UNIVERSITY OF THE PUNJAB

NOTIFICATION

It is hereby notified that the Syndicate at its meeting held on 27-07-2023 has approved the recommendations of the Academic Council made at its meeting dated 24-05-2023 regarding approval of the Revised Syllabi and Courses of Reading for MS/M.Phil. in Environmental Sciences under Semester System at the College of Earth and Environmental Sciences w.e.f. the Academic Session, 2021 and onward.

The Revised Syllabi and Courses of Reading for MS/M.Phil. in Environmental Sciences under Semester System is attached herewith as Annexure 'A'.

Sd/-
REGISTRAR

Admin. Block,
Quaid-i-Azam Campus,
Lahore.

No. D/ 7674 /Acad. **Dated: 11 – 10 /2023.**

Copy of the above is forwarded to the following for information and further necessary action: -

1. Dean, Faculty of Geo Sciences.
2. Principal, College of Earth and Environmental Sciences.
3. Controller of Examinations
4. Director, IT for placement at the website
5. Admin Officer (Statutes)
6. Secretary to the Vice-Chancellor.
7. PS to the Registrar.
8. Assistant Syllabus.

Assistant Registrar (Academic)
for Registrar

COLLEGE OF EARTH AND ENVIRONMENTAL SCIENCES
UNIVERSITY OF THE PUNJAB, LAHORE

Approval of Revised Courses & Syllabi for MS/M.Phil. in Environmental Sciences

Program Title: **02 Year MS/M. Phil. Degree in Environmental Sciences**

Department: **College of Earth and Environmental Sciences**

Faculty: **Geosciences**

The curriculum and courses for MS / M.Phil. in Environmental Sciences were revised in the year 2018 and approved from various statutory bodies of the University of the Punjab.

Presently College of Earth and Environmental Sciences revised the courses & syllabi keeping in view the advancements in the field of environmental sciences and new courses recommended by the Higher Education Commission (HEC) revised in 2018. Most of the courses have been designed according the latest trends of the subject that can provide an interest to the students and later help them for competing in the job market.

1. Department Mission

Our mission is to find solutions to environmental complications through environmental impact assessment (EIA) for the novel and ongoing projects. We should correct our mistakes and selfishness towards environment to make it sustainable and safe from pollution. The basic goal is pollution management by using environmental friendly technologies like power generation from renewable technologies, rehabilitation of filthy sites by clean development mechanism (CDM), alternative technologies, recycling, composting etc. As Environmental Sciences is a professional degree, the College seeks to provide education and training in the multiple dimensions of contemporary Environmental issues toward developing solution for a more sustainable future.

2. Introduction

College of Earth and Environmental Sciences provides a learning educational environment to students with the opportunities to acquire knowledge and skill to build a successful career and become an integral part of the community. Students will study different aspects of climate change, agro-biodiversity, environmental management, pollution and control, population

dynamics, ecosystems and urbanization. Impart quality education based on knowledge, research and skill to produce graduates of international calibre who contribute to science and technology, of the country with global perspectives. Teach high ethical and moral standards, develop leadership capabilities and equip with professionalism for the socio-economic and sustainable development of the society particularly in the industrial hub of Pakistan.

Keeping in view the importance and the growing demands for training manpower in the emerging discipline, the College of Earth and Environmental Sciences has been established in the University of the Punjab in 2005. The new building of the College was completed in November 2008, featuring spacious rooms, moderately equipped laboratories, a library and large grounds.

3. Program Introduction

As MS/M. Phil. Environmental Sciences is a professional degree, the degree is expected to provide education and training in the multiple dimensions of contemporary Environmental issues toward developing solution for a more sustainable future. Our overriding objective is to provide the next generation of national and international leaders with the knowledge, skills and experience needed to advance environmental decision making, formulate effective solution to enhance environmental goals, and meet the challenges and opportunities of environmental management, in way that provide broad, sustainable, resilient and equitable advances for human well-being in a complex and interdependent world,

4. Program Objectives

In order for our program to remain preeminent our key goals are:

1. To impart advanced knowledge about major areas of Environmental Sciences.
2. To enable the students to learn data collection, organization and statistical analyses.
3. To augment the capabilities of the students to use various practical techniques of planning and management of resources.
4. To train students to plan and execute studies on local environmental issues.
5. To develop abilities and keen interest in students to seek higher education in areas relevant to environmental sciences.
6. To equip students with professional skills to be demonstrated in teaching, research and environmental management.
7. To enable the students to review published literature critically.

5. Market Need / Rationale of the Program

An environmental science degree equips you with skills and knowledge for a variety of jobs in many areas including conservation, sustainability, and environmental research and education. Moreover, global climate change, habitat loss, water and air pollution, ozone depletion, species invasions, loss of biodiversity, and the accumulation of toxic wastes are among the many environmental dilemmas our society faces each day. These complex problems cause environmental limits against economic development, diverse cultures, ethics, values, and social stability, and therefore require an understanding of science, policy, society, history, and economics in order to address problems realistically and effectively. Environmental scientists must use integrated and holistic approaches to understand and find sustainable solutions to these problems. Graduates of the environmental science degree are well prepared for a variety of environmentally sustainable careers including consulting, research, policy, and outreach, or further graduate work in a doctoral program.

6. Admission Eligibility Criteria

Name of Program / No. of Seats	**Criteria Laid Down for Admission**
MS/M.Phil. (Regular Scheme) ENVIRONMENTAL SCIENCES **Total Merit Reserved** **40 40 00**	**ELIGIBILITY** BS Environmental Sciences with 16 years of education or equivalent **Admission Criteria:** Basic **Merit Formula** As per Basic Criteria *No third division in the whole career.*
MS/M.Phil. (Self-Supporting) ENVIRONMENTAL SCIENCES **Total Merit Reserved** **40 40 00**	**ELIGIBILITY** BS / M.Sc. in Environmental Sciences and Allied Sciences with 16 year of education or equivalent **Admission Criteria:** Basic **Merit Formula** As per Basic Criteria *No third division in the whole career.*

7. Duration of the Program

The CEES is following the HEC guidelines and MS/M. Phil degree is awarded by the university after a minimum of two (2) years period. The general timeline followed by the CEES is two years. Number of courses taught in MS/M. Phil Environmental sciences degree program will be 8 with each course having 3 credit hours. A total of 12 credit hours of courses are taught in

each semester (6 credit hours of core courses and 6 credit hours of elective courses). After successful completion of course work, students' have to conduct thesis/research work having 6 credit hours.

The college designated competent authority (DDPC) to determine whether the delay is caused by circumstances beyond the student's control and if so, grant an extension for two years in such exceptional circumstances. The date of notification of the award of the MS/M. Phil degree after the MS/M. Phil defence is considered to be the date of the completion of MS/M. Phil studies.

8. Categorization of Courses as per HEC Recommendation and Difference

Semester	Courses	Category (Credit Hours)					
		Core Courses	Basic Courses	Major Electives	Minor Electives	Any Other	Semester Load
1	4	6	-	3	3	-	12
2	4	6	-	3	3	-	12
3	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-
HEC Guidelines	-	12	-	6	6	-	24
Difference HEC & PU	-	-	-	-	-	-	-

9. Scheme of Studies / Semester –Wise Workload

FIRST SEMESTER: ***(12 Credit Hours)***

Sr. No.	Course Code	Course Title	Course Type	Pre-Requisite	Credit Hours
CORE-COURSES ***(06 credit hours core-courses will be offered in 1st semester)***					
1.	ENSC 501	Climate Change Adaptation and Mitigation	Core-Course	B.S/M.Sc. Environmental Sciences or related disciplines	03
2.	ENSC 502	Environmental Toxicology	Core-Course	B.S/M.Sc. Environmental Sciences or related disciplines	02+01
ELECTIVE COURSES ***(02 Elective courses of 06 credit hours will be offered in 1st semester)***					
3.	ENSC 503	Remediation Strategies for Contaminated Environment	Elective Course	B.S/M.Sc. Environmental Sciences or related disciplines	03
4.	ENSC 504	Environmental Biotechnology	Elective Course	B.S/M.Sc. Environmental Sciences or related disciplines	02+01
5.	ENSC 505	Population Dynamics and Environment	Elective Course	B.S/M.Sc. Environmental Sciences or related disciplines	03
6.	ENSC 506	Natural and Constructed Wetlands	Elective Course	B.S/M.Sc. Environmental Sciences or related disciplines	03
7.	ENSC 507	Environmental Impacts of Petroleum Industry	Elective Course	B.S/M.Sc. Environmental Sciences or related disciplines	03
8.	ENSC 508	Soil Pollution	Elective Course	B.S/M.Sc. Environmental Sciences or related disciplines	03
9.	ENSC 509	Environmental Auditing	Elective Course	B.S/M.Sc. Environmental Sciences or related disciplines	03
10.	ENSC 510	Cleaner Production Technologies	Elective Course	B.S/M.Sc. Environmental Sciences or related disciplines	03
11.	ENSC-511	Sustainable Development	Elective Course	B.S/M.Sc. Environmental Sciences or related disciplines	03
12.	ENSC 512	Environmental Risk Assessment and Management	Elective Course	B.S/M.Sc. Environmental Sciences or related disciplines	03

SECOND SEMESTER **(*12 Credit Hours)***

Sr. No.	Course Code	Course Title	Course Type	Pre-Requisite	Credit Hours
CORE-COURSES ***(06 credit hours core-courses will be offered in 2nd Semester)***					
1.	ENSC 513	Research methods in Environmental Science	Core-Course	B.S/M.Sc. Environmental Sciences or related disciplines	03
2.	ENSC 514	Advanced Analytical Techniques in Environment	Core-Course	B.S/M.Sc. Environmental Sciences or related disciplines	02+01
ELECTIVE COURSES ***(02 Elective courses of 06 credit hours will be offered in 2nd Semester)***					
3.	ENSC 515	Environmental Impact Assessment and Strategic Environmental Assessment	Elective Course	B.S/M.Sc. Environmental Sciences or related disciplines	03
4.	ENSC 516	Environmental Management System and Integrated management System	Elective Course	B.S/M.Sc. Environmental Sciences or related disciplines	03
5.	ENSC 517	Advanced GIS and Remote Sensing	Elective Course	B.S/M.Sc. Environmental Sciences or related disciplines	02+1
6.	ENSC 518	Waste Reduction and Recycling	Elective Course	B.S/M.Sc. Environmental Sciences or related disciplines	03
7.	ENSC 519	Advanced Industrial Wastewater Treatment	Elective Course	B.S/M.Sc. Environmental Sciences or related disciplines	02+1
8.	ENSC 520	Coastal Environment and Management	Elective Course	B.S/M.Sc. Environmental Sciences or related disciplines	03
9.	ENSC 521	Urban Ecology	Elective Course	B.S/M.Sc. Environmental Sciences or related disciplines	03
10.	ENSC 522	Biological Conservation	Elective Course	B.S/M.Sc. Environmental Sciences or related disciplines	03
11.	ENSC 523	Health, Safety and Environmental Management	Elective Course	B.S/M.Sc. Environmental Sciences or related disciplines	02+1
12.	ENSC 524	Sustainable Agriculture	Elective Course	B.S/M.Sc. Environmental Sciences or related disciplines	03

3rd & 4th Semester (Thesis): **(*06 Credit Hours)***

Sr. No.	Course Code	Course Title	Credit Hours
THRID & FOURTH SEMESTER			
1.	ENSC 601	Thesis (Based on Original Research)	06

10. Award of Degree

As a requirement, 02 Year MS/ M. Phil degree will be awarded on the successful completion of courses & syllabi and research thesis with minimum required CGPA 2.5/4.00. After completing course work, the student is officially allowed to start the research and DPCC evaluates the projects and refers to the advanced research board. Each MS/ M. Phil researcher is required to write a thesis that meets the HEC defined criteria. The MS/ M. Phil thesis is supervised by a full-time faculty member who holds a Ph.D. (or equivalent) degree. The MS/ M. Phil thesis is evaluated by the committee member and by at least two external experts. Further, a plagiarism test following the HEC's Plagiarism Policy is conducted on the thesis before its submission to the external experts. An open defense of the thesis is required after a positive evaluation of the thesis by the committee members.

11. NOC from Professional Councils (if applicable)

Not Applicable

12. Faculty Strength

Degree	Area / Specialization	Total
PhD	1. Prof. Dr. Sajid Rashid Ahmad 2. Prof. Dr. Irfan Ahmad Shaikh 3. Prof. Dr. Nadia Jamil 4. Dr. Abdul Qadir 5. Dr. Yumna Sadef 6. Dr. Muhammad Kamran 7. Dr. Muzaffar Majid Ch. 8. Dr. Azhar Ali 9. Dr. Sana Ashraf 10. Dr. Muhammad Bilal Shakoor 11. Dr. Naeem Akhtar Abbasi 12. Dr. Mehwish Mumtaz 13. Dr. Muhammad Awais 14. Dr. Rizwan Aziz 15. Dr. Muhammad Asif Javed	**15**
MS / M.Phil.	16. Mr. Muhammad Waqar 17. Mr. Muhammad Dastgeer 18. Ms. Zahra Majid 19. Ms. Anum Tariq	**04**

13. Present Student Teacher Ration in the Department

19 : 66 **1:4**

14. Course Outlines Separately for Each Course

FIRST SEMESTER

Sr. No.	Course Code	Course Title	Course type	Pre-requisite	Credit Hours
CORE-COURSES *(06 credit hours core-courses will be offered in 1st semester)*					
1.	ENSC 501	Climate Change Adaptation and Mitigation	Core-Course	B.S/M.Sc. Environmental Sciences or related disciplines	03
2.	ENSC 502	Environmental Toxicology	Core-Course	B.S/M.Sc. Environmental Sciences or related disciplines	02+01
ELECTIVE COURSES *(02 Elective courses of 06 credit hours will be offered in 1st semester)*					
3.	ENSC 503	Remediation Strategies for Contaminated Environment	Elective Course	B.S/M.Sc. Environmental Sciences or related disciplines	03
4.	ENSC 504	Environmental Biotechnology	Elective Course	B.S/M.Sc. Environmental Sciences or related disciplines	02+01
5.	ENSC 505	Population Dynamics and Environment	Elective Course	B.S/M.Sc. Environmental Sciences or related disciplines	03
6.	ENSC 506	Natural and Constructed Wetlands	Elective Course	B.S/M.Sc. Environmental Sciences or related disciplines	03
7.	ENSC 507	Environmental Impacts of Petroleum Industry	Elective Course	B.S/M.Sc. Environmental Sciences or related disciplines	03
8.	ENSC 508	Soil Pollution	Elective Course	B.S/M.Sc. Environmental Sciences or related disciplines	03
9.	ENSC 509	Environmental Auditing	Elective Course	B.S/M.Sc. Environmental Sciences or related disciplines	03
10.	ENSC 510	Cleaner Production Technologies	Elective Course	B.S/M.Sc. Environmental Sciences or related disciplines	03
11.	ENSC 511	Sustainable Development	Elective Course	B.S/M.Sc. Environmental Sciences or related disciplines	03
12.	ENSC 512	Environmental Risk Assessment and Management	Elective Course	B.S/M.Sc. Environmental Sciences or related disciplines	03

ENSC-501: CLIMATE CHANGE ADAPTATION AND MITIGATION (THEORY) (03 Credit hrs)

PRE-REQUISITE: B.S/M.Sc. Environmental Sciences or related disciplines

LEARNING OUTCOMES

At the conclusion of this course, students will be able:

- To carry out research, teaching, and consultancy in the field of climate change and adaptation.
- To discuss how a changing climate translates into impacts
- To highlight the most vulnerable regions and sectors of the climate change
- To recognize uncertainties in climate change science
- To use the current knowledge to discuss climate change adaptation and mitigation options

CONTENTS

The focus of the course is climate change impacts and the human response to climate change, including efforts to adapt to climate change, as well as efforts to achieve long term sustainability by avoiding or reducing the negative impacts of climate change

THEORY

Unit-1 Climate and Weather

1.1 Introduction to climate change
1.2 Weather forecasting and climate change
1.3 modeling of climate change
1.4 types of climate change models

Unit-2 Climate change drivers and consequences

2.1 Climate change drivers and clues
2.2 Identify the anthropogenic drivers of climate change
2.3 Analyze different climate change scenarios and their implications
2.4 Environmental and health insecurities and adaptation in the climatic zone.

