences of „natural" catastrophic at both short and long terms. It finally tends to provide the students with basic knowledge on hazard reduction and vulnerability mitigation.

Course Outlines:

Natural hazards and disasters: The need for hazard and disaster studies Historical background on Hazard and Disaster research; Disaster its types Natural *vs* Man-made; Flooding, Earthquake, Landslide; Natural cycles and their role, Prediction, Hazards, Risk and Vulnerability: Definitions and characterization, Different approaches and Indicators; Factors of vulnerability, Demographic factors, Socio-economic factors, Cultural factors, Political factors, Physical factors, The impact of natural disasters: Direct and short-term impact of disasters, Indirect and long-term consequences of catastrophes, Disaster as an opportunity for development; Disaster Management: Components of management, identifying communities at risk, International phenomenon, Hazard and vulnerability reduction and Mitigation: hard and soft measures; Earthquake Management, Flood Management: Organizational, Role; Role of Government and Non-Governmental Organizations (NGOs); Role of Media in Disaster Management; Techniques and methods to assess hazard, vulnerability and risk: Qualitative and Quantitative approaches; Disaster Management Trainings and Policies, Pre-disaster management (Early warning system, emergency communication), Common environmental disasters in Pakistan, Plate Tectonics and Physical Hazards, Earthquake and their damages, Landslides and their down slope movements, Climate and weather related Hazards, Storms on the horizon, streams and flood processes, flood and human interactions, Coastal erosion.

Recommended Books:

1. Natural Disasters, Alexander, D., Chapman & Hall, New York, 1993.
2. Natural Hazards and Disasters. Donald Hydman, David Hyndman. 2006 Update. Natural Hazards and Disasters. Donald Hyndman, David Hyndman. ISBN-10: 0538737522.
3. The Environment as Hazard Burton I., Kates, R.W., and White G.F., 2nd Edition, The Guilford Press, New York, 1993.
4. Disaster Management: A Disaster Manager‟s Handbook. Carter N.W., ADB, Manila, 1991.
5. Rising from the Ashes: Development Strategies in Time of Disaster, Anderson, M.B., and Woodrow, P.J, Westview Press, Boulder, UNESCO, Paris, 1989.

MARINE POLLUTION MANAGEMENT

Course Code. ENV-710

Credit hours 3 (3-0)

Objectives:

To develop a basic understanding of marine pollution, its sources, impact of pollutants on the biotic and abiotic environment impacting the marine recourses. Develop a clear understanding of pollution control and management techniques.

Course Outline:

Introduction to marine pollution, Chronic and acute inorganic marine pollutants, Chronic and acute organic marine pollutants, Causes, effects and impacts on marine environment and humans, Health of the oceans, Various forms of environmental pollution as they affect both the land and maritime environment, Control of pollution in marine and coastal environments, Pollution Management, Ocean disposal: marine outfalls, shipboard wastes, Ocean disposal: dumping of sludge, disposal of dredge spoil, radioactive wastes Impacts of ocean disposal, Marine pollution control and mitigation measurements; oil spills contingency plan and combating techniques.

Recommended Books:

1. Managing Ocean Environments in a Changing Climate: Sustainability and Economic Perspectives Kevin J. Noone‟ Ussif Rashid SumailaRobert J. Diaz 2013.
2. Marine Pollution and Human Health (Issues in Environmental Science and Technology) R E Hester, R M Harrison RSC Publications 2011
3. Coastal Pollution: Effects on Living Resources and Humans (Marine Science) by Carl J. Sindermann (2005).
4. Marine Pollution and Its Control (McGraw-Hill series in water resources and environmental engineering) by Paul L. Bishop (1982).

5. Protecting the Marine Environment from Land-Based Sources of Pollution: Towards Effective International Cooperation by Daud Hassan (2006).

6. Transboundary Environmental Governance: Inland, Coastal and Marine Perspectives Robin Warner, Simon Marsden 2012

Journals/Periodicals:

Marine Pollution Bulletin.

Journal of Environmental Chemistry and Ecotoxicology. Marine Chemistry.

EPIDEMIOLOGY

Course Code. ENV-711

Credit hours 3 (3-0)

Objectives:

The objective of the course is to provide the student with insight in the principles and important issues of environmental epidemiology. This course will focus on assessment of disease burden, measurement of exposure and interpretation of mortality, morbidity concepts. Upon completion of this course, it is assumed that students will be able to comprehend emerging diseases in the context of climate change and global environmental change.

Course Outline:

Environmental risks to human health. Epidemics, endemics, and pandemics, Epidemiology triangle. Disease concepts: Communicable and noncommunicable diseases and conditions. Modes of disease transmission and chain of infection. Portals of entry to the human body, Zoonoses, Type of epidemiology: social, occupational, environmental, nutritional and infectious disease epidemiology, Occupational health and industrial hygiene, Disease surveillance and health impact assessment, Basic concepts: rates, ratios, proportions and relative risks. Measures of association and odds ratio analysis, Design strategies and experimental epidemiology: case-control studies, cohort studies, double-cohort studies, Role of confounding factors in causation of disease. Web of causation, Sensitivity and Specificity, Designing a randomized controlled trial

Ethics in epidemiologic research.

Statistical Methods in Epidemiology: Sample size determination and statistical inference.

Integrating toxicological and epidemiological data.

Regression methods. Time-series, spatial analysis and meta-analysis in epidemiology.

Field Epidemiology: Epidemiological field work in population-based studies.

Exposure assessment, surveillance and screening methods.

Examples of case studies: cardiovascular, cancer, asthma and vector borne diseases.

Recommended Books:

1. Ahrens, W. and Pigeot, I. (2013). *Handbook of Epidemiology. 2nd Ed.* Springer, London. UK.

2. Merril, R. M. and Timmreck, T. C. (2006). Introduction to Epidemiology. (4th ed.). Jones and Barlett Publishers. Boston, USA.

3. Merril, R. M. (2008). *Environmental Epidemiology: Principles and Methods*. (4thed.). Jones and Barlett Publishers. Boston, USA.

4. Aschengrau, A. and Seage, G. R. 2003. *Essentials of Epidemiology in Public Health.* Jones & Bartlett Learning, 5 Wall Street Burlington, MA

POPULATION DYNAMICS AND ENVIRONMENT

Course Code. ENV-712

Credit hours 3 (3-0)

Objectives:

This course will provide the conceptual framework to the students for understanding of complex web of multiple dimensions of environmental issues linked with population and development.

Course Outline:

World Population: current scenario and future trends. Framework for understanding population environment nexus, population size and environment, population distribution and environment. Population composition and environment, Population growth and climate change, Population growth and land use change, Research need for correlation studies, Poverty-population-environment linkages in the context of migration and urbanization. Population-development nexus: integrating environment and development, response to demographic crisis: Government responses, Individual attitudes and perceptions,

Sustainable approach to population stabilization, Population dynamics in Pakistan,

Pakistan‟s Biocapacity, resource consumption & crisis.

