

UNIVERSITY OF THE PUNJAB

NOTIFICATION

It is hereby notified that the Syndicate at its meeting held on 01-01-2026 has approved the recommendations of the Academic Council made at its meeting dated 16-12-2025 regarding approval of the Revised Curriculum/Scheme of Studies/Syllabi and Courses of Reading for 02 years MS in Environmental Sciences Programs w.e.f the Academic Session, Fall, 2025 to onward.

The Revised Curriculum/Scheme of Studies/Syllabi and Courses of Reading for 02 years MS in Environmental Sciences Programs is attached herewith as Annexure-A.

**Admin. Block,
Quaid-i-Azam Campus,
Lahore.
No. D/ 6112 Acad.**

**Sd/-
Dr. Ahmad Islam
Registrar**

Dated: 25-09 /2026.

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 Centre *(for uploading on website).*
5. Secretary to the Vice-Chancellor
6. Secretary to Registrar
7. Assistant Registrar (Statutes)
8. A.R. Syllabus (W.F)


Assistant Registrar (Academic)
for Registrar

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

Approval of Revised Courses & Syllabi for MS in Environmental Sciences

Program Title: 02 Year MS Degree in Environmental Sciences

Department: College of Earth and Environmental Sciences

Faculty: Geosciences

The curriculum and courses for MS in Environmental Sciences was revised in the year 2022 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 2025. 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 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 (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 <i>No third division in the whole career.</i>
MS (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 <i>No third division in the whole career.</i>

7. Duration of the Program

The CEES is following the HEC guidelines and MS degree is awarded by the university after a minimum of two (2) years period and maximum 04 years. The general timeline followed by the CEES is two years. Number of courses taught in MS Environmental sciences degree program will be 10 with each course having 1-3 credit hours. There will be 04 mandatory subject courses with 12 credit hours, 04 subject elective courses with 12 credit hours and 2 mandatory Quranic courses of 02 credit hrs weightage in MS Environmental Sciences degree program. In addition, there will be 06 credit hours research thesis. 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)		
		No. Core Subject Courses	No. of Subject Elective Course	Semester Load
1	4	02	02	12
2	4	02	02	12
3 & 4 th	03	02 Core Quranic Course and Research Work	--	08
HEC Guidelines	--	07	04	32
Difference HEC & PU	--	--	--	-

9. Revised Scheme of Studies / Semester –Wise Workload

Minimum Credit Hours		32
COURSE WORK	a). Mandatory Subject Core	12 credit hours (4 courses)
	b). Subject Electives	12 credit hours (4 courses)
	c). Mandatory Quranic Courses	02 Credit hours (02 courses)
	Total Coursework Requirements	26 credit hours
Research Thesis		06 credit hours
Program Duration	Minimum: 1.5 Years (3 regular semesters) Maximum: 4 Years (8 regular semesters) <u>Note:</u> In case a student is unable to secure an MS within the prescribed timeframe and claims for extension in duration, the university may constitute appropriate authority and determine the causes of delay. In the event of force majeure (i.e., delay on account of circumstance beyond the control of student), the university may grant an extension in the period of award of MS degree in accordance with the duration limiting factor(s) and shall also take corrective measures in case the delay is caused by process or administrative reasons.	
Semester Duration	16-18 weeks for regular semesters (1-2 weeks for examination) 8-9 weeks for summer semesters (1 week for examination)	
Course Load (Per semester)	09-12 credit hours for regular semesters Up-to 8 credit hours for summer semesters (for remedial / deficiency / failure / repetition courses only)	
3 Credit Hours (Theory)	3 classes (1 hour each) OR 2 classes (1.5 hour each) OR 1 class (3 hours) per week throughout the semester	
1 Credit Hour (Lab/Equivalent)	Practical / lab / field work of 1 credit hour requires 3 hours per week throughout the semester	

Standard scheme of studies for MS Environmental Science is given below:

Sr. No.	Course Code	Course Title	Course Type	Pre-Requisite	Credit Hours
FIRST SEMESTER					
MANDATORY SUBJECT CORE-COURSES <i>(06 credit hours core-courses will be offered in 1st semester)</i>					
1.	ENSC 701	Strategic Environmental Assessment	Core Course	B.S/M.Sc. Environmental Sciences or related disciplines	03
2.	ENSC 702	Advanced Research Methods in Environmental Science	Core-Course	B.S/M.Sc. Environmental Sciences or related disciplines	03
SECOND SEMESTER					
MANDATORY SUBJECT CORE-COURSES <i>(06 credit hours core-courses will be offered in 1st semester)</i>					
3.	ENSC 703	Climate Change Adaptation and Mitigation	Core-Course	B.S/M.Sc. Environmental Sciences or related disciplines	03
4.	ENSC 704	Advanced Analytical Techniques in Environmental Science	Core-Course	B.S/M.Sc. Environmental Sciences or related disciplines	02+01
SUBJECT ELECTIVE COURSES <i>(02 Elective courses of 06 credit hours will be offered in each 1st and 2nd semester)</i>					
5.	ENSC 705	Applied Environmental Toxicology	Elective Course	B.S/M.Sc. Environmental Sciences or related disciplines	03
6.	ENSC 706	Remediation Strategies for Contaminated Environment	Elective Course	B.S/M.Sc. Environmental Sciences or related disciplines	03
7.	ENSC 707	Environmental Biotechnology	Elective Course	B.S/M.Sc. Environmental Sciences or related disciplines	02+01
8.	ENSC 708	Advanced GIS and Remote Sensing	Elective Course	B.S/M.Sc. Environmental Sciences or related disciplines	02+1
9.	ENSC 709	Natural and Constructed Wetlands	Elective Course	B.S/M.Sc. Environmental Sciences or related disciplines	03
10.	ENSC 710	Environmental Impacts of Petroleum Industry	Elective Course	B.S/M.Sc. Environmental Sciences or related disciplines	03
11.	ENSC 711	Soil Pollution	Elective Course	B.S/M.Sc. Environmental Sciences or related disciplines	03
12.	ENSC 712	Environmental Auditing	Elective Course	B.S/M.Sc. Environmental Sciences or related disciplines	03
13.	ENSC-713	Cleaner Production Technologies	Elective Course	B.S/M.Sc. Environmental Sciences or related disciplines	03
14.	ENSC 714	Sustainable Development	Elective Course	B.S/M.Sc. Environmental Sciences or related disciplines	03
15.	ENSC 715	Environmental Risk Assessment and Management	Elective Course	B.S/M.Sc. Environmental Sciences or related disciplines	03
16.	ENSC 716	Environmental Management System and Integrated management System	Elective Course	B.S/M.Sc. Environmental Sciences or related disciplines	03

Sr. No.	Course Code	Course Title	Course Type	Pre-Requisite	Credit Hours
17.	ENSC 717	Population Dynamics and Environment	Elective Course	B.S/M.Sc. Environmental Sciences or related disciplines	03
18.	ENSC 718	Waste Reduction and Recycling	Elective Course	B.S/M.Sc. Environmental Sciences or related disciplines	03
19.	ENSC 719	Advanced Industrial Wastewater Treatment	Elective Course	B.S/M.Sc. Environmental Sciences or related disciplines	03
20.	ENSC 720	Coastal Environment and Management	Elective Course	B.S/M.Sc. Environmental Sciences or related disciplines	03
21.	ENSC 721	Urban Ecology	Elective Course	B.S/M.Sc. Environmental Sciences or related disciplines	03
22.	ENSC 722	Biological Conservation	Elective Course	B.S/M.Sc. Environmental Sciences or related disciplines	03
23.	ENSC 723	Health, Safety and Environmental Management	Elective Course	B.S/M.Sc. Environmental Sciences or related disciplines	02+1
24.	ENSC 724	Sustainable Agriculture	Elective Course	B.S/M.Sc. Environmental Sciences or related disciplines	03

3rd & 4th Semester:

(08 Credit Hours)

Sr. No.	Course Code	Course Title	Course Type	Credit Hours
THIRD & FOURTH SEMESTER				
25.	ENSC 725	Understanding of Holy Quran/ Fahm-e-Quran I	General Education	01
26.	ENSC 726	Understanding of Holy Quran/ Fahm-e-Quran II	General Education	01
27.	ENSC-727	Thesis (Based on Original Research)	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 Sadeef 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

16 : 40

1:3

MANDATORY COURSES

Program	MS Environmental Sciences	Course Code	ENSC-701	Credit hours	03
Course Title	STRATEGIC ENVIRONMENTAL ASSESSMENT				
COURSE INTRODUCTION					
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.					
LEARNING OUTCOMES					
By the end of this course the students will learn:					
1. This course will provide an introduction to the environmental impact assessment (EIA) & strategic environmental assessment (SEA) to the students.					
2. The students will learn about the how to differentiate between different types of EIA & SEA.					
3. They will have the knowledge about how to explain the purpose and role of EIA & SEA in the decision-making process.					
4. The students will learn to identify the technical and social/political limitations of EIA&SEA					
COURSE CONTENTS				Assignments / Readings	
WEEK-1	Introduction to EIA			Baharul & Mahfooz (2021), Environmental Impact Assessment: Precept & Practice Chapter 1: Introduction to Environmental Impact Assessment (pp. 1–18)	
	Significance of EIA				
	Checklist for EIA report				
WEEK-2	Steps for EIA screening			Baharul & Mahfooz (2021) Chapter 2: EIA Process, Screening and Scoping (pp. 19–42)	
	Steps for EIA Scoping				
	Steps for EIA reporting				
WEEK-3	Public participation in EIA			Morrison-Saunders (2018), Advanced Introduction to Environmental Impact Assessment Chapter 3: Public Participation in EIA (pp. 45–67)	
	Stakeholder participation in EIA				
	Addressing stakeholders and public concerns				
WEEK-4	Monitoring of EIA targets			Morrison-Saunders (2018) Chapter 5: Monitoring and Environmental Management (pp. 85–108)	
	Monitoring of EIA goals				
	Managing long term goals of EIA				
WEEK-5	Difference between EIA, ESIA, IEE and SEA			Assignment: Comparative review of EIA, IEE, ESIA and SEA.	
	Structure and conditions of IEE report				
	Structure and conditions of ESIA report				
WEEK-6	Case study of EIA			Pakistan EPA Guidelines for IEE & EIA	
	Case study of ESIA				
	Case study of IEE				
WEEK-7	EIA quiz			Assignment: Prepare a quiz bank containing 25 MCQs and 5 short questions.	
	ESIA quiz				
	IEE quiz				
WEEK-8	Pakistan EPA guideline for EIA			Pakistan Environmental Protection Agency (EPA) Guidelines IEE and EIA Regulations (pp. 1– 45)	
	Pakistan EPA guideline for EIA				
	Pakistan EPA guideline for ESIA				
MID-TERM PAPER					