Unit-3 Climate change Adaptation

3.1 Introduction to Climate Change Adaptation
3.2 Potential adaptation strategies in different sectors
3.3 Ways to measure vulnerability
3.4 Linkages between climate change adaptation and community development

Unit-4 Climate change mitigation

4.1 Carbon sequestration
4.2 Transition to carbon-neutral energy sources
4.3 Carbon and global warming
4.4 Conventional mitigation measures
4.5 Five-step methodology for preparing a low-emission climate-resilient
4.6 Geoengineering Technologies
4.7 Integrated climate change mitigation
4.8 Climate adaption and sustainable development

Unit-5 Impacts of the climate change

5.1 Impacts of climate change
5.2 Atmospheric phenomenon’s
5.3 Food insecurity
5.4 Water quality
5.5 Climate Change and Wetlands, desertification, shrinkage of lakes and rivers
5.6 Agriculture
5.7 Flora and fauna, and mass extinction,
5.8 cryosphere to water

Unit-6 Climate Change Policy

6.1 Overview of planning processes for climate change
6.2 Adaption to climate change
6.3 Climate change policy and social change
6.4 International climate change negotiations,
6.5 The Role of National and Sectoral Institutions in Climate Change Planning
6.6 Protocol and agreement
6.7 Climate finance and politics

TEACHING-LEARNING STRATEGIES

- Lecture-based examination
- Presentation/seminars
- Class discussion
- Quizzes

ASSIGNMENTS – TYPE AND NUMBER WITH CALENDAR

It is a continuous assessment. The weightage of Assignments will be 25% before and after midterm assessment. It includes:

- classroom participation,
- attendance, assignments, and presentation,
- homework
- attitude and behavior,
- hands-on-activities,
- short tests, quizzes, etc.

ASSESSMENT AND EXAMINATIONS:

Sr. No.	Elements	Weightage	Details
1.	Mid Term Assessment	35%	It takes place at the mid-point of the semester
2.	Formative Assessment	25%	It is a continuous assessment. It includes classroom participation, attendance, assignments, and presentation, homework, attitude and behavior, hands-on activities, short tests, quizzes, etc.
3.	Final Assessment	40%	It takes place at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on a term paper, research proposal development, fieldwork, and report writing, etc.

RECOMMENDED TEXTBOOKS / SUGGESTED READINGS

1. Beer, T., Li, J., & Alverson, K. (2018). *Global Change and Future Earth: The Geoscience Perspective (Special Publications of the International Union of Geodesy and Geophysics)*. Cambridge: Cambridge University Press.
2. Klepp, S., & Chavez-Rodriguez, L. (2018). *A critical approach to climate change adaptation: Discourses, policies and practices.* Routledge.
3. Ramakrishna, A., & Gill, S. S. (2018). *Metabolic adaptations in plants during abiotic stress*. CRC Press.

4. Lipper, L., McCarthy, N., Zilberman, D., Asfaw, S., & Branca, G. (2017). *Climate smart agriculture: building resilience to climate change*. Springer Nature.
5. Ussiri, D. A., & Lal, R. (2017). *Carbon sequestration for climate change mitigation and adaptation.* Cham, Switzerland: Springer International Publishing.
6. Juha, I., Uitto, J., & Robd, V. B., (2017). *Evaluating Climate Change Action for Sustainable Development*, Springer.
7. Avery, E. H. (2017). *A Global Threat: The Emergence of Climate Change Science*, Cavendish Square Publishing L.L.C.

Assorted Research Papers / Further Reading: As suggested by the instructor.

ENSC-502: ENVIRONMENTAL TOXICOLOGY (THEORY) (02 Credit hrs)

PRE-REQUISITE: B.S/M.Sc. Environmental Sciences or related disciplines

LEARNING OUTCOMES

After this course, students will be able to

- Interpret a vast knowledge on the recent advances in techniques for studying environmental toxicology and assessing environmental impact and risk.
- Learn fundamental knowledge on major classes of chemicals of environmental concern
- Have some understanding of how toxic chemicals can be detected and quantified in the environment
- Understand the toxicological effects of environmental pollutants.

CONTENTS

This course is designed to develop the understanding of students about the basic concepts in environmental toxicology viz; Classification and properties of toxic substances, biological properties of important classes of chemical compounds in relation to ecosystems, Fate of xenobiotics in the environment and Environmental risk assessment

THEORY

Unit-1 Introduction to environmental Toxicology

1.1 Introduction and Brief history of toxicology
1.2 General Principles and Concepts in environmental toxicology
1.3 Patterns in Environmental toxicology
1.4 Occurrence and sources of toxicants, and their classification
1.5 Application of toxicology in Environmental Sciences

Unit-2 Action of Toxicants

2.1 Movement of toxicants in the environment,
2.2 Root of entry of toxic substances in living organisms,
2.3 Biotransformation – metabolism of xenobiotic compounds
2.4 Factors Affecting Xenobiotic Action
2.5 Allergic reactions

Unit-3 Environmental Disrupters

3.1 Brief Review of Disruption of Endocrinal Function
3.2 Impacts of xenobiotics on the individuals and Environmental integrity
3.3 Teratogens and Mechanisms of Actions
3.4 Plastic and its associated xenobiotics
3.5 Mutagenesis and Carcinogenesis.

Unit-4 Toxicants in Atmosphere

1.1 Sources and health effects of Air Pollutants
1.2 Gaseous Pollutants
1.3 Particulate matter and Asbestos
1.4 Automobile and Industrial Exhaust

Unit-5 Inorganic Toxicants

5.1 Environmental toxicology of trace elements
5.2 Toxicity of non-metallic inorganic substances viz; Cyanides, Phosphate, Nitrates

Unit-6 Organic Toxicants

6.1 Classification and types of organic pollutants
6.2 Persistent Organic Pollutants
6.3 Food additives and contaminants

Unit-7 Agricultural Chemicals

7.1 Pesticides and their chemical origin
7.2 Organochlorines, Organophosphorus, Pyrethroids, Carbamate
7.3 Neonicotinoids, and other types
7.4 Fertilizers and soil additives

Unit-8 Environmental toxicants and human health

8.1 Pharmaceuticals and personal care products
8.2 Therapeutic and Drugs, Drugs of abuse.
8.3 Toxicological Evaluation, Risk Assessment
8.4 Toxicity test and Ecological risk assessment

ASSESSMENT STRATEGIES

1. Lecture based examination
2. Presentations/seminars
3. Class discussion
4. Quizzes

ASSESSMENT AND EXAMINATIONS:

Sr. No.	Elements	Weightage	Details
1.	Mid Term Assessment	35%	It takes place at the mid-point of the semester
2.	Formative Assessment	25%	It is continuous assessment during the semester covering: classroom participation, attendance, assignments and presentation, homework, hands-on-activities, short tests, quizzes etc.
3.	Final Assessment	40%	At the end of the semester, it is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

RECOMMENDED BOOKS / SUGGESTED READINGS

1. D'Mello, J. F. (2019). *A Handbook of Environmental Toxicology: Human Disorders and Ecotoxicology*. CABI.
2. Robinson, L. (2018). *A practical guide to toxicology and human health risk assessment*. John Wiley & Sons.
3. Chadwick, J. and Shaw, I., (2016). *Principles of Environmental Toxicology*. CRC Press.
4. Philp, R. B. (2016). *Ecosystems and human health: Toxicology and environmental hazards*. CRC Press,
5. Gruiz, K., Meggyes, T., & Fenyvesi, É. (2015). *Engineering tools for environmental risk Management: 2. Environmental toxicology*. CRC Press.

Further Reading: As suggested by the Instructor.

ENSC-502: ENVIRONMENTAL TOXICOLOGY (PRACTICAL) (01 CREDIT HRS)

PRE-REQUISITE: B.S/M.Sc. Environmental Sciences or related disciplines

LEARNING OUTCOMES

The students will learn:

- about toxicological sampling techniques for various segments of environment
- to perform various toxicity tests on plants and animals and analyses of micropollutants in the environment
- to study the effect of selected toxicants on germination of plants and preparation of biological assays
- to perform human and ecological risk assessment studies using various statistical techniques

CONTENTS

This course aims to provide students with the knowledge of how biological systems respond to and are affected by pollutants.

PRACTICAL

Unit-1 Sampling techniques in Toxicological studies:

1.1 Toxicological sampling techniques for water, soil, sediments, or biological samples
1.2 Study of toxicological data for Dose–Response and Dose–Effect relationships (Daphnia)

Unit-2 Analytical techniques in Environmental Toxicology

2.1 Solution preparations for the Toxicity Test analysis on selected animal or plant
2.2 Analysis of micro-plastic pollution in water and soil Sample preparation for organic pollutant analysis.

Unit-3 Toxicological assays

3.1 Study of selected toxicants on germination of radish seeds
3.2 Biological assays to determine the toxicological effects on house fly.

Unit-4 Ecological and Human Risk Assessment

4.1 Study of toxicity at community level using biological indicators invertebrates or fish
4.2 Application of statistical techniques to assess the human health risk assessment

ASSESSMENT STRATEGIES

1. Lecture based examination
2. Presentations/seminars
3. Class discussion
4. Quizzes

ASSESSMENT AND EXAMINATIONS:

Sr. No.	Elements	Weightage	Details
1.	Mid Term Assessment	35%	It takes place at the mid-point of the semester
2.	Formative Assessment	25%	It is continuous assessment during the semester covering: classroom participation, attendance, assignments and presentation, homework, hands-on-activities, short tests, quizzes etc.
3.	Final Assessment	40%	At the end of the semester, it is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

RECOMMENDED BOOKS / SUGGESTED READINGS

1. D'Mello, J. F. (2019). *A Handbook of Environmental Toxicology: Human Disorders and Ecotoxicology*. CABI.
2. Robinson, L. (2018). *A practical guide to toxicology and human health risk assessment*. John Wiley & Sons.
3. Chadwick, J. and Shaw, I., (2016). *Principles of Environmental Toxicology*. CRC Press.
4. Philp, R. B. (2016). *Ecosystems and human health: Toxicology and environmental hazards*. CRC Press,
5. Gruiz, K., Meggyes, T., & Fenyvesi, É. (2015). *Engineering tools for environmental risk Management: 2. Environmental toxicology*. CRC Press.

Further Reading: As suggested by the Instructor.

ENSC-503: REMEDIATION STRATEGIES FOR CONTAMINATED ENVIRONMENT (THEORY) (03 Credit hrs)

PRE-REQUISITE: B.S/M.Sc. Environmental Sciences or related disciplines

LEARNING OUTCOMES

The students will be able to:

- Understand the basic concepts of pollution, environmental contaminants and their sources.
- Understand basics of Environmental remediation and types of remediation strategies.
- Develop the ability to screen, choose and design appropriate technologies for remediation.
- Develop understanding of integrated approaches to remediate contaminated sites.

CONTENTS

This course aims at providing students with the necessary knowledge and understanding to the following:

THEORY

Unit-1 Environmental Contamination

1.1 Environmental contaminants and their sources in the environment
1.2 Types and impacts of environmental contamination in
  1.2.1 Soil
  1.2.2 Sediment
  1.2.3 Groundwater

Unit-2 Environmental Remediation

2.1 Basics of Environmental remediation
2.2 Factors affecting remediation efficiency
2.3 Factors affecting contaminant degradation

Unit-3 Environmental Laws and regulatory approaches

3.1 Clean Air Act Laws
3.2 Montreal Protocol
3.3 Clean Water Act
3.4 The Comprehensive Environmental Response, Compensation and Liability Act (CERCLA)
3.5 Remediation Standards

Unit-4 Remediation Strategies

4.1 Physical Remediation
4.2 Chemical Remediation
4.3 Biological Remediation
4.4 Thermal Remediation

Unit-5 Remediation Techniques (based on mechanism)

5.1 Ex-situ/ In -situ Soil Remediation techniques
5.2 Ex-situ/ In -situ Bio Remediation of contaminated soil and sediment by composting
5.3 Ex-situ/ In -situ Ground water Remediation techniques

Unit-6 Environmental Remediation Assessment

6.1 Remediation and response decision making
6.2 Chernobyl case study (Remediation technology and administrative control)
6.3 Remediation strategic planning
6.4 Environmental protection agencies

TEACHING – LEARNING STRATEGIES

- Lecture based examination
- Presentation/seminars
- Class discussion
- Quizzes

ASSIGNMENTS – TYPE AND NUMBER WITH CALENDAR

It is continuous assessment. The weightage of Assignments will be 25% before and after midterm assessment. It includes:

- classroom participation,
- attendance, assignments and presentation,
- homework
- attitude and behavior,
- hands-on-activities,
- short tests, quizzes etc.

ASSESSMENT AND EXAMINATIONS:

Sr. No.	Elements	Weightage	Details
1.	Mid Term Assessment	35%	It takes place at the mid-point of the semester
2.	Formative Assessment	25%	It is continuous assessment. It includes: classroom participation, attendance, assignments and presentation, homework, attitude and behavior, hands-on-activities, short tests, quizzes etc.
3.	Final Assessment	40%	It takes place at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

RECOMMENDED TEXT BOOKS / SUGGESTED READINGS

1. Pichtel, J. (2019). *Fundamentals of site remediation*. Rowman & Littlefield.
2. Hasegawa, H., Rahman, I. M. M., & Rahman, M. A. (Eds.). (2016). *Environmental remediation technologies for metal-contaminated soils*. Springer Japan.
3. Ghafoor, A., Murtaza, G., Rehman, M. Z., Sabir, M., Ahmad, H. R., & Ullah, S. (2012). Environment pollution: Types, sources and management. *Allied Book Centre, Urdu Bazar, Lahore, Pakistan*.
4. Bhandari, A., Surampalli, R., Champagne, P., Tyagi, R. D., Ong, S. K., & Lo, I. (2007). *Remediation technologies for soils and groundwater*.
5. Raskin, I., & Ensley, B. D. (2000). *Phytoremediation of toxic metals*. John Wiley and Sons.

ENSC-504: ENVIRONMENTAL BIOTECHNOLOGY (THEORY) (02 Credit hours)

PRE-REQUISITE: B.S/M.Sc. Environmental Sciences or related disciplines

LEARNING OUTCOMES

Students will learn about:

- Basic concepts of environmental biotechnology and role of biotechnology in pollution abatement
- Biodegradation of various organic pollutants using biotechnological tools
- Biotreatment of organic and inorganic wastes and environmental management
- Role of environmental biotechnology in agriculture with special focus on reducing environmental stresses to crops

CONTENTS

The goal of this course is to develop a sound technical foundation for evaluating the appropriateness of using environmental biotechnology for environmental cleanup and to examine current applications of biotechnology to environmental quality monitoring and remediation of contaminated environments.