Recommended Books:

1. Botkin D. & Keller E., 2000. *Environmental Science: Earth as Living Planet.* 8th ed. John Wiley and Sons

2. Cunningham W.P., & Saigo, B.W., 2001. *Environmental Science*, 6th Ed. McGraw- Hill.

ENVIRONMENTAL BIOTECHNOLOGY

Course Code. ENV-713

Credit hours 3 (2-1) Objectives:

This course will provide sound technical foundation for using biotechnology in solving environmental issues and cleanup of the polluted environments. After completion of this course, students will be able to understand the significance, and application of biotechnology in the environment.

Course Outline:

Introduction to biotechnology, Tools of environmental biotechnology, Fundamentals of biological interventions, Recombinant DNA Technology, Genetic manipulations, GMOs: Release and Regulations, Environmental applications of GMOs, Biosafety concerns of GMOs,

Bio-strategies for pollution control, bioremediation, Phytoremediation, biofilm, Biomarkers, Biosensor, Bioreactors. Ethic and legal problems in creations and use of transgenic organisms.

Lab Work:

Introduction to basic molecular techniques; Isolation, purification and preservation of DNA, Recombinant DNA technology, PCR. Gel Electrophoresis, DNA measurement through spectrophotometer.

Recommended Books:

1. *Environmental Biotechnology: Concepts and Applications*, Hans-Joachim, J. and Josef, W. (ed.). Wiley-VCH Verlag, Germany, 2005.
2. *Biotechnology*,Smith, J.E., 5thEd. Cambridge University Press, New York, USA, 2009.
3. *National Biosafety Guidelines*. National Biotechnology Commission, Government of Pakistan. 2005.
4. Environmental Biotechnology: Theory and Application. Gareth M. Evans and Judith C. Furlong. John Wiley & Sons Ltd, The Atrium, Southern Gate, Chichester, West Sussex PO19 8SQ, England, 2003.
5. Environmental Microbiology. 2ndEdition. 2010. Edited by Ralph Mitchell and Ji- Dong Gu. John Wiley & Sons, Inc., Hoboken, New Jersey
6. Genetically Engineered Organisms: Assessing Environmental and Human Health Effects. 2002. Edited by Deborah K. Letourneau and Beth Elpern Burrows. CRC Press, USA

WETLAND MANAGEMENT

Course Code. ENV-714 Credit hours 3 (3-0)

Objectives:

The course will be helpful to understand the ecological structure and functions of wetlands, significance of wetlands, sustainable use of wetlands, and know how to write a conservation and management plan for wetland.

Course Outline:

Introduction to wetland ecosystem, wetland communities, wetland classification and inventory, wetland values, functions, and evaluation, identification of important flora and its role within the wetlands, identification of important fauna and its role within the wetlands, ecosystem approach to wetland management, participatory approach to wetland management, government regulations and policies on wetland, formulation of wetland management plans for Pakistan.

Recommended Books:

1. William J. M. and James G. G. (2007). Wetlands. USA.
2. Falconer R A and Goodwin, P. (1994). Wetland Management. United Kingdom
3. Mary, E.K., Roberts, P.B., Staphanie, F.G., Cindy, C.H., Arthur, D.S. and Jean, C.F. (1992). Wetlands: An approach to improving decision making in wetland restoration and creation. USA
4. Hammer, D.A. (1992). Creating freshwater wetlands. Chelsea, Michigan.

WILDLIFE AND FOREST CONSERVATION

Course Code. ENV-715

Credit hours 3 (3-0)

Objectives:

This course will make the students familiar with the concepts of wildlife and forest management practices. It further aims to introduce factors that lead towards loss of wildlife and forest resources and its consequences on ecosystems.

Course Outline:

Philosophy and concepts in wildlife management, Biological, scientific, commercial, recreational, philosophical, educational, ethical, social values of wildlife and forests, Variety of wildlife, abundance, evolution, Ecological niches, competition and population dynamics, National parks, Wildlife sanctuaries and game reserves of Pakistan, Impact of human population on habitat degradation and fragmentation, Effect of pollution and overgrazing on wildlife and forest resources, Role of databases in wildlife management, Wildlife and habitat measurements, Indices of ecological density, data collection and analyses for wildlife management. Forests: their ecological and economic importance, factors affecting forest growth and management. Status of forests in Pakistan, their types, distribution, management, deforestation and its control. Participatory forest management, Sustainable forest management, Rangeland management as mitigating measure to resolve human wildlife conflicts.

Recommended Books:

1. Bailey, J. A. 1998. Principals of Wildlife Management. John-Wiley and Sons, New York, USA.
2. Hosetti, B.B. 2005. Concepts in Wildlife management. Daya Publishing House, New Delhi, India.

3. Sinclair, A. R. E., J. M. Fryxell and G. Caughley. 2006. Wildlife Ecology, Conservation and Management. 2nd Ed. Blackwell Publishing, New York, USA.

ALTERNATIVE ENERGY SOURCES

Course Code. ENV-716

Credit hours 3 (3-0)

Objectives:

The overarching aim of this graduate course is to enable the students to learn how the energy scenario is building globally in the context of environmental and economic concerns. The specific objectives are to enable the students to:

- gain knowledge of the dynamics of energy in the environment
- learn about skills and techniques of obtaining energy from various sources
- develop attitude for using energy from alternative sources with efficiency

Course Outline:

Matter and energy in nature; Flow of energy in nature in ecosystem, Carbon cycle in nature, Energy efficiency in nature, Fossil fuels and their environmental effects; Greenhouse effect and acid rain etc. Renewable energy principles; fluid mechanics, thermodynamics etc., Solar radiation characteristics, measurements and local data, Passive use of solar energy (water heating, air heating, crop dryers, space heating, water desalination, solar ponds and solar concentrators etc), Photovoltaic; Micro-hydroelectric plants; Wind power; Concept and Principles, evaluating potential to use this resource, Biofuels; Ethanol from Biomass; Wave and tidal and ocean thermal energy; Geothermal energy; Energy storage (batteries and fuel cells etc.), hydrogen from renewable energy sources, role of energy in Green Economy

Recommended Books:

1. Walisiewicz, M and Gribbin, J (ed.), 2002. *Alternative Energy (Essential Science Series)*. D K Publishing.

2. Hoffmann, P., 2002. *Tomorrow's Energy: Hydrogen, Fuel Cells and the Prospects for a Cleaner Planet*. MIT Press.

3. Cassedy, E.D., 2002. *Prospects for Sustainable Energy: A Critical Assessment.* Cambridge University Press.

4. Trivedi, P.R. and Raj, Gurdeep., 1992. *Environmental Energy Resources*. Akashdeep Publishing, New Delhi.

REMOTE SENSING AND GIS

Course Code. ENV-717

Credit hours 3 (2-1)

Objectives:

The main objectives of the RS & GIS are to maximize the efficiency of decision making and planning, provide efficient means for data distribution and handling, eradication of the duplicated data, integration of information from many sources. Remote sensing (RS) Geographical Information System (GIS) and had been one of the key subprojects envisaged in the National Information System. The attempts of a digital description of that world create a computerized GIS which is usually a partial description of the world in relation with some feature tasks.