WEEK-9	SEA Introduction	Therivel (2004), European Union Directives on EIA and SEA in Action Chapter 1: Introduction to Strategic Environmental Assessment (pp. 1–24)
	Significance of SEA	
	SEA and industrial growth	
WEEK-10	Introduction of SEA report structure	Therivel (2004) Chapter 3: SEA Screening and Scoping (pp. 53–88)
	Screening in SEA	
	Scoping in SEA	
WEEK-11	Reporting in SEA	Therivel (2004) Chapter 5: SEA Reporting and Consultation (pp. 119–145)
	Public participation in SEA	
	Stakeholder participation in SEA	
WEEK-12	Addressing public concerns in SEA	Assignment: Evaluate the effectiveness of public consultation in environmental planning.
	Addressing stakeholders concerns in SEA	
	Stakeholders’ joint sitting and SEA	
WEEK-13	Monitoring SEA targets	Morrison-Saunders (2018) Chapter 7: Monitoring Environmental Outcomes (pp. 141–167)
	Monitoring SEA goals	
	SEA goals and stakeholder’s responsibilities	
WEEK-14	SEA case study 1	Comparative analysis of three SEA case studies from different countries.
	SEA case study 2	
	SEA case study 3	
WEEK-15	SEA report compilation	Assignment: Prepare a mini SEA report outline for an urban development project.
	SEA report compilation	
	SEA quiz	
WEEK-16	Pakistan EPA guideline for SEA	Pakistan EPA SEA Framework and International Best Practices
	Pakistan EPA guideline for SEA	
	Comparisons of global SEA guidelines	
FINAL-TERM PAPER		
TEXT BOOKS AND READING MATERIAL		
1. Baharul, I.K.M.,& Mahfooz, N.Z. (2021). <i>Environment Impact Assessment: Precept& Practice</i>. CRC Press. 2. Biswas, W. (2020). <i>Environmental Impact Assessment of Buildings</i>. Sciprofile. 3. Morrison-Saunders, A. (2018). <i>Advanced introduction to environmental impact assessment</i>. Edward Elgar Publishing. 4. Fisher, T.B., and Nadeem, O. (2014). <i>Environmental Impact Assessment: Course Curriculum for Higher Education Institutions in Pakistan</i>. National Impact Assessment Programme. 5. Therivel, R. (2004). <i>European Union Directives on EIA and SEA in Action</i>. Earth Scan, UK. Assorted Research Papers / Further Reading: As suggested by the instructor.		
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.

Program	MS Environmental Sciences	Course Code	ENSC-702	Credit hours	03
Course Title	ADVANCED RESEARCH METHODS IN ENVIRONMENTAL SCIENCE				
COURSE INTRODUCTION					
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.					
LEARNING OUTCOMES					
By the end of this course the students will learn: 1. Comprehensively plan different studies in Environmental Sciences 2. Analyze data and apply coding strategies in qualitative and quantitative methods. 3. Conduct statistical analysis and understand how to interpret the results. 4. Have the skills of writing thesis and reports					
COURSE CONTENTS					Assignments / Readings
WEEK-1	Introduction to Research and Methods				Mukherjee (2019), Ch. 1: Introduction to Research Methodology (pp. 1–22)
	Introduction to Research and the Research Process				
	Scientific Methods, Techniques & Pre- requisites for Scientific Research				
WEEK-2	Application of Scientific Method in Research				Mukherjee (2019), Ch. 2: Scientific Method and Research Ethics (pp. 23–48)
	Research Ethics and Integrity				
	Critical appraisal				
WEEK-3	Types of scientific manuscripts				Assignment: Develop three environmental research questions.
	Critical Thinking				
	Developing the Research Question				
WEEK-4	Defining the Research Problem				Creswell (2018), Ch. 3 (pp. 41–72)
	Sources of Research Problem				
	Choosing the Research Topics				
WEEK-5	Understanding the Research Process				Assignment: Formulate descriptive and analytical research questions.
	Types of Research Questions				
	Descriptive question				
WEEK-6	Relationship question				Assignment: Develop hypotheses for a selected environmental issue.
	Difference question				
	Research Hypothesis, Types of hypothesis, Characteristics of Research Hypothesis				
WEEK-7	Concept of Variables				Assignment: Identify dependent and independent variables.
	Types of Variables				
	Research proposal development				
WEEK-8	Types of Research Proposals its importance				Alley (2018), Ch. 2–4 (pp. 15–68)
	Research Project Conceptualization				
	Research Proposal Writing Techniques, Elements of a Research Proposal				
MID TERM EXAMINATION					

WEEK-9	Sampling Strategies	Assignment: Compare probability and non-probability sampling.
	Introduction to sampling design	
	Logic of Sampling	
WEEK-10	Concepts and Terminologies	Mukherjee (2019), Ch. 6 (pp. 131–160)
	Types of Sampling Designs	
	Importance of Research Design	
WEEK-11	Formulation of Research Design, Reliability, validity, generalization	Assignment: Develop an experimental research design.
	Experimental design and use of indicators in research,	
	Classification experimental design,	
WEEK-12	Factorial design, randomized block design	Smith et al. (2018), Ch. 4–6 (pp. 75–150)
	Covariance design, Quasi experimental design	
	Factorial designs of experimental research	
WEEK-13	Data Collection and Evaluation Research	Assignment: Develop a data collection instrument.
	Data Collection and Research Evaluation	
	How to carry out evaluation research	
WEEK-14	Techniques in data collection	Tjora (2018), Ch. 4–5 (pp. 61–102)
	Quantitative Data, Experimental Research	
	Qualitative Data, Case Studies, Surveys, Interviews, Questionnaire	
WEEK-15	Statistical techniques and Interpretation of Results, Data Interpretation, Descriptive Statistics	Smith et al. (2018), Ch. 8–10 (pp. 181–280) Assignment: Perform descriptive statistical analysis.
	Analysis of Variance, Univariate Analysis, Bivariate Analysis	
	Multivariate Analysis, Correlation and Regression	
WEEK-16	Research Presentation Techniques – Data presentation	Prepare a scientific presentation and mini research report.
	How to put things together for better Research reporting	
	Introduction, Objectives, Review of Literature, Material and Methods, Results and discussion, conclusion and Bibliography	
FINAL TERM EXAMINATION		
TEXT BOOKS AND READING MATERIAL		
1. Mukherjee, S. P. (2019). <i>A guide to research methodology: An overview of research problems, tasks and methods</i>. CRC Press. 2. Tjora, A., (2018). <i>Qualitative Research as Stepwise-Deductive Induction</i>. Routledge Publisher. 3. Bartels, K.P.R. & Wittmayer, J.M. (2018). <i>Action Research in Policy Analysis: Critical and Relational Approaches to Sustainability Transitions</i>. Routledge Publisher. 4. Alley, M. (2018). <i>The Craft of Scientific Writing</i>. Springer-Verlag. New York. 5. Smith, R.L., Nychka, D., Waller, L.A. & Schmidt, A. (2018). <i>Applied Environmental Statistics</i>. CRC Press, 6. Creswell, J. W. (2018). <i>Research design: Qualitative, quantitative and mixed methods approaches</i>. Thousand Oaks, CA: Sage Further Reading: As suggested by the Instructor.		

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:

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- homework
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- 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.

Program	MS Environmental Sciences	Course Code	ENSC-703	Credit hours	03
Course Title	CLIMATE CHANGE ADAPTATION AND MITIGATION				
COURSE INTRODUCTION					
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					
LEARNING OUTCOMES					
By the end of this course the students will learn: 1. To carry out research, teaching, and consultancy in the field of climate change and adaptation. 2. To discuss how a changing climate translates into impacts 3. To highlight the most vulnerable regions and sectors of the climate change 4. To recognize uncertainties in climate change science 5. To use the current knowledge to discuss climate change adaptation and mitigation options					
COURSE CONTENTS				Assignments / Readings	
WEEK-1	Climate and Weather, Introduction to climate change			Streimikiene and Mikalauskiene (2021) Ch 1 pp: 1-27 Neelin (2010) Ch. 5 pp: 145-191	
	Weather forecasting and climate change				
	Modeling of climate change				
WEEK-2	Modeling of climate change			Neelin (2010) Ch. 5 pp: 145-191	
	Types of climate change models				
	Importance of climate change modeling				
WEEK-3	Climate change drivers and consequences, Climate change drivers and clues			Streimikiene and Mikalauskiene (2021) Ch 1 pp: 1-27 Neelin (2010) Ch. 1 p: 1-29	
	Identify the anthropogenic drivers of climate change				
	Analyze different climate change scenarios and their implications				
WEEK-4	Environmental and health insecurities and adaptation in the climatic zone.			Pelling (2010) Ch. 1 Pp: 3-19 Pelling (2010) Ch. 2 Pp: 20-50	
	Key Environmental and Health Insecurities				
	Climate change Adaptation, Introduction to Climate Change Adaptation				
WEEK-5	Potential adaptation strategies in different sectors			Pelling (2010) Ch 3 pp: 55-67 Pelling (2010) Ch. 5 pp: 83-104	
	Ways to measure vulnerability				
	Linkages between climate change adaptation and community development				
WEEK-6	Climate change mitigation			White (2012) Ch 1 pp: 1-51	
	Transition to carbon-neutral energy sources				
	Carbon and global warming				
WEEK-7	Methods to Reduce Carbon Emissions			Streimikiene and Mikalauskiene (2021) Ch 4 pp: 121-153	
	Conventional mitigation measures				
	Structural Approaches to Risk Reduction				
	Physical Infrastructure-Based Measures				