THEORY

Unit-1 Introduction to Environmental Biotechnology

1.1 Environment biotechnology
1.2 Air, soil and water pollution abatement using environmental biotechnology
1.3 Biological treatment of wastewater

Unit-2 Biotreatment of Organic and Inorganic Pollutants

2.1 Genetically modified organisms for pollution reduction
2.2 Compositing, bioleaching, biofuels and bioenergy
2.3 Bioscrubbers, biofilters, advanced activated sludge processes,
2.4 Oxidation Ditches, Biological filters-fixed film systems, Rotating biological contractors,
2.5 Fluidized bed reactors, Packed bed reactors
2.6 Upflow Anaerobic Sludge blanket reactor, membrane bioreactor

Unit-3 Xenobiotic Compounds and their Treatment

3.1 Introduction
3.2 Biodegradation of xenobiotic compounds
3.3 Detoxification methods

Unit-4 Biotechnology and Agriculture

4.1 Introduction,
4.2 Plant breeding and crop improvement,
4.3 Transgenic plants for food security, nutrition and health care methods
4.4 Biofertilizers and biopesticides
4.5 Ethical and legal problems

Unit-5 Biosorption of Pollutants

5.1 Biosorption of heavy metals
5.2 Biosorption of organic pollutants
5.3 Enhanced biosorption using tailored sorbents

TEACHING – LEARNING STRATEGIES

- Lecture based examination
- Presentation/seminars
- Class discussion
- Quizzes

ASSIGNMENTS – TYPE AND NUMBER WITH CALENDAR

It is continuous assessment. The weightage of Assignments will be 25% before and after midterm assessment. It includes:

- classroom participation,
- attendance, assignments and presentation,
- homework
- attitude and behavior,
- hands-on-activities,
- short tests, quizzes etc.

ASSESSMENT AND EXAMINATIONS:

Sr. No.	Elements	Weightage	Details
1.	Mid Term Assessment	35%	It takes place at the mid-point of the semester
2.	Formative Assessment	25%	It is continuous assessment. It includes: classroom participation, attendance, assignments and presentation, homework, attitude and behavior, hands-on-activities, short tests, quizzes etc.
3.	Final Assessment	40%	It takes place at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

RECOMMENDED TEXT BOOKS / SUGGESTED READINGS

1. Gothandam, K. M., Ranjan, S., Dasgupta, N., & Lichtfouse, E. (2020). *Environmental Biotechnology* Vol. 3. Springer International Publishing.
2. *Sobti, R. C., Arora, N. K., & Kothari, R. (Eds.). (2018). Environmental biotechnology: for sustainable future*. Springer.
3. Kumar, P., & Kumar, V. (2018). *Textbook of Environmental Biotechnology*. Woodhead Publishing India.
4. Viswanath, B. (2017). *Environmental Biotechnology*. Heritage Publishers.
5. Sangeetha, J., Thangadurai, D., David, M., & Abdullah, M. A. (2016). *Environmental Biotechnology: Biodegradation, Bioremediation, and Bioconversion of Xenobiotics for Sustainable Development*. CRC Press.
6. Thakur, I.S. (2016). *Environmental Biotechnology*. *Basic Concepts and Applications*. I.K.International Pvt.Ltd, New Delhi
7. A.K.Chatterji. (2015). *Introduction to Environmental Biotechnology*. Prentice Hall of India Private Limited, New Delhi

Further Reading: As suggested by the Instructor.

ENSC-504: ENVIRONMENTAL BIOTECHNOLOGY (PRACTICAL) (01 Credit hours)

PRE-REQUISITE: B.S/M.Sc. Environmental Sciences or related disciplines

LEARNING OUTCOMES

Students will learn about:

- Various methods of bioremediation of heavy metals
- Case studies related to biosorption and biotreatment of water and soil
- Case studies of genetically modified organism and their role in reducing environmental stresses in agriculture
- biodegradation techniques for organic pollutants

CONTENTS

The aim of the practical course in environmental biotechnology is to teach methods and processes in environmental biotechnology. The course will introduce to the students the major biotechnology-tools and their most important environmental applications.

PRACTICAL

Unit-1 Biosorption of heavy metals and other compounds

1.1 Chromium removal
1.2 Arsenic removal
1.3 Nitrate and ammonium removal

Unit-2 Bioremediation case studies

2.1 Heavy metals removal
2.2 Anions treatment
2.3 Organic contaminants
2.4 Biotransformation

Unit-3 Renewable energy resources

3.1 Biofuels
3.2 Biogas
3.3 Biomass

Unit-4 Genetically modified organisms for environmental pollution treatment

4.1 Case studies
4.2 Decolourization of effluents
4.3 Degradation of organic pollutants

TEACHING – LEARNING STRATEGIES

- Lecture based examination
- Presentation/seminars
- Class discussion
- Quizzes

ASSIGNMENTS – TYPE AND NUMBER WITH CALENDAR

It is continuous assessment. The weightage of Assignments will be 25% before and after midterm assessment. It includes:

- classroom participation,
- attendance, assignments and presentation,
- homework
- attitude and behavior,
- hands-on-activities,
- short tests, quizzes etc.

ASSESSMENT AND EXAMINATIONS:

Sr. No.	Elements	Weightage	Details
1.	Mid Term Assessment	35%	It takes place at the mid-point of the semester
2.	Formative Assessment	25%	It is continuous assessment. It includes: classroom participation, attendance, assignments and presentation, homework, attitude and behavior, hands-on-activities, short tests, quizzes etc.
3.	Final Assessment	40%	It takes place at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

RECOMMENDED TEXT BOOKS / SUGGESTED READINGS

1. Patra, J. K., Das, G., Das, S. K., & Thatoi, H. N. (2020). *A Practical Guide to Environmental Biotechnology*. Springer.
2. Gothandam, K. M., Ranjan, S., Dasgupta, N., & Lichtfouse, E. (2020). *Environmental Biotechnology* Vol. 3. Springer International Publishing.
3. Akunna, J. C. (2018). *Anaerobic waste-wastewater treatment and biogas plants: A practical handbook*. CRC Press.
4. Sangeetha, J., Thangadurai, D., David, M., & Abdullah, M. A. (2016). *Environmental Biotechnology: Biodegradation, Bioremediation, and Bioconversion of Xenobiotics for Sustainable Development*. CRC Press.
5. Chrispeels M.J., Chopra V.L., Malik V.S. and Bhat S.R. (2016). *Applied Plant Biotechnology*, Oxford University Press.
6. Srivastava, S. (2015). *Applied environmental biotechnology: present scenario and future trends* . Springer, New Delhi.

Further Reading: As suggested by the Instructor.

ENSC 505 POPULATION DYNAMICS AND ENVIRONMENT (THEORY) (03 Credit Hours)

PRE-REQUISITE: B.S/M.Sc. Environmental Sciences or related disciplines

LEARNING OUTCOMES

- The students will be able to understand about overall population scenarios.
- The students can identify the trends of population dynamics in Pakistan
- The students will gain knowledge about the effect of population on environment
- The students will be able to learns different approaches for population control and stability

CONTENTS

The population dynamics syllabus includes overview of world population, concepts related to population, population-environment-development nexus, and government responses around the globe and Pakistan.

THEORY

Unit-1 Overview of World Population

1.1 Introduction
1.2 Demographic data
1.3 Population: Historic review and future trends

Unit-2 Population dynamic Concepts

2.1 Fertility concepts and trends, age and sex structure, birth cohorts
2.2 Fertility issues, problems and policies
2.3 Marriage and family
2.4 Mortality and Morbidity
2.5 Migration and urbanization
2.6 Poverty and welfare (Effects of sex, race, and other characteristics on status attainment; the financial problems of the middle class)

Unit-3 Population and Environmental Resources

3.1 Population growth
3.2 Theories of Malthus Marx
3.3 The demographic transition
3.4 Examination of the effect of overpopulation on the world today
3.5 Population resources, environment and food

Unit-4 Population Environment Nexus

4.1 Population size and environment
4.2 Population distribution and environment.
4.3 Population composition and environment,
4.4 Population growth and climate change,
4.5 Population growth and land use change
4.6 Poverty population-environment linkages

Unit-5 Population Development Nexus

5.1 Population and development
5.2 Integrating environment and development

Unit-6 Population Dynamics in Pakistan and Government Responses

6.1 Population dynamics and environment in Pakistan,
6.2 Pakistan's Bio capacity, resource consumption & crisis.
6.3 Government responses
6.4 Individual attitudes and perceptions,
6.5 Sustainable approach to population stabilization
6.6 Global responses
6.7 Situation in Pakistan

6.8 Future trends and strategies to overcome population growth

TEACHING – LEARNING STRATEGIES

- Lecture based examination
- Presentation/seminars
- Class discussion
- Quizzes

ASSIGNMENTS – TYPE AND NUMBER WITH CALENDAR

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- homework
- attitude and behavior,
- hands-on-activities,
- short tests, quizzes etc.

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RECOMMENDED TEXT BOOKS / SUGGESTED READINGS

1. Banerjee, A., Jana, N. C., & Mishra, V. K. (2020). *Population Dynamics in Contemporary South Asia: Health, Education and Migration*: Springer Singapore.
2. Oro, D. (2020). *Perturbation, Behavioural Feedbacks, and Population Dynamics in Social Animals: When to Leave and Where to Go*: Oxford University Press.
3. Arizpe, L., Stone, M. P., Major, D., & Stone, P. (2019). *Population And Environment: Rethinking The Debate*: Taylor & Francis.
4. James, H. (2019). *Population, Development, and the Environment: Challenges to Achieving the Sustainable Development Goals in the Asia Pacific*: Springer Singapore.
5. Gardiner, S. M., & Thompson, A. (2017). *The Oxford Handbook of Environmental Ethics*: Oxford University Press.
6. Iannelli, M., & Milner, F. (2017). *The Basic Approach to Age-Structured Population Dynamics: Models, Methods and Numerics*: Springer Netherlands.
7. Baudot, B. S., & Moomaw, W. R. (2016*). People and their Planet: Searching for Balance*: Palgrave Macmillan UK.
8. Anderson, B. A. (2015). *World Population Dynamics: An Introduction to Demography*: Pearson.

ENSC-506: NATURAL AND CONSTRUCTED WETLANDS (THEORY) (03 Credit Hours)

PRE-REQUISITE: B.S/M.Sc. Environmental Sciences or related disciplines

LEARNING OUTCOMES

- The course will provide basic knowledge and scientific concepts of wetlands for their natural and man-made uses.
- This course will introduce and discuss a wetland; characteristics of wetland systems; the principles of wetland ecology;
- The students will learn the functions of wetlands; and regulations
- The students will learn the permitting process regarding development near and within wetlands.

CONTENTS

This course intends to provide the knowledge about the natural wetlands and their characteristics and functions as well as importance of constructed wetlands for wastewater treatments.

Unit-1 Introduction

1.1 Concept of wetland as given by RAMSAR Convention
1.2 Importance of natural wetlands and climate change
1.3 Types of Wetlands based on establishment
1.4 Types of wetlands based on flow
1.5 Working phenomenon and functions of natural wetlands

Unit-2 Constructed Wetlands

2.1 Science and Wetland Law
2.2 Borrowing concept of natural wetlands for constructed wetlands
2.3 Potential applications of constructed wetlands
2.4 Major hydrological parameters of constructed wetlands (CW)

Unit 3 Wetlands and Plants

3.1 Major types of biofilms and microbial diversity in CW
3.2 Options for bedding material
3.3 Options for wetland plants
3.4 Types of hydrophytes and its suitability for CW

Unit 4 Management of Wetlands

4.1 Wetland fauna, assessment and monitoring of an established CW
4.2 Tracking evaporation loss of water
4.3 Stressor identification
4.4 Natural factors inducing disturbance in CW and its impacts
4.5 Eutrophication and management

Unit 5 Working of Wetlands and Modeling

5.1 Hydrogeomorphic models for predicting working of CW at large scale
5.2 CW as an established ecosystem, its development stages i.e. succession
5.3 Community development, landscape patterns

Unit 6 Wetlands for Wastewater Treatment and Field Visits

6.1 CW as treatment wetlands
6.2 Urban wetlands and their uses for wastewater treatment
6.3 Field Visits

ASSIGNMENTS – TYPE AND NUMBER WITH CALENDAR

It is continuous assessment. The weightage of Assignments will be 25% before and after midterm assessment. It includes:

- Classroom participation,
- Attendance, assignments and presentation,
- Homework
- Attitude and behavior,
- Hands-on-activities,
- Short tests, quizzes etc.

ASSESSMENT AND EXAMINATIONS

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RECOMMENDED TEXT BOOKS / SUGGESTED READINGS

1. Finlayson, C. M. (2018). *The Wetland Book I: Structure and Function, Management, and Methods.* Springer Publishers.
2. Finlayson, C. M. (2018). *The Wetland Book II: Distribution, Description, and Conservation***.** Springer Publishers.
3. Rice, E.W. et.al. (2017). *Standard Methods for the Examination of Water and Wastewater***.** Published by APHA, AWWA, WEF.
4. Santín, I., Pedret, C., & Vilanova, R. (2016). *Control and decision strategies in wastewater treatment plants for operation improvement* . Springer.
5. Ben, A. L. (2011). *Wetlands: Integrating Multidisciplinary Concepts*. Springer.
6. Vymazal, J. (2008). *Wastewater Treatment, Plant Dynamics and Management in Constructed and Natural Wetlands***.** Springer Publishers, Netherland

ENSC-507: ENVIRONMENTAL IMPACTS OF PETROLEUM INDUSTRY (THEORY) (03 Credit hrs)

PRE-REQUISITE: B.S/M.Sc. Environmental Sciences or related disciplines

LEARNING OUTCOMES

- This course will provide an introduction to the Petroleum Industry to the students.
- The students will learn to differentiate different types of Fossils Fuels.
- They will have the knowledge to explain the purpose and role of Petroleum in Industry.
- The students will learn about environmental Impacts of Petroleum Industry

CONTENTS

This course gives the students with information about fossils fuels of Pakistan and to provide the foundations for understanding the Environmental Impacts on Petroleum Industry.

THEORY

Unit-1 Introduction

1.1 Occurrence of Petroleum, Geological Ages
1.2 Surface and Subsurface Mining

Unit-2 Source Rocks and Traps

2.1 Source Rocks, Reservoir Rocks
2.2 Traps and Regional Top Seal

Unit-3 Petroleum Distribution in Pakistan

3.1 The Theory of the Plate Tectonic
3.2 Regional Distribution of Petroleum

Unit-4 Petroleum Exploration and Production

4.1 Structure Geological Features,
4.2 Introduction to structural geology
4.3 Introduction to Geophysics

Unit-5 Drilling Methods

5.1 Cable Tool
5.2 Rotary Drilling
5.3 Turbo Drilling
5.4 Drilling Fluids
5.5 Offshore Drilling
5.6 Vertical and Directional Drilling

Unit-6 Environmental Impacts Associated with Petroleum Industry

6.1 Geology and Geophysics
6.2 Drilling Operations
6.3 Drilling Fluids
6.4 Petroleum Production
6.5 Midstream Activities
6.6 Oil Slick
6.7 Seepages
6.8 Tight Gas

TEACHING – LEARNING STRATEGIES

- Lecture based examination
- Presentation/seminars
- Class discussion
- Quizzes

ASSIGNMENTS – TYPE AND NUMBER WITH CALENDAR

It is continuous assessment. The weightage of Assignments will be 25% before and after midterm assessment. It includes:

- classroom participation,
- attendance, assignments and presentation,
- homework
- attitude and behavior,
- hands-on-activities,
- short tests, quizzes etc.