Course Outline:

Review of Basic Remote Sensing,

Electromagnetic Spectrum. History and data collection,

Advantages and limitations of Remote Sensing process, energy Sources, energy matter interaction in the atmosphere. Aerial photography, history and platforms.

Active and Passive remote sensing.

Remote sensing of vegetation and landscape.

Introduction to Photogrammetry, Satellite Imageries,

Image Processing: Image enhancement, Histogram, stretching, color palettes, contrast enhancement, Linear Stretch , Histogram equalization,

Interpretation, visual interpretation, Preparation of thematic maps.

Review of Geographic Information System(GIS).

Integration with other technologies and its importance.

Data acquisition, analysis and output. Types of data used in GIS. Week 14: Cartography, map projection and coordinate systems.

GIS applications in: Environmental protection and resource conservation,

Environmental Impact Assessment (EIA), Agriculture, Forestry, Fishery and wildlife. Introduction to relevant Pakistani Institutions working in GIS.

Lab Work:

Review of Image processing and GIS software. Conversion of raster to vector data. Demonstration of GPS operations, Interpretation of satellite images for different application, Ground Truthing. Thematic Maps Generation, Preparation of GIS Maps for different utilities.

Recommended Books:

1. Remote Sensing and Image Interpretation. Thomas Lillesand (Author), Ralph W. Kiefer (Author), Jonathan Chipman Wiley; 6 edition (2007)

2. Fundamentals of remote sensing and airphoto interpretation *Prentice Hall series in geographic information science* Authors Thomas Eugene Avery, Graydon Lennis Berlin Edition 5, 2009 ISBN0023050357

3. *A Primer of GIS-fundamentals Geographic and Cartographic Concepts.* Harvey, F. Guilfoud Press, New York, 2009.

4. *Dynamic Earth Environmental Remote Sensing Observations from shuttle Mission.* Lulla, K and L. V. Dess inov. John Wiley and Sons. Inc. 2000.

5. *Introduction to GIS.* Campbell. McGraw-Hill Education. 2008.

6. *Remote Sensing of the environment: An Earth perspective.* Jensen, R. Pearsons Education, Inc. 2000.

ENVIRONMENTAL RISK ASSESSMENTS AND MANAGEMENT

Course Code. ENV-718

Credit hours 3(2-1)

Objectives:

The course aims to review the forms of hazards and their associated risks, define the elements of risk assessment and describe the types of information needed for each element of risk assessment, describe the ways to risk identification, estimation of magnitude of the potential risks and illustrate different approaches of exposure assessment, explain the principles of risk management and control strategies and outline the approaches to managing the environmental emergencies.

Course Outline:

Environmental risk assessment and management; the what‟s, whys and how‟s a historical perspective

Risk assessment to human health from chemicals in the environment.

Risk assessment to ecological systems from chemicals, from biological introductions (excluding genetically modified organisms).

Evaluation of the likelihood of, major accidents in industrial processes

Assessing risks to ecosystems and human health from genetically modified organisms.

Retrospective assessment, eco-epidemiology and ecological monitoring.

Hazard identification, dose and exposure assessment, risk quantification, Epidemiology and environmental risk assessment.

Risk assessment in legislation: Application of risk assessment in policy and legislation in developed and developing countries.

Balancing risks with other considerations: The psychology of risk and uncertainty, the economics of risk. Valuing risks. Natural hazards, risk analysis and risk management.

Risk management: Principles, approaches and concepts: Corporate chemical management; a risk based approach.

Environmental risk assessment in business.

Risk assessment and management for water treatment and disposal.

Risk assessment and management in the exploitation of the seas.

Risk assessment and management for inland waters.

Environmental risk assessment in development programmes, the experience of World Bank.

Risk communication. A framework for sustainable product development.

Lab Work:

The practical exercises will be based on following aspects and will involve site visit.

1. Pollution risk assessment and management by tools and checks.

a. Primary protection standards.

b. Emission standards.

c. Environmental standards in an industrial setup.

2. To study the cause, nature and frequency of chemical accidents in two industries e.g., tanneries and sports industries involving comparison of accident data base.

3. Site visits for ecological risk assessment e.g., habitat survey and study of flora and fauna in certain areas (industrial, agricultural and urban setups).

4. Questionnaires design and epidemiological studies for risk assessment and formation of recommendations for risk management in industrial, agricultural, rural and urban setups.

Recommended Books:

1. *Environmental Risk Analysis.* (2001). Larche, I. and Paleologos, E. K. McGraw-Hill NY, USA.

2. *Occupational Health Hazards and Remedies.* (2002). Mohapatra, R. Jaypee Brothers Medical Publishers Pvt. Ltd., India.

3. *Biosafety Management: Principles and Applications.* (2000). Tarynor, P. L. Virginia Polytechnic Institute Publications. USA.

4. *Environmental Risk Evaluation of Polluted Soils.* (2000). Riviere, J. Oxford and IBH Publishing Company Pvt. Ltd. India.

5. *Environmental Hazards: Plants and People.* (2000). Iqbal, M., Srivastava, P. S.and Siddiqi, T. O. CBS Publishers and Distributors, India.

PRINCIPLES AND APPLICATIONS OF BIOREMEDIATION

Course Code. ENV-719

Credit hours 3 (3-0)

Objectives:

Bioremediation is the study of role of living entities in treatment of contaminated environments. The course will emphasize how bioremediation works and the students will also learn the role of microbes and different enzymes in bioremediation. This course will also help to design different bioremediation strategies.

Course Outline:

Introduction to biodegradation and bioremediation, types and nature of recalcitrant,

Types and nature of xenobiotics.

Types and mechanisms of biodegradation and bioremediation.

Bioremediation of organic pollutants (hydrocarbons, PCBs, PAHs, halogenated compounds, plastics, dyes, herbicides and pesticides).

Bioremediation of heavy metals.

Various methods and technologies used for remediation.

Role of enzymes in bioremediation.

Factors effecting bioremediation.

Aerobic and anaerobic degradation pathways of contaminants.

Microbial ecology and metabolism.

Microbial community dynamics during bioremediation.

Molecular strategies used to explore the role of microbes in bioremediation.

Recommended Books:

1. Environmental Microbiology, 2nd Edition, Mitchell, T., G. J-Dong. John Wiley & Sons, Inc., Hoboken, New Jersey (2010).

