

**CURRICULUM OF
BS IN ENVIRONMENTAL SCIENCE**



**Institute of Environmental Studies
University of Karachi
Karachi-75270**

2024

Introduction

Environmental Science is an inter-disciplinary field that reconnoiters the biological, cultural, societal and political traits of environmental issues. This interdisciplinary approach instead of focusing on problems like climate change, species extinctions and pollution that are likely to exacerbate in coming future, they are perceived as closely associated to everyday life. As a result, understanding and responding to environmental problems requires the kinds of critical and original approaches that are forte of the arts and humanities. This approach has gathered environmental philosophers and literary critics from all over the world who developed contact and collaboration since 1990s with the idea that environmentally oriented humanistic research should be integrated in a more sustained fashion in the universities

This vital conceptual change in environmentalism will give crucial impulses to environmental Science in the near future as nature itself now be considered as part of a social and cultural realms.

Program Overview

BS in Environmental Science shall foster the basic understanding of convolution of environmental challenges and shall focus on interdisciplinary responses. The program shall widely explain the concept of “nature” and human interactions and human influences on nature with varying thoughts. The program shall further evolve the strategies to confront with environmental concerns through multi-disciplinary approaches of environment with particular emphasis on human health.

What will students achieve?

The students shall be successfully able to appraise the expediency of Environmental Science in resolving the contemporary environmental challenges. The students will develop ability to nurture creative environmental thoughts to elucidate the relationship between nature and human beings. The students will be able to apply Environmental Science theory and practice to foster global and local environmental challenges.

Eligibility

This program is suitable for undergraduates having a professional interest in Environmental Science or related disciplines. It is also suitable for learners around the country who are interested in influencing environmental change and understanding through problem-solving approach.

Eligibility criteria will be same as prescribed by the University. Intermediate Science for undergraduate students and B.Sc., B.E., B. Pharm., M.B.B.S, B.Sc. Nursing (with at least 50% marks) OR any other degree related to science at the graduate level or equivalent. According to the current HEC policy 2023 for BS program the graduate level students will be enrolled from fifth semester.

Bridging semester

Those students who will enroll in fifth semester must have to complete a bridging semester in which they have to qualify 4 courses i.e. one from each semester from semester 1 to 4.

Course duration

4 years (8 semesters)

2 years for graduate students who enroll in 5th semester

INSTITUTE OF ENVIRONMENTAL STUDIES

UNIVERSITY OF KARACHI

BS Environmental Science

First Year - Semester I

S.No.	Course No.	Course Title	Credit Hours	CourseType
1	300.1 (I. S)	Islamic Studies/ Ethics (Non-Muslim)	2(2+0)	Gen Ed
2	300.1 (U)	Urdu	2(2+0)	Gen Ed
3	300.1 (Civ/Com)	Civics and Community Engagement	2(2+0)	Gen Ed
4	300.1 (N. Sc)	Natural Science	3(3+0)	Gen Ed
5	STA-301	Subsidiary-I (Statistics-I)	3(3+0)	Int Disc
6	GEG-301/GEL-301/ BOT-301/CHM-301	Subsidiary-II (Geography-I/ Geology-I/ Botany-I/ Chemistry-I)	3(2+1)	Int Disc
7	ENV-301	Introduction to Environment	3(3+0)	Major
Total Credit Hours			18	

First Year - Semester II

S.No.	Course No.	Course Title	Credit Hours	CourseType
1	300.2 (IC)	Ideology & Constitution of Pakistan	2(2+0)	Gen Ed
2	300.2 (FE)	Functional English	3(3+0)	Gen Ed
3	300.2(Entr)	Entrepreneurship	2(2+0)	Gen Ed
4	300.2 (Soc. Sc)	Intro to Social Sciences	2(2+0)	Gen Ed
5	300.2 (Pak. Stud)	Pakistan Studies	2(2+0)	Compulsory
5	STA-302	Subsidiary-I (Statistics-II)	3(3+0)	Int Disc
6	GEG-302/ GEL-302/ BOT-302/ CHM-302	Subsidiary-II (Geography-II/ Geology-II/ Botany- II/ Chemistry-II)	3(2+1)	Int Disc
7	ENV-302	Environmental and Analytical Chemistry	3(2+1)	Major
Total Credit Hours			20	

Second Year - Semester III

S. No.	Course No.	Course Title	Credit Hours	CourseType
1	400.1 (Q. Reas)	Quantitative Reasoning -I	3(3+0)	Gen Ed
2	400.1 (E. Writ)	Expository Writing	3(3+0)	Gen Ed
3	STA-401	Subsidiary-I (Statistics-III)	3(3+0)	Int Disc
4	GEG-401/ GEL-401/ BOT-401/ CHM-401	Subsidiary-II (Geography-III/ Geology-III/ Botany- III/ Chemistry-III)	3(2+1)	Int Disc
5	ENV-401	Fundamentals of Ecology	3(3+0)	Major
6	ENV-403	Environmental Sampling and Instrumentation	3(2+1)	Major
Total Credit Hours			18	

Second Year - Semester IV

Sr.No.	Course No.	Course Title	Credit Hours	CourseType
1	400.2 (Q. Reas)	Quantitative Reasoning-II	3(3+0)	Gen Ed
2	400.2 (ICT)	Application of Inf. & Comm. Technologies	3(3+0)	Gen Ed
3	STA-402	Subsidiary-I (Statistics-IV)	3(3+0)	Int Disc
4	GEG-402/ GEL-402/ BOT-402/ CHM-402	Subsidiary-II (Geography-IV/ Geology-IV/ Botany-IV/ Chemistry-IV)	3(2+1)	Int Disc
5	ENV 402	Basic Microbiology	3(2+1)	Major
6	ENV-404	Environmental Geology	3(3+0)	Major
		Total Credit Hours	18	

Third Year - Semester V

Sr.No.	Course No.	Course Title	Credit Hours	CourseType
1	ENV-501	Environmental Management	3(3+0)	Major
2	ENV-503	Research Methodologies	3(3+0)	Major
3	ENV-505	Environmental Pollution Measurement and Assessment-I	3(2+1)	Major
4	ENV-507	Water and wastewater treatment	3(3+0)	Major
5	ENV500.1	Internship	3(0+3)	Compulsory
		Total Credit Hours	15	

Third Year - Semester VI

S.No.	Course No.	Course Title	Credit Hours	CourseType
1	ENV-502	Air and Noise Pollution	3(3+0)	Major
2	ENV-504	Environmental Microbiology	3(3+0)	Major
3	ENV-506	Environmental Pollution Measurement & Assessment- II	3(2+1)	Major
4	ENV-508	Environmental Toxicology	3(2+1)	Major
5	ENV500.2	Capstone Project	3(0+3)	Compulsory
		Total Credit Hours	15	

Fourth Year- Semester VII

S .No.	Course No.	Course Title	Credit Hours	CourseType
1	ENV 601	Industrial Pollution and Control	3(3+0)	Major
2	ENV-603	Aquatic Pollution	3(3+0)	Major
3	ENV-605	Env. Hygiene & Occupational health	3(2+1)	Major
4	ENV-607	Environmental Economics	3(3+0)	Major
5	ENV-609	Solid Waste Management	3(3+0)	Major
6	ENV-600...	Elective – I	3(3+0)	Major/Elective
7	ENV-627**	Thesis	6 (0+3) Optional	Major
		Total Credit Hours	18	

Four Year - Semester VIII

S. No.	Course No.	Course Title	Credit Hours	CourseType
1	ENV-602	Environmental Impact Assessment	3(2+1)	Major
2	ENV-604	Environmental Epidemiology	3(3+0)	Major
3	ENV-606	Sustainability & Natural Resource Management	3(3+0)	Major
4	ENV-608	Environmental Biotechnology	3(3+0)	Major
5	ENV-600...	Elective – II	3(3+0)	Major/Elective
6	ENV-600...	Elective – III	3(3+0)	Major/Elective
7	ENV-626*	Project	3(0+3) Optional	Major
8	ENV-627**	Thesis	6 (0+3) Optional	Major
		Total Credit Hours	18	

Note:

- **Thesis can be taken in lieu of two courses of final year (one course each from 7th and 8th Semester)
- *Project can be taken in lieu of two courses of final year (one course from 8th Semester)

Major/ Elective courses

The student may also opt from the floating courses in semester 7 and 8.

S. No.	Course No.	Course Title	Credit hours
1.	ENV-610	Wildlife Ecology & Wetland Management	3+0
2.	ENV-611	Climate & Climate Change	3+0
3.	ENV-612	Environmental Remote Sensing	3+0
4.	ENV-613	Anthropology and Environment	3+0
5.	ENV-614	Population dynamics	3+0
6.	ENV-615	Art of sustainability	3+0
7.	ENV-616	Recreation Management	3+0
8.	ENV-617	Environmental migration	3+0
9.	ENV-618	Urban ecology and landscape	3+0
10.	ENV-619	Introduction to environmental humanities	3+0
11.	ENV-620	Ecotourism	3+0
12.	ENV-621	Environmental governance	3+0
13.	ENV-622	Biodiversity and conservation management	3+0
14.	ENV-623	Basic anthropology	3+0
15.	ENV-624	Energy and sustainable environment	3+0
16.	ENV-625	Disaster Risk Management	3+0

Frame Work of BS program at the Institute of Environmental Studies

Degree Title	BS (Environmental Science)
Total Credit Hours	140 Credit Hours
Degree Qualifying CGPA	2.2/4.0
Pass Percentage	50%
Duration	4 Years
Semester	8

Curriculum Outline

Year	Semester	Credit Hours
I	I	18
	II	20
II	III	18
	IV	18
III	V	15
	VI	15
IV	VII	18
	VIII	18
Total Credit Hours		140

Courses Distribution

Types of Courses	No. of Courses	Credit Hours
Gen. Ed.	12	30
Major	26	78
Interdisciplinary	8	24
Capstone (Compulsory)	1	3
Internship (Compulsory)	1	3
Pakistan Studies (Compulsory)	1	2
TOTAL	49	140

COURSE OUTLINE (Major Courses)

Course No:	ENV-301
Course Title:	Introduction to Environment
Credit Hours:	3 (3+0)
Status of the course	Already approved

Course Objective

It is an introductory course designed to create awareness about the multidisciplinary nature of the environment. The objectives include:

- Development of environmental concepts, problems and their solutions
- World population growth and the environment
- Ecosystem and the changes taking place in air, water and soil, ozone depletion, global warming and the greenhouse effects.

At the end of the course the participants should be able to comprehend environmental issues related to ecosystem and their possible solution.

Course Outcomes

The students will gain the knowledge about the basic principles of environmental management and how it influences the human society and vice versa. Students will gain in depth knowledge about the spheres of environment including land, water, air and sea and how they interlinked and interconnected with each other. How the spheres of environment influencing life on earth will also be learnt during the course of study. The students will be able to acquainted ecosystems functions and services and how they vary structurally and functionally. The students will also learn about the international treaties pertaining to the environmental pollution control.

Course contents

Module 1

Environmental science as an interdisciplinary subject.

Environmental crises and interrelationship to environmental issue.

Module 2

Origin of earth

Origin and evolution of life

Evolution of human beings and development of human societies

Human societies and natural environment.

Population dynamics

Module 3

Biomes

Energy flow in an ecosystem.

Food chain and food web

Ecological pyramid

Module 4

World Resources

Renewable and nonrenewable resources

Resource management

Module 5

Water resource management

Air quality management

Sustainable agriculture and soil management

Waste management

Recommended books

Datta, Rupali, Hannigan, Robyn, Mukherjee, Avinandan, Sarkar, Dibyendu, 2015. An Integrated Approach to Environmental Management. Wiely.

Takayuki Shimaoka, Takahiro Kuba, Hirofumi NakayamaToshiyuki Fujita, Nobuhiro Horii (eds.)2016. Basic Studies in Environmental Knowledge, Technology, Evaluation, and Strategy: Introduction to East Asia Environmental Studies. Springer Japan.

Daniel P. Loucks, Eelco van Beek .2017. Water Resource System planning and Management. An introduction to methods, models and applications. Springer International Publishing.

IGI Global/Engineering Science. 2018. Information Resources Management Association. Hydrology and water resource management: Breakthroughs in research and practice.

Jon C. Lovett, 2010. A Handbook of Environmental Management. Edward Elgar Publishing.

Mary K. Theodore and Louis Theodor. 2009. Introduction to Environmental Management.CRC Press. Taylor and Francis.

Hertel, Thomas W., Baldos, Uris and Lantz C.2016. Global Change and the Challenges of Sustainably Feeding a Growing Planet. Springer

Imura, Hidefumi. 2013. Environmental Systems Studies. A Macroscopic for Understanding and Operating Spaceship Earth. Springer

Alexander, Mike. 2013. Management Planning for Nature Conservation .A Theoretical Basis and Practical Guide.Springer.

Adams, W M (2008) Green development: Environment and development in a changing world. 3 Rdedition.Routledge, London

Botkin, D B (2005) Environmental science; earth as a living planet.5th edition. John Wiley, New York.

Manly, B F J (2009) Statistics for environmental science and management.2nd edition. CRC Press, London.

Course No:	ENV- 302
Course Title:	Environmental and Analytical Chemistry
Credit Hours:	3 (2+1)
Status of the course	Already approved

Course Objectives

The course will demonstrate a solid foundation of the literacy as it relates to environmental chemistry. The course shall provide the knowledge of the design and use of field instrumentation, computer models, data analysis and laboratory procedures for environmental chemistry, research and applications. The course elaborates the theoretical basis and observational methods for study of contaminants and interactions with the land surface, biota and climate change. The student will be able to formulate ideas and evaluate results through written, numerical, graphical, spoken, and computer-based forms of communication.

Learning Outcomes

The students will learn the basic principles of environmental chemistry. They will be able to apply previous knowledge on analytical chemistry to environmental processes and samples. They will understand the interconnections between different sectors of the environment (soil, water, and atmosphere) and the effect of human activities on the natural chemical processes. The students will be able to develop an understanding of chemicals and their effects on the environment. After the completion of this course, they will learn how business and government policies toward chemicals in the environment affect the planet.

Course Content

Module 1

Introduction to environmental chemistry
 Principles of environmental analytical chemistry
 Chemistry of organic and inorganic contaminants in the environment
 Natural chemical cycles in the biosphere, aerospace hydrosphere and atmosphere
 Chemical equilibrium and kinetics

Module 2

Fundamentals of aquatic, atmosphere and soil chemistry
 Fate of pollutants in the environment
 Application of different processes to remove contaminants in natural and engineered systems
 Energy and Environmental Geochemistry

Module 3

Atmospheric Chemistry
Organic Pollutants (Dioxins, Furans, PCBs)
Radioactivity, Radon, Nuclear Energy,
Water chemistry
Water Pollution
Toxic heavy metals

Module 4

Carbon Cycle
Nitrogen Cycle
Sulphur Cycle
CO formation in atmosphere
Pollution from Combustion Systems
Coal Combustion
Photochemical Smog
Indoor Air Pollution

Module 5

Soil Pollution
Soil around us
Soil Pollution Management
Nuclear Waste Management
Sewage Treatment

Practicals

Quality control methods and Quality assurance in laboratory
Precision and accuracy in analytical techniques
Laboratory and field instruments calibration and standard operating procedures
Use of titrimetric and Gravimetric analysis
Chromatography and Spectro-photometric techniques

Recommended Books

Farwa Nadeem, Hafiz Muhammad Tauqeer, Muhammad A. Hanif, Ijaz Ahmad Bhatti (2020).
Environmental Chemistry: A Comprehensive Approach. John Wiley & Sons,
Pallavi Saxena, Anju Srivastava (2020). Air Pollution and Environmental Health. Springer
V. Subramanian (2011). A Textbook of Environmental Chemistry. Dreamtech Press
Andrews, J.E., Brimblecombe, P., Jickells, T.D., Liss, P.S. and Reid, B.J. (2004). An Introduction to
Environmental Chemistry. 2nd Edition, Blackwell Science.
Girard, J.E. (2005). Principles of Environmental Chemistry. Jones and Bartlett.
Hill, M.K. (2004). Understanding Environmental Pollution. 2nd Edition Cambridge University Press.
Manahan, S.E. (2000). Environmental Chemistry. 7th Edition, Lewis Publishers Inc.
Schwedt, G. (2001). The Essential Guide to Environmental Chemistry. John Wiley and Sons.
Spiro, T.G. and Stigliani, W.M. (2003) Chemistry of the Environment. 2nd Edition. Prentice Hall.
Skoog, D.A., West, D.M. and Holler, F.J. (2004). Fundamentals of Analytical Chemistry. 8th Ed.
Thomson and Brooks.