ASSESSMENT AND EXAMINATIONS:

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3.	Final Assessment	40%	It takes place at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

RECOMMENDED TEXT BOOKS / SUGGESTED READINGS

1. Kuppusamy, S., Maddela, N. R., Megharaj, M., & Venkateswarlu, K. (2020). *Total petroleum hydrocarbons: environmental fate, toxicity, and remediation*. Springer.
2. Skovhus, T. L., Enning, D., & Lee, J. S. (2017). *Microbiologically influenced corrosion in the upstream oil and gas industry*. CRC press.
3. Olaguer, E. P. (2016). *Atmospheric impacts of the oil and gas industry*. Academic Press.
4. Li., G. (2011). *World Atlas of Oil and Gas Basins.* Wiley-Blackwell.
5. Gorelick, S.M. (2009) .*Oil Panic and Global Crisis; Predictions and Myths.* Wiley-Blackwell.

ENSC-508: SOIL POLLUTION (THEORY) (03 Credit Hours)

PRE-REQUISITE: B.S/M.Sc. Environmental Sciences or related disciplines

LEARNING OUTCOMES

- Students will gain concepts about soil, its importance and extent of loss if soil gets polluted
- They will understand causes and impacts of soil pollution
- Students can explain the fate of pollutants in the soil
- Students will learn about soil remediation techniques

CONTENTS

Importance of soil for agriculture sector in Pakistan, components of soil, soil pollution types, interaction of soil components with pollutants, transportation modes and fate of pollutants in soil, impacts of pollutants on soil and remediation technologies.

THEORY

Unit-1 Components and Properties of Soil

1.1 Soil components
1.2 Soil properties viz. physical, chemical and biological
1.3 Soil quality/productivity and its degradation modes

Unit-2 Importance of Soil for Agriculture Sector

2.1 Soil as natural capital and resource
2.2 Ecosystem services of soil
2.3 Importance of soil for Pakistan being an agricultural country

Unit-3 Soil Pollutants

3.1 Soil as major sink of pollutants
3.2 Types of soil pollutants viz. inorganic and organic
3.3 Persistent organic pollutants (POPs) in soil; pesticide pollution in soils

Unit-4 Sources of Soil Pollutants

4.1 Urban sources of soil pollution
4.2 biological pollution of soils
4.3 Interaction of soil constituents and pollutants

Unit-5 Fate of Pollutants in the Soil

5.1 Tracking pathways of pollutants across soils
5.2 Heavy metals' transport in soils and their bioavailability and biochemical effects
5.3 Organic pollutants' transport, retention and degradation in soil
5.4 Solubility, toxicity and fate of different types of pollutants in soils; major brownfield sites of the world

Unit-6 Remediation of Polluted Soil

6.1 Soil polluted site investigation and risk assessment
6.2 Sampling and analytical approaches for contaminated soils
6.3 In-situ and ex-situ remediation technologies for polluted soils
6.4 Soil ecology and pollutant degradation
6.5 Soil remediation challenges in Pakistan

TEACHING – LEARNING STRATEGIES

- Lecture based examination
- Presentation/seminars
- Class discussion
- Quizzes

ASSIGNMENTS – TYPE AND NUMBER WITH CALENDAR

It is continuous assessment. The weightage of Assignments will be 25% before and after midterm assessment. It includes:

- classroom participation,
- attendance, assignments and presentation,
- homework
- attitude and behavior,
- hands-on-activities,
- short tests, quizzes etc.

ASSESSMENT AND EXAMINATIONS:

Sr. No.	Elements	Weightage	Details
1.	Mid Term Assessment	35%	It takes place at the mid-point of the semester
2.	Formative Assessment	25%	It is continuous assessment. It includes: classroom participation, attendance, assignments and presentation, homework, attitude and behavior, hands-on-activities, short tests, quizzes etc.
3.	Final Assessment	40%	It takes place at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

RECOMMENDED TEXT BOOKS / SUGGESTED READINGS

1. Saha, J. K., Selladurai, R., Coumar, M. V., Dotaniya, M. L., Kundu, S., & Patra, A. K. (2017). *Soil pollution-an emerging threat to agriculture* (Vol. 10). Springer.
2. Yap, C. K. (2019). *Soil Pollution: Sources, Management Strategies and Health Effects*. Nova Science Publishers, Incorporated.
3. Rodríguez-Eugenio, N., McLaughlin, M., & Pennock, D. (2018). *Soil pollution: a hidden reality*. FAO.
4. Duarte, A. C., Cachada, A., & Rocha-Santos, T. A. (2017). *Soil Pollution: From Monitoring to Remediation*. Academic Press.
5. Soriano, M. C. H. (2014). *Environmental risk assessment of soil contamination*. BoD–Books on Demand.
6. Khan, M. S., Zaidi, A., Goel, R., & Musarrat, J. (2011). *Biomanagement of metal-contaminated soils* (Vol. 20). Springer Science & Business Media.

ENSC-509: ENVIRONMENTAL AUDITING (THEORY) (03 Credit hrs)

PRE-REQUISITE: B.S/M.Sc. Environmental Sciences or related disciplines

LEARNING OUTCOMES

After successful completion of this course, students will be able to:

1. Know the various environmental standards and types of auditing.
2. Know how to conduct an audit according to ISO 14001 as well as to local management systems.
3. Understand the project definition and project management tools.
4. Understand the identification of stakeholders, the role of sponsors and the role of project manager.
5. Know how to apply project life cycle to a project.

CONTENTS

The course includes auditing standards such as ISO 19011, ISO 14010 (general principles for environmental audits) - ISO 14011/1 (procedures for conducting audits of Environmental Management Systems) - ISO 14012 (addresses the qualifications of auditors) - Role of Environmental Auditing in an EMS and corporate governance – Integration of management systems and auditing processes

THEORY

Unit-1 Introduction to Environmental Standards

1.1 History of ISO 14000 Family
1.2 ISO 14001
1.3 Integrated management system

Unit-2 Fundamentals of Auditing

2.1 Introduction to ISO 19011 for auditing,
2.2 Principals of Environmental Auditing,
2.3 Local and international environmental auditing systems

Unit-3 Audit Process

3.1 History of Environmental Auditing
3.2 Types of environmental audits,
3.3 Audit preparation and planning,
3.4 Selection of team and their competence
3.5 Methods of Gathering Audit Evidence,
3.6 Practical Audit Exercise,
3.7 Audit communication and reporting system.

Unit-4 Case Studies of Environmental Auditing

4.1 Case study-I
4.2 Case Study-II

Unit-5 Environmental auditing and Project Management

5.1 Project Philosophy,
5.2 Project methodologies,
5.3 Project perspectives
5.4 Stakeholders Analysis and Participation
5.5 Project goal and scope management,
5.6 Project life cycle

Unit-6 Economic role of Environmental Audit in Industries

6.1 Role of local and international bodies

TEACHING – LEARNING STRATEGIES

- Lecture based examination
- Presentation/seminars
- Class discussion
- Quizzes

ASSIGNMENTS – TYPE AND NUMBER WITH CALENDAR

It is continuous assessment. The weightage of Assignments will be 25% before and after midterm assessment. It includes:

- classroom participation,
- attendance, assignments and presentation,
- homework
- attitude and behavior,
- hands-on-activities,
- short tests, quizzes etc.

ASSESSMENT AND EXAMINATIONS:

Sr. No.	Elements	Weightage	Details
1.	Mid Term Assessment	35%	It takes place at the mid-point of the semester
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3.	Final Assessment	40%	It takes place at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

RECOMMENDED TEXT BOOKS / SUGGESTED READINGS

1. Meredith, J.R., Shafer, S.M., Mantel Jr, S.J. and Sutton, M.M. (2020). *Project management in practice.* John Wiley & Sons.
2. Das, T.K. (2020). *Industrial Environmental Management: Engineering, Science, and Policy*. John Wiley & Sons.
3. Prasad, A. (2018). *Environmental Performance Auditing in the Public Sector: Enabling Sustainable Development*. Routledge.
4. Turner, Rodney. (2016). *Gower handbook of project management*. Routledge Publishers.
5. Beasley, Mark S. (2015). *Auditing cases: An interactive learning approach.* Prentice Hall.
6. Hillary, R. (2017). *Introduction. In ISO 14001*. Routledge.

ENSC-510: CLEANER PRODUCTION TECHNOLOGIES (THEORY) (03 Credit hrs)

PRE-REQUISITE: B.S/M.Sc. Environmental Sciences or related disciplines

LEARNING OUTCOMES

- Students will learn and propose strategies and actions for different industrial environmental problems, based on a system analysis perspective
- Student can suggest different unit operations as process integrated cleaning stages in an industrial production process in order to minimize pollutions to air or water
- After completing the course, students can apply different approaches of cleaner production in industries, and can conduct energy and material balances for processes as part of a Cleaner production assessment
- Students will learn the management and leadership skills necessary for helping companies plan and implement policies and programs designed to achieve Cleaner Production.

CONTENTS

This course teaches techniques for reduction and/or elimination of source of pollution from industry. This course provides both theoretical and applied knowledge of strategies and technologies for a cleaner industrial production.

THEORY

Unit-1 Strategies for a better environment

1.1 Evaluation process
1.2 Internal solutions (process changes, raw materials change etc.)
1.3 Process external solutions, product changes and other
1.4 Advantages and disadvantages using different strategies

Unit-2 Basic concepts of Cleaner Production

2.1 Process management
2.2 Product design and material selection as components of Cleaner Production development
2.3 Learning methods and techniques of pollution prevention during production

Unit-3 Air pollution control and gas cleaning technology

3.1 Process internal solutions and external solutions in order to minimize air pollutions
3.2 Emissions of VOCs and flue gases from energy production.
3.3 Advantages and disadvantages of different methods

Unit-4 Wastewater treatment

4.1 Pollution prevention and cleaner production awareness plan for effluents
4.2 Process internal solutions and external solutions
4.3 Advantages and disadvantages of different methods

Unit-5 Cleaner production practices

5.1 Passive environmental strategies
5.2 Reactive environmental strategies
5.3 Onsite Vs. end-of-pipe approaches

Unit-6 Case studies

6.1 Case studies of various industries, including:
6.2 Textile & Chemical industries
6.3 Automobile
6.4 Leather
6.5 Paper, packaging, and allied industries

TEACHING – LEARNING STRATEGIES

- Lecture based examination
- Presentation/seminars
- Class discussion
- Quizzes

ASSIGNMENTS – TYPE AND NUMBER WITH CALENDAR

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- classroom participation,
- attendance, assignments and presentation,
- homework
- attitude and behavior,
- hands-on-activities,
- short tests, quizzes etc.

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3.	Final Assessment	40%	It takes place at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

RECOMMENDED TEXT BOOKS / SUGGESTED READINGS

1. SpringerLink (Online service), Aravind, J., Kamaraj, M., Prashanthi Devi, M., &Rajakumar, S. (2021). *Strategies and tools for pollutant mitigation: Avenues to a cleaner environment*. Springer.
2. SpringerLink (Online service), Leal Filho, W., Azul, A. M., Brandli, L., Özuyar, P. G., & Wall, T. (2021). *Affordable and clean energy*. Springer.
3. Filho, L., &Witschel. (2020). *Clean Water and Sanitation*. Springer International Publishing.
4. Zimmer, M. (2019). *Solutions for a cleaner, greener planet: Environmental chemistry*. Twenty-First Century Books.
5. Chandrappa, R., & Chandra Kulshrestha, U. (2016). *Sustainable Air Pollution Management: Theory and Practice* (1st edition 2016.). Springer International Publishing: Imprint: Springer.
6. Das, T. K. (2005). *Toward zero discharge: Innovative methodology and technologies for process pollution prevention*. J. Wiley.

ENSC-511: SUSTAINABLE DEVELOPMENT (THEORY) (03 Credit Hours)

PRE-REQUISITE: B.S/M.Sc. Environmental Sciences or related disciplines

LEARNING OUTCOMES

Students will learn to:

- Demonstrate understanding of the processes generating social and environmental changes and how to respond to such changes
- Critically examine the theory and practice of environment and sustainable development at the international, national and urban levels
- Provide input to the sustainable development theoretical debate and practice, unveiling the political, social and economic forces underlying environmental conflicts
- Explore concrete approaches to address causes of the above issues and suggest sustainable solutions

CONTENTS

The course intends to provide a theoretical and practical understanding of socio-environmental change, and giving students the skills to explore and critically evaluate issues pertaining to sustainable development in developing countries.

THEORY

Unit-1 Introduction to sustainable development

1.1 Definitions and history of sustainable development
1.2 Rio Declaration on environment and development
1.3 Concept of sustainability in developing countries
1.4 Contemporary debate on development and environmental sustainability

Unit-2 Economic and social development

2.1 Poverty and wealth, social inequality
2.2 Rethinking the socio-economic system
2.3 Social development: crises and solutions

Unit-3 The environmental challenges

3.1 Urban environmental planning and management
3.2 Environment and sustainable development in practice
3.3 Environmental problems in urban areas and their underlying causes

Unit-4 Climate change and sustainability

4.1 Climate change: adaptation and mitigation
4.2 International treaties and conventions
4.3 Threats to developing countries; adaptation responses and plans

Unit-5 Food Security and Safety

5.1 Sustainable food security a political imperative and challenge
5.2 Food losses and waste vs. food Security
5.3 Source reduction—Reduce waste and losses
5.4 Food recycling
5.5 Recovery as biofuel and nutrients

Unit-6 Future perspectives

6.1 Future perspectives on the prosperity of mankind
6.2 Education for sustainable development
6.3 Applying sustainability at the local community for finding solutions to problems

TEACHING – LEARNING STRATEGIES

- Lecture based examination
- Presentation/seminars
- Class discussion
- Quizzes

ASSIGNMENTS – TYPE AND NUMBER WITH CALENDAR

It is continuous assessment. The weightage of Assignments will be 25% before and after midterm assessment. It includes:

- classroom participation,
- attendance, assignments and presentation,
- homework
- attitude and behavior,
- hands-on-activities,
- short tests, quizzes etc.

ASSESSMENT AND EXAMINATIONS:

Sr. No.	Elements	Weightage	Details
1.	Mid Term Assessment	35%	It takes place at the mid-point of the semester
2.	Formative Assessment	25%	It is continuous assessment. It includes: classroom participation, attendance, assignments and presentation, homework, attitude and behavior, hands-on-activities, short tests, quizzes etc.
3.	Final Assessment	40%	It takes place at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

RECOMMENDED TEXT BOOKS / SUGGESTED READINGS

1. Mojekwu, J. N., Thwala, W., Aigbavboa, C., Atepor, L., & Sackey, S. (2021). *Sustainable Education and Development*. Springer.
2. Muralidharan, K. (2021). *Sustainable Development and Quality of Life: Through Lean, Green and Clean Concepts*. Springer Nature.
3. Brebbia, C. A., Miralles I. and Garcia, J. L. (2017). *Environmental and Economic Impact on Sustainable Development*. WIT PRESS, UK.
4. Mal, S., Singh, R. B., & Huggel, C. (2017). *Climate change, extreme events and disaster risk reduction: Towards sustainable development goals*. Springer.
5. Jacques, P. (2015). *Sustainability: the basics*. Routledge.
6. Sharma T. (2015). *Global Environmental Governance*. Random Publications

Further Reading As suggested by the Instructor.

ENSC-512: ENVIRONMENTAL RISK ASSESSMENT AND MANAGEMENT (THEORY)

(03 Credit Hours)

PRE-REQUISITE: B.S/M.Sc. Environmental Sciences or related disciplines

LEARNING OUTCOMES

Students will learn to:

- Define risk in the context of environmental management.
- Identify factors that alter people's perception of risk.
- Apply various approaches for environmental and ecological health risk assessment
- Examine concepts such as exposure and consequence assessment and analysis models
- Apply risk assessment concepts to specific environmental risks
- Understand risk management approaches

CONTENTS

This course will provide the understanding about assessment of human and ecological health risks from environmental stresses and various risk management approaches.