WEEK-8	Five-step methodology for preparing a low-emission climate-resilient	Pelling (2010) Ch p: 163-176
	Baseline Assessment and Situation Analysis	
	Implementation Planning and Resource Mobilization	
MID TERM EXAMINATION		
WEEK-9	Climate change mitigation	White (2012) Ch 2 pp: 55-86
	Carbon sequestration	
	Transition to carbon-neutral energy sources	
WEEK-10	Carbon and global warming	White (2012) Ch 1 pp: 1-51
	Conventional mitigation measures	
	Five-step methodology for preparing a low-emission climate-resilient	
WEEK-11	Geoengineering Technologies	Streimikiene and Mikalauskiene (2021) Ch 2 pp; 45-88
	Integrated climate change mitigation	
	Climate adaption and sustainable development	
WEEK-12	Impacts of the climate change	Harris (2022) Ch. 2 pp: 17-44
	Impacts of climate change	
	Climate change and Atmospheric phenomenon’s	
WEEK-13	Climate change and Food insecurity	Neelin (2010) Ch 6 pp: 193-219
	Climate change and Water quality	
	Climate Change and Wetlands, desertification, shrinkage of lakes and rivers	
WEEK-14	Climate change and Agriculture	Harris (2022) Ch.3 pp: 47-68; Ch 5 pp: 83-102
	Climate change, Flora and fauna, and mass extinction	
	Cryosphere to water	
WEEK-15	Climate Change Policy, Overview of planning processes for climate change	White (2012) Ch. 5 pp:179-202
	Adaption to climate change, Climate change policy and social change	
	International climate change negotiations	
WEEK-16	The Role of National and Sectoral Institutions in Climate Change Planning	White (2012) Ch. 5 pp:179-202
	Protocol and agreement	
	Climate finance and politics	
FINAL TERM EXAMINATION		
TEXT BOOKS AND READING MATERIAL		
1. Streimikienė, D., & Mikalauskiene, A. (2021). Climate change and sustainable development: mitigation and adaptation. CRC Press. 2. Pelling, M. (2010). Adaptation to climate change: from resilience to transformation. Routledge. 3. Harris, S. (Ed.). (2022). The nature, causes, effects and mitigation of climate change on the environment. BoD–Books on Demand. 4. Neelin, J. D. (2010). Climate change and climate modeling. Cambridge University Press.		

5. White, W. A. (2012). Biosequestration and ecological diversity: mitigating and adapting to climate change and environmental degradation. Crc Press.
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.

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.

Program	MS Environmental Sciences	Course Code	ENSC-704	Credit hours	02
Course Title	ADVANCED ANALYTICAL TECHNIQUES IN ENVIRONMENT (THEORY)				
COURSE INTRODUCTION					
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.					
LEARNING OUTCOMES					
By the end of this course the students will learn:					
1. Understand and apply the fundamental principles of analytical chemistry					
2. Understand and follow standard documented procedure of analysis					
3. Competently undertake advanced qualitative and quantitative laboratory tasks					
4. To learn the operation of advanced analytical instrumentation.					
COURSE CONTENTS				Assignments / Readings	
WEEK-1	What is Analytical Chemistry and its role of Analytical chemistry in environment			Fundamentals of Analytical Chemistry by Skoog Page 1-10	
	What is Qualitative and Quantitative analysis and how different environmental analytical				
WEEK-2	What is Analytical process how to solve Analytical problem in environment.			Fundamentals of Analytical Chemistry by Skoog Page 11-13	
	What are major sampling techniques for different samples (Solid, liquid and gaseous samples).			Analytical Chemistry by G.D. Christian Page 620	
WEEK-3	Major Sample preservation methods			Analytical Chemistry by G.D. Christian Page 629-668	
	How to digest different types of sample and what are major Digestion techniques.				
WEEK-4	What are Errors and its major types,			Fundamentals of Analytical Chemistry by Skoog Page 11-20	
	how to avoid these errors during analytical problem.				
WEEK-5	Classical methods versus instrumental analysis			Principles of Analytical Chemistry by Haq Nawaz Bhatti, Page 1-11	
	Types of Classical analysis				
WEEK-6	Gravimetric analysis, Volumetric analysis, Argentometry			Quiz / Presentation	
	Complexometry, Reduction oxidation and iodometry				
WEEK-7	Spectroscopy and Spectrophotometer			Fundamentals of Analytical Chemistry by Skoog Page 497-510	
	What is Spectroscopy, its major types and phenomenon involved (Absorption and Emission)				
WEEK-8	Inductively coupled plasma Mass Spectrophotometer			Fundamentals of Analytical Chemistry by Skoog Page 527-530	
	Lambert Beer's law				
MID TERM EXAMINATION					
WEEK-9	Flame Emission photometry and its applications in environment			Analytical Chemistry by G.D. Christian Page 398-410	
	Atomic Absorption spectrophotometry and its applications in environment				
WEEK-10	FTIR Analysis			Analytical Chemistry by G.D. Christian Page 629-635	
	SEM Analysis				
WEEK-11	Introduction to Chromatography and its applications.			Analytical Chemistry by G.D. Christian Page 505-510	
	Adsorption and Partition chromatography				
WEEK-12	Applications of XRD in Environmental Analysis			Quiz / Presentation	
	Limit of Detection and Limit of Quantification				

WEEK-13	Principle and working of Gas chromatography and GCMS	<i>Analytical Chemistry by G.D. Christian Page 530-540</i>
	Stationary and mobile Phases	
WEEK-14	Paper, Column and Thin Layer Chromatography	<i>Analytical Chemistry by G.D. Christian Page 520-530</i>
	Principle and working of Gas chromatography	
WEEK-15	Principles and working of GCMS	<i>Analytical Chemistry by G.D. Christian Page 550-5560</i>
	Liquid Chromatography	
WEEK-16	Use of Standards in Environmental Analysis	Quiz / Presentation
	Quality Control and Quality Assurance	

FINAL TERM EXAMINATION

TEXT BOOKS AND READING MATERIAL

1. Fundamentals of Analytical Chemistry by Douglas A. Skoog, Donald M. West and F. James Holler (2011). 10 Edition Fort Worth, Tex: Saunders College Publishers.
2. Analytical Chemistry by Gary D. Christian (2014), Jon Willey & Sons Inc
3. Harris, D.C., and Lucy, C.A. (2020). *Quantitative Chemical Analysis*, Tenth Edition. W.H. Freeman & Company, New York
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.

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.

Program	MS Environmental Sciences	Course Code	ENSC-704	Credit hours	01
Course Title	ADVANCED ANALYTICAL TECHNIQUES IN ENVIRONMENT (PRACTICAL)				
COURSE INTRODUCTION					
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.					
LEARNING OUTCOMES					
By the end of this course the students will learn:					
1. Understand and apply the fundamental principles of analytical chemistry					
2. Understand and follow standard documented procedure of analysis					
3. Competently undertake advanced qualitative and quantitative laboratory tasks					
4. To learn the operation of advanced analytical instrumentation.					
COURSE CONTENTS				Assignments / Readings	
WEEK-1	Sample preparation and preservation			Book Advance Practical Chemistry	
WEEK-2	Metal analysis (Na, Ca, K) by Flame photometry			Laboratory Manual Practical # 1	
WEEK-3	Metal analysis (Cr, Cd, Pb etc.) by using Atomic Absorption spectroscopy			Laboratory Manual Practical # 2	
WEEK-4	E. Coli analysis			Laboratory Manual Practical # 3	
WEEK-5	PO ₄ & SO ₄ and Chloride estimation			Laboratory Manual Practical # 4	
WEEK-6	TDS, TSS			Laboratory Manual Practical # 5	
WEEK-7	Conductivity, pH			Laboratory Manual Practical # 6	
WEEK-8	DO of water samples and Hardness of water			Laboratory Manual Practical # 7	
MID TERM EXAMINATION					
WEEK-9	COD Estimation			Laboratory Manual Practical # 8	
WEEK-10	BOD Estimation			Handouts	
WEEK-11	Digestion methods (Acid digestion, Ash digestion)			Handouts	
WEEK-12	Chemical analysis of digested biological samples			Discussions	
WEEK-13	Estimation of different Physical, chemical and Biological parameters from soil using spectroscopic and chromatographic instrumental methods			Handouts	
WEEK-14	Paper Chromatography exp 1			Laboratory Manual Practical # 9	
WEEK-15	Discussion regarding students queries before final exam			Quiz	
WEEK-16	Discussion regarding students queries before final exam			Quiz	
MID TERM EXAMINATION					
TEXT BOOKS AND READING MATERIAL					
1. Fundamentals of Analytical Chemistry by Douglas A. Skoog, Donald M. West and F. James Holler (2011). 10 Edition Fort Worth, Tex: Saunders College Publishers.					
2. Analytical Chemistry by Gary D. Christian (2014), Jon Willey & Sons Inc					
3. Harris, D.C., and Lucy, C.A. (2020). Quantitative Chemical Analysis, Tenth Edition. W.H. Freeman & Company, New York					

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.
 6. Advanced Practical Chemistry by Ilmi Kitab Khana for B.Sc. Hons Students latest edition.
- Further Reading:** As suggested by the Instructor.

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.