Course No:	ENV-401
Course Title:	Fundamentals of Ecology
Credit Hours:	3 (3+0)
Status of the Course	To be approved

Course Objectives

In this course the students will learn about the interaction between organisms and the environment and the components of the ecosystems including abiotic and biotic components. The course also shall envisage about the environmental factors, and the interplay between these components at the organism, population, community and ecosystem levels. The students shall also

be taught about the contemporary ecological functions and issues including biodiversity losses, habitat destruction, invasive species, sustainability and disease patterns. The course intends to develop student's skills in researching and evaluating information

Learning outcomes

After completion of this course the student will be able to explicate the core concepts of ecological principles with regards to species interaction, population dynamics, communities, ecosystem and ecosystem services. The students will also learn about the theories of evolution and earth systems science. Another important aspect the students also deals with is the human societal impacts on ecological systems. After having the ownership of this course, the students will be able to improvised their functioning in the society.

Course Contents

Module 1

Introduction to Ecology

Brief intro to evolution

Natural selection

Speciation

Extinction

Module 2

Behavioral Ecology

Functional Ecology: temperature, water

Functional Ecology: nutrients, soil

Populations

Metapopulations and Life History

Module 3

Population growth and dynamics

Sustainability and Harvesting

Competition

Facilitation

Predation

Herbivory

Parasitism

Disease

Module 4

Species diversity and Richness

Diversity Patterns

Community dynamics

Diversity and restoration

Climate

Global climate change

Module 5

Terrestrial biomes

Aquatic biomes

Food chain

Food webs

Chemical cycles

Books Recommended

Smith and Smith (2012). Elements of Ecology. 8th edition. Pearson Benjamin Cummings, San Francisco USA

W.D. Bowman, S.D. Hacker, and Cain, M.L. 2017. Ecology, 4th or 5th Edition. Sinauer Associates, Inc., Publishers. Sunderland, MA.

Eugene Odum (2004). Fundamentals of Ecology. Cengage Learning

Dk , Foreword by Tony Juniper (2019). The Ecology Book: Big Ideas Simply Explained. Dorling Kindersley Ltd.

Andrea Wulf (2015). The Invention of Nature. John MurrayUK.Publishers

Dan Saladino (2021). Eating to Extinction. Penguin Books

Samuel M. Scheiner, Michael R. Willig (2011). The Theory of Ecology. Springer Link

Jaboury Ghazoul. Ecology: A Very Short Introduction. Oxford University Press

Course No:	ENV-402
Course Title:	Basic Microbiology
Credit Hours:	3 (2+1)
Status of the course	Already approved

Course Objectives

Microorganisms are ubiquitous in nature. This course is designed to enhance understanding of the students about the nature and behavior of microorganisms in the environment. The course would provide opportunities for learning fundamental principles of microbiology as they are applied for the solution of environmental health related problems.

Learning Outcomes

Upon successful completion of the course, the students will be able to comprehend the concepts of environmental microbiology and will be able to demonstrate the distribution of microorganisms in natural environment. They will better describe the microbial diversity and demonstrate how diversity is assessed and identify methodological issues associated with each technique. They can envisage the influence of biotic and abiotic factors on environmental distribution of microorganism. Ecological significance of microorganism is another learning outcome of this course. Within the context of environment the students will be able to describe the bacterial metabolism, genetics, growth and nutritional requirement of microorganisms. They will summarize and apply methods commonly used in environmental microbiology and identify their limitation

Module 1

This module describes scope and historical background of microbiology, characteristics and classification of microorganisms and their method of study.

Introduction to Microbiology

Scope of Microbiology

History of Microbiology

Diversity of microorganisms

Structure of a bacterial cell

Structural difference between prokaryotes and eucaryotes

Module2

Growth, generation time, mathematical expression of growth and growth phases

Growth and food utilization

Nutritional types of microorganisms

Types of interactions between different microbial species in mixed population

Microbial metabolism

Module 3

Physical methods of control of microorganisms

Chemical methods of control of microorganisms

Sanitization, use of different sanitizers in different situations

Nosocomial infections and control measures

Infection control programme

Module 4

Microbiology of water

Food microbiology

Soil microbiology

Air microbiology

Module 5

Useful activities of microorganisms

Industrial microbiology

Biodegradation of hazardous waste

Practicals

Methods of studying microorganisms
Techniques for the determination of microbiological quality of water
Physical methods of control of microorganisms
Chemical methods of control of microorganisms

Recommended books

Gary W. Procop, Deirdre L. Church, Geraldine (2017). Koneman's Color Atlas and Textbook of Diagnostic Microbiology. 6th ed. Jones and Bartlett Learning
Sumathi Muralidhar (2019). Lippincott Illustrated Reviews Microbiology> Wolter Kluwer India Publishers
Patrick R. Murray, Ken S. Rosenthal, Michael. (2013) Medical Microbiology. 7th ed. Elsevier Publishers
Michael J. Leboffe, Burton E. Pierce.(2019) . Microbiology: Laboratory Theory and Application, Essentials. Morton Publishers
Richard Goering, Hazel Dockrell, Mark Zuckerman, Ivan Roitt, Peter L. Chiodini (2013). Mims' Medical Microbiology. 6th ed. Elsevier Publishers
Patricia Tille (2022). Bailey & Scott's Diagnostic Microbiology. Elsevier Publishers
Jacquelyn G. Black, Laura J. Black (2012). Microbiology: Principles and Explorations. Wiley

Course No:	ENV -403
Course Title:	Environmental Sampling and Instrumentation
Credit Hours:	3 (2+1)
Status of the Course	Already approved

Course Objectives

The principal objective of this course is to understand the basic concepts of environmental pollution monitoring, and enable the students to select, design and configure pollution monitoring instruments. This course renders the students to various analytical techniques and instruments utilized in environmental chemical analysis. Students will be able to learn and practice different methods to collect samples with particular emphasis on quality control checks so that they will be able to defend their data and can base good decisions on their measurements.

Learning outcomes

The students will be able to understand the concept of site selection through the rigorous characterization of soil, water, air and marine environment. They will get familiarize with the scientific method and significance in assessing site environmental conditions. The students will also be able to develop statistically valid sampling plans and the methods of sample collection and preservation. They will also learn about the data recording, coding and reporting. They will understand the principles and working of various scientific equipment.

Module 1

Sampling protocol
Planning a Sampling Strategy
Development of monitoring strategy, Scheduling and sampling frequency
Site selection

Module 2

Sampling equipment
Sampling Techniques
Collection of samples
Preservation of samples

Module 3

Field quality control
Laboratory quality control
Equipment calibration
Precision and accuracy

Sensitivity and control of error
Laboratory certification and standardization

Module 4

Database management
Data analysis
Statistical treatment of data
Sources of error

Module 5

Use of bench top and field pH and Dissolved Oxygen meters.
Use of Spectrophotometer; Visible light, Infrared (IR Spectrophotometer), Ultraviolet (UV/Visible Spectrophotometer)
Atomic Absorption Spectrophotometer
Chromatography: Solid, Liquid and Gas chromatography
Mass Spectroscopy

Practicals

Devices and containers for soil, air and water sampling and their working
Equipment calibration
Use of bench top and field pH and Dissolved Oxygen meters
Use of Spectrophotometer

Recommended Books

Alfred R. C., Rolf M. (2004). Field Sampling: Principles and Practices in Environmental Analysis, CRC Press.
Spellman, F. R. (2004). Manual for Water and Wastewater Treatment Plant; CRC Press
Chunlong Z, Chunlong C. Z. (2007). Fundamentals of Environmental Sampling and Analysis, Wiley-Interscience.
APHA, WPCF, APHA (2003) Standard Methods for the Examination of Water and Wastewater; APHA, WPCF, APHA
Crompton, T.R. (1999). Determination of Organic Compounds in Soils, Sediments and Sludges; E & F Spon Press
Montgomery, D.C. (2000). Design and analysis of Experiments (5th d.) Wiley New York.
Kromadas, S. (2005) More practical problems solving HPLC. Wiley & Sons, New York.
Randy D. Down P.E., Jay H. Lehr (ed.s) (2005). Environmental Instrumentation and Analysis Handbook. John Wiley & Sons, Inc.

Course No:	ENV-404
Course Title:	Environmental Geology
Credit Hours:	3 (3+0)
Status of the course	Already approved

Course Objectives

The objective of this course is to impart a basic knowledge of geological principals relevant to environmental scientist. The students are educated about the fate of waste disposal in subsoil and rocks. Safety of projects, oil and gas exploration and relevant environmental issues are addressed. Natural hazards such as earthquakes, cyclones, landslides, land subsidence their causes and remedial measures are discussed.

Learning Outcomes

By the end of this course the students will be able to understand the dynamicity of the earth complex systems. The students also foster the relationship of human population growth and its impact on the natural world. The students comprehend the tectonic plate theory and functions and processes of the natural disasters. The students will also be able to demonstrate the impact of climate change and the issues pertaining to the anthropogenic warming. The students will also have the better learning of integrated coastal zone management and the process of soil erosion.

Course Contents

Module 1

The planet earth, Mass, Shape
Size, Density, Processes and Materials
Minerals: Physical properties
Classification, Uses and types

Module 2

Magma, Crystallization of igneous rocks
Classification and description of igneous and sedimentation rocks
Internal structure of earth, Plate tectonics
Earthquakes seismic waves and instrument
Seismic risk evaluation, Prediction, Mitigation
Earthquake in Pakistan
Seismic, Drilling and Blowouts

Module 3

Drainage basin, River-systems of Pakistan
Floods, Floodplains, Discharge
Flood probability, Corrective measures
Groundwater, Hydrologic cycles, Porosity and Permeability
Groundwater contamination, Waste disposal wells

Module 4

Sanitary landfills, water logging and salinity
Deserts and desertification, Types of deserts
Wind erosions and deposition
Conservation of soil
Oceans, morphology, tectonics

Module 5

Coasts, erosion and deposition
Protection of coasts
Pollution due to petroleum industry
Air pollution due to petroleum industry
Burning of fossil fuel
Oil spills and their control
Physical barriers and chemical dispersants

Recommended Books

Knödel, K., Lange, G., & Voigt, H. J. (2007). Environmental Geology: Handbook of field methods and case studies. Springer Science & Business Media
Klaus Knödel, Gerhard Lange, Hans-Jürgen Voigt (2007). Environmental Geology: Handbook of Field Methods and Case Studies. Springer
Bernard W. Pipkin, Dee D. Trent, Richard Hazlett, Paul Bierman (2014). Geology and the Environment. 7th Ed. Brooks/Cole. Cengage Learning
Tome Freeman (2004). Environmental Geology Laboratory. John Wiley and Sons
Edward A. Keller, Duane E. DeVecchio. Natural Hazards: Earth's Processes as Hazards, Disasters, and Catastrophes. 4th Ed. Rutledge
Richard T. Wright. (2016) Environmental Science: Toward a Sustainable Future. Jones and Bartlet Learning
Edward A. Keller, Duane E. DeVecchio (2019). Natural Hazards: Earth's Processes as Hazards, Disasters, and Catastrophes. Taylor & Francis Group.

Course No:	ENV-501
Course Title:	Environmental Management (Major)
Credit Hours:	3 (3+0)
Status of the Course	Already approved

Course Objectives

This course deals with multidisciplinary nature of environment. The course intends to provide the knowledge as how the human activities influencing the environment. Environmental management in general is the question of survival of life on this planet. The significance of environmental problems is already highlighted that calls an urgent action from all parties to re-evaluate their practices and consider sustainable ways of managing natural resources. The course also entails the scientific principles of environmental issues and environmental management practices, with special focus on human and ecosystem health. The contemporary issues pertaining to air, water, land, climate change and toxic substances in the environment will be discussed during the course of the study. It is therefore imperative to understand the basics of environmental management (theory and practice) as well as be acquainted with systematic approaches to environmental management.

Learning Outcomes

After the end of this course the students will be able to comprehend the scope and nature of environmental management with its ethical, legal and financial background. The students will have the firm grasp on the issue of environmental sustainability and its relationship with corporate social responsibility. As a complete pursuance of this course the students demonstrate knowledge of Environmental Management Systems and environmental management tools. The student fosters the identification of environmental problems and applies appropriate knowledge and skills in real life situations.

Course Contents

Module 1

What is environment?
Basics of environment and its management
Environmental sustainability
Stages of human environmental impacts

Module 2

Human population
Human population growth phases
Carrying capacity
Sustainable yield
Population environment relationship
Ecosystem characteristics and services
Biomes
Food web and Food chain
Ecological pyramid

Module 3

Environmental Management System (EMS)
Creating Environmental policy in EMS
Role of ISO 14000 series in Environmental Management
Environmental management tools,

Module 4

Environment and sustainable development goals (SDG's) of the UN
Approaches for Environmental Protection
Principles of cleaner productions
Tools of sustainable consumption and production
Corporate and social responsibilities.
Sustainable and nature-based solutions for environmental problems.

Recommended Books

Mary K. Theodore, Louis Theodore (2010). Introduction to Environmental Management. CRC Press/Taylor & Francis Group
Valli Manickam, Naresh Davergave, Iyyanki V. Murali Krishna, Anil Shah (2017). Environmental Management: Science and Engineering for Industry. Elsevier Science
Chris Barrow. (2002). Environmental Management for Sustainable Development. Rutledge
John Pallister (2017). Environmental Management. Cambridge

Brian Waters (2013). Introduction to Environmental Management: For the NEBOSH Certificate in Environmental Management. Rutledge

Alexander Trautrim, Chee Yew Wong, David B. Grant (2013). Sustainable Logistics and Supply Chain Management. Kogan page

Modak Prasad (2018). Environmental Management Towards Sustainability. Taylor & Francis

Søren Nors Nielsen (2020). Sustainable Development Indicators. CRC Press

Adrian Belcham (2014). Manual of Environmental Management. Taylor and Francis

Course No:	ENV-502
Course Title:	Air and Noise Pollution
Credit Hours:	3 (3+0)
Status of the course	Already approved

Course Objectives

Air pollution has momentous impacts on human health in particular and the environment in general. Air pollution is attributed to number of interconnected tribulations including criteria air pollutants, ozone depletion, acid rain, visibility dilapidation and climate change. Significant steps have been taken in the past to improve understanding of the sources, chemical transformation, transport, deposition, and impacts of different air pollutants. The air pollutants are associated through intricate chemical interdependencies. The course is designed for the students to comprehend the fate and transport of air pollutants, air pollution health effects and environmental modeling. The course enable the students to better understand the relevant concepts drawn mainly from the earth sciences, chemistry, physics, and engineering.

Learning Outcomes

After the successful completion of the course the students will be able to learn about the interrelationships and interdependencies of different air pollutants in the context of contemporary air pollution issues worldwide. The students will also be familiarize with the history of air pollution science. They will be able to comprehend the sources of air pollution, their concentrations in the atmosphere and their environmental effects. The students will also be explained about the basic concepts of quantitative scientific methods and air pollution modeling.