Unit-1 Fundamentals of Environmental Risk Assessment and Management

1.1 Definition and major types of environmental risk
1.2 Introduction to environmental risk assessment
1.3 Introduction to environmental risk management

Unit-2 Types and Application of Environmental Health Risk

2.1 Risk assessment as an early warning
2.2 Risk assessment via inhalation and ingestion
2.3 Risk assessment via external contact and/or deposition
2.4 Risk assessment environmental micropollutants/chemicals
2.5 Risk assessment for GMOs
2.6 Risk assessment for microbes and pathogens
2.7 Risk assessment for changing climate

Unit-3 Approaches and Models of Environmental Health Risks Assessment

3.1 Human health risk assessment
3.2 Ecological health risk assessment
3.3 Toxicology assessment studies
3.4 Dose response based studies
3.5 Exposure assessment studies
3.6 Epidemiology and environmental risk assessment

Unit-4 Aquatic Habitats and Environmental Risk Assessment

4.1 Water bodies and concentrations of pollutants
4.2 Pathways of environmental pollutants in aquatic bodies
4.3 Risk assessment for aquatic flora and fauna
4.4 Risk evaluation through food chain and food web
4.5 Fish toxicology and human health concerns

Unit-5 Terrestrial Matrices and Environmental Risk Assessment

5.1 Risk through air, dust, soil and sediments
5.2 Pathways of environmental pollutants in terrestrial habitats
5.3 Exposure of human and wildlife to contaminants in terrestrial environment

Unit-6 Risk Management Strategies

6.1 Pollution control strategies
6.2 Bioremediation of environmental pollutants
6.3 Waste disposal strategies
6.4 Control of pathogens, microbes, viruses and GMOs
6.5 Laws and legislations

TEACHING – LEARNING STRATEGIES

- Lecture based examination
- Presentation/seminars
- Class discussion
- Quizzes

ASSIGNMENTS – TYPE AND NUMBER WITH CALENDAR

It is continuous assessment. The weightage of Assignments will be 25% before and after midterm assessment. It includes:

- classroom participation,
- attendance, assignments and presentation,
- homework
- attitude and behavior,
- hands-on-activities,
- short tests, quizzes etc.

ASSESSMENT AND EXAMINATIONS:

Sr. No.	Elements	Weightage	Details
1.	Mid Term Assessment	35%	It takes place at the mid-point of the semester
2.	Formative Assessment	25%	It is continuous assessment. It includes: classroom participation, attendance, assignments and presentation, homework, attitude and behavior, hands-on-activities, short tests, quizzes etc.
3.	Final Assessment	40%	It takes place at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

RECOMMENDED TEXT BOOKS / SUGGESTED READINGS

1. Dalezios, N. R. (2017). *Environmental hazards: methodologies for risk assessment and management.* IWA Publishing, London.
2. Greenberg, R. M. (2017). *Explaining Risk Analysis: Protecting health and the environment.* Routledge, New York.
3. Muralikrishna, I. V. and Manickam, V. (2017). *Environmental Management Science and Engineering for Industry.* BS Publications, Oxford.
4. Pritchard, P. (2014). *Environmental Risk Management.* Earthscan, USA.
5. Mohapatra, R. (2002). *Occupational Health Hazards and Remedies.* Jaypee Brothers Medical Publishers Pvt. Ltd., India.

Assorted Research Papers

SECOND SEMESTER

Sr. No.	Course Code	Course Title	Course Type	Pre-Requisite	Credit Hours
CORE-COURSES *(06 credit hours core-courses will be offered in 2nd Semester)*					
1.	ENSC 513	Research methods in Environmental Science	Core-Course	B.S/M.Sc. Environmental Sciences or related disciplines	03
2.	ENSC 514	Advanced Analytical Techniques in Environment	Core-Course	B.S/M.Sc. Environmental Sciences or related disciplines	02+01
ELECTIVE COURSES *(02 Elective courses of 06 credit hours will be offered in 2nd Semester)*					
3.	ENSC 515	Environmental Impact Assessment and Strategic Environmental Assessment	Elective Course	B.S/M.Sc. Environmental Sciences or related disciplines	03
4.	ENSC 516	Environmental Management System and Integrated management System	Elective Course	B.S/M.Sc. Environmental Sciences or related disciplines	03
5.	ENSC 517	Advanced GIS and Remote Sensing	Elective Course	B.S/M.Sc. Environmental Sciences or related disciplines	02+1
6.	ENSC 518	Waste Reduction and Recycling	Elective Course	B.S/M.Sc. Environmental Sciences or related disciplines	03
7.	ENSC 519	Advanced Industrial Wastewater Treatment	Elective Course	B.S/M.Sc. Environmental Sciences or related disciplines	02+1
8.	ENSC 520	Coastal Environment and Management	Elective Course	B.S/M.Sc. Environmental Sciences or related disciplines	03
9.	ENSC 521	Urban Ecology	Elective Course	B.S/M.Sc. Environmental Sciences or related disciplines	03
10.	ENSC 522	Biological Conservation	Elective Course	B.S/M.Sc. Environmental Sciences or related disciplines	03
11.	ENSC 523	Health, Safety and Environmental Management	Elective Course	B.S/M.Sc. Environmental Sciences or related disciplines	02+1
12.	ENSC 524	Sustainable Agriculture	Elective Course	B.S/M.Sc. Environmental Sciences or related disciplines	03

ENSC-513: RESEARCH METHODS IN ENVIRONMENTAL SCIENCE (THEORY)

(03 Credit Hours)

PRE-REQUISITE: B.S/M.Sc. Environmental Sciences or related disciplines

LEARNING OUTCOMES

The students will be able to

- Comprehensively plan different studies in Environmental Sciences
- Analyze data and apply coding strategies in qualitative and quantitative methods.
- Conduct statistical analysis and understand how to interpret the results.
- Have the skills of writing thesis and reports

CONTENTS

The course is designed for teaching students how to think scientifically while beginning with research, planning of research designing and defining a research problem, developing scientific manuscripts after collecting valid scientific data from experimental research.

Unit-1 Introduction to Research and Methods

1.1 Introduction to Research and the Research Process
1.2 Scientific Methods, Techniques & Pre-requisites for Scientific Research
1.3 Research Ethics and Integrity
1.4 Critical appraisal

Unit-2 Research planning

2.1 Types of scientific manuscripts,
2.2 Critical Thinking and Developing the Research Question,
2.3 Defining the Research Problem
2.4 Choosing the Research topics

Unit-3 Research proposal development

3.1 Types of Research Proposals its importance
3.2 Research Project Conceptualization
3.3 Research Proposal Writing Techniques
3.4 Elements of a Research Proposal

Unit-4 Sampling Strategies

4.1 Introduction to sampling design,
4.2 Logic of Sampling.
4.3 Concepts and Terminologies,
4.4 Types of Sampling Designs

Unit-5 Experimental designs

5.1 Valid experimental design and its basic requirements.
5.2 Importance of Research Design,
5.3 Formulation of Research Design Reliability, validity, generalization,
5.4 Experimental design and use of indicators in research,
5.5 Classification experimental design,
5.6 Factorial design, randomized block design, covariance design, Quasi experimental design
5.7 Factorial designs of experimental research

Unit-6 Data Collection and Evaluation Research

6.1 How to carry out evaluation research:
6.2 Techniques in data collection: Quantitative & Qualitative Data,
6.3 Experimental Research, Case Studies,
6.4 Surveys, Interviews, Questionnaire

Unit-7 Statistical techniques and Interpterion of Results

7.1 Data Interpretation,
7.2 Descriptive Statistics,
7.3 Analysis of Variance
7.4 Univariate Analysis, Bivariate Analysis,
7.5 Multivariate Analysis,
7.6 Correlation and Regression,

Unit-8 Research Presentation Techniques – Data presentation

8.1 How to put things together for better Research reporting
8.2 Introduction, Objectives,
8.3 Review of Literature,
8.4 Material and Methods, Results and discussion,
8.5 Conclusion and Bibliography,

TEACHING – LEARNING STRATEGIES

- Lecture based examination
- Presentation/seminars
- Class discussion
- Quizzes

ASSIGNMENTS

It is continuous assessment. The weightage of Assignments will be 25% before and after midterm assessment. It includes:

- classroom participation,
- attendance, assignments and presentation,
- homework
- attitude and behavior,
- hands-on-activities,
- short tests, quizzes etc.

ASSESSMENT AND EXAMINATIONS:

Sr. No.	Elements	Weightage	Details
1.	Mid Term Assessment	35%	It takes place at the mid-point of the semester
2.	Formative Assessment	25%	It is continuous assessment during the semester covering: classroom participation, attendance, assignments and presentation, homework, hands-on-activities, short tests, quizzes etc.
3.	Final Assessment	40%	At the end of the semester, it is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

RECOMMENDED BOOKS / SUGGESTED READINGS

1. Mukherjee, S. P. (2019). *A guide to research methodology: An overview of research problems, tasks and methods.* CRC Press.
2. Tjora, A., (2018). *Qualitative Research as Stepwise-Deductive Induction*. Routledge Publisher.
3. Bartels, K.P.R. & Wittmayer, J.M. (2018). *Action Research in Policy Analysis: Critical and Relational Approaches to Sustainability Transitions*. Routledge Publisher.
4. Alley, M. (2018). *The Craft of Scientific Writing*. Springer-Verlag. New York.
5. Smith, R.L., Nychka, D., Waller, L.A. & Schmidt, A. (2018). *Applied Environmental Statistics*. CRC Press,
6. Creswell, J. W. (2018). *Research design: Qualitative, quantitative and mixed methods approaches*. Thousand Oaks, CA: Sage **Further Reading:** As suggested by the Instructor.

ENSC-514: ADVANCED ANALYTICAL TECHNIQUES IN ENVIRONMENT (THEORY)
(02 Credit Hours)

PRE-REQUISITE: B.S/M.Sc. Environmental Sciences or related disciplines

LEARNING OUTCOMES

Upon successful completion of this course, students will be able to:

- Understand and apply the fundamental principles of analytical chemistry
- Understand and follow standard documented procedure of analysis
- Competently undertake advanced qualitative and quantitative laboratory tasks
- To learn the operation of advanced analytical instrumentation.

CONTENTS

This course illustrates the analytical approach to chemical analysis, particularly in environmental analysis. The theoretical principles of classical and instrumental analysis will be reinforced. The students will be able to develop problem solving skills and apply these to find solution to real environmental problems.

THEORY

Unit-1 Introduction to Analytical Chemistry

1.1 Role of Analytical Chemistry in Environmental Studies
1.2 Principles of physical, chemical and microbiological analysis of environmental pollutants

Unit-2 Sampling Strategies

2.1 vsampling rules
2.2 sample collection and preservation.
2.3 Laboratory techniques and field monitoring for parameters of importance causing environmental pollution

Unit-3 Spectroscopic techniques

3.1 Absorption spectroscopy
3.2 Emission Spectroscopy
3.3 Instrumental techniques like UV-Vis spectrophotometry, IR Spectrometry, Flame photometry and Atomic absorption spectroscopy in environmental analysis.

Unit-4 Chromatographic techniques

4.1 Separation techniques
4.2 Basic concept of partition and adsorption chromatography
4.3 Role of Gas Chromatography, GC-MS, High Pressure Liquid Chromatography in environmental analysis.

TEACHING – LEARNING STRATEGIES

- Lecture based examination
- Presentation/seminars
- Class discussion
- Quizzes

ASSIGNMENTS – TYPE AND NUMBER WITH CALENDAR

It is continuous assessment. The weightage of Assignments will be 25% before and after midterm assessment. It includes:

- classroom participation,
- attendance, assignments and presentation,
- homework
- attitude and behavior,
- hands-on-activities,
- short tests, quizzes etc.

ASSESSMENT AND EXAMINATIONS:

Sr. No.	Elements	Weightage	Details
1.	Mid Term Assessment	35%	It takes place at the mid-point of the semester
2.	Formative Assessment	25%	It is continuous assessment. It includes: classroom participation, attendance, assignments and presentation, homework, attitude and behavior, hands-on-activities, short tests, quizzes etc.
3.	Final Assessment	40%	It takes place at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

RECOMMENDED TEXT BOOKS / SUGGESTED READINGS

1. Harris, D.C., and Lucy, C.A. (2020). *Quantitative Chemical Analysis*, Tenth Edition. W.H. Freeman & Company, New York
2. Dunkle, M.N., Winniford, W.W. (2020). *Analytical Techniques in the oil and Gas industry for Environmental Monitoring*, John Wiley& Sons
3. Price, L. (2019). *Analytical Chemistry: Processes and Techniques*. Willford Press
4. Bhatti, H. N. (2017). *Principles of Analytical Chemistry*. Carvan Book House, Lahore.
5. Greenberg, A. (2005). *Standard Methods for the Examination of Water & Wastewater*. American Public Health Association.

Further Reading: As suggested by the Instructor.

ENSC-514: ADVANCED ANALYTICAL TECHNIQUES IN ENVIRONMENT (PRACTICAL)

(01 Credit Hrs)

PRE-REQUISITE: B.S/M.Sc. Environmental Sciences or related disciplines

LEARNING OUTCOMES

Upon successful completion of this course, students will be able to:

- Understand and apply the fundamental principles of analytical chemistry
- Understand and follow standard documented procedure of analysis
- Competently undertake advanced qualitative and quantitative laboratory tasks
- To learn the operation of advanced analytical instrumentation.

CONTENTS

This course illustrates the analytical approach to chemical analysis, particularly in environmental analysis. The theoretical principles of classical and instrumental analysis will be reinforced. The students will be able to develop problem solving skills and apply these to find solution to real environmental problems.

PRACTICAL

Unit-1 Water Analysis

1.1 Sample preparation and preservation
1.2 Metal analysis (Na, Ca, K) by Flame photometry
1.3 Metal analysis (Cr, Cd, Pb etc.) by using Atomic Absorption spectroscopy
1.4 *E. Coli* analysis
1.5 PO_4 & SO_4 and Chloride estimation
1.6 TDS, TSS
1.7 Conductivity, pH
1.8 DO
1.9 Hardness of water
1.10 Alkalinity
1.11 COD Estimation
1.12 BOD Estimation

Unit-2 Analysis of Biological Samples

2.1 Digestion methods (Acid digestion, Ash digestion)
2.2 Chemical analysis of digested biological samples

Unit-3 Soil Analysis

3.1 Estimation of different Physical, chemical and Biological parameters from soil using spectroscopic and chromatographic instrumental methods

TEACHING – LEARNING STRATEGIES

- Lecture based examination
- Presentation/seminars
- Class discussion
- Quizzes

ASSIGNMENTS – TYPE AND NUMBER WITH CALENDAR

It is continuous assessment. The weightage of Assignments will be 25% before and after midterm assessment. It includes:

- classroom participation,
- attendance, assignments and presentation,
- homework
- attitude and behavior,
- hands-on-activities,
- short tests, quizzes etc.

ASSESSMENT AND EXAMINATIONS:

Sr. No.	Elements	Weightage	Details
1.	Mid Term Assessment	35%	It takes place at the mid-point of the semester
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RECOMMENDED TEXT BOOKS / SUGGESTED READINGS

1. Harris, D.C., and Lucy, C.A. (2020). *Quantitative Chemical Analysis*, Tenth Edition. W.H. Freeman & Company, New York
2. Dunkle, M.N., Winniford, W.W. (2020). *Analytical Techniques in the oil and Gas industry for Environmental Monitoring*, John Wiley& Sons
3. Price, L. (2019). *Analytical Chemistry: Processes and Techniques*. Willford Press
4. Bhatti, H. N. (2017). *Principles of Analytical Chemistry*. Carvan Book House, Lahore.
5. Greenberg, A. (2005). *Standard Methods for the Examination of Water & Wastewater*. American Public Health Association.