2. Bioremediation: Applied Microbial Solutions for Real-World Enviornment Cleanup by Ronald M. Atlas and Jim Philp (2005).

3. Environmental Biotechnology. Concepts and Applications. Jordening H.-J., J. Winter. Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim (2005).

4. Biodegradation and Bioremediation- Vol 2. Singh and Ajay Springer- Verlang Berlin and Heidelberg GmbH & Co. Kg, Germany (2004).

5. Biodegradation and Biocatalysis. Wackett, L. P., C. D Hershberger. ASM Press, American Society for Microbiology, N. W. Washington, DC (2001).

SUSTAINABBLE AGRICULTURE

Course Code. ENV-721

Credit hours 3 (3-0) Objectives:

To extend students' knowledge about management of agricultural resources on sustainable basis.

Course Outline:

Concept of sustainable agriculture, Threatened agricultural resources in Pakistan; soil, water and environment. Sustaining soil resources. Organic farming Soil erosion control, Soil natural amendments; sewage sludge and other organic wastes, sustaining water resources, Control of run-off and evaporation losses, Reduction of water losses from deep percolation, Use of salt tolerant and drought resistant crops and varieties, Reduction of agricultural pollutants, Optimum use of agricultural chemicals, fertilizers, cropping systems to sustain productivity, Multiple cropping, rotations, N-fixation, mycorrhizae and alternate land uses, Compromise between higher yields and resource conservation, Principles and strategies for designing sustainable farming systems. Week 16: Site specific technological options for sustainable crop production.

Recommended Books:

1. Shaw, T. 2010. Dryland Farming. Nabu Press, USA

2. Dixit,R.S.2007.CroppingsystemsresearchKalyaniPub.New Dehli.

3. Lichtfouse, E., M. Nanarrete, B. Debacke, and V. Souchere. 2009. Sustainable Agriculture. Springer, The Netherland.

4. Reddy, T.Y. and G.H.S. Reddy. 2002. Principles of Agronomy. 3rdEdition, Kalayani Publishers, New Delhi.

5. DAS, P.C. 2000. Crops and their production technology under different conditions. 1stEdition. Kalyani Publishers. New Delhi.

HEALTH, SAFETY & ENVIRONMENTAL MANAGEMENT

Course Code. ENV-722

Credit hours 3(2-1)

Objectives:

The objective of this course to provide orientation to the students on importance of occupational safety, health and environment.

Course Outline:

Health, safety and environment: Hazards; Physical, mechanical, biological, chemical and psychological hazards and stress, Health and environment, Environmental safety, Hazards identification and risk assessment and management process, Work place environment: Occupational safety and health issues in industries, construction, agriculture and service sectors, Accidents, injuries and workplace fatalities statistics, Occupational safety and health management systems (international and national), Safety Management: Regulations of health, safety and environment, Internal control and management philosophy, Duties and rights, strategies and goals, Roles and responsibilities of occupational health and safety professionals, Key principles of management and HSE, Measures and models for HSE, Organizational environment, HSE statutes and regulations, Establishing HSE plans, Challenges of health within working environment, external environment and safety,

Different tools and instruments, Culture, Behavior, Interactions, participation and communication, health surveillance, injury reporting, Emergency response procedures; fires, spills, leaks etc.

Preparedness and monitoring of adverse events and follow-ups, Case studies.

Work place safety and health: Assessing current practices and promoting change in the profession, Personnel Protective Equipment,

Formulation of Standard operating procedures, Human Factors and Ergonomic, Planning, decision making and problem solving.

Recommended Books:

1. Reese, C. D. 2012. *Occupational Health and Safety Management: A Practical Approach*, 2nd ed., CRC Press, Taylor and Francis group. USA 2012

2. English, P. F. 2012. *Safety Performance in a Lean Environment: A Guide to Building Safety into a Process (Occupational Safety & Health Guide Series)*, CRC press. Taylor and Francis group. USA.

3. Salvendy, G. 2012. *Handbook of Human Factors and Ergonomics*. 4th ed., John Willey Inc. New Jersey, USA.

4. Pain, S. W. 2008. *Safety, Health and Environmental Auditing: A Practical Guide.* CRC press. Taylor and Francis group. USA.

ENERGY AND ENVIRONMENT

Course Code. ENV-723

Credit hours 3 (3-0)

Objectives:

The objective of this course is to provide knowledge about the linkages of energy with environment and the importance of renewable energy.

Course Outline:

Forms of energy, Sources of energy and their environmental/health concerns, Non-renewable and renewable sources: fossil fuels,

Non-renewable and renewable sources: nuclear, solar, wind, Non-renewable and renewable sources: hydel, tidal,

Non-renewable and renewable sources: waste-to-energy, bio-fuels, Non-renewable and renewable sources: thermal, fuel cells,

Non-renewable and renewable sources: hydrogen as energy carrier etc. Overview of energy sources in Pakistani perspective;

Losses of energy and its conservation; Building, insulation, cooling, lighting etc. Materials, hybrid vehicles;

Future trends in energy production and conservation.

Recommended Books:

1. *Energy & Environmental Security: A Cooperative Approach in South Asia.* Suba Chandran, D. and Jeganaathan, J. (Eds.). IPCS, New Delhi, India. 2011

2. *Biomass, Energy, and Environment: A Developing Country Perspective from India.* Ravindranath, N. H. and Hall D. O. Oxford University Press, USA. 1995.

3. *Energy: Its Use and the Environment.* Roger A. Hinrichs, Merlin H. Kleinbach. Cengage Learning; 5th edition. 2013.

CARBON SEQUESTRATION AND ENVIRONMENT

Course Code. ENV-724

Credit hours 3 (3-0)

Objectives:

The course will provide a comprehensive introduction to carbon sequestration and its role in the environmental sustainability.

Course Outline:

Carbon sequestration, Introduction and concepts, Global carbon cycle, Carbon emissions, Carbon capture and storage, Soil organic matter and terrestrial C cycle, Terrestrial bio sequestration, Soil enzymes and plants in C sequestration, Role of C sequestration in the climate change mitigation, Factors influencing C accumulation, National and International adaptation and mitigation plans, Carbon foot prints, Carbon offsets, Carbon trading, Carbon credits and clean development mechanisms

Recommended Books:

1. Carbon capture: Sequestration and storage. Hester, R.E. and R.M. Harrison. Vol 29. RSC Publishing, Cambridge, UK, 2010.

2. Plant litter: Decomposition, humus formation, carbon sequestration. Berg, B. and C. McClaugherty. 2nd Edition. Springer-Verlag, Berlin, Germany, 2008.

3. Climate change and terrestrial C sequestration in Central Asia. R. Lal, M. Suleimenov, P. Doraiswamy, P. Wall and D. Hansen. (Eds) Taylor and Francis, Amsterdam, Netherlands, 2007.