Course Contents

Module 1

Air as a component of ecosystem
Historical view of air pollution problems
Introduction to air
Biology and chemistry of air
Transport of pollutants, global meteorology

Module 2

Inorganic air pollutants
Oxides of carbon, nitrogen and sulphur
Ozone
Tropospheric ozone chemistry
Particulate matter
Effects on human health and ecosystem

Module 3

Organic air pollutants

Polynuclear aromatic hydrocarbons (PAH)
Vinyl chloride
Acrylonitrile
Odorants
TCE, DCE, Toluene
Formaldehyde, Styrene

Module 4

Metal pollutants in air

Sources of metals in air
Effects of air borne Pb, Cd, Mn, etc on plant and animal life

Module 5

Health effects of air pollutants

Effects of organic, inorganic and other air pollutants on human health
Mitigation measures for minimizing health effects of air pollutants
Sources of noise pollution: Stationary and mobile
Noise intensity, pressure and power
Propagation of noise
Effect of noise pollution on human and behavior

Books Recommended

John H. Seinfeld and Spyros N. Pandis (2006). Atmospheric Chemistry and Physics: From Air Pollution to Climate Change, 2nd Edition. Wiley.
Barbara J. Finlayson-Pitts and James N. Pitts, Jr. (1999). Chemistry of the Upper and Lower Atmosphere, Academic Press.
Mark Z. Jacobson (2002). Atmospheric Pollution: History, Science, and Regulation. Cambridge Univ. Press
Mark Z. Jacobson (2005). Fundamentals of Atmospheric Modeling, 2nd Edition, 2005, Cambridge Univ. Press.
Mark Z. Jacobson, Professor Mark Z Jacobson (2002). Atmospheric Pollution: History, Science, and Regulation Cambridge Univ. Press.
Sarah Metcalfe and Dick Derwent. (2005). Atmospheric Pollution and Environmental Change. Oxford University Press
Pallavi Saxena and Vaishali Naik. (2019) Air Pollution: Sources, Impacts and Controls. CAB International
Mark Z. Jacobson (2012). Air Pollution and Global Warming: History, Science, and Solutions. Cambridge University press
Jon Ayres , Robert Maynard and Roy Richards (2006). Air Pollution and Health. World Scientific Publishing
Bhola R. Gurjar, Luisa T. Molina, C.S. P. Ojha. (2010). Air Pollution: Health and Environmental Impacts. CRC Press

Course No:	ENV-503
Course Title:	Research Methodologies
Credit Hours	3 (3+0)
Status of the course	To be approved

Course objective

This course is designed to provide an overview of research methodology to the students including basic concepts employed in quantitative and qualitative research methods. This course entails the student to understand varied range of research methods. The fundamental issues regarding the formulation of research questions, research design, and data collection and analysis will be addressed during the course of study. The students will also learn about the basic components of the research process including conceptualization and measurement, sample selection, and causal modeling. The course further discloses the critical issues in the philosophy of science, ethical questions, and how to write a research proposal.

Learning Outcomes

At the end of this course the students will be able to practically demonstrate knowledge of research processes that include reading, developing and evaluation. They will be foster how to perform literature reviews using print and online databases. They will understand different methods of citing print and electronic materials. Upon completion of this course they will develop skills to identify, explain, compare, and prepare the key elements of a research proposal and report. They will have an insight to compare and contrast quantitative and qualitative research

Course contents

Module 1

Meaning and definitions of research
Objectives of research
Research motivation
General characteristics and criteria of good research
Types of research

Module 2

Scientific and critical thinking
What is a research problem
Selection and sources of the problem
Statement and delimiting of a problem
Evaluation of a Problem

Module 3

Meaning of review of literature
Objectives of review of literature
Sources of literature
How to Conduct the Review of Literature

Module 4

Definition and meaning of hypothesis
Nature and function of hypothesis
Functions of hypothesis
Importance of hypothesis
Kinds of hypothesis

Module 5

What are the research strategies
Which strategy to choose
Case Studies
Experiments
Action Research

Practicals

Questionnaires development
Interviews
Focus groups discussion
Observation
Sampling strategies
Methods of sampling
Size of a sample
The sample cycle

Recommended Books

Cohen, L. Lawrence, M., & Morrison, K. (2005). *Research Methods in Education* (5th edition). Oxford: Oxford University Press.

Denscombes, M. (2010). *The Good Research Guide: For small-scale social research projects*. Maiden-Read: Open University Press.

Dornyei, Z. (2007). *Research Methods in Applied Linguistics*. Oxford: Oxford University Press.

Kumar, R. (2011). *Research Methodology: a step-by-step guide for beginners* (3rd edition). London, UK: TJ International Ltd,

Padstow, Cornwall. 7. Leedy, P. D. (1980). *Practical Research: Planning and design*. Washington: Mc Millan Publishing Co., Inc.

Singh, Y. K. (2006). *Fundamental of Research Methodology and Statistics*. New Delhi. New International (P) Limited, Publishers

Tuckman, B. W. & Harper, B. E. (2012). *Conducting educational research* (6th ed.). Lanham, MD: Rowan & Littlefield Publishers. (ISBN: 978-1-4422-0964-0).

Course No:	ENV-504
Course Title:	Environmental Microbiology (Major)
Credit Hours:	3 (3+0)
Status of the course	Already approved

Course Objectives

Microorganisms are ubiquitous in nature. This course is designed to enhance understanding of the students about the nature and behavior of microorganisms in the environment. The course would provide opportunities for learning fundamental principles of microbiology as they are applied for the solution of environmental health related problems.

Learning Outcomes

Upon successful completion of the course, the students will be able to comprehend the concepts of environmental microbiology and will be able to demonstrate the distribution of microorganisms in natural environment. They will better describe the microbial diversity and demonstrate how diversity is assessed and identify methodological issues associated with each technique. They can envisage the influence of biotic and abiotic factors on environmental distribution of microorganism. Ecological significance of microorganism is another learning outcome of this course. Within the context of environment, the students will be able to describe the bacterial metabolism, genetics, growth and nutritional requirement of microorganisms. They will summarize and apply methods commonly used in environmental microbiology and identify their limitation

Course Contents

Module 1

This module describes scope and historical background of microbiology, characteristics and classification of microorganisms and their method of study.

Introduction to Microbiology

Scope of Microbiology

History of Microbiology

Diversity of microorganisms

Methods of studying microorganisms

Structure of a bacterial cell

Structural difference between prokaryotes and eucaryotes

Module2

Growth, generation time, mathematical expression of growth and growth phases

Growth and food utilization

Nutritional types of microorganisms

Types of interactions between different microbial species in mixed population

Microbial metabolism

Module 3

Physical methods of control of microorganisms

Chemical methods of control of microorganisms

Sanitization, use of different sanitizers in different situations

Nosocomial infections and control measures

Infection control programme

Module 4

Microbiology of water

Techniques for the determination of microbiological quality of water

Food microbiology

Soil microbiology

Air microbiology

Module 5

Useful activities of microorganisms

Industrial microbiology

Biodegradation of hazardous waste

Recommended books

Gary W. Procop, Deirdre L. Church, Geraldine (2017). Koneman's Color Atlas and Textbook of Diagnostic Microbiology. 6th ed. Jones and Berlett Learning

Sumathi Muralidhar (2019). Lippincott Illustrated Reviews Microbiology> Wolter Kluwer India Publishers

Patrick R. Murray, Ken S. Rosenthal, Michael. (2013) Medical Microbiology. 7th ed. Elsevier Publishers

Michael J. Leboffe, Burton E. Pierce. (2019). Microbiology: Laboratory Theory and Application, Essentials. Morton Publishers

Richard Goering, Hazel Dockrell, Mark Zuckerman, Ivan Roitt, Peter L. Chiodini (2013).

Mims' Medical Microbiology. 6th ed. Elsevier Publishers

Patricia Tille (2022). Bailey & Scott's Diagnostic Microbiology. Elsevier Publishers

Jacquelyn G. Black, Laura J. Black (2012). Microbiology: Principles and Explorations. Wiley

Course No:	ENV-505
Course Title:	Environmental Pollution Measurement and Assessment-1
Credit Hours:	3 (2+1)
Status of the course	already approved.

Course Objectives

Pollution monitoring is a prerequisite of pollution control. The objective of this course is to study and apply those methods that are directly and indirectly important in pollution control. The students will practically analyze for themselves those chemical parameters that are important in pollution control.

Learning outcomes

This course will provide the standard methods for the examination of pollutants in water and wastewater. The students will also be able to demonstrate the nature, occurrence and emergence of these pollutants with their dispersion mechanisms and the hazards associated with them. They will also learn that how these pollutants accumulate in the aquatic environment and how these pollutants can be eliminated with the methods of remediation. They will also be able to write a technical report on the basis of the data gathered during the analytical procedures.

Course Contents

Module 1

Sampling, preservation and quality control methods used in the physical and chemical analysis of water and wastewater

Sampling survey

Quality control assessment

Module 2

Determination of total solids (TS), total dissolved solids (TDS) and total suspended solids (TSS)

Determination of chlorides

Determination of alkalinity as CaCO₃

Determination of hardness as CaCO₃

Determination of dissolved oxygen by the Azide modification method

Determination of biochemical oxygen demand (BOD₅)

Determination of chemical oxygen demand (COD)

Module 3

Determination of ammonia-nitrogen (NH₃-N) by Nesslerization (distillation procedure)

Determination of nitrite-nitrogen (NO₂-N)

Determination of nitrate-nitrogen (NO₃-N) by the Brucine method

Determination of oil and grease (n-Hexane extract)

Determination of sulphates by the gravimetric method

Determination of total phosphate

Determination of total Kjeldahl nitrogen

Determination of Arsenic
Determination of phenols
Determination of cyanide
Determination of anionic detergents
Determination of mercury

Module 4

Determination of heavy metals

Module 5

Use of thin layer chromatographic technique
Use of paper chromatographic technique
Use of high pressure liquid chromatography (HPLC)

Practicals

Determination of total solids (TS), total dissolved solids (TDS) and total suspended solids (TSS)
Determination of chlorides
Determination of alkalinity as CaCO₃
Determination of hardness as CaCO₃
Determination of dissolved oxygen by the Azide modification method
Determination of biochemical oxygen demand (BOD₅)
Determination of chemical oxygen demand (COD)
Determination of heavy metals

Recommended Books

Roy Keith Smith, Water Environment Federation (2019). Water and Wastewater Laboratory Techniques. Water Environment Federation
Barbara Hause (2002). Drinking Water Chemistry: A Laboratory Manual. Lewis Publishers
Jo Allan Beran (2011). Laboratory Manual for Principles of General Chemistry. Kay Pace Publishers
Barbara Hauser (2002). Drinking Water Chemistry: A Laboratory Manual. CRC Press
Satinder Ahuja (2013) Monitoring Water Quality: Pollution Assessment, Analysis, and Remediation. Elsevier

Course No:	ENV- 506
Course Title:	Environmental Pollution Measurement and Assessment-II
Credit Hours:	3 (2+1)
Status of the course	Already approved

Course objective

Micro-organisms are present everywhere in the environment. They are involved in contaminations, infections and decay; therefore, it is important to control them according to their habitat. The effectual surveillance of micro-organisms in any environment (home, hospital or industry) depends up the knowledge how to control (killing, removal or inhibition) micro-organisms. This course is designed to develop the understanding of different techniques and agents used for the control of microbial population in different environments. Moreover, it highlights the importance of selection of a particular agent or method of control under variable conditions.

Learning Outcomes

At the end of this course the student understand the basic physiology of microorganisms including various metabolic processes. They will also be able to practically demonstrate the role of antimicrobial agents in controlling their proliferation. They will also have the practical knowledge regarding the production of bio gas and the methods of composting. They will be capable of applying essential principles of microbiology to wastewater treatment. They will gain practical insight of understanding the contemporary issues associated with environmental microbiology

Course Contents

Module 1

Study of the germicidal effect of UV radiations on micro-organisms of public health importance.
Finger imprint test of skin-substantively of germicides in Soaps.
Assessment of efficiency of toilet paper as barrier against micro-organisms

Determination of the effect of antiseptics on the test organism on human skin.
Study of the effect of pH on the thermal resistance of bacteria.
Determination of resistance of *Bacillus cereus* spores at 100 °C.
Determining the presence of antibiotic residues in milk.
Removal of micro-organisms by chemical flocculation.
Removal of micro-organisms by adsorption.
Determination of Break-point chlorination.

Module 2

Study of algal population of Waste Stabilization Ponds
Study of microbial population of Activated Sludge System.
Study of microbial degradation of Phenol.
Production of biogas by anaerobic decomposition of sewage sludge.
Composting of Municipal Solid Waste.

Module 3

Influence of metals on the growth of bacteria.
Brine Shrimp biotoxicity assay
Testing the toxicity of chemicals by the respiratory inhibition of activated sludge

Module 4

Bioremediation
Phytoremediation
Bioventing
Air sparging
Reactive barriers
Bioaugmentation

Practicals

Industrial microbiology, screening, typing, microbial growth
Batch culture
Fed batch
Continuous culture
Chemostat
Fermentation

Books Recommended

Encyclopedia of Environmental Microbiology (2003). John Wiley and Sons
Ian Pepper Charles Gerba and Terry Gentr (2014). Environmental Microbiology 3rd Edition. Elsevier
Anoop Singh, Shaili Srivastava, Dheeraj Rathore, Deepak Pant (2020) Environmental Microbiology and Biotechnology: Volume 2: Bioenergy and Environmental Health. Springer
Bibhuti Bhusan Mishra, Suraja Kumar Nayak (2020) Frontiers in Soil and Environmental Microbiology. CRC Press
Diana Marco (2019). Microbial Ecology: Current Advances from Genomics. Caister Academic Press.
Larry L. Barton, Robert J. C. McLean (2019). Environmental Microbiology and Microbial Ecology. Wiley Black Well
Roger Tim Haug (2019). Lessons in Environmental Microbiology. Taylor & Francis Ltd
Ram Prasad and Elisabet Aranda (2018). Approaches in Bioremediation: The New Era of Environmental Microbiology and Nano-biotechnology. Springer
International Commission on Microbiological Specifications for Foods (2018). Microorganisms in Foods 7: Microbiological Testing in Food Safety Management. Springer

Course No:	ENV-507
Course Title:	Water and wastewater treatment
Credit Hours:	3 (3+0)
Status of the course	Already approved

Course Objectives

Life is created from water, which is the lifeblood of environment. It is the most useful and important commodity on earth, yet it is the most misused. The survival of life on this planet depends on water.

With this background this course is designed to impart training to students to create awareness about the technologies that are available for the treatment of water for human consumption and non-human consumption. The wastewater is one of the greatest sources of pollution. Its treatment is important for sustainable development and for disease prevention and control.

After the course the students should be able (1) to supervise water and wastewater treatment facilities, (2) develop new facility and (3) implement water and wastewater treatment projects.

Learning outcomes

At the end of this course the students will have critical insight on the general characteristics of water and the classification of water. The students will also be able to characterize point and non point sources of water pollution with the associated physical, chemical and biological pollutants. The students will also gain a critical analysis of different waste water treatment systems to be employed in different climatological and economic conditions. The students will also gain an understanding of wastewater treatments systems with associated pros and cons. The water scenario of Pakistan is yet learning out come through which the students familiarized with. The students will also familiar with new technologies of water and water treatments systems.

Course Contents

Module 1

Measurements

Different systems of measurement

Different measurements that is applicable in water and wastewater systems engineering

Module 2

International and national water resources

History of water use

Water use in developed and developing countries

Hydrological cycle

Rural and urban water supply

Module 3

Different methods of water treatment for drinking purpose

Engineering principles involved in the treatment of water

Water disinfection (chlorine and compounds of chlorine, ozone, UV radiation)

Module 4

Historical perspective and development of wastewater treatment

Different stages of wastewater treatment (primary, secondary and tertiary)

Principle of biomechanical systems of wastewater treatment (activated sludge, trickling filters)

Biological system of wastewater treatment (Waste Stabilization Ponds)

Engineering principles involved in the treatment of wastewater

Recycling of wastewater

Module 5

Water and Human Health

Water borne pathogenic microorganisms and diseases

Water and socio-economic development

Recommended Books

Franklin Louis Burton, H. David Stensel, Ryujiro Tsuchihashi, George Tchobanoglous (2013). Wastewater Engineering Treatment and Design. McGraw-Hill's Inc.

John C. Crittenden, R. Rhodes Trussell, David W. Hand, Kerry J. Howe, George Tchobanoglous. (2012). Water Treatment: Principles and Design. 3rd Ed. John Wiley and Sons.

Kerry J. Howe, David W. Hand, John C. Crittenden, R. Rhodes Trussell, George Tchobanoglous. (2012). Principles of Water Treatment. John Wiley and Sons.