Further Reading: As suggested by the Instructor.

ENSC-515: ENVIRONMENTAL IMPACT ASSESSMENT AND STRATEGIC ENVIRONMENTAL ASSESSMENT (THEORY) (03 Credit hrs)

PRE-REQUISITE: B.S/M.Sc. Environmental Sciences or related disciplines

LEARNING OUTCOMES

- This course will provide an introduction to the environmental impact assessment (EIA) & strategic environmental assessment (SEA) to the students.
- The students will learn about the how to differentiate between different types of EIA & SEA.
- They will have the knowledge about how to explain the purpose and role of EIA & SEA in the decision-making process.
- The students will learn to identify the technical and social/political limitations of EIA&SEA

CONTENTS

This course gives an insight into the importance and historical development of EIA&SEA, principals and purposes of EIA & SEA, and main stages in EIA & SEA process.

THEORY

Unit-1 Introduction

1.1 Definition of EIA, Principles of EIA, Origin and Development of EIA.
1.2 Different types of impacts considered in EIA.
1.3 Purposes, Objectives, Scope and Effectiveness of EIA.

Unit-2 Decision Making Theory and Practice

2.1 EIA as an Advocacy Instrument.
2.2 Stakeholders interacting in EIA.
2.3 Organisational Behaviour and Decision Making Models
2.4 Influence on Effective Decision Making and EIA as part of the Decision Making Process.

Unit-3 Main Environmental Problems related to EIA/SEA

3.1 Physical, Biological, Social Aspects
3.2 Drivers for Environmental Change.
3.3 Existing and Emerging Environmental Threats
3.4 Principles for Environmental Integration.
3.6 Environmental Integration through different tools and instruments

Unit-4 Legal EIA Background and EIA guidance in Pakistan

4.1 Environmental Policies, Environmental Legislation, Pak-EPA's Guidelines for IEE/EIA.
4.2 Environmental Guidelines and Checklists by Provisional EPAs
4.3 Administrative set up for Implementation of EIA Related Legal Provisions and Guidelines.
4.4 Problems in Implementation of EIA.

Unit-5 EIA Requirements of the World Bank and the Asian Development Bank

5.1 Introduction, World Bank
5.2 Asian Development Bank.
5.3 EIA requirements of other Development Banks and Organisations.

Unit-6 Screening and Scoping

6.1 Screening and checklists
6.2 Project Categorisation
6.3 The Rapid Environmental Assessment Checklists of the ADB.
6.4 Scoping-Purpose, Objectives, Guiding Principles
6.5 Baseline data
6.6 Types of Impacts to be Identified

Unit-7 Methods and Techniques for Assessment of Impacts

7.1 Methods and Techniques used for Assessing Impacts in EIA
7.2 The most Frequently used EIA Methods and Techniques
7.3 Moderately used Methods and Techniques
7.4 Low usage of Methods and Techniques

Unit-8 Public Participation and Consultation in EIA

8.1 Key Role of Public Participation and Consultation in the EIA Process.
8.2 The Public and Public Interest, Stakeholders and their Representatives
8.3 History and Rationale of Public Involvement in EIA, Participation and Consulting Techniques
8.4 Public Participation in Pakistan

Unit-9 EIA Baseline Data Collection, Consideration of Alternatives and Mitigation

9.1 Report writing based on baseline data collection
9.2 Role of Alternatives in EIA
9.3 The Importance of Avoidance, Mitigation, as well as Compensation Measures.

Unit-10 EIA Reporting and EIA Report Quality Review

10.1 Focus of an EIA Report
10.2 Pakistan Guidelines for Preparing Environmental Reports of Specific Sectors.
10.3 The Importance of EIA Quality Review

Unit-11 Introduction to SEA

11.1 Appreciation of the Contexts and Role of SEA in Environmental Management.
11.2 Understanding of the Elements of SEA and EIA and the Processes
11.3 A Critical Appreciation of the Strengths and Limitations of SEA and EIA.

Unit-12 Framework of SEA

12.1 Understanding of SEA and EIA Directives
12.2 The Regulatory Framework and Guidance
12.3 Ability to Assess the Environmental Impact from Human Activities
12.4 Make Appropriate and Critical Use of Techniques in Different Sectors and Applications.

TEACHING – LEARNING STRATEGIES

- Lecture based examination
- Presentation/seminars
- Class discussion
- Quizzes

ASSIGNMENTS – TYPE AND NUMBER WITH CALENDAR

It is continuous assessment. The weightage of Assignments will be 25% before and after midterm assessment. It includes:

- classroom participation,
- attendance, assignments and presentation,
- homework
- attitude and behavior,
- hands-on-activities,
- short tests, quizzes etc.

ASSESSMENT AND EXAMINATIONS:

Sr. No.	Elements	Weightage	Details
1.	Mid Term Assessment	35%	It takes place at the mid-point of the semester
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3.	Final Assessment	40%	It takes place at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

RECOMMENDED TEXT BOOKS / SUGGESTED READINGS

1. Baharul, I.K.M.,& Mahfooz, N.Z. (2021). *Environment Impact Assessment: Precept& Practice. CRC Press.*
2. Biswas, W. (2020). *Environmental Impact Assessment of Buildings.* Sciprofile.
3. Morrison-Saunders, A. (2018). *Advanced introduction to environmental impact assessment*. Edward Elgar Publishing.
4. Fisher, T.B., and Nadeem, O. (2014). *Environmental Impact Assessment: Course Curriculum for Higher Education Institutions in Pakistan.* National Impact Assessment Programme.
5. Therivel, R. (2004). *European Union Directives on EIA and SEA in Action.* Earth Scan, UK.

Assorted Research Papers / Further Reading: As suggested by the instructor.

ENSC-516 ENVIRONMENTAL MANAGEMENT SYSTEM AND INTEGRATED MANAGEMENT SYSTEM (THEORY) (03 Credit Hours)

PRE-REQUISITE: B.S/M.Sc. Environmental Sciences or related disciplines

LEARNING OUTCOMES

Students will learn to:

- Identify key concepts in environmental management system (EMS)
- Identify the barriers and drivers in the development and implementation of Integrated Management System (IMS)
- To develop IMS for any organization/industry
- To carry out environmental auditing
- Apply appropriate knowledge and skills to selected case studies or real-life situations.

CONTENTS

This course intends to provide an understanding on Environmental Management System required up to the level for developing them to any industrial field. It will facilitate students to have an in depth interpretation of EMS standards.

THEORY

Unit-1 Introduction to EMS

1.1 Introduction of EMS
1.2 sustainable development and management
1.3 Industry and environment
1.4 Legislation and environment since the industrial revolution
1.5 General and environmental risk management
1.6 World trade organization (WTO) and environmental management,
1.7 Environmental performance and management
1.8 The Benefits and Common Characteristics of Successful Environmental Management Systems

Unit-2 Environmental Resource Management

2.1 Introduction of Environmental resource management
2.2 Scope
2.3 Aspect; ethical, economics and legal
2.4 Stakeholder; public, private, civil
2.5 Quality management
2.6 Eco-Management and Audit Scheme (EMAS)

Unit-3 Applications of EMS

3.1 Applications of EMS
3.2 Applications EMS in terms of Process flow chart
3.3 EMS and effluent Generation, composition, and treatment
3.4 EMS case in the industries i.e., sugar, pulp and paper, electroplating, dairy, oil refineries, still mills.

Unit-4 Organizational Responsibility

4.1 Country legislation and EMS
4.2 Organizational responsibility
4.3 Emergency operation plan (EOP) and Emergency Management Program (EMP)
4.4 Monitoring and measuring
4.5 EMS Audit i) Internal Audit ii) External Audit, iii) safety audits
4.6 External or third-party audit
4.7 The corporate environmental plan and its implementation
4.8 EMS and IMS budget

Unit-5 Organizational theory and Organizational Barriers

5.1 Organizational theory and organizational barriers
5.2 The case of small and medium enterprises-EM strategies,
5.3 Integrated approach and conceptual models,
5.4 EMS models, their analysis and applications.
5.5 ISO 9001, OHSAS 18001, ISO 14001, ISO 45001, and IMS,
5.6 Theory and practices of integrated environmental management system
5.7 Auditing practices of the integrated management system.

Unit-6 Environmental Management planning Policy

6.1 Environmental Management planning Policy
6.2 Environmental Aspects and Impacts
6.3 Environmental Management Program
6.4 Implementation and Operation
6.5 Structure and responsibility
6.6 Emergency preparedness, and response
6.7 Checking and Corrective Action
6.8 Monitoring, and Measurement

TEACHING-LEARNING STRATEGIES

- Lecture-based examination
- Presentation/seminars
- Class discussion
- Quizzes

ASSIGNMENTS – TYPE AND NUMBER WITH CALENDAR

It is a continuous assessment. The weightage of Assignments will be 25% before and after midterm assessment. It includes:

- classroom participation,
- attendance, assignments, and presentation,
- homework
- attitude and behavior,
- hands-on-activities,
- short tests, quizzes, etc.

ASSESSMENT AND EXAMINATIONS:

Sr. No.	Elements	Weightage	Details
1.	Mid Term Assessment	35%	It takes place at the mid-point of the semester
2.	Formative Assessment	25%	It is a continuous assessment. It includes classroom participation, attendance, assignments, and presentation, homework, attitude and behavior, hands-on activities, short tests, quizzes, etc.
3.	Final Assessment	40%	It takes place at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on a term paper, research proposal development, fieldwork, and report writing, etc.

RECOMMENDED TEXTBOOKS / SUGGESTED READINGS

1. Goodland, R. J., Watson, C., & Ledec, G. (2019). *Environmental management in tropical agriculture.* CRC Press.
2. Culley, W. C. (2019). *Environmental and quality systems integration.* CRC Press.
3. Kuhre, W. L. (2018). *ISO* 14001 *Certification: Environmental Management System*. Prentice-Hall.
4. Krishna, I. M., Manickam, V., Shah, A., & Davergave, N. (2017). *Environmental management: science and engineering for industry.* Butterworth-Heinemann.
5. Schaltegger, S., Burritt, R., & Petersen, H. (2017). *An introduction to corporate environmental management:* Striving for sustainability. Routledge.

Assorted Research Papers / Further Reading: As suggested by the instructor.

ENSC-517: ADVANCED GIS AND REMOTE SENSING (THEORY) (02 Credit hours)

PRE-REQUISITE: B.S/M.Sc. Environmental Sciences or related disciplines

LEARNING OUTCOMES

- This course will provide knowledge about applications of remote sensing and GIS in Environmental sciences.
- The students will learn about the different freely available online spatial data platforms
- Students will have the knowledge about different spatial models being used for environmental studies
- The students will learn different advanced digital cartography techniques

CONTENTS

This course provides an advanced knowledge about digital cartography, spatial models for environmental studies, suitability analysis, hydrological modeling and freely available platforms for spatial data collection.

Unit-1 Spatial and non-Spatial Datasets

1.1 Raster and Vector datasets
1.2 Digitization and Topological errors
1.3 Geodatabases

Unit-2 Advanced Digital Cartography

2.1 Advancement in Cartography
2.2 Cartography techniques
2.3 Large and Small scale maps

Unit-3 Spatial Data Acquisition

3.2 Online freely available platforms
3.3 Spatial data creation
3.4 Data joining and import

Unit-4 Geo-statistical Analysis

4.1 Interpolation methods
4.2 Analytical Hierarchy process
4.3 Multicriteria indexing and scoring

Unit-5 Spatial Analysis

5.1 Site suitability techniques
5.2 Digital Elevation models
5.3 Image classification techniques

Unit-6 Spatial Modelling

6.1 Model Builder in Arc GIS
6.2 1D and 2D Hydrological Modeling
6.3 Environmental and Hydrological Models

TEACHING – LEARNING STRATEGIES

- Lecture based examination
- Presentation/seminars
- Class discussion
- Quizzes

ASSIGNMENTS – TYPE AND NUMBER WITH CALENDAR

It is continuous assessment. The weightage of Assignments will be 25% before and after midterm assessment. It includes:

- classroom participation,
- attendance, assignments and presentation,
- homework
- attitude and behavior,
- hands-on-activities,
- Short tests, quizzes etc.

ASSESSMENT AND EXAMINATIONS:

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3.	Final Assessment	40%	It takes place at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

RECOMMENDED TEXTBOOKS / SUGGESTED READINGS

1. Kang-tsung, C. (2018). *Introduction to Geographic Information Systems*. 9th Edition, McGraw-Hill Education.
2. William, E. & Adriano, C. (2017). *Introduction to Satellite Remote Sensing: Atmosphere, Ocean, Land and Cryosphere Applications*. Elsevier,
3. Lavender, S. (2016). *Practical handbook of remote sensing*-CRC Press. Routledge, Taylor and Francis Group.
4. Lawrence, F. (2015). *Essential Earth Imaging for GIS*, Esri Press.
5. Thomas, L., Ralph, W., Kiefer, J. C. (2015). *Remote Sensing and Image Interpretation*, 7th Edition, Wiley,
6. Maribeth, P. (2018). *Mastering ArcGIS.* 8th Edition, McGraw-Hill Education.

Further Reading: As suggested by instructor.

ENSC-517:ADVANCED GIS AND REMOTE SENSING (PRACTICAL) (01 Credit hr)

PRE-REQUISITE: B.S/M.Sc. Environmental Sciences or related disciplines

LEARNING OUTCOMES

- This course will provide hands on practice about different applications of Remote sensing and GIS in Environmental sciences.
- Students will learn how to get the freely available data of different environmental variables (i.e. temperature, precipitation, evapotranspiration, vegetation cover, Landuse landcover etc.)
- Students will prepare and run different spatial models being used for environmental studies
- The students will develop large and small scale maps using advanced digital cartography techniques
- Students will process satellite and aerial imagery for suitability analysis, hydrological analysis and flood hazard assessment

CONTENTS

This course provides hands on practice about digital cartography, development of different spatial models for environmental studies, specie distribution analysis, Groundwater quality and quantity modelling, Acquisition and processing of satellite imagery for Landuse, landcover, classification, Watershed and Flood hazard analysis.

PRACTICAL

Unit-1 Spatial and non-Spatial Datasets

1.1 Working on Google Earth
1.2 Spatial and non-spatial data creation
1.3 Data imports from Google earth, Excel, Auto-cad in ArcGIS

Unit-2 Advanced Digital Cartography

2.1 Map indexing and Grids
2.2 Fishnet
2.3 Large and Small scale maps

Unit-3 Spatial Data Acquisition

3.1 Landsat and Sentinel imagery downloading
3.2 SRTM & ASTER DEM
3.3 Satellite imagery and DEM rectification and processing

Unit-4 Geo-statistical Analysis

4.1 IDW and Kriging Interpolation techniques
4.2 Development of Paired Comparison Matrix
4.3 Inter and Intra class weighting and scoring

Unit-5 Spatial Analysis

5.1 Specie distribution mapping
5.2 Elevation, Slope and Drainage mapping using DEM
5.3 Landuse and Landcover classification
5.4 LULC Supervised and unsupervised techniques

Unit-6 Spatial Modelling

6.1 Developing Suitability model for specie distribution modeling
6.2 Hydrological model generation for watershed analysis
6.3 Models for flood hazard assessment

TEACHING – LEARNING STRATEGIES

- Lecture based examination
- Presentation/seminars
- Class discussion
- Quizzes

ASSIGNMENTS – TYPE AND NUMBER WITH CALENDAR

It is continuous assessment. The weightage of Assignments will be 25% before and after midterm assessment. It includes:

- classroom participation,
- attendance, assignments and presentation,
- homework
- attitude and behavior,
- hands-on-activities,
- short tests, quizzes etc.