ADVANCES IN PLANT ECOLOGY

Course Code. ENV-725

Credit hours 3 (3-0)

Objectives:

This course is designed to update the students about recent developments in plant ecology and physiological modifications with reference to environment, its conservation and management.

Course Outline:

Global aspects of plant ecology, Life history strategies of plants, survival and extinction, Plant population dynamics, Species richness, Vegetation dynamics, fine–scale to large–scale dynamics Leaf Energy Budgets, Effects of Radiation and Temperature Week 9: Life Cycles: annuals and perennials, Environmental influences and plant adaptations, Biotic Influences: symbiotic associations, Pathogenicity, parasitic associations and carnivory. Ecological Biochemistry, Allelopathy and defense against herbivores, Plant invasions and its threats of plant diversity Conservation, management and restoration of threatened plant communities.

Recommended Books:

1. Vegetation Ecology. Ed. Maarel, ED. Blackwell Publishing, Oxford, UK. 2005.
2. Introduction to Plant Population Biology. Silvertown, J. & Charlesworth, D. Blackwell Publishing.Oxford UK. 2005.
3. Plant Physiological Ecology. Hans Lambers, F. Stuart Chapin, Francis Stuart Chapin (III.), Thijs L. Pons, Springer, 2008.
4. Plant Ecology. Shulze, E.D; Beck, E & Muller-Hohenstein, K. Springer, Berlin. 2005.

BIOLOGICAL CONSERVATION

Course Code. ENV-726

Credit hours 3(2-1)

Objectives:

The objectives of this course are to develop a thorough understanding among the students about threats to biodiversity and its conservation using *ex-situ* and *in-situ* approaches and laws and policies related to species and habitat conservation.

Course Outline:

Introduction, biological diversity, Global and national biodiversity

Ecological and economic values of biodiversity

Monetizing Economic tools to promote conservation of Biodiversity

Extinction of Species; The process of extinction

Characteristics of declining populations

Influence of humanity on extinction and loss of biodiversity

Protection and restoration of species, habitats and ecosystems; Translocation and reestablishment

The role of ecological restoration in conservation Week 9: *In-situ* and *Ex-situ* conservation

Protected areas, their types and role in conservation, Establishment and management of protected areas

Ex-situ Conservation strategies (The role of botanic gardens, Gene banks and germplasm conservation, Zoological Gardens and Aquaria)

Population Management; maintaining population characteristics

Viable population planning and risk analysis, Field study techniques, Habitat fragmentation

The Role of Institutions and Policymaking in Conservation

Types of institutions and their roles in conservation, Institution and policy challenges for conservation biology, Conservation Legislation

Conservation of biodiversity in Pakistan, problems and solutions.

Recommended Books:

1. A Primer of Conservation Biology. 5th Ed. Sinauer, P.R.B. Associates Inc. Publ. Sunderland. 2012.
2. Conservation Biology: A Primer for South Asia. Orient Blackswan Bawa, K., Primack, S., Oommen, R.B. and Anna, M., 2011. ISBN # : 9788173717246.
3. Essentials of conservation Biology, 5th Ed., Primack, R. B. Sinauer, P.R.B associates Inc. Publishers, Sunderlander MA, USA. 2010.
4. Conservation Biology: Foundations, Concepts, Applications. 2nd Ed. Dyke, F.V., Springer, 2010.

URBAN ECOLOGY

Course Code. ENV-727

Credit hours 3 (3-0)

Objectives:

This course is designed to develop a thorough understanding of the influence of urbanization and urbanized areas on populations, communities, ecosystem and human societies.

Course Outline:

Introduction to urban ecology

Humans as components of urban ecosystems

Global urbanization patterns (past, present, future) and recent trends in Pakistan

Populations and community diversity in the urban environment

Urbanization effects on environmental health

Functions in urban ecosystem: growth

Productivity, disease, exotic species and invasive species in urban areas

Landscape signature and urban heat-island effect

Ecological design and sustainable cities

Concept of urban green spaces for people and biodiversity Week 13: Urban inequalities and slum area characteristics

Urban health and emerging diseases

Urban land use planning and management in Pakistan.

Recommended Books:

1. *Urban Ecology.* Cambridge University Press, Cambridge. Gaston, K.J. (ed.) 2010.

2. *Applied Urban Ecology.* Wiley-Blackwell, UK. Richter M and U. Weiland (ed.) 2012.

3. *Land-Use Planning for Sustainable Development,* Silberstein, J.and Maser, C., CRC Press LLC. USA, 2000.

LABORATORY MANAGEMENT AND PRACTICES

Course Code. ENV-728

Credit hours 3 (1-2)

Objectives:

The objectives of this course are to impart skills for sampling techniques and identification of sampling locations where high molecular-mass organic compounds and metals may accumulate, provide understanding about sampling and sample variability in air, water, land, solid and waste analysis, impart skills for the range of the methods needed for subsequent chemical analysis i.e., from classical to instrumental methods including Mass spectrometer, UV/visible spectrophotometer, Infrared spectrometer, NMR, GC-MS, HPLC etc. and train for methods to interpret the result of analysis and quality assurance.

Course Outline:

The environmental issues Reasons for concern, Pollution, The necessity of chemical analysis, Transport of pollutants in the environment and approaches to their analysis: Sources, dispersal, re-concentration and degradation, Transport and reconcentration of neutral organic

compounds; Bio- concentration, Accumulation in sediments, Bio-magnification and Degradation, Transport and reconcentration of, metal ions: Solubilization, Deposition and uptake by organisms and What is safe level, Sampling and sampling variability: Representative sampling, Samples storage and Critical path and critical group, Water analysis-Major constituents: Sampling Techniques for analysis of common ions; UV/visible spectrometry, Emission spectrometry (Flame photometry), ion-chromatography and Examples of uses of other techniques, Water analysis-Trace pollutants: Organic trace pollutants, Sampling and storage, Extraction techniques for chromatographic analysis, Gas chromatography, Liquid

chromatography, immunoassay and Spectrometric methods, Metal ions; Storage of samples, Pre-treatment, Atomic spectrometry, Visible Spectrometry, Anodic stripping voltammetry and Examples. Ultra-trace analysis

Analytical methods; Mass spectrometry detection, Quantification, Gas chromatography and Examples. Quality control and quality assurance.

Lab Work:

1. Extraction of chlorophyll from plant material.
2. Determination of amount of Fe (II) in a given industrial water sample by visible spectrometry.
3. Quantification of lead in industrial wastewater.
4. Determination of total alkalinity due to Carbonate and Bicarbonate ions present in a given sample.
5. Separation of neutral, acidic/basic organic components by using separating funnel.
6. Complex metric titration for the detection of temporary and permanent hardness of water in terms of ppm.
7. Determination of Total Dissolved Solids (TDS), Total Suspended Solids (TSS), pH and Conductivity of industrial effluents.