ELECTIVE COURSES

Program	MS Environmental Sciences	Course Code	ENSC-705	Credit hours	03
Course Title	APPLIED ENVIRONMENTAL TOXICOLOGY				
COURSE INTRODUCTION					
Advanced Environmental Toxicology is a multidisciplinary course designed to provide in-depth understanding of the sources, fate, behavior, and biological effects of toxic substances in the environment, with particular emphasis on human health and ecosystem integrity. The course introduces fundamental principles and emerging concepts in environmental toxicology, highlighting its applications in environmental sciences and contemporary research directions. Students will explore toxicokinetics and toxicodynamics to understand how toxicants move through environmental compartments and biological systems, and how they exert effects from molecular and cellular levels to whole organisms and communities. The course addresses major classes of environmental toxicants, including inorganic elements, industrial chemicals, agricultural chemicals, pharmaceuticals, personal care products, atmospheric pollutants, and emerging contaminants such as PFAS and engineered nanomaterials.					
LEARNING OUTCOMES					
At the end of this course the students will be able to:					
1. Interpret and critically evaluate recent advances in experimental, analytical, and modeling techniques used in environmental toxicology, with emphasis on environmental impact assessment and risk analysis. 2. Acquire comprehensive knowledge of the major classes of chemicals of environmental concern, including inorganic toxicants, industrial and agricultural chemicals, pharmaceuticals, and emerging contaminants. 3. Develop an understanding of analytical approaches for the detection, identification, and quantification of toxic chemicals in environmental matrices such as water, soil, sediments, and biological samples. 4. Understand and explain the toxicological effects of environmental pollutants across different levels of biological organization, from molecular and cellular responses to organismal, population, and ecosystem-level impacts.					
COURSE CONTENTS			Assignments / Readings		
WEEK-1	Introduction, General Principles and Concepts in environmental toxicology		Historical Review of Human Impact on the Environment pp. 1- 17) Chadwick, J. and Shaw, I., (2016).		
	Research progress and direction of environmental toxicology				
	Application of toxicology in Environmental Sciences				
WEEK-2	Patterns in Environmental Toxicology		Reading (Chapter 2; Frameworks and paradigms for environmental toxicology :). Landis et al., (2018).		
	Toxicological effects at different Biological level				
	Types of Environmental Toxicants:				
WEEK-3	Movement of toxicants in the environment: Root of entry of toxic substances in living organisms		Reading (Chapter 5, the Fate and transport of Contaminants Landis et al., (2018). Assignments (Individual Assignments Topics for Review Paper)		
	Biotransformation – metabolism of toxic compounds				
	Factors affecting toxic actions of toxicants				
WEEK-4	Teratogens		Hodgson, (2010). Chapter. 12. Teratogenesis Pp.265-272 D'Mello, (2019). Chapter 15. 214 – 232.		
	Basic principles in teratogenesis				
	Teratogens and Mechanisms of Actions				
WEEK-5	Endocrinal disruptor		Philp, (2016). Chapter 12. PP 335- 353 Khetan (2014). Chapter 1. PP1-18		
	Major types of EDs				
	Impacts of EDs on human and wildlife				
WEEK-6	Plasticizer and its associated xenobiotics		Nano- and microplastics: The invisible danger to the body DW Documentary, or related documentary https://www.youtube.com/watch?v=55e1UMKJhc8) followed by Quiz		
	Drugs of Abuse				
	Narcotics				
WEEK-7	Pharmaceuticals		Garg, et al., (2024). Chapter 3. 31- 44		
	Personal care products				
	Discussions				

WEEK-8	Toxicants in Atmosphere Gaseous pollutants	Inorganic Gaseous pollutants Landis et al., (2018). Chapter 8 PP 227 – 242. Watching The Miracle Material That Killed Millions Documentary- or related documentary https://www.youtube.com/watch?v=cMx139eTxoc followed by quiz
	Indoor Pollution	
	Asbestos and particulate matter	
MID TERM EXAMINATIONS		
WEEK-9	Toxicology of trace inorganic elements	Landis et al., (2018). Chapter 10 pp 255-264 D'Mello, (2019). Chapter 24-27.pp 353-392
	Mercury and Cadmium	
	Arsenic and Lead	
WEEK-10	Toxicity of non-metallic inorganic substances	Critical review on Newspaper/ Popular article related to Environmental Toxicology
	Cyanides,	
	Phosphate and Nitrates	
WEEK-11	Per- and Polyfluoroalkyl Substances (PFAS)	Landis et al., (2018). Chapter 11, Pp 269-284. We're all contaminated: The toxin inside us — PFAS People & Power Documentary, or related documentary (https://www.youtube.com/watch?v=JPTk6YxZolA) followed by quiz
	Flame retardants and Chlorinated Paraffins	
	Discussion	
WEEK-12	Pesticides and their chemical origin	D'Mello, (2019). Chapter 16-19.pp 353-392
	Integrated Pest Management	
	Impacts of pesticides on human, wildlife and ecosystems	
WEEK-13	Fertilizers and	Poisoned Soil: How Intensive Farming Ruins Our Future or related documentary https://www.youtube.com/watch?v=-cTxJuIQEAo followed by quiz
	Soil additives	
	Engineered Nanomaterials	
WEEK-14	Food Additives	Philp, (2016). Chapter 8. PP 227- 255
	Drug Residues	
	Food Contaminants	
WEEK-15	Ecological risk assessment	Landis et al., (2018). Chapter 15 pp 414-430
	Risk Characterization	
	Techniques in ecological risk assessment	
WEEK-16	Occupational toxicology	Baker, et al., (Eds.). (2012).chapter 8 PP96 - 106
	occupational disease and hazardous chemicals	
	Legal controls and standards	
FINAL TERM EXAMINATIONS		
TEXT BOOKS AND READING MATERIAL		
1. Reshi, M. S., Javaid, D., Qadri, S. S., & Sinha, N. (2025). Environmental Toxicology: Concepts and Principles. 2. Landis, W G., Sofield R. M. Yu, M., (2018). Introduction to Environmental Toxicology Molecular Substructures to Ecological Landscapes Fifth Edition, CRC Press. 3. D'Mello, J. F. (2019). A Handbook of Environmental Toxicology: Human Disorders and Ecotoxicology. CABI. 4. Baker, D., Karalliedde, L., & Murray, V. (Eds.). (2012). Essentials of toxicology for health protection: A handbook for field professionals (2nd ed.). Oxford University Press. 5. Garg, V. K., Pandey, A., Kataria, N., & Faggio, C. (Eds.). (2024). Pharmaceuticals in aquatic environments: Toxicity, monitoring, and remediation technologies. CRC Press.		

6. Robinson, L. (2018). A practical guide to toxicology and human health risk assessment. John Wiley & Sons.
 7. Chadwick, J. and Shaw, I., (2016). Principles of Environmental Toxicology. CRC Press.
 8. Philp, R. B. (2016). Ecosystems and human health: Toxicology and environmental hazards. CRC Press,
 9. Gruiz, K., Meggyes, T., & Fenyvesi, É. (2015). Engineering tools for environmental risk Management: 2. Environmental toxicology. CRC Press.
 10. D'Mello, J. F. (2019). A Handbook of Environmental Toxicology: Human Disorders and Ecotoxicology. CABI.
 11. Khetan S. K., . (2014). Endocrine disruptors in the environment. Hoboken, New Jersey: John Wiley & Sons, Inc.
 12. Yu, M, H. Tsunoda, M.Tsunoda (2011). Environmental Toxicology Biological and Health Effects of Pollutants, Third Edition. CRC Press.
 13. Hodgson, E. (2010) A textbook of modern toxicology. 4th Edition, John Wiley & Sons Publication, New Jersey. Yu, M.-H., Tsunoda, H., & Tsunoda, M. (2011). Environmental toxicology: Biological and health effects of pollutants (3rd Ed.). CRC Press. ISBN-13: 978-1439840382.
- Further Reading:** As suggested by the Instructor.

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:

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- 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.

Program	MS Environmental Sciences	Course Code	ENSC-706	Credit hours	03
Course Title	REMEDIATION STRATEGIES FOR CONTAMINATED ENVIRONMENT				
COURSE INTRODUCTION					
This course aims at providing students with the necessary knowledge and understanding to the following:					
LEARNING OUTCOMES					
By the end of this course the students will learn: 1. Understand the basic concepts of pollution, environmental contaminants and their sources. 2. Understand basics of Environmental remediation and types of remediation strategies. 3. Develop the ability to screen, choose and design appropriate technologies for remediation. 4. Develop understanding of integrated approaches to remediate contaminated sites.					
COURSE CONTENTS					Assignments / Readings
WEEK-1	Introduction to environmental contamination and pollution				Pichtel (2019), Ch. 1 (pp. 1–28)
	Environmental contaminants and their sources in the environment				
	Biodegradable and non-biodegradable environmental pollutants				
WEEK-2	Types and impacts of environmental contamination				Assignment: Compare soil, water and air contamination pathways.
	Water and sediment contamination				
	Soil and air contamination				
WEEK-3	Introduction to environmental remediation				Pichtel (2019), Ch. 2 (pp. 29–60)
	Factors affecting remediation efficiency				
	Factors affecting contaminant degradation				
WEEK-4	Significance of bioremediation				Bhandari et al. (2007), Ch. 5 (pp. 95–128)
	Effectiveness of bioremediation				
	Limitations and delimitations of bioremediations				
WEEK-5	Clean Air Act Laws				USEPA Clean Air Act and Clean Water Act Documents Assignment: Regulatory comparison report.
	Clean water act				
	Montreal Protocol and clean development strategies				
WEEK-6	The Comprehensive Environmental Response, Compensation and Liability Act (CERCLA)				CERCLA Guidance Manual
	USEPA and WHO guideline for contaminants				
	PEQs and NEQs standards				
WEEK-7	Remediation Standards comparisons				Assignment: Compare international remediation standards.
	Class quiz				
	Implications of remediation standards				
WEEK-8	Remediation strategies: Physical remediation				Compare physical, chemical and biological remediation.
	Remediation strategies: chemical remediation				
	Remediation strategies: Biological remediation				
MID TERM EXAMINATION					