James Edzwald (2010). Water Quality and Treatment: A Hand Book on Drinking Water. American Water Works association

Joanne E. Drinan, Frank Spellman (2013). Water and Wastewater Treatment: A Guide for the Non Engineering Professional. CRC PressCRC Press
Mika Sillanpää (2020). Advanced Water Treatment: Adsorption. Elsevier Publishers
Frank R. Spellman (2003). Handbook of Water and Wastewater Treatment Plant Operations. Lewis Publishers
Chris Binnie, Martin Kimber, George Smethurst, (2003). Basic Water Treatment 3rd Ed. Thomas Telford Publishing
Mackenzie L. Davis (2011). Water and Wastewater Engineering. Mc Graw Hill
Rumana Riffat. (2013). Fundamentals of Wastewater Treatment and Engineering. CRC Press
Nicholas G. Pizzi. (2005). Water Treatment Operator Handbook. American Water Works Association

Course No: ENV- 508
Course Title: Environmental Toxicology
Credit Hours: 3 (2+1)
Status of the course Already approved

Course Objectives

This course is designed to develop basic knowledge of the adverse effects of environmental pollutants on humans and to some extent, on the environment as a whole. The main objective of this course is to develop an insight in the student about the actions of xenobiotics on the living organism.

Modules 1 and 2 are tailored to provide an understanding of the principles of toxicology. The student is made to appreciate how processes such as absorption, distribution, metabolism and excretion of toxicants influence their toxicodynamic properties. Module 3 relates to toxicants inducing target-organ toxicities. Mechanisms of non-target organ toxic effects, namely carcinogenesis, developmental toxicology and genetic toxicology are also studied. Module 4 deals with the toxic effects of the substances in the environment. Module 5 covers aspects on the applications of environmental toxicology in risk assessment. Management of the poisoned patient, exposure to pollutants at the workplace, and ecological impact of environmental pollutants will be discussed.

Learning outcomes

After this course the students should have the background knowledge about the occurrence, emergence and their fate in the environment. They will be able to reveal the acquaintance on the effects of toxicants in the human body associated with their exposure. They will gain the basic understanding of the tools used in the environmental toxicology. They will successfully demonstrate the knowledge of environmental toxicants in the Perspective of environmental quality in general and public health in particular.

Course Contents

Module 1

General Principles of Toxicology
Environmental Toxicology and Eco-toxicology
Xenobiotic
LD50; Acute, Sub-acute and Chronic Toxicity
Principles of toxic action
Spectrum of toxic responses; Exposure and Dose: Response
Interactions: Additivity, Potentiation; Synergism, Antagonism

Module 2

Toxicokinetics
Absorption; Distribution (half-life, bioavailability)
Metabolism (Phase I & Phase II); Elimination (bioaccumulation)
Toxicodynamics
Local vs systemic effect; Receptor theory (Agonist/Antagonist)
Agonist, Receptor, Action, Effect, Response
TCDD and Ah receptor

Module 3

Mechanisms of Toxicity

Neurotoxicology

Neuroopathy e.g Methyl mercury

Axonopathy e.g. Organophosphorus compounds

Mylenopathy e.g. inorganic lead, hexachlorophene

Neurotransmission related toxicity e.g. DDT

Module 4

Reproductive toxicology and endocrine disruption (Diethylstilbestrol, xenoestrogens, DDT)

Developmental toxicology

Teratogenesis; Thalidomide story

Ethanol, Cadmium, Carbon monoxide toxicity

Genetic toxicology (Mutation; Ames test for mutagenesis)

Carcinogenesis (Mechanisms, Initiators and Promoters)

Module 4

Toxic substances in the Environment

Toxicity of Heavy Metals (Lead, Mercury, Cadmium and Arsenic)

Toxicity of halogenated organic compounds (PCBs, PBBs, PCDFs and DIOXINS)

Toxicity of polycyclic aromatic hydrocarbons (Benzopyrene)

Toxicity of radiation and radioactive materials (Radon)

Toxic effects of animal and plant toxins

Toxicity of pesticides

Module 5

Applications of Environmental Toxicology

Clinical toxicology

Occupational toxicology

Ecotoxicology (Aquatic and Terrestrial)

Hazard and Risk

Practicals

Determination of risk assessment

Toxic effects of animal and plant toxins

Recommended Books

Curtis Klaassen, and John B. Watkins III (2010). Casarett and Doull's Essentials of Toxicology, Second Edition. Mc-Graw Hill Publishers

Jason Armstrong and Ovidiu Pasc (2015) Toxicology Handbook. 3rd Edition. Elsevier

Ernest Hodgson. (2010). Textbook of Modern Toxicology. 4th Ed. John Wiley and Sons

Ramesh C. Gupta. (2012). Veterinary Toxicology: Basic and Clinical Principles, 2nd Ed. Elsevier

Patricia Frank, M and Alice Ottoboni (2011). The Dose Makes the Poison: A Plain-Language Guide to Toxicology. John Wiley and Sons

Bruce Anderson, Ann de Peyster, Shayne C. Gad, P.J. Bert Hakkinen, Michael Kamrin, Betty Locey, Harihara M. Mehendale, Carey Pope and Lee Shugart (1998). Encyclopedia of Toxicology. Elsevier

A. Wallace Hayes (2008). Principles and Methods of Toxicology 5th Ed. CRC Press

Stine Karen, Thomas M. Brown (1996). Principles of Toxicology. CRC Press

Brian Kloss and Travis Bruce.(2014). Toxicology in a Box. Mc—Graw Hill Gautam Biswas. (2012).

Review of Forensic Medicine and Toxicology. JayPee Brothers Publishers

Course No.	ENV-601
Course Title:	Industrial Pollution and Control
Credit Hours:	3 (3+0)
Status of the course	Already approved

Course Objectives

The rapid progress in industrialization and development has tremendously improved the standard of living and quality of life but at the same time it has damaged the environment and depreciated

its well-being. The developing world in its efforts for industrialization has been facing the untoward consequences of industrial development in terms of environmental deterioration. This course is therefore designed to look into the problems and issues related to industrial pollution and its environmental and health consequences. The students will be taught industry specific pollution control and minimization technology.

Learning outcomes

Upon successful completion of this course the students will be able to quantify and analyze pollution load emerging from different industrial units. They will have better understanding of the characteristics of different industrial waste. They will gain the critical knowledge about the physical, chemical and biological treatment processes related to industrial pollution and control. The students shall also be familiarized with the methods of risk assessment and various international and national environmental quality standards. They will understand the pollution prevention strategies, waste minimization concepts and life cycle impacts.

Course Contents

Module 1

Effect of wastes on stream and wastewater treatment plants

Stream protection measures

Stream sampling

Module 2

Volume reduction

Strength reduction

Neutralization

Equalization and proportioning

Flotation

Evaporation, Dialysis and Ion exchange

Removal of suspended and colloidal solids

Removal of inorganic and organic dissolved solids

Treatment and disposal of sludge

Module 3

Apparel industries

Textile wastes

Tannery wastes

Cannery wastes

Brewery, distillery and pharmaceutical wastes

Module 4

Meat and poultry packing and rendering wastes

Food industries

Sugar industry waste

Dairy wastes

Module 5

Materials industries

Pulp and paper mill waste

Steel mill waste

Petroleum refinery waste

Pesticide waste

Steam power plants

Radioactive waste

Recommended Books

Lesley C. Batty and Kevin B. Hallberg (2010) Ecology of Industrial Pollution. Cambridge University Press

Afsah, S., Laplante, B., & Wheeler, D. (1996). *Controlling Industrial Pollution: a new paradigm* (No. 1672). World Bank, Policy Research Department, Environment, Infrastructure, and Agriculture Division.

Thomas T. Shen (1999). Industrial Pollution Prevention. Springer

Freeman, H. M. (1995). *Industrial pollution prevention handbook*. New York: McGraw-Hill.
 Nancy J. Sell. *Industrial Pollution Control: Issues and Techniques*. 2nd Ed. John Wiley and Sons
 Karl B. Schnelle, Jr and, Charles A. Brown. (2002). *Air Pollution Control Technology Handbook*. CRC Press
 Nelson Leonard Nemerow (2007) *Industrial Waste Treatment: Contemporary Practice and Vision for the Future*. Elsevier
 Martin B. Hocking. (2005). *Handbook of Chemical Technology and Pollution Control*. 3rd Ed. Academic Press

Course No:	ENV-602
Course Title:	Environmental Impact Assessment
Credit Hours	3 (2+1)
Nature of Course	To be approved

Course Objectives

All developmental activities whether related to housing and town planning, development of services infrastructure, industrialization, agriculture, rural development, communication etc. exploration have positive and negative impacts on the environment. The course is designed to look into the impact of these activities, develop procedures and protocols for the assessment of impacts, and suggest mitigation measures for minimizing impacts. The course is largely based on case studies so that the participants would develop skills to carry out environmental impact assessment and audit themselves. After the completion of course the students would be able to develop and implement Environmental Management System (ISO 14000) in different settings. The core objective of this course is to foster an understanding of how environmental impact assessment is conducted and used as a valuable tool in the development project management and decision-making process.

Learning Outcomes

The students will be able to critically evaluate the predictions inherently involved in impact assessment. They will have professional skills in identification, evaluation, prediction of the environmental impacts likely to be occurred due to proposed development. They will be successfully trained to work in the field to carry out environmental impact assessment. They will have the skills in critical thinking and professional procedures through various forms of oral and written presentation and individual and group work.

Course Contents

Module 1

Introduction to environment management
 Fundamental of environmental impact assessments
 History and devolution of environmental impact
 Development vs sustainability

Module 2

Legal frame work and provision
 Policy frame work
 Regulatory framework
 Environmental protection act (1997)
 IEE and EIA regulations in Pakistan

Module 3

Screening
 Scooping
 Baseline conditions
 Impact identification
 Impact prediction
 Impact evaluation
 Analysis of alternatives

Module 4

Stakeholder's consultation / Public Involvement in EIA

How to write EIA report

EIA reporting and review of EIA quality

Decision making

Project management

Module 5

Air quality and noise impact assessment

Ecological impact assessment

Archeology impact assessment

Water and soil impact assessment

Socioeconomic impact assessment

Practicals

EIA case studies

Preparation of EIA reports

Recommended Books

Andrew Chadwick, John Glasson, and Riki Therivel (1994). Introduction to Environmental Impact Assessment: Principles and Procedures, Process, Practice, and Prospects. UCI Press

Charles H. Eccleston (2011). Environmental Impact Assessment: A Guide to Best Professional Practices. CRC Press

Riki Therivel Graham Wood (2017). Methods of Environmental and Social Impact Assessment.

Rutledge David Philip Lawrence (2003). Environmental Impact Assessment: Practical Solutions to Recurrent Problems. John Wiley & Sons, Inc., New York

Arjun Kumar A. Rathi (2021). Handbook of Environmental Impact Assessment: Concepts and Practice. Rathi Cambridge Scholars Publishing

Angus Morrison-Saunders (2018). Advanced Introduction to Environmental Impact Assessment. Edward Elgar Publishing Ltd.

Angus Morrison-Saunders and Jenny Pope (2021). Teaching Environmental Impact Assessment. Edward Elgar Publishing

Neil Craik (2008). The international law of environmental impact assessment. Cambridge University Press

Course No:	ENV-603
Course Title:	Aquatic Pollution
Credit Hours:	3 (3+0)
Status of the course	Already approved

Course Objectives

Anthropogenic and natural environmental activity taking place on the land ultimately affect the aquatic environment including economic resources of the oceans and seas. There has been an increasing concern about the continued pollution of marine environment and aquatic ecosystem. This course is designed to look into the aquatic pollution problems with a view to design and develop methods for the control of pollution including protection of marine economic resources.

Learning Outcomes

The course shall be helpful to understand physical and chemistry involved in aquatic environment. The students will also be able to identify the chemical reactions and changes in contaminants. The course also enable to understand the microbiology and its usefulness to environment. The participants also be able to identify global and regional agreements and initiatives addressing marine pollution

Module 1

Physical Oceanography

Introduction to aquatic pollution

Composition of hydrosphere

Geography and geomorphology of oceans

Structure and characteristics of oceans

Tides and their impact on oceans
Various types of coasts and shores

Module 2

Chemical Oceanography

Physico-chemical features of estuaries
Physico-chemical features of marine and inland waters
Physico-chemical features of sediments
London Dumping convention
MARPOL convention

Module 3

Biology of marine ecosystem
Biology of inland water ecosystem
Nature and types of marine microbial population
Biological productivity of aquatic environment: Marine and Inland waters

Module 4

Marine Pollution

Sources of pollution: Domestic, industrial and marine traffic
Biology and chemistry of pollutants
Effects of pollutants on marine biota and on marine productivity
Effects on food chain

Module 5

Treatment technologies important for the prevention and mitigation of pollution of aquatic environment: Primary, Secondary and Tertiary Treatment.
Treatment of domestic and industrial pollution entering into the aquatic environment
Microbial pathogens and their health effects

Books Recommended

Edward A. Laws (2000). Aquatic Pollution: An Introductory Text. John Wiley and Sons
C. A. Brebbia (2014). Water Pollution XII. WIT Press. UK
Marq de Villiers (2000). Water: The Fate of Our Most Precious Resource. Houghton Mifflin Company
McKeown, A. Elaine (2015). Impact of Water Pollution on Human Health and Environmental Sustainability (PPPS) Book series
Vandana Shiva (2002). Water Wars: Privatization, Pollution and Profit. Pluto Press London
Robert Clark (2001). Marine Pollution. Fifth Edition. Oxford University Press
Roy M. Harrison. (2000). Pollution: Causes, Effects and Control Third Edition. Royal Society of Chemistry
Judith Weis (2014). Marine Pollution: What Everyone Needs to Know. Oxford University Press
De-Sheng Pei, Muhammad Junaid (2019). Marine Pollution: Current Status, Impacts and Remedies. Bentham publishers
Chris Frid, Bryony A. Caswell (2017). Marine Pollution Oxford University Press
Andr Arias, Jorge Eduardo Marcovecchio (2017) Marine Pollution and Climate Change. Routledge
Senthil Kumar (2020). Modern Treatment Strategies for Marine Pollution. Elsevier Science

Course No:	ENV-604
Course Title:	Environmental Epidemiology
Credit Hours:	3 (3+0)
Status of the course	Already approved

Course Objectives

The field of Environmental Epidemiology can be thought of as a relatively new and burgeoning field. Since the advent of Rachel Carson's, Silent Spring in the early 1990's, there has been an increased awareness among both the public and scientific community of the relationship between environmental hazards and human health. With the beginnings in the area of infectious diseases. Environmental Epidemiology has now moved toward quantification of pollutants in air, water and

soil through a complex mixture of chemicals, toxins, pesticides and non-biological agents and the possible association of environmental exposure with adverse health effects such as cancer, cardiovascular diseases, and reproductive outcomes. This course is designed to give comprehensive knowledge about Environmental Epidemiology and the principles of medicine as applied for the study of Epidemiology.

Learning outcomes

After completion of this course the students will have an adequate level of understanding of epidemiological principles and problems. The students shall gain competences in toxicology and will have knowledge about critical evaluation of the processes necessary to show a relationship of specific diseases to a certain environmental impact. The students will also be able to demonstrate epidemiological models associated with contemporary diseases. The students will also be able to analyze case studies pertains to specific disease and environmental health issues in both developed and developing countries will be presented.

Module 1

Introduction to Environmental Epidemiology

Definition

Significance

Uses of Environmental Epidemiology

Module 2

The Disease Process and its Principles

Pathology, infection and disease

Normal microbial and Opportunistic micro-flora

Etiology of infectious disease

Pathogenicity, virulence and infectivity

Module 3

Factors important for the survival of pathogens in the environment.