ASSESSMENT AND EXAMINATIONS:

Sr. No.	Elements	Weightage	Details
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2.	Formative Assessment	25%	It is continuous assessment during the semester covering: classroom participation, attendance, assignments and presentation, homework, hands-on-activities, short tests, quizzes etc.
3.	Final Assessment	40%	At the end of the semester, it is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

RECOMMENDED TEXTBOOKS / SUGGESTED READINGS

1. Kang-tsung, C. (2018). *Introduction to Geographic Information Systems*. McGraw-Hill Education.
2. Maribeth, P. (2018). *Mastering ArcGIS*. McGraw-Hill Education.
3. William, E. & Adriano, C. (2017). *Introduction to Satellite Remote Sensing: Atmosphere, Ocean, Land and Cryosphere Applications*. 1st Edition, Elsevier.
4. Lavender, S. (2016). Practical handbook of Remote sensing-CRC Press.
5. Lawrence, F., (2015). *Essential Earth Imaging for GIS*. Esri Press.
6. Thomas, L., Ralph, W., Kiefer, J. C. (2015). *Remote Sensing and Image Interpretation*. 7th Edition, Wiley.

Further Reading: As suggested by instructor.

ENSC-518: WASTE REDUCTION AND RECYCLING (THEORY) (03 Credit hrs)

PRE-REQUISITE: B.S/M.Sc. Environmental Sciences or related disciplines

LEARNING OUTCOMES

The students will be able to:

- Understand the concept of waste recycling and recovering nutrients and energy from waste.
- Understand the drivers of solid waste management, alternative methods for waste reduction.
- Develop cost effective and user-friendly recycling options and other waste treatment technologies.
- Observe waste treatment practices on-site by lecture material and tutorials, supported by verbal communication of self-study findings together with industrial visits.

CONTENTS

This course aims at providing students with the necessary knowledge and understanding to the following:

THEORY

Unit-1 Introduction to Waste Management Hierarchy

1.1 4R's hierarchy (Reduce-Reuse-Recycle-Recover)
1.2 Functional elements of Integrated Waste Management in Pakistan
1.3 Waste management strategy
1.4 Categories of waste

Unit-2 Alternative Methods for Waste Reduction

2.1 BATNEEC (Best Available Technique Not Entailing to Excessive Cost)
2.2 BPEO (Best Practicable Environmental Option)
2.3 BAT (Best available technology)
2.4 BM (Best Practical Means)

Unit-3 Waste Characterization

3.1 Physical characterization
3.2 Chemical characterization
3.3 Factors controlling waste generation and composition

Unit-4 Laws for Waste Management

4.1 Waste management approaches and regulations
4.2 General Laws
4.3 Special Laws
4.4 International laws
4.5 Development Drivers for waste management

Unit-5 Waste Recycling

5.1 Source separation systems
5.2 Paper, glass, plastic, metal & electronic waste recycling
5.3 Biodegradable waste recycling
5.4 Recycled bio-waste as soil amendment
5.5 Recycling as a waste reduction option and benefits of recycling
5.6 Life cycle analysis of recycling systems

Unit-6 Waste treatments for the reduction of waste

6.1 Thermal (Incineration/autoclaving)
6.2 Chemical (Filtration, Flotation, coagulation, centrifugation, solidification /stabilization)
6.3 Biological treatment (anaerobic digestion/ composting)
6.4 Recovery of energy and nutrients from waste
6.5 Zero Waste Policy

TEACHING – LEARNING STRATEGIES

- Lecture based examination
- Presentation/seminars
- Class discussion
- Quizzes

ASSIGNMENTS – TYPE AND NUMBER WITH CALENDAR

It is continuous assessment. The weightage of Assignments will be 25% before and after midterm assessment. It includes:

- classroom participation,
- attendance, assignments and presentation,
- homework
- attitude and behavior,
- hands-on-activities,
- short tests, quizzes etc.

ASSESSMENT AND EXAMINATIONS:

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RECOMMENDED TEXT BOOKS / SUGGESTED READINGS

1. Reddy, P. J. (2019). *Energy recovery from municipal solid waste by thermal conversion technologies*. CRC Press.
2. Ghosh, S. K. (2019). *Waste Valorisation and Recycling*. Springer.
3. Rao, M. N., Sultana, R., Kota, S. H., Shah, A., & Davergave, N. (2016). *Solid and hazardous waste management: science and engineering*. Elsevier Publishing.
4. Connett, P. (2013). *The zero-waste solution: untrashing the planet one community at a time*. Chelsea Green Publishing.
5. Pichtel, J. (2005). *Waste management practices: municipal, hazardous, and industrial*. CRC press.
6. Cheremisinoff, N. P. (2003). *Handbook of solid waste management and waste minimization technologies*. Butterworth-Heinemann.

ENSC-519: ADVANCED INDUSTRIAL WASTEWATER TREATMENT (THEORY) (02 Credit hours)

PRE-REQUISITE: B.S/M.Sc. Environmental Sciences or related disciplines

LEARNING OUTCOMES

- Students will understand the multidisciplinary nature of wastewater treatments, various types of methods and technological advances being used in industrial wastewater treatment systems
- Students will acquire the knowledge on operational problems of common effluent treatment plants
- Students will get knowledge of disposal of different industrial wastewater into natural water bodies.
- At the end of the course, the students will develop the skill to propose a preliminary design of a modern treatment plant

CONTENTS

The focus of this course is on management of industrial wastewater including topics such as cleaner production, industrial water management, toxicity, physical chemical processes, anaerobic industrial wastewater treatment, and sludge management and treatment.

THEORY

Unit-1 Wastewater treatments: Process analysis and selection

1.1 Evaluation and selection of treatment systems
1.2 Sources of Pollution - Physical, chemical, organic & biological properties of industrial wastes
1.3 Difference between industrial & municipal wastewaters
1.4 Effects of industrial effluents on sewers and natural water bodies
1.5 Wastewater characterization
1.6 Advantages and disadvantages of various treatment systems

Unit-2 Advances in preliminary / pre-treatments

2.1 Equalization, neutralization, oil separation by flotation
2.2 Waste reduction-volume reduction-strength reduction
2.3 Wastewater collection systems
2.4 Measurements and monitoring discharge

Unit-3 Advances in treatment technologies

3.1 Trickling filters, activated sludge, constructed wetlands
3.2 Nitrification and de-nitrification-Phosphorous removal –Heavy metal removal
3.3 Membrane separation process, absorption, electrocoagulation, special treatment methods
3.4 Advanced oxidation processes- Ozone/UV/Fenton/H202/ Photocatalysis and their combinations

Unit-4 Process selection and Integration

4.1 Process selection ‘rule of thumb’
4.2 Effluent system optimization
4.3 Zero Liquid Discharges
4.4 Emerging trends and future perspectives

TEACHING – LEARNING STRATEGIES

- Lecture based examination
- Presentation/seminars
- Class discussion
- Quizzes

ASSIGNMENTS – TYPE AND NUMBER WITH CALENDAR

It is continuous assessment. The weight age of Assignments will be 25% before and after midterm assessment. It includes:

- classroom participation,
- attendance, assignments and presentation,
- homework
- attitude and behavior,
- hands-on-activities,
- short tests, quizzes etc.

ASSESSMENT AND EXAMINATIONS:

Sr. No.	Elements	Weightage	Details
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RECOMMENDED TEXT BOOKS / SUGGESTED READINGS

1. SpringerLink, Muthu, S. S. (2021). *Advances in textile waste water treatments*. Springer.
2. Filho, L., & Witschel. (2020). *Clean Water and Sanitation*. Springer International Publishing.
3. Chen, J., Luo, J., Luo, Q., Pang, Z., & Group, C. E. P. (2018). *Wastewater treatment: Application of new functional materials*. China Environment Publishing Group ; Walter de Gruyter.
4. PALCI EBSCO books & Sen, T. K. (2015). *Physical, chemical and biological treatment processes for water and wastewater*. Nova Science Publishers, Inc.
5. Hammer, M. J., & Hammer, M. J. (2012). *Water and wastewater technology* (7th ed.). Pearson/Prentice Hall.

ENSC-519: ADVANCED INDUSTRIAL WASTEWATER TREATMENT (PRACTICAL)

(01 Credit hrs)

PRE-REQUISITE: B.S/M.Sc. Environmental Sciences or related disciplines

LEARNING OUTCOMES

- Students will be able to gain knowledge about different sampling techniques
- They will be able to evaluate various types of industrial effluents
- Students will learn to demonstrate different treatment methods for the removal of pollutants from industrial effluents
- Student will know the practical hands-on understanding about evaluating and treating pollution load in any industrial effluent

CONTENTS

This laboratory based course is comprised of most commonly applied wastewater treatment technologies and suitable industrial waste treatment applications.

PRACTICAL

Unit-1

1.1 Sampling and testing techniques for Industrial effluents

Unit-2

2.1 Generation of synthetic industrial wastewaters in the laboratory

Unit-3

3.1 Pollution loads (kg/day, ppm, flow, etc.) in typical wastewater coming from the industry.
3.2 Measurement of discharge parameters in real wastewaters collected from various industrial sectors

Unit-4

4.1 Application of widely used treatment methods to industrial wastewaters: adsorption, reverse osmosis, coagulation/flocculation, ozonation, biological treatments, tertiary treatments, etc.

Unit-5

5.1 Recycling of industrial effluents
5.2 Visit to industries

TEACHING – LEARNING STRATEGIES

- Lecture based examination
- Presentation/seminars
- Class discussion
- Quizzes

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- hands-on-activities,
- short tests, quizzes etc.

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3. Chen, J., Luo, J., Luo, Q., Pang, Z., & Group, C. E. P. (2018). *Wastewater treatment: Application of new functional materials*. China Environment Publishing Group; Walter de Gruyter.
4. PALCI EBSCO books & Sen, T. K. (2015). *Physical, chemical and biological treatment processes for water and wastewater*. Nova Science Publishers, Inc.
5. Hammer, M. J., & Hammer, M. J. (2012). *Water and wastewater technology* (7th ed.). Pearson/Prentice Hall.

ENSC-520: COASTAL ENVIRONMENT AND MANAGEMENT (THEORY) (03 Credit Hours)

PRE-REQUISITE: B.S/M.Sc. Environmental Sciences or related disciplines

LEARNING OUTCOMES:

- Students will develop an understanding and importance of Coastal and Marine resources
- Students will learn about the concepts and importance of Coastal and Marine Ecosystems
- Students will have the overview of Environmental issues in coastal and marine ecosystems
- They will have the understanding about Integrated Coastal Zone Management to safeguard coastal and marine ecosystems/resources

CONTENTS

This course will provide the overview and understanding of coastal marine and offshore areas, resources, marine ecosystems, economic significance of coast line, coastal phenomena, coastal erosion and accretion and integrated coastal zone management.

Unit-1 Introduction

1.1 Basic definitions and Introduction to coastal area coastal resources
1.2 Overview of coastal management concepts and principles
1.3 important tools for coastal management
1.4 An overview of coastal resources, boundaries, and offshore areas of Pakistan
1.5 Wetlands along Pakistan coast

Unit-2 Coastal Resources and Ecosystems

2.1 An overview on living resources and natural marine ecosystems
2.2 Introduction and importance of Mangroves
2.3 Introduction and importance Coral reefs
2.4 Significance of Biotic communities
2.5 Nonliving Marine Resources
2.6 Potential energy from Tides, Waves, and Ocean Thermal Energy.

Unit-3 Coastal Landforms and Classifications

3.1 Overview to coastal landforms and classification
3.2 Rocky coasts
3.3 Reef coasts
3.4 Beach and barriers coasts
3.5 Deltas and estuaries
3.6 Muddy coasts
3.7 Age, tectonic settings, Sea levels, Sediment Supply, Hydrodynamic Energy levels

Unit-4 Environmental Issues in Coastal and Marine Systems

4.1 Introduction to marine and coastal pollution
4.2 Chronic and acute inorganic and organic marine pollutants
4.3 Ocean disposal (marine outfalls, shipboard wastes, dumping of sludge, disposal of dredge spoil, radioactive wastes) and its impact
4.4 Eutrophication
4.5 Coastal erosion and accretion
4.6 Seawater Intrusion
4.7 Impact of coastal pollution on coastal resources and amenities
4.8 Climate change impacts on coastal zones

Unit-5 Management of Coastal and Marine Systems

5.1. An overview to integrated coastal management practices
5.2. Marine pollution control and mitigation measurements in coastal zones
5.3. Management of Beaches & Coastal Hazards:
5.4. Beach erosion and water quality control, Copping with Beach Erosion
5.5. Guarding People and Property against Natural Hazards
5.6. Oil spills contingency plan and combating techniques

5.7. Policy, legislation and institutional arrangement for costal management
5.8. Applications of GIS in coastal management

Unit-6 Case Studies

6.1 Management on Mangrove/study cases
6.2 Management on Coral reef /study cases
6.3 Management on Seagrass/ study cases
6.4 Management on Coastal fisheries and coastal aquaculture /study cases

TEACHING – LEARNING STRATEGIES

- Lecture based examination
- Presentation/seminars
- Class discussion
- Quizzes

ASSIGNMENTS – TYPE AND NUMBER WITH CALENDAR

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- classroom participation,
- attendance, assignments and presentation,
- homework
- attitude and behavior,
- hands-on-activities,
- short tests, quizzes etc.

ASSESSMENT AND EXAMINATIONS:

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3.	Final Assessment	40%	It takes place at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

RECOMMENDED TEXT BOOKS / SUGGESTED READINGS

1. Wang, Y. (2020). *Coastal and marine environments*. CRC Press.
2. Liang, X. S., & Zhang, Y. (2018). Coastal environment, disaster, and infrastructure: A case study of China's coastline. BoD – Books on Demand
3. Ahlhorn, F. (2017). *Integrated coastal zone management: Status, Challanges and prospects*. Springer Vieweg.
4. FRID, C., & CASWELL, B. A. (2016). *Marine Pollution*. Oxford University Press.
5. Zanuttigh, B., Nicholls, R. J., Vanderlinden, J., Thompson, R. C., & Burcharth, H. F. (2014*). Coastal risk management in a changing climate*. Butterworth-Heinemann.

ENSC-521 URBAN ECOLOGY (THEORY) (03 Credit Hours)

PRE-REQUISITE: B.S/M.Sc. Environmental Sciences or related disciplines

LEARNING OUTCOMES

- To have a conceptual and critical understanding of urban aquatic and terrestrial systems, the main processes that link the components of these systems and the environmental issues that confront cities
- To have the critical ability to assess methods for the measurement and evaluation of aquatic terrestrial processes within cities;
- To have the skills to undertake critical reflection and construct reasoned suggestions and judgements concerning the causes and possible solutions to environmental management problems in cities related to urban aquatic and terrestrial issues;
- To have the ability to learn about about the nature, relative limitations, merits and appropriate contexts for application of particular aquatic and terrestrial environment management approaches in cities
- To be able to offer critical insights into the potential consequences of the application of ecological engineering techniques in an urban context.

Contents

A series of lectures will be used to cover topics relating to the ecology of urban landscapes across the globe. Introductory lectures will address the history of urban development and differences in the structure of urban areas; particular emphasis will be given to consideration of a lack of a standardized definition of an urban area in different countries.