WEEK-9	Remediation strategies: Thermal remediation	Bhandari et al. (2007), Ch. 8 (pp. 221–280)
	Remediation techniques comparisons	
	Choice of Remediation strategy	
WEEK-10	Remediation techniques: is-situ soil remediation	Design an in-situ remediation plan.
	Remediation techniques: is-situ bioremediation	
	Remediation techniques: is-situ ground remediation	
WEEK-11	Remediation and response decision making	Chernobyl Technical Reports
	Chernobyl case study (Remediation technology and administrative control)	
	Remediations and oil spills in seas and oceans	
WEEK-12	Remediation strategic planning	Assignment: Prepare a remediation strategic plan.
	Bioremediation site selection and control measures	
	Bioremediation and aera of contaminated sites	
WEEK-13	Phyto-remediation and myco-remediation	Raskin & Ensley (2000), Ch. 3–5 (pp. 61–145)
	Choice of plants and fungal species for remediation	
	Choice of microbial species and bioremediation	
WEEK-14	Bioremediation and legislation	EPA Bioremediation Guidelines
	Bioremediation and EPA guidelines	
	Disposal of plants and fungus after Phyto- and myco-remediation	
WEEK-15	Environmental protection agencies	Assignment: Stakeholder analysis for remediation projects.
	Environmental remediation and stakeholders’ inclusions	
	Class quiz	
WEEK-16	Environmental bioremediation field visit	Submission of remediation field assessment report.
	Environmental bioremediation report preparation	
	Environmental bioremediation viva voce	
FINAL TERM EXAMINATION		
TEXT BOOKS AND READING MATERIAL		
1. Pichtel, J. (2019). <i>Fundamentals of site remediation</i>. Rowman & Littlefield. 2. Hasegawa, H., Rahman, I. M. M., & Rahman, M. A. (Eds.). (2016). <i>Environmental remediation technologies for metal-contaminated soils</i>. Springer Japan. 3. Ghafoor, A., Murtaza, G., Rehman, M. Z., Sabir, M., Ahmad, H. R., & Ullah, S. (2012). Environment pollution: Types, sources and management. <i>Allied Book Centre, Urdu Bazar, Lahore, Pakistan</i>. 4. Bhandari, A., Surampalli, R., Champagne, P., Tyagi, R. D., Ong, S. K., & Lo, I. (2007). <i>Remediation technologies for soils and groundwater</i>. 5. Raskin, I., & Ensley, B. D. (2000). <i>Phytoremediation of toxic metals</i>. John Wiley and Sons.		
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.

Program	MS Environmental Science	Course Code	ENSC-707	Credit hours	02
Course Title	ENVIRONMENTAL BIOTECHNOLOGY (THEORY)				
COURSE INTRODUCTION					
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.					
LEARNING OUTCOMES					
By the end of this course the students will learn:					
1. Basic concepts of environmental biotechnology and role of biotechnology in pollution abatement					
2. Biodegradation of various organic pollutants using biotechnological tools					
3. Biotreatment of organic and inorganic wastes and environmental management					
4. Role of environmental biotechnology in agriculture with special focus on reducing environmental stresses to crops					
COURSE CONTENTS				Assignments / Readings	
WEEK-1	Introduction to environmental Biotechnology			Gothandam et al. (2020),	
	Modern-day applications of environmental biotechnology			Ch. 1 (pp. 1–25)	
WEEK-2	Air, soil and water pollution abatement using environmental biotechnology			Kumar & Kumar (2018),	
	Biological treatment of wastewater			Ch. 2 (pp. 31–58)	
WEEK-3	GMOs and pollution reduction			Thakur (2016), Ch. 5 (pp.	
	Composting and bioleaching			90–118)	
WEEK-4	Biofuel and bioenergy			Report on biofuel	
	Bio-scrubbers and biofilters			production technologies.	
WEEK-5	Advanced activated sludge process			Sangeetha et al. (2016),	
	Oxidation ditches, biological filter-fix films			Ch. 3 (pp. 55–90)	
WEEK-6	Rotating biological contractors			Assignment: Reactor	
	Fluid and packed bed reactors			design comparison	
WEEK-7	Up-flow anaerobic sludge blanket and membrane reactors			Assignment: Review	
	Introduction to xenobiotics			anaerobic sludge blanket	
WEEK-8	Xenobiotics and Biodegradation			Sangeetha et al. (2016),	
	detoxification of xenobiotics			Ch. 8 (pp. 191–225)	
MID TERM EXAMINATION					
WEEK-9	Challenges of xenobiotics			Assignment: Challenges	
	Biotechnology and agriculture			associated with xenobiotic	
WEEK-10	Plants breeding and crop improvements			Assignment:	
	Tissue culturing and agriculture			Biotechnology	
WEEK-11	genetic engineering and agriculture			Gothandam et al. (2020),	
	Transgenic plants, food security,			Ch. 8 (pp. 181–225)	
WEEK-12	Food safety and nutrition			Sobti et al. (2018), Ch. 11	
	Biofertilizers and biopesticides			(pp. 245–280)	
WEEK-13	Biosorption of heavy metals			Viswanath (2017), Ch. 9	
	Biosorption of organic pollutants			(pp. 210–245)	

WEEK-14	Enhanced biosorption using tailored sorbents	Sangeetha et al. (2016), Ch. 12 (pp. 281–320)	
	Recalcitrant compounds and their removals		
WEEK-15	Wastewater Treatment Techniques	Assignment: Evaluate wastewater treatment challenges.	
	Wastewater Treatment Challenges		
WEEK-16	Biotechnology and medicine and health care	Seminar on ethical issues in biotechnology	
	Ethical and moral concerns with biotechnology		
FINAL TERM EXAMINATION			
TEXT BOOKS AND READING MATERIAL			
1. Gothandam, K. M., Ranjan, S., Dasgupta, N., & Lichtfouse, E. (2020). <i>Environmental Biotechnology</i> Vol. 3. Springer International Publishing. 2. Sobti, R. C., Arora, N. K., & Kothari, R. (Eds.). (2018). <i>Environmental biotechnology: for sustainable future</i>. Springer. 3. Kumar, P., & Kumar, V. (2018). <i>Textbook of Environmental Biotechnology</i>. Woodhead Publishing India. 4. Viswanath, B. (2017). <i>Environmental Biotechnology</i>. Heritage Publishers. 5. Sangeetha, J., Thangadurai, D., David, M., & Abdullah, M. A. (2016). <i>Environmental Biotechnology: Biodegradation, Bioremediation, and Bioconversion of Xenobiotics for Sustainable Development</i>. CRC Press. 6. Thakur, I.S. (2016). <i>Environmental Biotechnology. Basic Concepts and Applications</i>. I.K.International Pvt.Ltd, New Delhi 7. A.K.Chatterji. (2015). <i>Introduction to Environmental Biotechnology</i>. Prentice Hall of India Private Limited, New Delhi Further Reading: As suggested by the Instructor.			
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.

Program	MS Environmental Sciences	Course Code	ENSC-707	Credit hours	01
Course Title	ENVIRONMENTAL BIOTECHNOLOGY (PRACTICAL)				
COURSE INTRODUCTION					
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.					
LEARNING OUTCOMES					
By the end of this course the students will learn: 1. Various methods of bioremediation of heavy metals 2. Case studies related to biosorption and biotreatment of water and soil 3. Case studies of genetically modified organism and their role in reducing environmental stresses in agriculture 4. biodegradation techniques for organic pollutants					
COURSE CONTENTS			Assignments / Readings		
WEEK-1	Introduction to lab equipment used in biotechnology		Patra et al. (2020), A Practical Guide to Environmental Biotechnology Chapter 1: Laboratory Equipment and Instrumentation (pp. 1–25)		
WEEK-2	Lab safety protocols		Patra et al. (2020) Chapter 2: Laboratory Safety and Biosafety Procedures (pp. 26–48)		
WEEK-3	General method for Removal of environmental contaminants from water		Assignment: Laboratory report on contaminant removal from water samples.		
WEEK-4	Chromium removal from wastewater		Assignment: Chromium removal efficiency experiment and data analysis.		
WEEK-5	Arsenic removal from water		Assignment: Comparative assessment of arsenic removal methods.		
WEEK-6	Heavy metals removal from soil and sediments		Patra et al. (2020) Chapter 8: Soil and Sediment Remediation (pp. 185–220)		
WEEK-7	Anion treatment		Assignment: Experimental report on anion treatment techniques.		
WEEK-8	Treatment for organic contaminants removal		Assignment: Removal efficiency analysis of selected organic contaminants		
MID TERM EXAMINATION					
WEEK-9	Biotransformation		Chapter 11: Biotransformation Processes (pp. 289–322)		
WEEK-10	Biogas preparation in lab		Laboratory preparation and monitoring of biogas production.		
WEEK-11	Biofuel preparation in lab		Biofuel yield calculation and process evaluation.		
WEEK-12	Biomass as energy resources		Assignment: Assessment of biomass as a renewable energy resource.		
WEEK-13	Dyes removal using microbes and fungus		Sangeetha et al. (2016) Chapter 13: Dye Degradation by Microorganisms (pp. 331–368)		
WEEK-14	Degradation of organic pollutants		Assignment: Prepare a biodegradation kinetics report.		
WEEK-15	Case study		Recent Research Articles in Environmental Biotechnology		
WEEK-16	Case study		Submission of Practical Record Book, Laboratory Portfolio and Viva Voce.		
FINAL TERM EXAMINATION					

TEXT BOOKS AND READING MATERIAL

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.