Methods of transmission of infectious agents

How microorganisms fight against the host defense system

Seven challenges that face pathogenic microorganisms

Mechanism of resistance by the host

Barriers to infectious agents

Mechanical factors

Chemical factors

Module 4

Phagocytosis

Inflammation

Tissue repair

Fever

Antimicrobial substances

Constitutive defenses (Leucocytes: Defenders of the body's interior, Complement, Interferon

Module 5

Food borne diseases

Picnic poisoning

Deadly desert

Toxin in a jar

Epidemic asthma

Pesticide poisoning

Typhoid epidemic

Practicals

Quantitative Epidemiology

Basic statistical concepts and terminology

Distributions and Summary measures

Measures of variability and central tendency

Normal log and normal distributions

Statistical inference
Relationship between two models
Regression
Transmission models of water and food borne diseases
Transmission models of air borne diseases

Recommended Books

Mark J. Nieuwenhuijsen, Dean Baker (2008). Environmental Epidemiology: Study Methods and Application. CRC Press
Ray M. Merrill (2007). Environmental Epidemiology: Principles and Methods. Jones & Bartlett Learning
Mark J. Nieuwenhuijsen (2015.) Exposure Assessment in Environmental Epidemiology. Oxford University Press
Roger D. Peng and Francesca Dominici (2008). Statistical Methods for Environmental Epidemiology with R: A Case Study in Air Pollution and Health. Springer
Megan, Landon (2016). Environmental Epidemiology. Open University Press. Mc. Graw Hill
Irene A. Kreis, Araceli Busby, Giovanni Leonardi, Jill Meara, Virginia Murray (2013). Essentials of Environmental Epidemiology for Health Protection. Oxford University Press
Robert H. Friis (2006). Essentials of Environmental Health. Jones & Bartlett Publishers
Gavin Shaddick and James V. Zidek (2015). Spatio-Temporal Methods in Environmental Epidemiology. Taylor & Francis Ltd
Duncan C. Thomas (2009). Statistical Methods in Environmental Epidemiology. Oxford University Press

Course No:	ENV-605
Course Title:	Environmental Hygiene and Occupational Health
Credit Hours	3 (2+1)
Status of the course	Already approved

Course objective

The course foster to examine health issues related to different occupation and provides scientific understanding of causal agents and possible remedies to control major environmental health problems. The course further encompasses how the body responds to environmental pollutants. The biological agents responsible for environmental contamination will studied in detail so as to encounter the environmental hygiene problems caused by them through the consumption of contaminated food, water and air. The students will also learn the susceptible population and the biomarkers. Risk analysis will also be taught to the students during the course of studies.

Learning outcomes

At the end the student will be able to understand the major sources and types of environmental/biological agents with an overview of transport and fate of these agents in the environment. The student will also be able to learn the carriers or vectors that promote the transfer of these agents from the environment to the human. The students will also acquire the knowledge of models for prediction of the magnitude of adverse effects in biological systems. The students would also be to conduct risk assessment and will be able to identify the gaps in the contemporary knowledge base concerning the health effects of environmental agents.

Course Contents

Module 1

Fundamental principles of environmental hygiene and occupational health
Principles of environmental hygiene
Principles of occupational health

Module 2

Growth and survival of micro-organisms
Principles of microbial growth
Microbial nutritional requirements
Factors affecting microbial growth and survival in various environments

Kinetics of microbial growth: Methods of determining microbial growth

Module 3

Control of micro-organisms in the environment

Physical and mechanical methods

Chemical methods including the use of antibiotics

Sources of contamination

Principles of microbial control during food production, food transportation, food processing, and food storage

Module 4

Control of microorganisms in specific industrial environments

Principles of industrial hygiene

Hazard Analysis Critical Control Point: Concept, Principles, and Application

Module 5

Principles of occupational health

Nature and evaluation of health problems due to industrialization

Industrial health problems associated with different industries

Mitigation measures of occupational health problems

Occupational health problems in developing countries

Practicals

Factors affecting microbial growth and survival in various environments

Occupational health problems case studies

Techniques for microbial control during food production, food transportation, food processing, and food storage

Books Recommended

Mock, Charles N.; Nugent, Rachel; Kobusingye, Olive; Smith, Kirk R.. 2017. Disease Control Priorities, Third Edition: Volume 7. Injury Prevention and Environmental Health. Washington, DC: World Bank. © World Bank.

Eino Elias Hakalehto (2018). Microbiological Environmental Hygiene. Nova Science Publishers

David L. Johnson (2017). Statistical Tools for the Comprehensive Practice of Industrial Hygiene and environmental Sciences. Wiley and Sons

Herman Koren and Michael S. Bisesi (2002). Handbook of Environmental Health. Lewis Publishers

Frances Alston., Emily J. Millikin and Willie Piispanen (2018) Industrial Hygiene Improving Worker Health through an Operational Risk Approach. CRC Press

LeeAnn Racz, Kirk A. Phillips and Dirk P. Yamamoto (2020). Total Exposure Health: An Introduction. CRC Press

Julia Smedley, Finlay Dick and Steven Sadhra (2007). Oxford Handbook of Occupational Health. Oxford University Press

Sue Reed, Geza Benke and Dino Pisaniello (2013). Principles of Occupational Health and Hygiene: An Introduction. Allen & Unwin Publisher. Sydney Australia

Joseph LaDou (2004). Current Occupational & Environmental. McGraw Hill Publishers

Robert H. Friis(2016) Occupational Health and Safety for the 21st Century. Jones and Bartlet Learning

S. Z. Mansdorf (2019). Handbook of Occupational Safety and Health. Wiley

Charles D. Reese (2017). Occupational Safety and Health: Fundamental Principles and Philosophies. CRC Press.

Course No: ENV- 606

Course Title: Sustainability and Natural resource management

Credit Hours: 3 (3+0)

Status of the course Need to be approved

Course objective

This course inherently an interdisciplinary field of study that considers the physical, biological, economic and social aspects of dealing with natural resources and sustainability. The course shall

primarily focus on how resources can be best put to use for human purposes in addition to preserving natural systems and linked to UN sustainable development goals. The course also oriented to deal with sustainable management of the Earth's depleting natural resources such as clean water, energy, minerals and biological resources, in relation to the growth of the human population. To answer these pressing issues, professionals need to be able to work in interdisciplinary teams and apply scientific, ecological, economic and social knowledge to come up with holistic solutions. The course will be helpful in understanding the principles of environmentalism and the history of the conservation movement.

Learning outcomes

Management and conservation of natural resources essentially requires an elemental understanding of natural resources dynamics. After this course the students will have the adequate knowledge about the concepts of ecology and will be familiarized with ecosystem services and processes at various spatial and temporal scales. Each of the modules will have specific outcomes. Eventually, students will develop critical thinking skills to communicate how society perceives what natural resource management is and what strategies to be adopted to manage or conserve our natural resources so as to minimize environmental impact likely to occur due to their depletion.

Course contents

Module 1

Introduction to the natural resources
Inter-relationship within environmental system
Natural resource ecosystem
Urban ecosystem
Principles of natural resource conservation and management theory and approach

Module 2

Non renewable resources
Mineral: Problems and management
Fossil fuel: Problems and management
Energy crises

Module 3

Renewable resources
Air and air quality management
Solar energy
Geothermal energy
Tidal energy
Bio-energy

Module 4

Soil conservation and management
Forestry and wildlife management
Marine and coastal resource management
Water resource management
Wildlife ecology and management

Module 5

UN Sustainable development goals.
Global change biology (climate change, land-use change, etc.)
Ecosystem goods and service
Spatial analysis tools in natural resource management (GIS, GPS)

Recommended books

David James, Herminia A. Francisco (eds.). 2015. Cost-Benefit studies of natural resource management in Southeast Asia. Springer-Verlag Singapore.
Singh, Chander Kumar. 2018 Geospatial Applications for Natural Resources Management. CRC Press
Aley, Jennifer, Burch, William R., Conover, Beth, Field, Donald R. 2020. Ecosystem management: Adaptive strategies for natural resources organizations in the twenty-first century. CRC Press.

E. Carina H. Keskkitalo (eds.)2017. Globalization and change in forest ownership and forest use. Natural resource management in transition. Palgrave Macmillan UK,
 Mohamed Behnassi, Olaf Pollmann, Himangana Gupta. 2019. Climate change, food security and natural resource management: Regional case studies from three continents. Springer International Publishing.
 Daniel P. Loucks, Eelco van Beek. 2017. Water resource systems planning and management: An introduction to methods, models and applications. Springer International Publishing.
 Chiras, D.D. and Reganold, J.P. 2010. Natural Resource Conservation: Management for a Sustainable Future.10th ed. Benjamin Cummings.
 Coastal Ecology and Management Mann, K.H. 2000. Ecology of Coastal Waters with Implications for Management (2nd Edition).Kluwer Academic Publishers.
 Singer, M. J and Muns, D. N. 2006.Soils, an Introduction.Kluwer Academic Publishers.
 Chiras, D. D., Reganold, J. P., and Owen, O. S. 2005. Managing water resources sustainably Prentice-Hall
 Bolstad, P. 2005. Geographic Information Systems (GIS). Eider Press, Minnesota.
 William E.G., Ellen K.P., Sandra L.M. 1997. Ecology and Natural Resource Management: Systems Analysis and Simulation. John Wiley and Sons

Course No: ENV-607
Course Title: Environmental Economics
Credit Hours: 3 (3+0)
Status of the course Need to be approved

Course objective

This course provides an overview of the theory and empirical practice of economic analysis as it applies to environmental issues. The objective of the course is to provide an understanding of key environmental issues from an economic perspective. Building on microeconomic analysis the course shall focus on economic concepts to issues such as valuing the environment, cost-benefit analysis, depleted resource allocation, water, fisheries, forests, ecosystem goods and services, pollution and climate change.

Learning outcomes

Upon completion of this course the students will have basic understandings of the real causes and possible solutions to the current environmental problems from an economic perspective. They will have an insight driven from economic theory in designing and evaluating policy solutions to environmental issues. They will also comprehend the role of economics in environmental issues and in the formation of environmental policy. They can be able to well differentiate between economic objectives and environmental goals. The course will also improve their understanding regarding the market failure in response of environmental crises and how the marketing system can improve the environmental quality.

Course contents

Module 1

Introduction
 Main environmental problems
 Brief overview of the history of economic thought
 Environmental vs. ecological economics
 Origins of environmental economics
 Economic cycle and relation with the environment
 Definitions and importance of the sustainability concept
 Limits to growth
 Environmental Kuznets Curve

Module 2

Introduction to micro-economics I
 Consumer behavior, incl. preferences, utility, budget constraints, utility maximization, demand
 Refresher of mathematic calculus

Constrained optimization problems: Lagrange method

Introduction to writing a case study report

Module 3

Introduction into micro-economics II

Producer behavior, profit maximization, cost minimization, supply

Economies of scale

Efficiency and Pareto optimality

Introduction into micro-economics III: welfare economics

Social welfare function

Optimal allocation on a competitive market

Partial analysis: Consumer and producer surplus

Module 4

Market failure and public goods I

Public vs. private goods

Optimal allocation of a public good

Strategic behavior and the prisoner's dilemma

Market failure and public goods II

Externalities

Partial welfare analysis of external effects

Regulation of external effects

Coase theorem

Pigouvian taxation

Module 5

Pollution control: targets

Pollution flows and stocks

Privately and socially efficient level of pollution

Pollution control: Instruments I

Criteria for choice of instruments

Cost efficiency and cost effectiveness

Command and control instruments

Economic (market based) instruments

Institutional instruments

International environmental problems: Trans boundary pollution and international agreements

Recommended books

Barry c. Field. 2016. Environmental economics: An introduction. McGraw-Hill

Alfred Endres, Volker Radke. 2016. Economics for Environmental Studies. McGraw-Hill

Frank R. Spellman. 2018. Economics for Environmental Professionals. Springer Berlin Heidelberg,

Hansa Jain. 2015. Trade liberalization, economic growth and environmental externalities: An analysis of Indian manufacturing industries. CRC Press

Perman, R., Y. Ma, J. McGilvray, and M. Common (2011): "Natural Resource and Environmental Economics", Pearson Education, Harlow,

Perloff, Jeffrey M. (2004): "Microeconomics". 3rd ed., Pearson, Addison Wesley

Paul Hawken. 2002. The Ecology of Commerce: A Declaration of Sustainability. Harper Business

David W. Pearce and R. Kerry Turner. 1989. Economics of Natural Resources and the Environment.

Johns Hopkins University Press

Naomi Klein. 2014. This Changes Everything: Capitalism vs. The Climate. Simon and Schuster

Geoffrey Heal. 2016. Endangered Economies: How the Neglect of Nature Threatens Our Prosperity.

Columbia University Press

Course No:	ENV- 608
Course Title:	Environmental Biotechnology
Credit Hours:	3 (3+0)
Status of the course	Already approved

Course Objective

Biotechnology aims to commercially exploit microorganisms and their biological activities. It covers a wide range of subjects. These include brewing, antibiotic production, recombinant protein production, vaccine production and waste treatment. Microbial biotechnology research aims to get microorganisms to perform particular tasks well. This may involve introducing new activities into a host microbe or improve naturally occurring activities. As a result, research in this area involves many scientific disciplines. They include biochemical engineering, applied molecular biology, microbial genetics and physiology, biochemistry and bioinformatics. In this course, students will learn the techniques of biotechnology for the analysis of the environment and to apply these techniques to alleviate the environmental problems. Study areas include bioremediation of hazardous substances, genetic mechanisms functioning in the environments, development of novel microorganism for environmental applications etc.

Learning Outcomes

At the end of this course the student will be able to understand the classification of microorganisms on the basis of nutritional requirements and energy outcome of the energy metabolism. They will have adequate knowledge of basic chemo-stat theory to determine microbial growth rates, biomass yield, and substrate concentration and removal rate. They will be able to operate lab scale bioreactor for the biodegradation of hazardous waste. They will have appropriate knowledge of microbial processes underlying the activated sludge process, nitrification, de-nitrification, enhanced phosphorus removal, and anaerobic digestion. They will successfully evaluate. They will successfully evaluate the potential for biodegradation of organic pollutants.

Course Content

Module 1

An introduction to biotechnology
Microbial growth
Batch culture
Continuous culture
Factors affecting microbial growth
Cultivation of microorganisms (at commercial level).
Microbial nutrition

Module 2

Microbial metabolism
Energy generation and role of ATP in microbial metabolism.
Biochemical cycles (Glycolysis, Krebs cycle and Oxidative phosphorylation)
Metabolism of one-, two- and three- carbon containing compounds.

Module 3

Microbial genetics
Structure and function of DNA.
Protein synthesis (Types of RNA and their function, Genetic code and degeneracy of codon, Process of transcription and translation)
Genetic recombination in bacteria.
Methods of gene transfer in bacteria.
Recombinant DNA technology and its application.
Genetic engineering
Techniques of gene manipulation.
Prospects of genetic engineering.

Module-4

Bioreactors
Enzyme technology
Enzyme production
Enzyme application
Problems and prospects of enzymology

Module 5

Bioremediation
Metal concentration by plants (Phyto-remediation)
Microbiological and technical aspects.
Treatment evaluation, site characterization and scale-up process.
Biosorption
Bioaccumulation process
Bioleaching
Biodegradation of naturally occurring substances
Biosensors as an environmental monitors

Recommended Books

Michael A. Palladino and William J. Thieman (2004). Introduction to Biotechnology. Benjamin-Cummings Publishing Company
Colin Ratledge, Bjørn Christiansen (2012). Basic Biotechnology. Cambridge University Press
Sally Smith Hughes (2011). Genentech: The Beginnings of Biotechnology. University of Chicago Press.
Ed.Regis and George Church (2012). Regenesi. New York: Basic Books
U Satyanarayana (2017). Biotechnology. Books & Allied Ltd
Reinhard Renneberg (2005) Biotechnology for beginners. Academic Press
W.T. Godbey (2014). An Introduction to Biotechnology. Woodhead Publishing
Firdos Alam Khan (2011). Biotechnology Fundamentals. CRC Press
Murray Moo-Young (2011). Comprehensive Biotechnology. Elsevier

Course No:	ENV- 609
Course Title:	Solid Waste Management
Credit Hours:	3 (3+0)
Status of the course	Already approved

Objectives

This course intends to develop to provide acquaintance pertaining to technological, organizational and legislative developments and practices related to management of solid wastes. The course also encompasses engineering and scientific principles applied to the management of municipal solid waste (MSW) to protect human health and the environment. The course also entails the conservation of environmental resources through resource recovery and recycling of waste material.

Learning outcomes

The course will conceptualize the generation of waste in technological society also it will highlight the importance of Integrated Solid Waste Management. This course will touch upon the correlation between solid waste generation and population growth. Moreover, it will also realize the urbanization factor in SWM. Worldwide trends of population growth, paper production, urbanization and paper recycling will be shared with the students. The course will enhance the understanding of the students about composition and origins of solid waste.

Course Contents

Module 1

Evolution of Solid Waste Management
Management, Management skills, Management role, Management decision making process
Solid waste -A consequence of life.
Material flow and waste generation. Sources of solid wastes.
Types of solid waste. Composition of solid waste. Distribution of individual waste components.