Recommended Books:

1. Carson, P.and Mumford, C. 2002. *Hazardous Chemical Handbook.* 2nd Ed. Butterworth-Heinmann. Oxford, UK.
2. Patnaik, P.1997. *Handbook of Environmental Analysis: Chemical Pollutants in Air, Water, Soil, and Solid Wastes* .CRC Press Inc. USA.
3. *Extraction }'; Methods for Environmental Analysis.* 1999. John Wiley and Sons Ltd. UK.

RESTORATION ECOLOGY

Course Code. ENV-729

Credit hours 3 (3-0)

Objectives:

The objectives of this course are to develop an understanding among the students of the need and approach of ecological restoration at species, population and landscape level and to enable them to apply their knowledge in real world situation.

Course Outline:

The Background; Introduction and Philosophy, Rationale for Restoration, The Ecological Context; A Landscape Perspective, A Species Population Perspective, The Evolutionary Context; A Species Perspective, Manipulation of the Physical Environment; Terrestrial Ecosystems, Wetlands and still waters, Manipulation of the Chemical Environment, Manipulating the Chemical Environment of the Soil, Chemical Treatment of Water and Sediments, Manipulation of the Biota; In Terrestrial Ecosystems, In Aquatic Ecosystems ,Monitoring and Evaluation, Restoration in a changing climate, Biological invasions, resilience and restoration, Restoration Policy and Infrastructure, Social and institutional support, Restoration policy in Pakistan and other countries, Case Studies.

Recommended Books:

1. Clewell, A.F. 2013. Ecological Restoration: Principles, Values, and Structure of an Emerging Profession. 2nd Edition. Island Press.

2. Andel, J.V. and J. Aronson (Eds.). 2012. *Restoration Ecology*: *The New Frontier*. 2nd Edition. Blackwell.

3. Galatowitsch, S.M. 2012. Ecological Restoration. Sinauer Associates.

4. Howell, E.A., Harrington, J.A. and Glass, S.G. 2011. Introduction to Restoration Ecology. Island Press.

5. Perrow, M.R. and A.J. Davy. (Eds.). 2002. *Handbook of Ecological Restoration. Vol. 1.Principles of Restoration*.Cambridge University Press.

6. Perrow, M.R. and A.J. Davy. (Eds.). 2002. *Handbook of Ecological Restoration. Vol. 2.Restoration in Practice.*Cambridge University Press.

GENDER AND ENVIRONMENT

Course Code. ENV-730

Credit hours 3 (3-0)

Objective:

The objective of the course to draw linkages of environmental degradation with gender and the role it can play in addressing the environmental degradation.

Course Outline:

Gender and Environment: Concepts, issues and perspectives, Eco feminism, theories related to Eco feminism, Gender, environment and sustainable environment, emerging perspectives on gender and environment: Relationship between Woman and Nature, Question of domination of women and nature rooted in patriarchal ideology. Feminist critiques of science and western concepts of development, Relationship of gender division of labor structure and the natural world, Women in the two-thirds world: environmental degradation and the struggle for survival, The Green Revolution and its impacts on food production. Cash crop production, appropriation and degradation of land, Effect of environmental degradation on the lives of poor women. Women, water, fuel and forest resources, Gender division of labor and environmental impacts on women's work. Women's traditional ecological knowledge, Poverty, survival and women's roles in maintaining the means of sustenance, Dialogues with and within ecological feminism: Women engagement in environmental action, Ecofeminist perspectives on gender and environment, Major weaknesses of ecofeminist theory and practice, Political action and cultural transformation: Ecofeminist politics, ethics, and spirituality, Issues in cultural transformation and cultural appropriation, Greenham Common, Chipko Movement, Kenya Green Belt Movement World Women's Congress for a Healthy Planet, Local stories of women and environmental action

Recommended Books:

1. Nightingale, A. (2006) 'The nature of gender:Work, gender, and environment', *Environment and Planning D: Society and Space* 24: 165– 185

2. McIlwaine, C. and K. Datta (2003) 'From feminizing to engendering development', *Gender, Place and Culture* 10: 369–382

3. Rodda, A. (1991) *Women and the Environment*, London: Zed Books

4. Dankelman, Irene. (2003) Gender, Environment and Sustainable Development:

5. Varadarajan, "Women and Environment Eco-feminists‟perspectives". In Empowerment of Women and Ecological Development 2002:445)

6. Kurian, P. (2000) *Engendering the Environment? Gender in the World Bank's Environmental Policies*, Aldershot: Ashgate

GLOBAL ENVIRONMENTAL POLITICS

Course Code. ENV-731

Credit hours 3 (3-0)

Objectives:

This course provides a comprehensive approach of Global Environmental Politics. It gives insight in leading international environmental issues and global politics about environment.

Course Outline:

Global environmental politics as a discipline and its historical perspective, Actors and institutions in global environmental politics, Role of states, international organizations, Domestic politics and corporations in global environmental issues, Environmental justice movements, Environmental security uncertainty, North-South relations, Participation and citizenship as key factor in shaping global politics, Political ecology, climate change and globalization, Trade in hazardous waste, endangered species and genetically modified foods, International treaties and regional agreements, Transboundary disputes and environmental threats, Environmental advocacy at global, regional and local level.

Recommended Books:

1. Kutting, G. 2010. Global Environmental Politics: Concepts, Theories and Case Studies. Routledge.
2. Chasek, P. S., D. L. Downie, J. W. Brown, 2010. Global Environmental Politics, Dilemmas in World Politics Series, Westview Press,
3. Macmillan, P. 2000. Understanding Global Environmental Politics.
4. Elliott, L. M.1998. The global politics of the environment. New York University, pp 311.

COASTAL ENVIRONMENTAL MANAGEMENT

Course Code. ENV-732

Credit hours 3 (3-0)

Objectives:

To have a better understanding of Coastal Marine and offshore Areas, Marine Ecosystems. Economic significance of coastline. Coastal phenomena, coastal erosion and accretion, Integrated Coastal Zone Management.

Course Outline:

Develop a Clear understanding of Definitions and boundaries of coastal and offshore areas of Pakistan, Coastal ecosystems, Mangroves, Coral reefs, rocky, sandy, muddy shores and biotic communities, Understanding of coastal Physical phenomena that generate potential energy from Tides, Waves, and Ocean Thermal Energy, Significance, Coastal erosion and accretion, Pelagic and Demersal Living Resources and products of natural marine ecosystems, Non-Living Marine Resources, Impact of coastal pollution on coastal resources and amenities, Develop integrated coastal management, conservation and sustainable development of resources, The course will be complimented by Assignment and case studies. Students assess the assigned projects of interests for development, conservation of coastal areas, ecosystems and critical habitats.