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

ASSESSMENT AND EXAMINATIONS:

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Program	MS Environmental Sciences	Course Code	ENSC-708	Credit hours	02
Course Title	ADVANCED GIS AND REMOTE SENSING (THEORY)				
COURSE INTRODUCTION					
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.					
LEARNING OUTCOMES					
By the end of this course the students will learn: 1. This course will provide knowledge about applications of remote sensing and GIS in Environmental sciences. 2. The students will learn about the different freely available online spatial data platforms 3. Students will have the knowledge about different spatial models being used for environmental studies 4. The students will learn different advanced digital cartography techniques					
COURSE CONTENTS				Assignments / Readings	
WEEK-1	Spatial Data Models			Introduction to Geographic Information Systems (CH#02, Page 25-55)	
	Raster and Vector datasets				
WEEK-2	Tracing and Vectorization			Mastering ArcGIS (CH#03, Page 85-115)	
	Manual and Automatic Digitization Methods and				
WEEK-3	Geodatabases			Introduction to Geographic Information Systems (CH#04, Page 110-135)	
	Topological errors				
WEEK-4	Advancement in Cartography			Essential Earth Imaging for GIS (CH#04, Page 110-135)	
	Cartography techniques				
WEEK-5	Large and Small Scale Concept			Introduction to Geographic Information Systems (CH#01, Page 1-20)	
	Online freely available platforms				
WEEK-6	USGS Earth Explorer, GIOVANI etc.			Practical Handbook of Remote Sensing (Page 120-150)	
	Datasets Downloading and Processing				
WEEK-7	Spatial data creation			Mastering ArcGIS (Page 150-180)	
	Data joining				
WEEK-8	Data Import			Introduction to Geographic Information Systems (Page 140-165)	
	Data Transformation				
MID TERM EXAMINATION					
WEEK-9	Understanding of Interpolation			Remote Sensing and Image Interpretation (Page 500-530)	
	Different Interpolation Methods				
WEEK-10	Analytical Hierarchy process			Introduction to Geographic Information Systems (Page 300-320)	
	Multicriteria indexing				
WEEK-11	Multicriteria Scoring			Mastering ArcGIS (Page 250-275)	
	Inter and Intra Criteria Ranking				
WEEK-12	Site suitability techniques-i			Introduction to Satellite Remote Sensing (Page 200-230)	
	Site suitability techniques-ii				
WEEK-13	Digital Elevation models			Introduction to Geographic Information Systems (Page 330-360)	
	Variables Extraction from DEM				
WEEK-14	Image classification techniques				

	Supervised and Unsupervised Classification	<i>Remote Sensing and Image Interpretation (2015)</i>	
WEEK-15	Model Builder in Arc GIS	<i>Mastering ArcGIS (Page 320-350)</i>	
	1D and 2D Hydrological Modeling		
WEEK-16	Environmental and Hydrological Models-i	<i>Introduction to Satellite Remote Sensing (Page 350-380)</i>	
	Environmental and Hydrological Models-ii		
FINAL TERM EXAMINATION			
TEXT BOOKS AND READING MATERIAL			
1. Kang-tsung, C. (2018). <i>Introduction to Geographic Information Systems</i>. 9th Edition, McGraw-Hill Education. 2. William, E. & Adriano, C. (2017). <i>Introduction to Satellite Remote Sensing: Atmosphere, Ocean, Land and Cryosphere Applications</i>. Elsevier, 3. Lavender, S. (2016). <i>Practical handbook of remote sensing</i>-CRC Press. Routledge, Taylor and Francis Group. 4. Lawrence, F. (2015). <i>Essential Earth Imaging for GIS</i>, Esri Press. 5. Thomas, L., Ralph, W., Kiefer, J. C. (2015). <i>Remote Sensing and Image Interpretation</i>, 7th Edition, Wiley, 6. Maribeth, P. (2018). <i>Mastering ArcGIS</i>. 8th Edition, McGraw-Hill Education. Further Reading: As suggested by instructor.			
TEACHING – LEARNING STRATEGIES			
Lecture based examination Presentation/seminars Class discussion Quizzes			
ASSIGNMENTS – TYPE AND NUMBER WITH CALENDAR			
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Program	MS Environmental Sciences	Course Code	ENSC-708	Credit hours	01
Course Title	ADVANCED GIS AND REMOTE SENSING (PRACTICAL)				
COURSE INTRODUCTION					
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.					
LEARNING OUTCOMES					
By the end of this course the students will learn: 1. This course will provide hands on practice about different applications of Remote sensing and GIS in Environmental sciences. 2. Students will learn how to get the freely available data of different environmental variables (i.e. temperature, precipitation, evapotranspiration, vegetation cover, Landuse landcover etc.) 3. Students will prepare and run different spatial models being used for environmental studies 4. The students will develop large and small scale maps using advanced digital cartography techniques 5. Students will process satellite and aerial imagery for suitability analysis, hydrological analysis and flood hazard assessment					
COURSE CONTENTS			Assignments / Readings		
WEEK-1	Network Datasets and Topology Errors Rectification		Import shape files to Geodatabases and create topology to remove errors		
WEEK-2	Personal and File Geodatabases Creation		Store data in personal and file geodatabases		
WEEK-3	Large and Small Scale Maps		Digitize the given maps of Pakistan and Prepare small and large scale maps from digitized datasets		
WEEK-4	Downloading of Rainfall and Temperature Datasets (Excel)		Download dataset from USGS Earth Explorer and Climate Engine Platforms		
WEEK-5	Comparison of Different Sensors datasets		Comparison of ERA5, CHIRPS and TERRA Precipitation and Temperature datasets		
WEEK-6	Spatial Datasets Downloading (LST, NDVI etc.)		Downloading Landsat and MODIS LST and NDVIs for Lahore		
WEEK-7	Spatio-temporal Mapping for LST and NDVIs		Quantification and spatial mapping of NDVI and LST		
WEEK-8	Excel Data Joining (Groundwater Datasets)		Creation of Spatial datasets from Multan groundwater Excel data		
MID TERM EXAMINATION					
WEEK-9	Excel Data Joining (Air Pollution Datasets)		Creation of Spatial datasets from Lahore Air Quality Excel data		
WEEK-10	Interpolation Creation on Groundwater		Spatial distribution mapping of Multan groundwater using interpolation IDW and Kriging techniques		
WEEK-11	Air Pollution Datasets		Spatial distribution mapping of Lahore air pollution mapping using IDW and Kriging techniques		
WEEK-12	Applying IDW, Kriging and Spline Interpolation Methods		Compare the results of IDW, Kriging results for groundwater and air pollution mapping		

WEEK-13	Suitable sites Mapping for Parks	<i>Inter and Intra criteria ranking for parks sites identification</i>
WEEK-14	Suitable sites Mapping for Landfill sites	<i>Inter and Intra criteria ranking for landfill sites identification</i>
WEEK-15	Slope and Aspect Extraction from DEM	<i>Downloading of DEM and extraction of Slope and aspect</i>
WEEK-16	Contours Generation	<i>Contours mapping at different intervals I.e. 10,20 & 30 meters from DEM</i>

FINAL TERM EXAMINATION

TEXT BOOKS AND READING MATERIAL

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.

TEACHING – LEARNING STRATEGIES

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

ASSIGNMENTS – TYPE AND NUMBER WITH CALENDAR

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- homework
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ASSESSMENT AND EXAMINATIONS:

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Program	MS Environmental Sciences	Course Code	ENSC-709	Credit hours	03
Course Title	NATURAL AND CONSTRUCTED WETLANDS				
COURSE INTRODUCTION					
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.					
LEARNING OUTCOMES					
By the end of this course the students will learn:					
1. The course will provide basic knowledge and scientific concepts of wetlands for their natural and man-made uses. 2. This course will introduce and discuss a wetland; characteristics of wetland systems; the principles of wetland ecology; 3. The students will learn the functions of wetlands; and regulations 4. The students will learn the permitting process regarding development near and within wetlands.					
COURSE CONTENTS				Assignments / Readings	
WEEK-1	Introduction to wetlands, RAMSAR definition, global distribution and significance			Assignment 1: Prepare a report on the importance of wetlands and the objectives of the RAMSAR Convention (2–3 pages).	
	Wetlands and climate change mitigation, ecosystem services (carbon storage, flood control)				
	Classification of wetlands (natural vs constructed, inland vs coastal)				
WEEK-2	Hydrological classification (surface flow, subsurface flow wetlands)			Assignment 2: Develop a world map showing major RAMSAR sites and discuss their ecological significance.	
	Ecological functions (nutrient cycling, biodiversity support)				
	Introduction to constructed wetlands (types, applications in wastewater)				
WEEK-3	Design parameters (HRT, hydraulic loading rate, depth, porosity)			Assignment 3: Review the role of wetlands in carbon sequestration and climate change mitigation.	
	Wetland laws, policies and environmental regulations			Quiz 1	
	Wetland vegetation (hydrophytes, plant roles in pollutant removal)				
WEEK-4	Biofilms and microbial diversity in treatment wetlands			Assignment 4: Case study analysis of flood control and water purification services provided by wetlands.	
	Substrate materials (gravel, sand, soil) and treatment efficiency				
	Wetland monitoring, stressors, and disturbance factors				
WEEK-5	Eutrophication, nutrient enrichment and control strategies			Assignment 5: Compare natural and constructed wetlands with suitable examples and illustrations.	
	Introduction to wetlands, RAMSAR definition, global distribution and significance			Quiz 2	
	Wetlands and climate change mitigation, ecosystem services (carbon storage, flood control)				
WEEK-6	Classification of wetlands (natural vs constructed, inland vs coastal)			Assignment 6: Draw and explain surface flow and	