Module 2

Sources, Composition and Properties of Solid Waste
Determination of the composition of MSW in the field.
Physical, chemical and biological properties of MSW
Energy content, essential nutrients and other element in MSW
Properties and classification of hazardous waste

Value – weight measurement of solid waste

Module 3

Methods used to estimate waste quantities

Factors affecting waste generation rates

Waste collection system

Container system a) conventionnel mode b) Exchange container mode

Collections system, Collection routes/Lay outs

Waste minimization/Hierarchy basic model of pollution

Elements of waste management programme ISO 14000

Techniques of technologies of waste minimization

Inventory management, operational and maintenance charges, material control/charge etc. Results in reducing industrial waste

Module 4

Separation and Recycling of Solid Waste

Land filling terminologies

Landfills planning (Principal element)

Reactions occurring in landfills.

Mechanisms of generation of land fill gases

Selection, Closure and Restoration of Landfills

Composting

Vermin composting

Module 5

Incineration

Plasma arc technology

Pyrolysis

Energy recovery

The concept of zero waste

Waste is not a waste but a potential economic asset

Economics of solid waste management

Books Recommended

Ramesha Chandrappa and Diganta Bhusan Das. (2012) Solid Waste Management: Principles and Practice. Springer

John Pichtel (2005). Waste management practices. Boca Raton London New York Singapore

Graça Martinho, Maria Isabel Gomes, Susana Rodrigues, Ana Paula Pires (2018). Sustainable Solid Waste Collection and Management. Wiley

M. H. Fulekar, Bhawana Pathak, R K Kale (2013). Environment and Sustainable Development. Springer

Thomas H. Christensen (2010). Solid Waste Technology and Management. Chichester, West Sussex, U.K.:

Samuel Stucki, Christian Ludwig, Stefanie Hellweg (2003) Municipal Solid Waste Management: Strategies and Technologies for Sustainable Solutions. Springer

A.F. Kettrup, Herbert E Allen, William J. Lacy (2004). Solid Waste: Assessment, Monitoring and Remediation. Elsevier

Ashok K. Rathoure (2019). Zero Waste: Management Practices for Environmental Sustainability. Routledge

Hosam El-Din M. Saleh (2019). Municipal Solid Waste Management. Intech open. UK

Course No:	ENV- 610
Course Title:	Wildlife Ecology & Wetland Management
Credit Hours:	3 (3+0)
Nature of the course	Already approved

Course Objective

The course intends to provide the of basic concepts of ecology with regards to animal behavior, conservation and management of wildlife resources. The course is designed to with special emphasis on population dynamics, study of habitat, animal behavior and their relationships > the students will also learn about ecosystem services that wildlife and their habitats provide. The students also be able to develop a conservation or management plan with specific objectives and constraints. Wild life management issues in Pakistan will also be discussed during the course of studies.

Learning Outcomes

After completion of the course the students will be able to understand the best practices and guiding principles related to the wildlife management. The course outcome will also provide the learning about the contemporary issues of wild life worldwide and how the wildlife ecology relates to wildlife management. The students will also learn the key techniques used by wildlife biologist to analyze and inculcate scientific and social science data for wildlife management. The students will also be familiarized with the concept of animal behavior their interactions and their conservation and restoration issues. Understanding decision making processes, guiding principles and policy frame work will be an additive outcome of this course.

Course Contents

Module 1

Introduction and overview
Defining wildlife and wildlife management
History of wildlife conservation
Human dimensions of wildlife management

Module 2

Scale in wildlife management
Wildlife population dynamics
Wild life nutrition
Habitat
Habitat destruction
Habitat fragmentation

Module 3

Animal behavior
Predation
Predation prey model
Competition

Module 4

Population growth and interactions
Population movements and measurements
Population modeling
Hunting, Trapping and Pouching
Wildlife extinctions

Module 5

Environmental conditions necessary for survival
Types of harvest
Harvest management
Endangered species
Alien and invasive species

Books Recommended

Bolin, E.G. and Robinson, W.L. 2003. Wildlife Ecology and Management, 5th Edition. Prentice Hall, New Jersey
McComb, B.C. 2008. Wildlife Habitat Management: Concepts and Applications in Forestry. CRC Press.
DeGraaf, R.M., M. Yamasaki, W.B. Leak, and A.M. Lester. 2005. Landowner's guide to Wildlife habitat: forest management for the New England region. University of Vermont Press.

Fryxell, J.M., A.R.E. Sinclair, and G. Caughley. 2014. Wildlife Ecology, Conservation and Management. Wiley Inc.

Krausman, P.R., and J.W. Cain. 2013. Wildlife Management and Conservation. John Hopkins University Press.

Paul Krausman and James W. Cain (2013). Wildlife Management and Conservation: Contemporary Principles and Practices. Johns Hopkins University Press

Paul Krausman, John L. Koprowski (2019). International Wildlife Management: Conservation Challenges in a Changing World. Johns Hopkins University Press

David M. Williams, Chad J. Parent, William F. Porter, Rosemary A. Stewart (2021). Wildlife Management and Landscapes: Principles and Applications. Johns Hopkins University Press

Michael L. Morrison, Heather Alexis Mathewson (2015). Wildlife Habitat Conservation: Concepts, Challenges, and Solutions. Johns Hopkins University Press

Course No: ENV-611
Course Title: Climate and Climate Change
Credit Hours: 3 (3+0)
Status of the course To be approved

Course objective

Climate change is the biggest challenge of today's time. This course provides an over view of world climate change. In this course the students will learn about the scientific back ground of climate change along with the contemporary evidences. The course also entails the world climate change politics of developing and under developing world. The students will also comprehend the mitigation and adaptation mechanisms with respect to climate change. This course also provides an appropriate knowledge of climate change impacts on key economic sectors. The course also entails human security issues associated with climate change.

Learning Outcomes

After this course the students will have a state-of-the-art perspectives on climate change. They will be able to understand climate change mitigation and adaptation mechanisms to combat with future challenges. They will be exceptionally qualified to provide climate leadership across a wide range of sectors, agencies and organizations. They will be able to demonstrate the climate science in policy making and planning.

Course contents

Module 1

Atmospheric chemistry
Climate change science
Early discoveries
The energy balance model
Energy balance model with greenhouse emissions.

Module 2

Greenhouse gases
Radiative forcing
Radiative transfer
Aerosol Radiative Forcing
The global carbon cycle

Module 3

Introduction to Impacts
Impacts, adaptation, and vulnerability
Paleoclimate
Global atmospheric circulation

Module 4

Climate modeling
Climate change feedbacks: linking atmosphere, oceans, biosphere, and cryosphere
Scientific consensus and uncertainty

The IPCC science assessment Projection of future scenarios

Module 5

Climate change impacts on water resources

Climate change impacts terrestrial and inland water Systems (Ecosystems)

Climate change impacts on food security and food production

Climate change impacts on key economic sectors and services

Human health and human Security

Future technologies: carbon sequestration, bio-fuels, hydrogen, geo-engineering

Emissions trading and the Global Warming

Climate change from national perspectives

Books Recommended

Naomi Klein (2014). This Changes Everything: Capitalism vs. The Climate. Simon & Schuster Publishers

David Wallace-Wells (2019). The Uninhabitable Earth. Tim Duggan Books Publishers

Paul Hawken (2017). Drawdown: The Most Comprehensive Plan Ever Proposed to Reverse Global warming. Penguin Books

Bill Gates (2021). How to Avoid a Climate Disaster. Alfred A. Knopf Publishers

Greta Thunberg (2019). No One Is Too Small to Make a Difference. Penguin Books

Amitav Ghosh (2016). The Great Derangement: Climate Change and the Unthinkable. Penguin Books

Ayana Elizabeth Johnson, Katharine Wilkinson (Eds.) (2020). All we can save: Truth, Courage and Solutions for climate crises. Penguin Publishers

Michael E. Mann (2021). The New Climate War. Public Affairs Publishers

David Pogue (2021). How to Prepare for Climate Change. Simon and Schuster. Publishers NY. USA

The Sendai Framework for Disaster Risk Reduction 2015 -2030, United Nations Office for Disaster Risk Reduction (UNDRR)(2015).

Course No:	ENV- 612
Course Title:	GIS and Remote Sensing
Credit Hours	3 (2+1)
Nature of the course	Already Approved

Objective:

The course aims to equip students with an understanding of GIS and RS, evolution and applications of spatial data through Geo-spatial technologies.

To introduce knowledge of recording earth's surface features room space-borne platforms and different ways in which images can be analyzed.

To enable students to develop an understanding of common remote sensing products such as earth resources satellite images, aerial photographs etc.

To develop a comprehension ground-truthing aided by GPS.

Learning Outcomes:

By the end of course, the student will be able to:

Identify basic components of GIS

Differentiate between Raster and Vector models

Distinguish between spatial and non-spatial attribute data models

Have knowledge about the evolution of remote sensing

Develop a comprehension of satellite imageries and data extraction

Have visual and digital image Interpretation skills

Course Contents

Module 1

Geographical Information Science (GIS)

Nature and Scope

Definitions, key components, functional subsystem,
Raster data model, vector data model, attribute data model,
Data acquisition techniques, data sources, data capturing techniques and procedures,
Data transformation, visualization of spatial data, layers and projections, Coordinate
System and datum, Attribute Data Management, GIS Data Models (Raster, Vector,
Attribute), GIS Exploration. GIS Data Sources (Satellite, Air Photos, Drones,
Conventional Drawings, & Vector sources).

Map design: symbols to portray points, lines, polygons and volumes, graphic variables,
Visual hierarchy, Data classification graphic approach, mathematical approach.

Spatial analysis: neighborhood functions, network, and overlay analysis, buffering,
Spatial data quality: components of data quality, micro level component, macro level components,
usage components, sources of errors, accuracy and resolution and uncertainty.

Raster Data Analysis: Modeling and Project Management in GIS, 3D GIS

GIS Applications

Module 2

Remote Sensing

Nature and Scope

History and Development

Concepts and Foundation of Remote Sensing

Electromagnetic spectrum (Visible Spectrum, Color Theory. Atmospheric Attenuation)

Types of Remote Sensing Systems (Active Remote Sensing and Passive Remote Sensing)

Types of sensor

Types of satellite

Platforms (Orbits)

Ground Receiving Stations (Reception of Data)

Image Processing

Image Classification

Image Interpretation

Global Positioning System (GPS)

Applications (Hydrology, Geology, Climatology, Environmental Application, Planting,
Agricultural, Forestry, Socio-economic. Health etc.).

Lab Work:

Introduction to lab (hardware/software), Raster/Vector/Attribute Data Display, Scanning,
Digitalization, coordinate based point mapping, Raster/Vector Conversion, Data layers integration
and display of different projections, Map layout, Data Classification and Thematic Mapping,
Handling of Topological Errors, Overlay and network analysis.

Single band image interpretation, false color predictions, false color composite images

Interpretation, introduction to ERDAS imagine, display, geo-linking, identification of targets.

Books recommended

Basudeb Bhatta (2008). Remote Sensing and GIS. OUP India

Ballas, D., Clark, G.H., Franklin, R.S & Newing, A. (2018), GIS and the Social Sciences: Theory and
Applications, Routledge publishers, New York USA.

John R. Jensen (2000). Remote Sensing of the Environment: An Earth Resource Perspective.

Prentice Hall, Cynthia Brewer (2015). Designing Better Maps: A Guide for GIS Users. Esri Press,

M. Anji Reddy (2006). Textbook of Remote Sensing and Geographical Information Systems. BS
Publications, India

Jindi Wang, Shunlin Liang, Li xiao wen (2006). Advanced Remote Sensing: Terrestrial Information
Extraction and Applications. Elsevier Science Publishing Co Inc.

Adriano Camps and Marc Rodriguez (2017). Introduction to Satellite Remote Sensing. Elsevier

Gustau Camps-Valls (2011). Remote Sensing Image Processing. Morgan and Claypol Publishers

Jian Guo Liu, Philippa J. Mason (2016). Image Processing and GIS for Remote Sensing: Techniques
and Applications. John Wiley and Sons

James B Campbell and Randolph H. Wynne (2011). 5th Ed. Introduction to Remote Sensing, Fifth

Other Major/Floating Courses

Course No: ENV-613
Course Title: Anthropology and Environment
Credit Hours: 3 (3+0)
Status of the Course To be approved

Course objective

Humans have transformed natural environments as and when desired in order to satisfy their needs. However, after industrialization the environment has been altered in ways that have no precedent in human history or in geological time. With the existing environmental predicament as its backdrop, this course examines some classic and contemporary that includes anthropological approaches to the environment and environmentalism: cultural ecology, political ecology, environmental history, poststructuralist cultural studies, and environmental justice.

This course also examines anthropological approaches to diverse human understandings of and interactions with their changing environments and brings an anthropological approach to understanding the socio-cultural, socio-political, and socio-economic implications of environmental challenges and related development, conservation, and human rights issues.

Course contents

Module 1

Anthropological perspectives on the relationship between people and nature

History of anthropological entanglements with the environment: from ecological determinism to cultural constructivism, phenomenology, and the anthropocene;

Anthropological models of human environment relations

Anthropological perspectives on the utilization of natural resources (e.g. knowledge, rights, institutions).

Human population structure

Module 2

The theory of culture change

Cultural ecology

Cultural diversity and biodiversity

Nature vs. culture

Module 3

Anthropogenic landscapes

Political ecology

Indigenous management of natural resources

Module 4

Marginality

Poverty and environment

Anthropology of built environment

Module 5

What is nature

Nature is culturally constructed? Definition of nature.

How do different cultures and societies vary in their definitions of nature?

What is the "patenting of life?"

Environmental justice

How do race and other social and cultural differences affect human experience of ecological degradation?

Recommended books

Environmental anthropology: From Pigs to Policies, by Patricia K. Townsend, 2000. Prospect Heights, IL: Waveland Press. (PT)

Ellis, F (2000) Rural livelihoods and diversification in developing countries. Oxford University Press.

Livi-Bacci M (2007 4th ed'n) A Concise History of World Population. Blackwell Publishing

Newing, H. C.M. Eagle, R.K. Puri and C.W. Watson. (2011) Conducting Research in Conservation: social science methods and practice. Routledge

Eugene N. Anderson . 2010. The Pursuit of Ecotopia: Lessons from Indigenous and Traditional Societies for the Human Ecology of Our Modern World.Praeger.

Paul Robbins. 2007. Lawn People: How Grasses, Weeds, and Chemicals Make Us Who We Are Philadelphia: Temple University Press.

Course No: ENV-614
Course Title: Population Dynamics
Credit Hours: 3 (3+0)
Status of the Course To be approved

Course objective

The course deals with the study of the human population and the relationship between environmental conditions and changing human population dynamics. Students will study the current trends of human population dynamics and its impact on ecological and global environmental systems. The students will also study how key historical events led to major demographic transitions across time Finally, in light of the projections of future changes in population growth and environmental conditions, students study recent approaches to developing a more sustainable and equitable quality of life for present and future generations around the world.

Course contents

Module 1

Introduction to demography and sources of demographic data

Population theories

Theory of demographic transition

Theories related to fertility

Theories related to migration and urbanization

Module 2

Gender issues

Population and development

Population policy and programmes

Health and family welfare programme

Module 3

Pop Fertility

Mortality, morbidity and public health

Migration and urbanization

Evaluation and adjustments of demographic data and

Population projections

Health economics

Gender, development and health

Population and sustainable development

Module 4

Methods of Demographic / Population Analysis

Rates, Ratios, Proportions, Percentages, Person, Months / Years, incidence, prevalence.

Rates of Population Growth: Arithmetic, Geometric and Exponential Rates of Growth; Doubling Time; Location of Events in Time; the Lexis diagram.

Cohort and cross – sectional indicators

Crude rates and standardized methods

Methods of population projections

Module 5

Concepts, definitions, relevance and measurement.

Interrelationship between population growth, environment and sustainable development with special reference to Pakistan

Human development index

Implications of population growth on food supply, water, sanitation, housing, employment, health, education, etc.

Ecological balance and its maintenance

Status of women and women empowerment and its demographic consequences

Recommended books

Moonis Ahmer City dynamics in Pakistan. AERC, 2015

David E. Bloom; David Canning and Jaypee Sevilla. 2003. The Demographic Dividend: A New Perspective on the Economic Consequences of Population Change. Rand Publisher

Simon Szreter, Hania Sholkamy and. 2004. Anthropological and Historical Studies in Critical Demography. Oxford University Press.