Recommended Books:

1. Oceanography, An Invitation to Oceanography 2009 by Paul R. Pinet
2. Oceanography, an introduction to the Marine Environment by Peter K. Weyl. 2008
3. Oceanography: A view of the Earth by Grant Gross. 20

AGROCHEMICALS IN ENVIRONMENT

Course Code. ENV-733

Credit hours 3 (3-0)

Objectives:

Te objective of this course is to demonstrate the negative and positive impact of use of agrochemicals in the short term and in long term.

Course Outline:

Agrochemicals: Fertilizers, pesticides, Soil conditioners, hormones, pharmaceuticals (antibiotics) and fumigants, Fate of agrochemicals in the environment, Sorption/desorption, movement, drift, volatilization, availability, leaching and decay, Impact of agrochemicals on public health and environment Week 8: Environmental exposure to pesticides, Fertilizer pollution measurement and prediction models, Pest resistance and phyto-toxicity, Safe handling and awareness about agrochemicals, Factors affecting use for agrochemicals and environmental outcomes, Efficient use of agrochemicals, Management practices and strategies to control agrochemical pollution.

Recommended Books:

1. Cheremisinoff, N.P. and P.E. Rosenfeld. 2011. Handbook of Pollution Prevention and Cleaner Production. Best Practices in Agrochemical Industry. Elsevier, Kidlington, UK.

2. Matthews, G.A. 2006. Pesticides: Health, Safety and the Environment. Blackwell Publishers, Malden, MA, USA.

3. Wheeler, W.B. 2005. Pesticides in Agriculture and the Environment. Marcel and Dekker, Inc. New York, USA.

4. Sparks, D.L. 2003. Environmental Soil Chemistry. 2nd Ed. Academic Press, San Diego, CA, USA.

REMEDIATION STRATEGIES FOR CONTAMINANTED ENVIRONMENT

Course Code. ENV-734

Credit hours 3 (3-0) Course Outline:

Environmental remediation; Factors affecting remediation efficiency, Evaluating speciation and contaminant availability in polluted environment, Factors affecting contaminant degradation, Remediation strategies, Natural attenuation, Bioremediation and Phytoremediation, Conventional methods, Physical techniques, Chemical Oxidation and other chemical treatments, Photocatalytic processes, Electrochemical techniques, Chemical and biological sorption, Integrated approaches for remediation, Application of nano-materials, Social and economic aspects of remediation.

Recommended Books:

1. Ghafoor, A., G. Murtaza, M.Z. Rehman, M. Sabir, H.R. Ahmad and Saifullah. 2012. Environmental Pollution: Types, Sources and Management. Allied Book Centre, Lahore.

2. Sarkar, B. 2002. Heavy Metals in the Environment. Marcel Dekker Inc., New York, USA.

3. Raskin, I. and B.D. Ensley. 2000. Phytoremediation of Toxic Metals: Using Plants to Clean Up the Environment. John Wiley & Sons Inc. New York, USA.

4. Lens, P., T. Grotenhuis, G. Malina and H. Tabak. 2005. Soil and Sediment Remediation: Mechanisms, Technologies and Applications. IWA Publishing, London, UK.

TREATMENT & MANAGEMENT OF WASTEWATER

Course Code. ENV-735

Credit hours 3 (3-0) Course Outline:

The nature and sources of wastewater, Modern wastewater treatment, Primary treatment, Secondary treatment, Tertiary treatment, Removal of pathogens by sewage treatment process, Removal of organics and inorganics by sewage treatment processes, Oxidation Ponds, Septic tanks, Use of treated wastewater, Wetland and Aqua culture system, Sludge processing and land application of biosolids, Biofuel production from wastewater.

Recommended Books:

1. Sharma, S.K. and R. Sanghi (eds.). 2012. Wastewater Reuse and Management. Springer, Heidelberg, Germany.

2. Maier, R.M., I.L. Pepper and C.P. Gerba. 2009. Environmental Microbiology. 2ndEd. Academic Press, London, UK.

3. Tchobanoglous, G. F.L. Burton and D.H. Stensel. 2003. Wastewater Engineering: Treatment and Reuse. 4th Ed. McGraw-Hill Inc.

4. APHA. 1998. Standard Methods for Water and Wastewater. American Public Health Association. Washington, DC.

ENVIRONMENTAL APPLICATION OF NANOMATERIALS

Course Code. ENV-736

Credit hours 3 (3-0)

Course Outline:

Introduction to nanomaterials, Application of nanomaterials in: remediation of polluted soil and water, pollutant sensing and detection, filtration membranes, green chemistry. Nanomaterials as adsorbents, Nanomaterials for groundwater remediation, Use of nanomaterials as antimicrobial agents, Renewable energy and nanotechnology, Eco-toxicological risks associated with nano-materials, Future challenges in nanotechnology.

Recommended Books:

1. *Environmental Nanotechnology: Applications and Impacts of Nanomaterials.* Mark R. Wiesner and Jean-Yves Bottero. The McGraw-Hill Companies. New York, USA. 2007.

2. (http://accessengineeringlibrary.com/browse/environmentalnanotechnology- applications-and-impacts-of-nanomaterials)

3. *Environmental Applications of Nanomaterials Synthesis, Sorbents and Sensors*. Glen E Fryxell and Guozhong Cao. World Scientific. 2007.

GREEN ECONOMY

Course Code. ENV-737

Credit hours 3 (3-0)

Objectives:

The objective of this course is to develop understanding of basic principles of green economy within the economic, energy and food security context of the country and the region.

Course Outline:

The concept of green economy, Framework of policies and approaches that accelerates progress toward sustainable development goals, Caron foot prints, Carbon footprint assessment, Carbon trading and carbon sequestration, REDD and REDD plus mechanisms, Employment and labor market policies for Green Jobs in context of Pakistan, Role of Microfinance in Promoting Renewable Energy, Institutional Framework for Renewable Energy and community adaptation, Entrepreneurship in Energy Solutions, Green economy and its relationship to Livelihood and Poverty Alleviation.

Recommended Books:

1. Lightfoot, H. Douglas, et al, "Nuclear Fission Fuel is Inexhaustible", *Climate Change Technology Conference: Engineering Challenges and Solutions in the 21stCentury*, Engineering Institute of Canada, Ottawa, Ontario, Canada, May 10-12, 2006.
2. Boyd, David R, *Sustainability within a generation: a new vision for Canada*, The David Suzuki Foundation, ISBN 0-9689731-6-7, 2004.
3. Day, Danny M. et al, Distributed Hydrogen Production with Profitable Carbon Sequestration: A Novel Integrated Sustainable System for Clean Fossil Fuel Emissions and a Bridge to the New Hydrogen Economy and Global Socio-Economic Stability, *National Hydrogen Association Conference*, Washington, DC., Poster Presentation, March 4-8, 2003.
4. Lehmann, J., D. Kern, B., Glaser, W. Woods, *Amazonian Dark Earths: Origin, Properties, Management*, Kluwer Academic Publishers, the Netherlands, ISBN 1-4020- 1839-8, 2003.
5. Love, Murray, et al, *Utility-Scale Renewable Energy Systems: Spatial and Storage Requirements*, Institute for Integrated Energy Systems, University of Victoria (IESVic) and Love, Murray, "*Land Area and Storage Requirements for Wind and Solar Generation to Meet the US Hourly Electrical Demand*", *M.A.Sc. Thesis*, University of Victoria, August 2003.