Unit 1: Concepts of urban ecology

1.1 Theories of urban ecology and linkages with sustainable urbanism
1.2 Concepts of Eco cities, smart cities, compact cities etc.
1.3 Challenges and opportunities of urban, rural and peri-urban growth

Unit 2: Green Spaces, bio-diversity conservation and conflicts

2.1 Urban greens: challenges and choices for management
2.2 Human nature interactions and urban forest management
2.3 Bio-diversity conservation conflicts
2.4 Spatial dimensions of urban ecology

Unit 3: Urban Environmental challenges

3.1 Industrial ecology and symbiosis
3.2 Management of air quality and noise
3.3 Urban water ecological challenges

Unit 4: Impact Analysis and Ecological Footprint Analysis

4.1 Environmental Impact Analysis
4.2 Social Impact Analysis and Strategic Environmental Assessment
4.3 Urban metabolism and Ecological Footprint Analysis

Unit 5: Urban planning and human well being

3.4 Human health issues in Cities
3.5 Urban planning and air pollution
3.6 Urban structure and impacts on human and wildlife
3.7 Urban planning and human health

Unit 6: Climate change, mitigation and adaptation

6.1 Climate modifications and managing climate change challenges in cities
6.2 Adaptation and mitigation measures to make cities resilient
6.3 Future predictions, risk assessment and preventive measures

TEACHING – LEARNING STRATEGIES

- Lecture based examination
- Presentation/seminars
- Class discussion
- Quizzes

ASSIGNMENTS – TYPE AND NUMBER WITH CALENDAR

It is continuous assessment. The weightage of Assignments will be 25% before and after midterm assessment. It includes:

- classroom participation,
- attendance, assignments and presentation,
- homework
- attitude and behavior,
- hands-on-activities,
- short tests, quizzes etc.

ASSESSMENT AND EXAMINATIONS:

Sr. No.	Elements	Weightage	Details
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3.	Final Assessment	40%	It takes place at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

RECOMMENDED TEXT BOOKS / SUGGESTED READINGS

1. Ossola, A. and Niemelä, J. (2018). *Urban Biodiversity; From Research to Practice*, Routledge, New York
2. Kirsten M. (2016). *Ecology of Urban Environments*, John Wiley & Sons Ltd. West Sussex.
3. Forman, R. T. (2014). *Urban ecology: science of cities*. Cambridge University Press.
4. Richter M. and Weiland, U., (2012). *Applied Urban Ecology*. Wiley-Blackwell, UK.
5. McDonnell, M. J., & Niemelä, J. (2011). *The history of urban ecology. Urban ecology*,

ENSC-522 BIOLOGICAL CONSERVATION (THEORY) (03 Credit hrs)

PRE-REQUISITE: B.S/M.Sc. Environmental Sciences or related disciplines

LEARNING OUTCOMES

- This subject will give the students understanding about the foundation and importance of conservation biology.
- The students will be able to identify the potential threats to biodiversity.
- The students will learn about the approaches adopted for the conservation.
- The students will also have the idea about the conservation problem and solutions in Pakistan.

Contents

The objectives of this course are to develop a thorough understanding among the students about threats to biodiversity and its conservation using ex-situ and in-situ approaches and laws and policies related to species and habitat conservation. For the purpose detailed outline is as follows:

Theory

Unit-1 Foundations of Conservation Biology

1.1 Concept of conservation biology
1.2 State of our planet
1.3 Rise of Conservation Biology
1.4 Biodiversity concepts, measurement
1.5 Estimating biodiversity
1.6 Global patterns and drivers of diversity

Unit-2 Importance of biodiversity

2.1 The values of biodiversity
2.2 Biodiversity and ecosystem functioning
2.3 Biodiversity and ecosystem services
2.4 Ecological economics

Unit-3 Threats to biodiversity

3.1 Extinction- IUCN Red List
3.2 Habitat loss
3.3 Habitat fragmentation & degradation
3.4 Overexploitation
3.5 Sustainable harvest models
3.6 Invasive alien species
3.7 Climate change

Unit-4 Approaches to conservation

4.1 Legal foundations of conservation
4.2 Conservation of genetic diversity
4.3 Conservation of species populations
4.4 Conservation of communities & ecosystems
4.5 Managing landscapes and networks
4.6 In situ and Ex situ conservation
4.7 Restoration and resurrection
4.8 Protected areas, their types and role in conservation,
4.9 Establishment and management of protected areas, ex-situ Conservation strategies
4.10 The future of conservation

Unit-5 The role of institution and policymaking in conservation

1.7 Policymaking in Conservation
1.8 Types of institutions and their roles in conservation,
1.9 Institution and policy challenges for conservation biology,

Unit-6 Biological conservation in Pakistan

6.1 Conservation of biodiversity in Pakistan
6.2 Problems regarding conservation of biodiversity in Pakistan
6.3 Solutions regarding conservation of biodiversity in Pakistan
6.4 Rules and regulations regarding conservation of biodiversity in Pakistan

TEACHING – LEARNING STRATEGIES

- Lecture based examination
- Presentation/seminars
- Class discussion
- Quizzes

ASSIGNMENTS – TYPE AND NUMBER WITH CALENDAR

It is continuous assessment. The weightage of Assignments will be 25% before and after midterm assessment. It includes:

- classroom participation,
- attendance, assignments and presentation,
- homework
- attitude and behavior,
- hands-on-activities,
- short tests, quizzes etc.

ASSESSMENT AND EXAMINATIONS:

Sr. No.	Elements	Weightage	Details
1.	Mid Term Assessment	35%	It takes place at the mid-point of the semester
2.	Formative Assessment	25%	It is continuous assessment. It includes: classroom participation, attendance, assignments and presentation, homework, attitude and behavior, hands-on-activities, short tests, quizzes etc.
3.	Final Assessment	40%	It takes place at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

RECOMMENDED TEXT BOOKS / SUGGESTED READINGS

1. Van Dyke, F., & Lamb, R. L. (2020*). Conservation Biology: Foundations, Concepts, Applications*: Springer International Publishing.
2. Cardinale, B., Primack, R. B., Murdoch, J. D., & Murdoch, J. (2019). *Conservation Biology*: Oxford University Press.
3. Sher, A. A., & Primack, R. B. (2019). *An Introduction to Conservation Biology*: Oxford University Press, Incorporated.
4. de Lima, I. B., & Green, R. J. (2017). *Wildlife Tourism, Environmental Learning and Ethical Encounters: Ecological and Conservation Aspects*: Springer International Publishing.
5. Berger-Tal, O., & Saltz, D. (2016). *Conservation Behavior: Applying Behavioral Ecology to Wildlife Conservation and Management*: Cambridge University Press.
6. Gillson, L. (2015). *Biodiversity Conservation and Environmental Change: Using Palaeoecology to Manage Dynamic Landscapes in the Anthropocene*: Oxford University Press.

ENSC-523 HEALTH, SAFETY AND ENVIRONMENTAL MANAGEMENT (THEORY) (02 Credit hrs)

PRE-REQUISITE: B.S/M.Sc. Environmental Sciences or related disciplines

LEARNING OUTCOMES

After successful completion of this course, students will be able to:

1. Learn basic understanding of potential workplace safety and health and environmental hazards
2. Identify and demonstrate a working knowledge of the environmental and occupational health and safety regulations.
3. Conduct basic safety inspections using strategies that has been developed though hazard identification, job hazard analysis and risk assessment.
4. Review the principles for developing and implementing a successful occupational health and safety program and evaluation of a work site.
5. Identify the major historical events that influenced accident prevention activities in the pre/post industrial revolution.
6. Identify the moral and economic consequences associated with the major classifications and causes of accidents and the cost of worker's compensation based on the risk classes of industries.

Contents

This course is a foundation of Environment and Health & Safety covering all basic areas of this discipline.

Theory

Unit-1 Foundation of occupational health and safety

1.1 Introduction of occupational health & safety
1.2 History of health and safety and environmental management
1.3 Evolution of health and safety standards,
1.4 Industrial hygiene
1.5 Role of national/international agencies

Unit-2 Elements of management systems

2.1 Elements of ILO-OSH 2001,
2.2 Elements of OHSAS 18001,
2.3 Elements of ISO 45001,
2.4 Elements of ISO 14001
2.5 Features and contents of EHS policy,

Unit-3 Health & safety culture

3.1 Concept and significance of Health & safety culture
3.2 Factors influencing safety related behavior and improving such behaviors

Unit-4 Planning and Implementation

4.1 Principles and practice of risk assessment,
4.2 Hierarchy of controls,
4.3 Electrical safety,
4.4 Confined spaces,
4.5 Permit to work system,
4.6 Impact of temporary works,
4.7 Physical and psychological health hazards and risk control,
4.8 Emergency preparedness,
4.9 Personal protective equipment.

Unit-5 Inspection and Audit system

5.1 Inspection system,
5.2 Safety audits

5.3 Reporting systems
5.4 Management review

Unit-6 Special hazards

1.6 Hazardous substances and health effects,
1.7 Toxicology and importance of material safety data sheet,
1.8 Lock out/tag out,
1.9 Work at height,
1.10 Fire safety
1.11 Ergonomics/musculoskeletal disorders and risk control
1.12 Occupational noise control

TEACHING – LEARNING STRATEGIES

- Lecture based examination
- Presentation/seminars
- Class discussion
- Quizzes

ASSIGNMENTS – TYPE AND NUMBER WITH CALENDAR

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RECOMMENDED TEXT BOOKS / SUGGESTED READINGS

1. Mushtaq, B., Bandh, S. A., & Shafi, S. (2020). *Environmental Management: Environmental Issues, Awareness and Abatement*. Springer Nature.
2. Hughes, P., & Ferrett, E. (2020). *Introduction to Health and Safety at Work: For the NEBOSH National General Certificate in Occupational Health and Safety*. Routledge.
3. Friend, Mark A., and James P. Kohn. (2018*). Fundamentals of Occupational Safety And Health*. Rowman and Littlefield.
4. David L. G. (2015). *The Basics of Occupational Safety, 2nd Edition*, Pearson Education, Inc.
5. Kelloway, E. K., Nielsen, K., & Dimoff, J. K. (2017). *Leading to occupational health and safety: How leadership behaviours impact organizational safety and well-being*. John Wiley & Sons.

ENSC-523 HEALTH, SAFETY AND ENVIRONMENTAL MANAGEMENT (PRACTICAL) (1 Credit hr)

PRE-REQUISITE: B.S/M.Sc. Environmental Sciences or related disciplines

LEARNING OUTCOMES

- This course will provide a demonstration about the different instruments.
- The students will learn about the practical aspects of measuring and monitoring of environment, occupational health and safety.
- The students will be able to conduct basic safety inspections using strategies that has been developed though hazard identification, job hazard analysis and risk assessment

Contents

This course will provide practical knowledge of occupational Health Safety and environment using different instruments/strategies.

Practical

Unit-1

1.1 Personal protective equipment

Unit-2

2.1 Noise level monitoring
2.2 Illumination level monitoring
2.3 Relative humidity and workplace temperature monitoring

Unit-3

3.1 Hazard identification and risk assessment techniques
3.2 Development of emergency response plan

Unit-4

4.1 Fire safety
4.2 Development of emergency response plan

Unit-5

4.3 First aid and Cardio Pulmonary Resuscitation (CPR)
4.4 Biological monitoring (workplace air and drinking water)

TEACHING – LEARNING STRATEGIES

- Lecture based examination
- Presentation/seminars
- Class discussion
- Quizzes

ASSIGNMENTS – TYPE AND NUMBER WITH CALENDAR

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- homework
- attitude and behavior,
- hands-on-activities,
- short tests, quizzes etc.

ASSESSMENT AND EXAMINATIONS:

Sr. No.	Elements	Weightage	Details
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RECOMMENDED TEXT BOOKS / SUGGESTED READINGS

1. Nag, P. K., & Nag, A. (2021). *Occupational Health and Safety Management Systems: Trends, Analysis, and Effectiveness. In Handbook of Standards and Guidelines in Human Factors and Ergonomics*. CRC Press.
2. Mushtaq, B., Bandh, S. A., & Shafi, S. (2020). *Environmental Management: Environmental Issues, Awareness and Abatement.* Springer Nature.
3. Hughes, P. and Ferrett, E. (2020). *Introduction to Health and Safety at Work: For the NEBOSH National General Certificate in Occupational Health and Safety*. Routledge.
4. Brauer, R. L. (2016). *Safety and health for engineers*. John Wiley and Sons.
5. Prakash, N. S. (2017). *Manual of Fire Safety*. CBS Publishers and Distributors.

ENSC-524 SUSTAINABLE AGRICULTURE (THEORY) (03 Credit hrs)

PRE-REQUISITE: B.S/M.Sc. Environmental Sciences or related disciplines

LEARNING OUTCOMES

- This course will provide the students with key concepts about sustainable agriculture
- This Couse will help students to understand how to satisfy the food and income requirements of farmers
- Students will learn about sustainable management of agricultural resources under different cultivation scenarios
- The students will learn how to Identify and protect the environmental quality and human health in light of agricultural practices

Contents

This course includes the agricultural resources of Pakistan, Strategies to control soil erosion, Reduction of agricultural pollutants and sustainable farming system.

Theory

Unit-1 Introduction

1.1 Concept of sustainable agriculture
1.2 Threatened agricultural resources in Pakistan; soil, water and environment.
1.3 Sustaining soil resources
1.4 Organic farming

Unit-2 Strategies to control soil erosion

2.1 Soil natural amendments; sewage sludge and other organic wastes
2.2 Use of salt tolerant crops and varieties
2.3 Use of drought resistant crops

Unit-3 Sustaining water resources

3.1 Control of water run-off
3.2 Control of evaporation losses
3.3 Reduction of water losses from deep percolation

Unit-4 Reduction of agricultural pollutants

4.1 Optimum use of agricultural chemicals, fertilizers
4.2 Multiple cropping, rotations
4.3 N-fixation
4.4 Alternate land uses

Unit-5 Plant growth promotion

4.5 Cropping systems to sustain productivity
4.6 Role of PGPR for plant growth promotion
4.7 Role of mycorrhizae for plant growth promotion

Unit-6 Sustainable farming system

1.13 Principles and strategies for designing sustainable farming systems
1.14 Site specific technological options for sustainable crop production
1.15 Kitchen gardening
1.16 Precision agriculture

TEACHING – LEARNING STRATEGIES

- Lecture based examination
- Presentation/seminars
- Class discussion
- Quizzes

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- homework
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- hands-on-activities,
- short tests, quizzes etc.

ASSESSMENT AND EXAMINATIONS:

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RECOMMENDED TEXT BOOKS / SUGGESTED READINGS

1. Parray, J. A., Mir, M. Y., & Shameem, N. (2019). *Sustainable Agriculture: Biotechniques in Plant Biology*. Springer.
2. Khan, I. A., & Khan, M. S. (2018). *Developing sustainable agriculture in Pakistan*. CRC press.
3. Singh, J. S., & Seneviratne, G. (2017). *Agro-Environmental Sustainability*. Berlin: Springer.
4. Lichtfouse, E. (Ed.). (2016). *Sustainable Agriculture Reviews: Volume 19* (Vol. 19). Springer.
5. Koohafkan, P., & Altieri, M. A. (2016). *Forgotten agricultural heritage: Reconnecting food systems and sustainable development*. Routledge.
6. Shepard, M. (2013). *Restoration agriculture* (No. 631.584 S547r). Texas, US: Acres, 2013.

Checklist for a New Academic Program

Parameters	
1. Department Mission and Introduction	✓
2. Program Introduction	✓
3. Program Alignment with University Mission	✓
4. Program Objectives	✓
5. Market Need/ Rationale	✓
6. Admission Eligibility Criteria	✓
7. Duration of the Program	✓
8. Assessment Criteria	✓
9. Courses Categorization as per HEC Recommendation	✓
10. Curriculum Difference	□
11. Study Scheme / Semester-wise Workload	✓
12. Award of Degree	✓
13. Faculty Strength	✓
14. NOC from Professional Councils (if applicable)	□

Program Coordinator **Principal**