Poston, Jr., Dudley L and Micklin, Michael. 2005. Handbook of Population. Springer

Saltzman Chafetz, J. 2006. Handbook of the Sociology of Gender. Springer

Myron Weiner and Michael S. Teitelbaum. 2001. Political Demography, Demographic Engineering Berghahn Books.

Simon Szreter Hania Sholkamy and A. Dharmalingam. 2004. Anthropological and Historical Studies in Critical Demography. Oxford University Press.

Course No:	ENV-615
Course Title:	Art of sustainability
Credit Hours:	3 (3+0)
Status of the Course	To be approved

Course objective

This course presents the academic approach of sustainability and explores how human societies can withstand in the current face of global change, ecosystem degradation and resource exploitation. The course focuses on key knowledge areas of sustainability theory and practice by exploring the environmental, economic and social implications of our decisions and attempts to find sustainable solutions to environmental problems.

Learning Outcomes

The student will be able to bring sustainability into all areas of society. This will also help them to choose their future carrier in the field of decision-maker, manager, planner, educator, researcher, etc. the course will encompass the students to respond to environmental and social changes with respect to Pakistan in the areas of population growth, urbanization and wealth distribution to resource scarcity, declining ecosystems and climate change. They will be able to successfully manage the risks and opportunities of these changes, and would be helpful in building society that is sustainable in the long term; it needs to go on a journey.

Course contents

Module 1

Population dynamics

How human population evolved overtime

Population environment nexus

Over population problems

Module 2

Energy and the built Environment

Trend of energy use

Transport and energy

Industrial development and energy

World energy crises

Energy and society

Energy policy and planning

Module 3

Global natural resources

Biodiversity extinction

Ecosystems

Climate change

Module 4

Water and its role in socioeconomic development

Water resource management

Sustainable agriculture

World food problem

Module 5

Environmental policy

Forces that shape or misshape policy

Business and Sustainability

Tools available to measure sustainability

Predictions on global sustainability for the 21st century

Recommended books

Natural Resources Institute Finland (Luke). 2020. Six paths towards sustainability: A tool kit to promote a systematic transformation towards sustainable development in Finland. Natural Resources Institute Finland (Luke).

Ganesh Shivakoti, Ujjwal Pradhan, Helmi Helmi. 2016. Redefining diversity and dynamics of natural resources management in Asia. Volume 1. Sustainable natural resources management in dynamic Asia. Elsevier, 2016

Helen James. Population, development and the environment. 2019. Challenges to achieving the sustainable development goals in Asia Pacific. Springer Singapore; Palgrave Macmillan, Mitsuo Matsushita, Thomas J. Schoenbaum (eds.) 2016. Emerging issues in sustainable development: International trade law and policy relating to natural resources, energy and environment. Springer Japan

Tatyana P. Soubbotina, 2004. Beyond Economic Growth: An Introduction to Sustainable Development. World Bank, (2nd edition)

Sisay Asefa, 2005. The Economics of Sustainable Development, W.E. Upjohn Institute for Employment Research.

Joseph H. Hulse. 2007. Sustainable Development at Risk: Ignoring the Past. International Development Research Centre.

Eugenie L. Birch and Susan M. Wachter. 2008. Growing Greener Cities: Urban Sustainability in the Twenty-First Century. University of Pennsylvania Press.

William M. Lafferty and James Meadowcroft. 2000. Implementing Sustainable Development: Strategies and Initiatives in High Consumption Societies. Oxford University Press.

Gary P. Sampson. 2005. WTO and Sustainable Development. United Nations University Press, Gerard Keijzers. 2004. Business, Government, and Sustainable Development. Routledge.

Course No:	ENV-616
Course Title:	Recreation Management
Credit Hours:	3 (3+0)
Status of the course	To be approved

Course objectives

This course serves as an introduction to the field of recreation management focusing on the exploration of career areas in the profession and the service delivery systems which define recreation management. The students will also analyze the interrelationship between leisure behavior and the natural environment, administrative functions such as staffing, risk management, and transportation while in the outdoors will be discussed. This course provides an overview of community-based recreation including municipal and non-profit recreation agencies in the local context. This course further explores the increasingly diversified nature of society and its impact on individuals' experiences of leisure.

Learning Outcomes

The students will have the understanding of theories and concepts of leisure. After successful completion of this course the student will give their contributions on leisure in contemporary society. They will address the wide range of practical issues related to leisure, recreation, well-being and quality of life in a flexible, interdisciplinary, course-based curriculum.

Course contents

Module 1

Introduction to recreation management

Foundations of Recreation

Principles of management in recreation

Review of the sociological, philosophical, economic, and historical aspects of recreation and leisure.

Recreation as a profession

Outdoor Education

Regional ecology a

Ecological niches, e.g. wetland, forest, prairie and riverine

Native and non-native plants

Native fauna

Leisure behavior and the natural environment

Module 3

Introduction to community recreation

Overview of community-based recreation including municipal and non-profit recreation agencies.

Planning and directing programs for diverse populations in a variety of physical settings.

Maintenance of recreation facilities

Module 4

Operation and management of swimming pools and spas

Environmental ethics, outdoor recreation and natural resources

Recreation and natural resources at the national, state, local and private levels

Youth development in the recreation profession

Contemplative leisure

Module 5

Recreation resource management

Interactions between natural resources and users

Carrying capacity

Limits of acceptable change

Competition

Planning for park and recreation facilities

Risk management in leisure service

Event management

Recommended books

George Torkildsen. 2002. Leisure and Recreation Management. Taylor and Francis.

Margie Arnold, Regina Glover and Cheryl Beeler. 2012. Human Resource Management in Recreation, Sport, and Leisure Services. Venture Publishing, Inc

Richard Mull, Brent Beggs and Mick Renneisen. 2009. Recreation Facility Management: Design, Development, Operations and Utilization. Human Kinetics.

William E. Hammitt, David N. Cole and Christopher A. Monz. 2015. Wild land Recreation: Ecology and Management. Wiley-Blackwell Publisher.

Jay Shivers and Joseph W. Halper. 2012. Strategic Recreation Management. Routledge.

Merry Moiseichik. 2010. Management of Park and Recreation Agencies. Sagamore Pub Llc; by

John Jenkins and John Pigram. 2005. Outdoor Recreation Management. Routledge

Course No:	ENV-617
Course Title:	Environmental migration
Credit Hours:	3 (3+0)
Status of the course	To be approved

Course objectives

Environmental migration may result in response to the natural calamities like earthquakes, tsunamis, floods, droughts, and desertification. The people leave their homes for seeking livelihood opportunities far and wide. In developing countries temporary migratory flows are also common driven by seasonality of the food supply. In this course the students will follow the migration pattern driven by environment which sometimes may lead them to environmental refugees. This course will be an interdisciplinary where the students study the experiential approach to forced migration and deepened understanding of the political, economic, social and cultural contexts of forced migration. They will also

Learning Outcomes

This course aims to provide the students regarding the overview of all areas of human migration - contemporary and historical. The students will have the understanding of rapid and transparent sharing of related research to the underlying data. The students will also understand the interdisciplinary topics of integration, ethnicity, identity, discrimination and nationalism and refugee status.

Course contents

Module 1

Introduction to environmental migration
Natural calamities and involuntary migration
Climate change and environmental refugees
Refugee resettlement

Module 2

Types of migration
Global and human migration?
Importance of migration in refugee politics, policy, and justice?
Legal approaches to refugee studies
Convention and the international refugee regime

Module 3

Socioeconomic problems related to involuntary migration
Climate change as accelerating driver
Poverty and environment
Poverty climate change nexus
Linkage between environment and human settlement

Module 4

Indigenous forced migration
Conservation and development induced displacement
Disability and forced migration
Human Trafficking

Module 5

Migration issues in developing countries
Involuntary migration in Pakistan
Migration and natural resources depletion

Recommended books

Collectif Argos, Jean Jouzel, Hubert Reeves. 2010. Climate Refugees. MIT Press.
Hansen, R. 2014. State Controls: Borders, Refugees and Citizenship. In Fiddian- Qismeyeh, E., Loescher, G., Long, K. and Sigona, N. (eds.) The Oxford Handbook of Refugee and Forced Migration Studies. Oxford University Press.
Macedo, Stephen. 2007. "The Moral Dilemma of U.S. Immigration Policy: Open Borders Versus Social Justice?" Cambridge University Press.
M. Mansha. 2014. Disability and Forced Migration. In The Oxford Handbook of Refugee and Forced Migration Studies. Oxford University Press.
P. Robbins. 2004. "The Hatchet and the Seed. In: Political Ecology. A critical introduction. Blackwell Publisher.
Black, R. 1998: Refugees, Environment and Development, Harlow: Addison Wesley Longman

Limited.

Myers, N. 2002: 'Environmental refugees: a growing phenomenon of the 21st century', Philosophical Transactions of the Royal Society of London Series Biological Sciences,

Piguet, E. (2008): Climate change and forced migration: How can international policy respond to climate-induced displacement? Geneva: UNHCR Evaluation and Policy Analysis Unit.

Kniveton, D., Schmidt-Verkerk, K., Smith, C. and Black, R. (2008): Climate Change and Migration: Improving Methodologies to Estimate Flows, IOM Migration Research Series Paper No. 33, Geneva: International Organization for Migration

Course No:	ENV-618
Course Title:	Urban Ecology and Landscape
Credit Hours:	3 (3+0)
Status of the Course	Need to be approved

Course objective

The course designed to familiarize the students with the components of urban ecosystem. The course further disclose about the urban ecosystems function and the response of flora and fauna to the urban environments. The course additionally oriented about the ecology of community interactions in urban systems, and how urban areas affect local, regional, and global biodiversity patterns. After successful completion of the course the students will make scientifically informed decisions about societal issues related to urban area.

Learning Outcomes

After this course the students will understand the key theories and models pertains to urban ecology. They will foster the cross cuttings of urban ecology with regard to the planning and design disciplines. They can help planners and others to, facilitate, harness and mitigate urban ecology systems in a way based on equity, public health, community development, environmental, and economic development goals. Their knowledge will be familiarized with urban ecology and diverse human populations with respect to gender, race, ethnicity, and socioeconomic status.

Course contents

Module 1

Introduction to landscape architecture
Landscape architecture history and society
Contemporary challenges in landscape planning, design and management
Drivers for change landscape design
The dynamic landscape
Urbanization patterns

Module 2

Landscape ecology
Ecological processes, design and management
Materials of landscape; construction design and detailing
Planting design
Landscape design; exploration and intervention

Module 3

Landscape design: residential housing design.
Landscape design: urban design
Landscape ecology: habitat survey techniques

Module 4

Sustainable communities
Green infrastructure and ecological master planning
Habitat Creation and Restoration

Module 5

Urban socio-ecological linkages
Landscape planning, law, policy and governance
Urban futures climate change and urbanization

Recommended books

Etingoff, Kimberly. 2015. Urban Ecology: Strategies for Green Infrastructure and Land Use CRC Press LLC.

Pramit Verma, Pardeep Singh, Rishikesh Singh, A. S. Raghubanshi.2020. Urban ecology: Emerging patterns and social –ecological systems. Elsevier, 2020

Enrique Murgui, Marcus Hedblom (eds.). 2017. Ecology and conservation of birds in urban environments. Springer International Publishing

Rajib Shaw, Atta-ur-Rahman, Akhilesh Surjan, Gulsan Ara Parvin.2016. Urban disasters and resilience in Asia. Elsevier/Butterworth Heinemann.

Encyclopedia of Landscape Design: Planning, Building, and Planting Your Perfect Outdoor Space. 2017. DK Publishing.

Joan Fitzgerald. 2010. Emerald Cities: Urban Sustainability and Economic Development. Oxford University Press.

Dimitri Devuyt, Luc Hens and Walter De Lannoy.2001. How Green Is the City? Sustainability Assessment and the Management of Urban Environments. Columbia University Press

Graham Haughton and Colin Hunter 2003. Sustainable Cities. Routledge.

Malcolm Miles and Tim Hall. 2003. Urban Futures: Critical Commentaries on Shaping the City Rutledge.

Course No:	ENV-619
Course Title:	Introduction to Environmental Humanities
Credit Hours:	3 (3+0)
Status of the Course	Need to be approved

Course objective

The Environmental Humanities is a new, emerging area of interdisciplinary studies of the environmental and climate crisis. The course is designed to both critically inspect the current planetary predicament as the crisis of environmental imagination which demands a pivotal paradigm shift in our values, habits, routines and representations.

The course invites students to examine environmental topics through the lens of philosophy and ethics, rhetoric, literary traditions, history, media, landscape studies and the arts.

Each week we will focus on a set of key readings, in order to discuss their key points, their strengths and weaknesses, and what they add to our understandings of the Environmental Humanities.

Each student will pick their own case study at the beginning of the course and will build up a portfolio of independent research that fleshes out how their case might be related to the topics we cover.

Learning Outcomes

At the end of this course the students will be familiarize with the basic concepts of humanities including philosophy, history, anthropology, literature, culture, music and theater. They will be able to perform the conceptual analysis with historical and moral reasoning. The students nurture the understanding of the cultural, moral, historical, spiritual, creative, and communication dimensions of environmental issues. They will be able to establish trans disciplinary discourse among environmental arts and humanities and the sciences.

Course contents

Module 1

Introduction to environmental humanities

Environmental ethics

Peace and environmental justice

Environmental perception and cognition

Cultures of environmentalism

Module 2

Climate and climate change

Green movements and green parties

Sustainability

Development and the environment
Global environmental issues

Module 3

Anthropology
Ecological imperialism
Nature and value in 21st century
Biodiversity conservation

Module 4

Interdisciplinary approaches that are remapping the university in the 21st century,
Cultural/environmental implications of urbanization
Non-human/human relations
Environmental and social justice

Module 5

Natural resources depletion
Long-term pollutant
Food and water security
The role of time within them. How do human understandings of time exacerbate these issues?

Recommended books

Birth, Kevin K. 2012. Objects of Time: How things shape temporality. New York: Palgrave Macmillan.
Ellsworth, Elizabeth, and Jamie Kruse, eds. 2012. Making the geologic now: Responses to material conditions of contemporary life. Brooklyn, NY: Punctum
Fincher, Ruth, Jon Barnett, and Sonia Graham. 2015. Temporalities in Adaptation to Sea-Level Rise. CRC. Press.
Nixon, Rob. 2011. Slow Violence and the Environmentalism of the Poor. Cambridge, MA. : Harvard University Press.
Adam, Barbara. 1998. Time scapes of Modernity: The environment and invisible hazards. London and New York: Routledge.

Course No:	ENV-620
Course Title:	Ecotourism
Credit Hours:	3 (3+0)
Status of the	To be approved

Course objectives

The students will follow the concept of ecotourism and how it relates to generic tourism. The course further focuses on understanding the development of natural resource attractions and demand for recreation and tourism opportunities. The course orientation will also towards understanding of impacts associated with multiple uses of natural resources, demand-supply, carrying capacity, economic benefits and sustainability issues inherent in long-term and successful ecotourism developments. The students will also learn about the basic planning and management guidelines for ecotourism development. Finally, the student will also develop understanding about the future of ecotourism in Pakistan.

Learning Outcomes

After this course, the students will be able to develop knowledge and basic concepts of environmentally sustainable travel to relatively undisturbed natural areas. The students will encompass the value of that nature conservation that promotes biodiversity conservation. They will be able to demonstrate the negative visitor impact, and will seek the socio-economic benefits to the local stakeholder communities. They will have clear understanding of the natural resources importance and the best management practices. They will be able to develop plans for sustainable ecotourism.