	Hydrological classification (surface flow, subsurface flow wetlands)	subsurface flow wetland systems.
	Ecological functions (nutrient cycling, biodiversity support)	
WEEK-7	Introduction to constructed wetlands (types, applications in wastewater)	Assignment 7: Prepare a concept diagram showing nutrient cycling and biodiversity support in wetlands.
	Design parameters (HRT, hydraulic loading rate, depth, porosity)	
	Wetland laws, policies and environmental regulations	
WEEK-8	Wetland vegetation (hydrophytes, plant roles in pollutant removal)	Assignment 8: Literature review on the application of constructed wetlands in municipal wastewater treatment.
	Biofilms and microbial diversity in treatment wetlands	
	Substrate materials (gravel, sand, soil) and treatment efficiency	
MID TERM EXAMINATION		
WEEK-9	Wetland monitoring, stressors, and disturbance factors	Assignment 9: Calculate HRT and hydraulic loading rate for a hypothetical wetland treatment system.
	Eutrophication, nutrient enrichment and control strategies	
	Introduction to wetlands, RAMSAR definition, global distribution and significance	
WEEK-10	Wetlands and climate change mitigation, ecosystem services (carbon storage, flood control)	Assignment 10: Review wetland conservation policies in Pakistan and compare them with international regulations.
	Classification of wetlands (natural vs constructed, inland vs coastal)	
	Hydrological classification (surface flow, subsurface flow wetlands)	
WEEK-11	Ecological functions (nutrient cycling, biodiversity support)	Assignment 11: Identify five common wetland plants (hydrophytes) and describe their role in pollutant removal.
	Introduction to constructed wetlands (types, applications in wastewater)	Quiz 3
	Design parameters (HRT, hydraulic loading rate, depth, porosity)	
WEEK-12	Wetland laws, policies and environmental regulations	Assignment 12: Prepare a report on microbial processes involved in nutrient and pollutant removal in wetlands.
	Wetland vegetation (hydrophytes, plant roles in pollutant removal)	
	Biofilms and microbial diversity in treatment wetlands	
WEEK-13	Substrate materials (gravel, sand, soil) and treatment efficiency	Assignment 13: Compare gravel, sand, and soil as wetland substrates for wastewater treatment.
	Wetland monitoring, stressors, and disturbance factors	
	Eutrophication, nutrient enrichment and control strategies	
WEEK-14	Introduction to wetlands, RAMSAR definition, global distribution and significance	Assignment 14: Design a wetland monitoring plan including physical, chemical, and biological indicators.
	Wetlands and climate change mitigation, ecosystem services (carbon storage, flood control)	Quiz 4
	Classification of wetlands (natural vs constructed, inland vs coastal)	
WEEK-15	Hydrological classification (surface flow, subsurface flow wetlands)	Assignment 15: Analyze a case study of eutrophication in a lake
	Ecological functions (nutrient cycling, biodiversity support)	

	Introduction to constructed wetlands (types, applications in wastewater)	or wetland and propose mitigation measures.	
WEEK-16	Design parameters (HRT, hydraulic loading rate, depth, porosity)	Assignment 16: Develop a management plan for the restoration and protection of a degraded wetland ecosystem.	
	Wetland laws, policies and environmental regulations		
	Wetland vegetation (hydrophytes, plant roles in pollutant removal)		
FINAL TERM EXAMINATION			
TEXT BOOKS AND READING MATERIAL			
1. Kumar, M., Singh, N. K., & Mathuriya, A. S. (2025). Integrated bioelectrochemical–constructed wetland system for future sustainable wastewater treatment. Springer Nature. 2. Kadlec, R. H., & Wallace, S. D. (2024). Treatment wetlands (3rd ed.). CRC Press. 3. Vymazal, J. (2023). Constructed wetlands for wastewater treatment: Processes, performance, design and operation. Springer Nature. 4. Mitsch, W. J., & Gosselink, J. G. (2023). Wetlands (6th ed.). John Wiley & Sons. 5. Brix, H., Arias, C. A., & Vymazal, J. (2024). Constructed wetlands for industrial wastewater treatment. IWA Publishing. 6. Rice, E.W. et.al. (2017). Standard Methods for the Examination of Water and Wastewater. Published by APHA, AWWA, WEF. 7. Santín, I., Pedret, C., & Vilanova, R. (2016). Control and decision strategies in wastewater treatment plants for operation improvement. Springer.			
TEACHING – LEARNING STRATEGIES			
Lecture based examination Presentation/seminars Class discussion Quizzes			
ASSIGNMENTS – TYPE AND NUMBER WITH CALENDAR			
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1.	Mid Term Assessment	35%	It takes place at the mid-point of the semester
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Program	MS Environmental Sciences	Course Code	ENSC-710	Credit hours	03
Course Title	ENVIRONMENTAL IMPACTS OF PETROLEUM INDUSTRY				
COURSE INTRODUCTION					
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.					
LEARNING OUTCOMES					
By the end of this course the students will learn: - 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					
WEEK-1	Unit-1 Introduction		Li (2011), World Atlas of Oil and Gas Basins Chapter 1: Petroleum Formation and Geological Ages (pp. 1–35)		
	Occurrence of Petroleum, Geological Ages				
	Surface and Subsurface Mining				
	Environmental Impacts and management of mining				
WEEK-2	Unit-2 Source Rocks and Traps		Li (2011) Chapter 2: Source Rocks and Reservoir Systems (pp. 36–68)		
	Source Rocks, Reservoir Rocks				
	Reservoir rock				
	Cap rocks				
WEEK-3	Traps and Regional Top Seal		Assignment: Comparative analysis of SPS and TPS systems.		
	Source-rock petroleum system (SPS)				
	Tight petroleum system (TPS)				
WEEK-4	Unit-3 Petroleum Distribution in Pakistan		Li (2011) Chapter 4: Plate Tectonics and Hydrocarbon Formation (pp. 103–140)		
	The Theory of the Plate Tectonic				
	Indian Plate Collision and petroleum formation				
	Arabian Plate Subduction and petroleum formation				
WEEK-5	Hazards of petroleum extraction in Pakistan		Chapter 3: Petroleum Resources and Energy Security (pp. 61–92) Assignment: Review petroleum reserves and extraction hazards in Pakistan.		
	Regional Distribution of Petroleum				
	Onshore Basins having petroleum reserves in Pakistan				
WEEK-6	Unit-4 Petroleum Exploration and Production		Assignment: Report on geological and geophysical exploration techniques.		
	Structure Geological Features,				
	Introduction to structural geology				
	Introduction to Geophysics				
WEEK-7	Exploration and Production (E&P) Industry in Pakistan		Assignment: Analyze risks associated with exploration and production activities.		
	Measurement of Crude Oil and Gas				
	Risks Specific to the Exploration and Production Industry				
WEEK-8	Various Phases of Exploration and Production (E&P) Activities		HSE Guidelines for Petroleum Industry		
	Health, Safety and Environment (HSE) & Petroleum industry				
	Staff Training, Development and social welfare				

MID TERM EXAM		
WEEK-9	Unit-5 Drilling Methods Cable Tool	<i>Petroleum Engineering Handbook Chapter on Drilling Technologies</i>
	Draw backs, limitations and latest trends in Cable Tool method	
	Rotary Drilling	
WEEK-10	Turbo Drilling	<i>Assignment: Evaluation of drilling fluids and turbo drilling systems.</i>
	Advantages and disadvantages of turbo drilling	
	Drilling Fluids	
WEEK-11	Offshore Drilling	<i>Offshore Drilling Technical Reports Assignment: Comparative review of offshore and directional drilling.</i>
	Vertical and Directional Drilling	
	Advantages and disadvantages of turbo drilling	
WEEK-12	Unit-6 Environmental Impacts Associated with Petroleum Industry Geology and Geophysics	<i>Kuppusamy et al. (2020) Chapter 4: Environmental Impacts of Petroleum Activities (pp. 95–138)</i>
	Drilling Operations	
	Occupational and environmental hazards of drilling operations	
WEEK-13	Drilling Fluids	<i>Kuppusamy et al. (2020) Chapter 5: Petroleum Production and Environmental Risks (pp. 139–188)</i>
	Petroleum Production	
	Preparation of documentaries on hazards of petroleum industry	
WEEK-14	Midstream Activities	<i>Assignment: Oil slick and seepage case study analysis.</i>
	Oil Slick	
	Seepages	
WEEK-15	Tight Gas	<i>Kuppusamy et al. (2020) Chapter 8: Petroleum Hydrocarbon Toxicity and Remediation (pp. 251–312) Assignment: Remediation strategy for crude oil contaminated soil.</i>
	Impacts of crude oil on environment	
	Remediation of crude oil polluted degraded soil and land	
WEEK-16	Impact petroleum industry on Air Quality and climate change	<i>Olaguer (2016) Chapter 10: Air Quality and Climate Impacts (pp. 301–352)</i>
	Impact petroleum industry on water quality	
	Oil spills in oceans, effects and management	
FINAL TERM EXAM		
TEXT BOOKS AND READING MATERIAL		
1. Kuppusamy, S., Maddela, N. R., Megharaj, M., & Venkateswarlu, K. (2020). <i>Total petroleum hydrocarbons: environmental fate, toxicity, and remediation</i>. Springer. 2. Skovhus, T. L., Enning, D., & Lee, J. S. (2017). <i>Microbiologically influenced corrosion in the upstream oil and gas industry</i>. CRC press. 3. Olaguer, E. P. (2016). <i>Atmospheric impacts of the oil and gas industry</i>. Academic Press. 4. Li., G. (2011). <i>World Atlas of Oil and Gas Basins</i>. Wiley-Blackwell. 5. Gorelick, S.M. (2009) .<i>Oil Panic and Global Crisis; Predictions and Myths</i>. Wiley-Blackwell.		