ENVIRONMENTAL EDUCATION

Course Code. ENV-738

Credit hours 3 (2-1) Objectives:

The course is designed to impart knowledge and understanding of the environmental education, introduce various concepts of environmental education at different levels, provide guidelines for the design and development of resource materials for environmental education, train and develop skills for teaching and learning in environmental education with reference to environmental issues and to provide the insight of status of environmental education at national, regional and global levels.

Course Outline:

Education: Knowledge, Information, Education and awareness, Skills, Values, Attitude, Behavior, Beliefs, Norms, Environmental Education: Aims of environmental education, Types of environmental education, Teaching and learning: Four stages of learning, Teaching learning theories and EE, How people learn, Types of learners, Role of teacher/educator, Teaching learning approaches: Inductive and deductive approaches, Teaching learning process, Active and passive learning, Curriculum, syllabus, course development for environmental education at various levels, History and Philosophy of Education: Guiding principles of Environmental Education (EE), Environmental literacy, Citizen Action and responsibilities, Status of Environmental Education: EE at National, regional and global levels Events that shaped the development of education in Pakistan, Role of, Government, NGOs, Educational institutions, Environmental policy: EE at primary, secondary and at higher levels of education, EE and research

Teaching Methodologies: Common teaching methods/activities of formal, nonformal and informal EE Using community resources for Environmental Education Teaching Environmental Issues in Classroom and in the real world methodologies Considerations for teaching environmental issues with particular reference to resources, pollution, population, management and enforcement of policies and regulations in Pakistan

Communication strategies to work in community: Reading, writing, listening and speaking skills, Designing of seminars, workshops, field trips for Environmental Education Computer and EE: Use of computer for Environmental Education, Computer

literacy, Internet, Websites and Databases etc.

Practical Work:

- Preparation of teaching material: Development of teaching material for Environmental Education and Sample lessons for different levels of EE.
- Preparation of resource material (brochures, pamphlets, posters, and booklets etc.) to provide information on various environmental issues.
- Field trips and visits to acquire knowledge on various environmental issues and to develop management strategies.
- Organization and arrangements of events, festivals and exhibits for EE.
- Campaign designing for National, regional, and local environmental issues.
- Organization of seminars and special lectures on general environmental management and specific issues.
- Making documentaries on various environmental issues.
- Preparation of portfolio for EE.

Recommended Books:

1. Arif, R. Status of Environmental Education in Sustainable development Strategies of Pakistan. (Comparative report). *NCS*. Islamabad.

2. Engleson, D. C. (1994). *A Guide to curriculum planning in Environmental Education.* Wisconsin Department of Public Instruction. USA.

3. Fordham, P. E. (1993) *Informal, non-formal and formal education program.'* In: YMCA George Williams College *ICE301 Lifelong Learning Unit 2*, London: YMCA George Williams College.

POLYMERS AND THE ENVIRONMENT

Course Code. ENV-739 Credit hours 3 (3-0) Objectives:

To develop the basic concepts about polymer science physical and chemical properties of polymers, various synthetic procedures involved in polymerization, characterization techniques used to analyze the type of polymers. Usefulness of thermal analytical techniques involved in polymer characterization techniques for stability and durability and to appreciate the applications of polymers in various fields such as industry, medicine, daily life *etc.* This course aims to provide knowledge and understanding of the environmental benefits and hazards of polymeric materials and responsible use plastics with emphasis on the importance of degradable and biodegradable polymers.

Course outline:

Introduction to Polymers: Basic definitions and nomenclature; Various Classifications of polymers; Mechanical properties of polymers; Spectroscopic Analysis of Polymers; Impact of Polymers on Environment: Stability of polymers, Resistance to degradation. Air, water, and solid waste pollution is caused by polymeric materials. Effect of additives, fillers and stabilizers on the environment; Monitoring of various types of pollution caused by polymeric materials. Biodegradable Polymer: Photolytic Polymers, Per-oxidisable Polymers, Photo- Polymers, Hydro-biodegradable Polymers; Biodegradable Copolymers and Composites; Agricultural Applications of Environmentally Degradable Polymers;

Technical Advantages of Degradable Mulching Films; Economics of Degradable Mulching Films; Soil Sterilization, Agricultural Packaging; Bioassimilation of Photo- biodegradable Plastics; Eco toxicological Aspects in the Biodegradation Process of Polymers, Management of Polymer Wastes: The Polymer Waste Problem; Legislation; Disposing of Post-consumer Plastics; Life-cycle Assessment; Air Pollution, Water Pollution, Waste Production, Mechanical Recycling; Reprocessing of Mixed Plastics Wastes, Energy Recovery by Incineration; Liquid Fuel and Feedstock Recovery; Management of Urban Waste; Biodegradable Plastics in Integrated Waste Management; Degradable Plastics: Sewage, Compost, Litter. Management of Polymer Wastes in Pakistan; Polymer Industry in Pakistan.

Recommended Books:

1. *Charles E. Carraher Jr.*, Polymer Chemistry-An Introduction, latest Edition. Marcel Dekket. Inc.
2. Robert J.Young, *Introduction to Polymers*, Chapman Hall Ltd.NY 1981.
3. Fred W. Billmeyer,Jr. *Textbook of Polymer Science*, Wiley- Interscience,John Wiley and Sons.
4. Gerald Scott., *Polymers and the Environment*, Royal Society of Chemistry, UK 1999.
5. Catia Bastioli, Editor, *Handbook of Biodegradable Polymers*, Rapra Technology. Ltd, UK. 2000.

ENVIRONMENTAL GEOLOGY

Course Code. ENV-740 Credit hours 3 (3-0)

Objectives:

This course aims to provide knowledge about a wide range of topics in geology, discussing fundamental geologic principles to the specific geologic hazards, from an environmental perspective.

Course Outline:

Earth materials and processes, Geology and Ecosystems, Hazardous natural processes: River flooding, Landslides and related phenomena, Earthquakes and related phenomena, Volcanic activity, Coastal hazards, Impact of extraterrestrial objects. Week 9: Human interaction with environment, Hydrology and human use, Waste disposal, Geologic aspects of environmental health, Climate change, Mineral resources and environment, Energy and environment, Land use and decision making: Landscape evaluation, Related environmental laws.

Recommended Books:

1. Environmental geology: Keller, E.A., 9th edition, Prentice Hall, 2011.
2. Introduction to environmental geology: Keller, E.A., 5th edition, Prentice Hall, 2012.