Course contents

Module 1

Introduction to ecotourism

Tourism and Sustainability
Ecotourism: Concept and Issues

Module 2

Natural Resources
Conservation of national resources
National parks
Wild life sanctuaries
Game reserves
Protected sites
Unprotected sites of high ecological values

Module 3

Ecotourism and local communities
Ecotourism: social and ecological impacts

Module 4

Economics and the business of ecotourism
Ecotourism planning and management
Ecotourism development
Future of ecotourism

Module 5

Ecotourism in Pakistan
Protected sites in Pakistan
Unprotected sites of high ecological values in Pakistan
Hurdles in developing ecotourism

Recommended books

Daniel T. Blumstein, Benjamin Geffroy, Diogo S. M. Samia, Eduardo Bessa (eds.) 2017. Ecotourism's Promise and Peril: A Biological Evaluation. Springer International Publishing, Dawson, M., & Jamal, T. (2006). Costa Rica: Banana plantations or ecotourism? In Herremans, I. (ed.), Cases in Sustainable Tourism. Binghamton, NY: Haworth Fennell, D. (2015). Ecotourism (4th Edition). New York: Routledge.
Honey, M. (2008). Ecotourism and Sustainable Development: Who Owns Paradise? (2nd Edition). Washington, D.C.: Island.
Weaver, D. (Ed.). (2001). The Encyclopedia of Ecotourism. New York: CABI.
Borges, M and Richardson, S. (2006). Ecotourism in extractive reserves in Brazil. In Herremans, I. (ed.), Cases in Sustainable Tourism. Binghamton, NY: Haworth.
Cater, C. (2011). Community involvement in trekking tourism - Indonesia. In Garrod, B. & Fyall, A. (eds.), Contemporary Cases in Tourism. Oxford, UK: Good fellow Publishers

Course No:	ENV-621
Course Title:	Environmental Governance
Credit Hours:	3 (3+0)
Status of the Course	To be approved

Course objective

After 1900 the use of environmental resources has been increased considerably which has tremendously affecting global ecosystem. The progress towards the betterment of human kind can be praised but at the same time this has created new challenges for environmental governance. Over the last few decades, it has been observed that there is a significant development in the number of international regimes and organizations established to cope with this challenge. However, the effectiveness of these institutions varies significantly, and the Millennium Ecosystem Assessment concluded that the overall growth in capacity for governance has not kept pace with the growth in human 'footprints' on the Earth System. This course reviews critical factors behind this discrepancy and explores how international regimes and organizations can narrow the gap. At the same time the course follows the issue of environmental governance in the country. It has to

be reviewed that what type of development we actually need for the country in view of current crises of depletion of natural resources.

Learning Outcomes

The students will be able to apply the concepts of Environmental Governance to figure out the current status of resource conservation also with risk indicators. The students can also develop environmental management plans and the strategies for their implementation. They will also foster the strategies to attract investor to respond to current pressure on environmental resources. They will act as first line of defense against the menace of environmental resource depletion and problems of pollution. They will be able to blend experiential observations and material changes in ways that inform general understanding of contemporary evolution of environmental policy and management.

Course contents

Module 1

Introduction to environmental governance
Global environmental change and sustainable development
Social, economic and political dimensions of global environmental change
Human impacts on the earth system
Relationship between ecologic and economic interests

Module 2

International environmental regimes
History of environmental policy-making since the 1970
International environmental agreements
Legal and political aspects of environmental treaty-making
Elements of environmental agreements (monitoring, compliance, enforcement, savings clauses etc.);

Module 3

Climate change
Sources of climate change
Economic dimensions and responses of climate change
Constellations of actors and interests
United Nations Framework Convention on Climate Change
Kyoto Protocol
Climate agreement under the Bali Road Map,
The current process towards a 2015 treaty under the Durban Platform

Module 4

International regimes governing the production, emission and cross-border movement of hazardous chemicals
The 1992 Basel Convention
1998 Rotterdam Prior Informed Consent Convention,
The 2002 Stockholm Convention on Persistent Organic Pollutants
The 2013 Minamata Mercury Convention.
Interactions between trade and environment regimes
Contractual obligations under the World Trade Organization

Module 5

Sustainable agriculture and agro biodiversity
Contemporary challenges to sustainable agriculture and agricultural biodiversity
Economic concentration processes in global agro business,
Intellectual property protection for seeds.
The convention on biological diversity, the food and agriculture organization and its international treaty
The international convention for the protection of new varieties of plants
The agreement on trade-related aspects of intellectual property rights under the world trade organization.

Recommended books

- Matthew W. Sherwood, Julia Pollard. 2018. Responsible Investing: An Introduction to Environmental, Social, and Governance Investments. Routledge.
- Andersen, Regine. 2008. Governing Agrobiodiversity: Plant Genetics and Developing Countries. Ashgate Publishing, Ltd.
- Hoffmann, Matthew J. 2013. The Handbook of Global Climate and Environment Policy. John Wiley & Sons.
- Winkler, Harald, and Judy Beaumont. 2010. Fair and effective multilateralism in the post-Copenhagen climate negotiations." Climate Policy
- Blewitt, John. 2008. Understanding sustainable development. Earthscan.
- Bodansky, Daniel. 2010. The art and craft of international environmental law. Harvard University Press.
- Bengtsson, Gunnar. 2010. "Global trends in chemicals management." In regulating chemical risks. Springer Netherlands.
- Biermann, Frank, and Philipp H. Pattberg, eds. 2012. Global environmental governance reconsidered. MIT Press.
- Clapp, Jennifer, and Peter Dauvergne. 2008. Paths to a Green World the Political Economy of the Global Environment. MIT Press.
- Falkner, Robert. 2013. The Handbook of Global Climate and Environment Policy. John Wiley & Sons, 2013.

Course No:	ENV-622
Course Title:	Biodiversity and Conservation Management
Credit Hours:	3 (3+0)
Status of the Course	To be approved

Course objective

This course will be helpful for the students to acquire, retain, and demonstrate a familiarity with the ecological and evolutionary mechanisms that cause spatial and temporal patterns of global biodiversity. Students will become familiar to the effects of biodiversity on basic ecosystem processes such as productivity and stability and understand the valuation of ecosystem services. The students will be able to understand the basic ecological principals and will be able to relate these fundamental biological processes to current conservation issues. The course will further follow the consequences of biodiversity loss in terms the economic valuation of ecosystem services.

Learning Outcomes

The students will have the concepts in biodiversity science and management from interdisciplinary perspectives. They will be able to critically assess the approaches through which conservation build. They will appreciate the societal norms in producing effective conservation interventions. They will evaluate the implications of emergent technologies for the future of biodiversity science and management; and

Course contents

Module 1

Overview of Global Biodiversity and the Extinction Crisis
Temporal Patterns of Biodiversity
Spatial Patterns in Biodiversity

Module 2

Species Extinctions: Historical Perspective
Species Extinctions: The Role of Early Humans
Global Change and Species Extinctions

Module 3

Ecosystem
Ecosystem Processes and Natural Disturbance
Effects of Biodiversity on Ecosystem Processes

Economic Valuation of Ecosystem Services

Module 4

Habitat Loss

Habitat Fragmentation

Invasive Species

Threats Overharvest

Disease and Pollution

Module 5

Conservation Genetics and the Conservation Physiology

Population Dynamics and Conservation

Conservation Restoration Ecology

Recommended books

Jeyabalan Sangeetha, D Thangadurai, Hong Ching Goh, Saher Islam. 2019. Biodiversity and conservation. Characterization and utilization of plants microbes and natural resources for sustainable development and ecosystem management. Apple Academic Press, 2019

Terry Louise Root, Kimberly R. Hall, Mark P. Herzog, Christine A. Howell. 2015. Biodiversity in a Changing Climate: Linking Science and Management in Conservation. University of California Press

Mike J. Jeffries, 2006. Biodiversity and Conservation. Routledge.

Richard Ladle. 2008. Biodiversity and Conservation (Critical Concepts in the Environment). Routledge.

Melina F. Laverty and Eleanor J. Sterling. 2008. Biodiversity 101. Greenwood Press.

Tim O'Riordan and Susanne Stoll-Kleemann. 2002. Biodiversity, Sustainability and Human Communities: Protecting beyond the Protected. Cambridge University Press

Anthony B. Anderson and Clinton N. Jenkins. 2006. Applying Nature's Design: Corridors as a Strategy for Biodiversity Conservation. Columbia University Press

David L. Hawksworth. 2013. Biodiversity and conservation. Springer.

Course No:	ENV-623
Course Title:	Basic Anthropology
Credit Hours:	3 (3+0)
Status of the Course	To be approved

Course Objective

Humans have transformed natural environments as and when desired in order to satisfy their needs. However, after industrialization the environment has been altered in ways that have no precedent in human history or in geological time. With the existing environmental predicament as its backdrop, this course examines some classic and contemporary that includes anthropological approaches to the environment and environmentalism: cultural ecology, political ecology, environmental history, poststructuralist cultural studies, and environmental justice.

This course also examines anthropological approaches to diverse human understandings of and interactions with their changing environments and brings an anthropological approach to understanding the socio-cultural, socio-political, and socio-economic implications of environmental challenges and related development, conservation, and human rights issues.

Learning Outcomes

Upon completion of this course the students will have understanding regarding the application of basic concepts and terminologies of anthropology. They will be able to critically analyze basic anthropological theories. They will have an awareness of Pakistani physical, cultural, and linguistic diversity.

Course Contents

Module 1

Anthropological perspectives on the relationship between people and nature

History of anthropological entanglements with the environment: from ecological determinism to cultural constructivism, phenomenology, and the Anthropocene; Anthropological models of human

environment relations Anthropological perspectives on the utilization of natural resources (e.g. knowledge, rights, institutions).

Human population structure

Module 2

The theory of culture change

Cultural ecology

Cultural diversity and biodiversity

Nature vs. culture

Module 3

Anthropogenic landscapes

Political ecology

Indigenous management of natural resources

Module 4

Marginality

Poverty and environment

Anthropology of built environment

Module 5

What is nature

Nature is culturally constructed? Definition of nature.

How do different cultures and societies vary in their definitions of nature?

What is the "patenting of life?"

Environmental justice

How do race and other social and cultural differences affect human experience of ecological degradation?

Recommended books

Environmental anthropology: From Pigs to Policies, by Patricia K. Townsend, 2000. Prospect Heights, IL: Waveland Press. (PT)

Ellis, F (2000) Rural livelihoods and diversification in developing countries. Oxford University Press.

Livi-Bacci M (2007 4th ed'n) A Concise History of World Population. Blackwell Publishing

Newing, H. C.M. Eagle, R.K. Puri and C.W. Watson. (2011) Conducting Research in Conservation social science methods and practice. Routledge

Eugene N. Anderson. 2010. The Pursuit of Ecotopia: Lessons from Indigenous and Traditional Societies for the Human Ecology of Our Modern World. Praeger.

Paul Robbins. 2007. Lawn People: How Grasses, Weeds, and Chemicals Make Us Who We Are Philadelphia: Temple University Press.

Course No:	ENV-624
Course Title:	Energy and Sustainable Environment
Credit Hours:	3 (3+0)
Status of the Course	To be approved

Course Objectives

The global energy sector is going through dramatic shifts in energy demand, the current energy resources are depleting. Population rise, industrialization, urbanization, and mechanization are changing how the energy is used, ecofriendly professionals are required who can steer this speedily changing landscape and this course offers that preparation.

This course is an introduction to studies in energy and sustainable environment, and it will give an outline and a far-reaching considerate of the subject. Students will be introduced to different types of renewable energy resources by engaging in various activities to help them understand the transformation of energy (solar, water, nuclear, biomass and wind) into electricity. Students explore the different tasks in renewable energy fields have in creating a sustainable environment – as a safe way. Students will apply the principles underlying, and social implications of implementing new technologies to address issues of energy and resource scarcity with economic consideration and environmental sustainability, as individuals and as a society. A huge component of this swing

comprises embracing suitable technologies to facilitate post-industrial lifestyles. They will be able to participate in the vital reorganization of society since the emergence of the industrial revolution utilizing conservation strategies.

Learning Outcomes

The course will make students thought-provoking in renewable and sustainable energy in order to bring them together with the private sector and policy and decision makers. They will be able to share problems, solutions, novel ideas and technologies to support sustainable development, the transition to a low carbon future and achieve the emissions targets as established by the United Nations Framework Convention on Climate Change.

Course Contents

Module 1

Fundamentals of energy
Resources available for energy consumption
Renewable resources
Non renewable resources
Bubble pattern of Depletion
Sustainable yield
Case studies
Current Global energy situation

Module 2

Electricity, Work, and Power
Energy Basics: Transitions, Vocabulary, Uses (basic concepts)
Fossil Fuels: Coal, oil, natural gas
Renewable Energy I: Hydro, Wind (Sailboats, windmills, and wind turbines), Solar (Power Systems)
Renewable Energy II: Geo, Ocean, Bio, Wave, Tidal
Nuclear Power

Module 3

Energy Policy
Energy & the Environment I: Air, Land, Water
Energy & the Environment II: Equity, Sustainability, and Climate Change
Energy Water Nexus
Food Energy Nexus
Energy Disasters, Reliability, and Resilience
Technologies of the Future, Energy & Humanity

Module 4

Cleaner automotive transportation
Thermal Energy from Light
Solar collectors to heat water and buildings
Creating Electricity from Light
Conservation and efficiency

Module 5

Passive Designs for Optimizing with Nature
Smart building designs for conservation of energy
Heating Ventilation and Air Conditioning Systems
Evaluate the economic benefits of passive-design buildings versus standard buildings.
Economic cost and environmental impacts of using geothermal energy
Microbial Bioenergy

Recommended Books

Nelson, V., Starcher, K., (2009) Wind Energy, Renewable Energy and the Environment (CRC Press, Boca Raton, FL, 2009).
Vincenzo Balzani, Nicola Armaroli (2011) Energy for a Sustainable World: From the Oil Age to a Sun-Powered Future 1st Edition by Wiley-VCH.
Albert Thumann, Terry Niehus, William J. Younger (2012) Handbook of Energy Audits, Ninth Edition River Publishers.

Sayigh.Ali., (2016) Sustainable Energy for All, Springer.
William,D., Shepherd(2014)Energy Studies 3rd Edition Imperial College Press.
Alan R. Carroll (2015) GeofuelsEnergy and the Earth1st edition Cambridge University Press;
Kirk Hagen., (2015) Introduction to Renewable Energy for Engineers 1st Edition by Pearson.

Course No: ENV- 625
Course Title: Disaster Risk Management
Credit Hours: 3 (3+0)
Status of the course To be approved

Course Objectives

This course will provide a foundational understanding of the natural hazards and disasters, the basic concepts of disaster management and disaster risk reduction (DRR) including the assessment of hazards, vulnerabilities exposure and risks, and learning on the strategies and approaches for effective management of disasters encompassing disaster preparedness, response, recovery and planning

Learning Outcomes

Understanding and explain the main component of disaster management and DRR and relevant frame work

Apply different DRR strategies to specific disaster scenarios

Analyze interdisciplinary approaches including the role of psychological, economic and technological approaches for disaster prediction and management

Course Content

Introduction to disaster and hazards: Definition and types of disasters (natural and human induced), Natural hazards of Pakistan and Sindh: Climate-induced , earthquakes and tsunamis and their impacts ; Basics of disaster management : Basic concepts, nature and scope, Historical evolution; Concept and principles of disaster risk reduction; Risk Assessment: concepts of vulnerability risk and exposure, Vulnerability of urban and rural areas in the Province; Identifying and assessing risks and vulnerability - tolls and methods, Economic valuation in disaster risk assessment, risk reduction strategies; Disaster preparedness and response: preparedness (training, planning, institution), response (early warning systems, emergency operation), recovery, and mitigation; Resilient infrastructure, green infrastructure and ecosystem-based approaches, land use planning and zoning; Disaster and public health: public health impacts, preparedness and response, resilient health systems; Role of AI in analyzing disaster trends and forecasting, Technological tools in preparedness, response, and risk reduction; Psychological aspects of disaster management: Disaster psychological impacts and significance of mental health in disaster recovery, Psychological approaches to DRR and community resilience; Role of government, NGOs, international organization and local communities in disaster response efforts; International and national frameworks for disaster management and DRR. Case study analysis of disaster risk reduction for practical insights.

Recommended Books

Madu, C. N. and Kuei, C. (2018) Handbook of Disaster risk reduction and management, World Scientific Publishing CO.

Coppola, D. P. (2015). Introduction to International Disaster Management (3rd ed.).

Leal Filho, W. (Ed.). (2012). Climate Change and Disaster Risk Management.

Eisner, B., Gaillard, J. C., & Kelman, I. (Eds.). (2012). Hand book of hazards and Disaster Risk Reduction and Management. Routledge.

Davis, I. Yanagisawa, K., & Georgieva, K. (2015) Disaster Risk Reduction for Economic Growth and Livelihood: Investing in Resilience and Development.

Information Technology in Disaster Risk Reduction (2023), 7th IFIP WG 5.15 International Conference, ITDRR 2022, Kristiansand, Norway, October 12-12, 2022, Revised Selected Papers, Springer.