TEACHING – LEARNING STRATEGIES

- Lecture based examination
- Presentation/seminars
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Program	MS Environmental Sciences	Course Code	ENSC-711	Credit hours	03
Course Title	SOIL POLLUTION				
COURSE INTRODUCTION					
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.					
LEARNING OUTCOMES					
By the end of this course the students will learn: - 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					
COURSE CONTENTS				Assignments / Readings	
WEEK-1	Components and Properties of Soil			Saha et al. (2017) Ch 1 pp:1-9; Ch 2 pp: 11-35	
	Physical, chemical and biological properties				
	Soil components				
WEEK-2	Soil properties viz. physical, chemical and biological			Saha et al. (2017) Ch 2 pp: 11-35	
	Soil quality/productivity and its degradation modes				
	Physical, chemical and biological degradation modes of soil				
WEEK-3	Importance of Soil for Agriculture Sector			Saha et al. (2017) Ch 1 pp:1-9; Ch 3 pp:37-69	
	Key Roles of Soil in Agriculture, threats and management				
	Soil as natural capital and resource				
WEEK-4	Ecosystem services of soil			Saha et al. (2017) Ch 2 pp: 11-35	
	Provisioning, Regulating, Supporting and Cultural services				
	Importance of soil for Pakistan being an agricultural country				
WEEK-5	Foundation for national food security and stability			Saha et al. (2017) Ch 4 pp:75-94; Ch 5 pp:105-120 Twardowska et al. (2007) Ch 1 pp: 1-25.	
	Soil Pollutants				
	Processes that cause soil pollution				
WEEK-6	Soil as major sink of pollutants			Saha et al. (2017) Ch 4 pp:75-94; Ch 5 pp:105-120 Twardowska et al. (2007) Ch 2 26-107	
	Types of soil pollutants viz. inorganic and organic				
	Comparison of Pollutant Characteristics				
WEEK-7	Persistent organic pollutants (POPs) in soil; pesticide pollution in soils			Twardowska et al. (2007) Ch 1 pp: 1-25.	
	Key Aspects of POPs and Pesticides in Soil				
	Key POPs/Pesticide Classifications and				
WEEK-8	Impact on Soil Ecosystems			Twardowska et al. (2007) Ch 2 26-107	
	Persistent Organic Pollutants in Soil and Its Phytoremediation				
	Factors affecting uptake of organic pollutants by plants				
MID TERM EXAMINATION					

WEEK-9	Sources of Soil Pollutants	Soriano (2014) Ch pp:3-56
	Urban sources of soil pollution	
	Soil pollution and health	
WEEK-10	Biological pollution of soils	Twardowska et al. (2007) Ch 2 26-107
	Interaction of soil constituents and pollutants	
	Key Interactions and Mechanisms	
WEEK-11	Fate of Pollutants in the Soil	Twardowska et al. (2007) Ch 2 26-107
	Tracking pathways of pollutants across soils	
	Tracking and Monitoring Technologies	
WEEK-12	Heavy metals’ transport in soils and their bioavailability and biochemical effects	Saha et al. (2017) Ch 7 Pp: 155-183
	Metal Toxicity and Microbial Resistance Mechanisms	
	Organic pollutants’ transport, retention and degradation in soil	
WEEK-13	Solubility, toxicity and fate of different types of pollutants in soils; major brownfield sites of the world	Saha et al. (2017) Ch 12 pp: 317-357. Twardowska et al. (2007) Ch 4 pp: 211-339
	Remediation of Polluted Soil	
	Soil polluted site investigation and risk assessment	
WEEK-14	Sampling and analytical approaches for contaminated soils	Twardowska et al. (2007) Ch 3 pp: 117-199; Ch 4 pp: 211-339
	Analytical Methods and Techniques	
	In-situ and ex-situ remediation technologies for polluted soils	
WEEK-15	Comparison of Technologies	Saha et al. (2017) Ch 12 pp: 317-357.
	Soil ecology and pollutant degradation	
	Impact of Soil Health on Degradation	
WEEK-16	Soil remediation challenges in Pakistan	Saha et al. (2017) Ch 12 pp: 317-357. Twardowska et al. (2007) Ch 4 pp: 211-339
	Proposed Remediation Approaches	
	Soil remediation and plants: prospects and challenges	
FINAL TERM EXAMINATION		
TEXT BOOKS AND READING MATERIAL		
1. Soriano, M. C. H. (Ed.). (2014). Environmental risk assessment of soil contamination. BoD–Books on Demand. 2. Twardowska, I., Stefaniak, S., Allen, H. E., & Häggblom, M. M. (Eds.). (2007). Soil and water pollution monitoring, protection and remediation (Vol. 69). Springer Science & Business Media. 3. 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. 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.		

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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Program	MS Environmental Sciences	Course Code	ENSC-712	Credit hours	03
Course Title	ENVIRONMENTAL AUDITING				
COURSE INTRODUCTION					
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					
LEARNING OUTCOMES					
By the end of this course the students will learn: • Know the various environmental standards and types of auditing. • Know how to conduct an audit according to ISO 14001 as well as to local management systems. • Understand the project definition and project management tools. • Understand the identification of stakeholders, the role of sponsors and the role of project manager. • Know how to apply project life cycle to a project.					
COURSE CONTENTS			Assignments / Readings		
WEEK-1	Introduction to environmental standards, ISO 14000 family overview		Assignment 1: Explain the importance of environmental standards in modern industries with examples.		
	ISO 14001 requirements and integrated management systems (IMS)				
	Auditing fundamentals and ISO 19011 guidelines		Reading: Seifi, M., & Crowder, S. (2025). <i>Environmental management systems and ISO 14001 implementation: Principles and practice (2nd ed.)</i> . CRC Press. Page; 10-35		
WEEK-2	Principles of environmental auditing (integrity, independence, evidence-based)		Assignment 2: Prepare a comparative summary of ISO 14000 family standards and ISO 14001 requirements.		
	Types of audits (compliance, performance, EMS audits)				
	Audit planning, scope definition, checklist development				
WEEK-3	Audit team selection, roles and competencies		Assignment 3: Develop a concept note on integrating ISO 14001 with ISO 9001 and ISO 45001.		
	Methods of evidence collection (interviews, records, observations)				
	Audit reporting, documentation and communication				
WEEK-4	Practical audit exercise and simulation		Reading: Seifi, M., & Crowder, S. (2025). <i>Environmental management systems and ISO 14001 implementation: Principles and practice (2nd ed.)</i> . CRC Press. Page; 70-150		
	Case study-I (industrial auditing example)				
	Case study-II (EMS auditing example)				
WEEK-5	Introduction to project management concepts		Assignment 4: Compare different types of environmental audits with real-world applications.		
	Stakeholder analysis and project life cycle phases				
	Economic benefits and industrial relevance of auditing				

WEEK-6	Final case presentation and course review	Assignment 5: Prepare a mock environmental audit report based on a sample industry scenario.
	Introduction to environmental standards, ISO 14000 family overview	
	ISO 14001 requirements and integrated management systems (IMS)	
WEEK-7	Auditing fundamentals and ISO 19011 guidelines	
	Principles of environmental auditing (integrity, independence, evidence-based)	
	Types of audits (compliance, performance, EMS audits)	
WEEK-8	Audit planning, scope definition, checklist development	Reading: Epstein, M. J., & Buhovac, A. R. (2024). Making sustainability work: Best practices in managing and measuring corporate environmental performance (3rd ed.). Routledge. Page 100-200
	Audit team selection, roles and competencies	
	Methods of evidence collection (interviews, records, observations)	
MID TERM EXAMINATION		
WEEK-9	Audit reporting, documentation and communication	Assignment 6: Perform stakeholder analysis for an environmental infrastructure project.
	Practical audit exercise and simulation	
	Case study-I (industrial auditing example)	
WEEK-10	Case study-II (EMS auditing example)	
	Introduction to project management concepts	
	Stakeholder analysis and project life cycle phases	
WEEK-11	Economic benefits and industrial relevance of auditing	Assignment 7: Compare different types of environmental audits with real-world applications.
	Final case presentation and course review	
	Introduction to environmental standards, ISO 14000 family overview	
WEEK-12	ISO 14001 requirements and integrated management systems (IMS)	Assignment 8: Compare different types of environmental audits with real-world applications.
	Auditing fundamentals and ISO 19011 guidelines	
	Principles of environmental auditing (integrity, independence, evidence-based)	
WEEK-13	Types of audits (compliance, performance, EMS audits)	
	Audit planning, scope definition, checklist development	
	Audit team selection, roles and competencies	
WEEK-14	Methods of evidence collection (interviews, records, observations)	Reading: Epstein, M. J., & Buhovac, A. R. (2024). Making sustainability work: Best practices in managing and measuring corporate environmental performance (3rd ed.). Routledge. Page 350-470
	Audit reporting, documentation and communication	
	Practical audit exercise and simulation	

WEEK-15	Case study-I (industrial auditing example)	Quiz	
	Case study-II (EMS auditing example)		
	Introduction to project management concepts		
WEEK-16	Stakeholder analysis and project life cycle phases	Quiz / Revision	
	Economic benefits and industrial relevance of auditing		
	Final case presentation and course review		
FINAL TERM EXAMINATION			
TEXT BOOKS AND READING MATERIAL			
1. Seifi, M., & Crowder, S. (2025). Environmental management systems and ISO 14001 implementation: Principles and practice (2nd ed.). CRC Press. 2. Epstein, M. J., & Buhovac, A. R. (2024). Making sustainability work: Best practices in managing and measuring corporate environmental performance (3rd ed.). Routledge. 3. Das, T.K. (2020). <i>Industrial Environmental Management: Engineering, Science, and Policy</i>. John Wiley & Sons. 4. Beasley, Mark S. (2015). <i>Auditing cases: An interactive learning approach</i>. Prentice Hall. 5. Hillary, R. (2017). <i>Introduction. In ISO 14001</i>. Routledge.			
TEACHING – LEARNING STRATEGIES			
Lecture based examination Presentation/seminars Class discussion Quizzes			
ASSIGNMENTS – TYPE AND NUMBER WITH CALENDAR			
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ASSESSMENT AND EXAMINATIONS:			
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Program	MS Environmental Sciences	Course Code	ENSC-713	Credit hours	03
Course Title	CLEANER PRODUCTION TECHNOLOGIES				
COURSE INTRODUCTION					
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.					
LEARNING OUTCOMES					
By the end of this course the students will learn:					
- 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.					
COURSE CONTENTS			Assignments / Readings		
WEEK-1	Introduction to cleaner production technologies		Strategies and Tools for Pollutant Mitigation: Avenues to a Cleaner Environment. Springer. Chapter 1: Introduction to Cleaner Production Technologies (pp. 1–28)		
	Significance of cleaner production technologies				
	Applications of cleaner production technologies				
WEEK-2	Industrial processes and sustainable development		Assignment: Evaluate the contribution of cleaner production towards reducing greenhouse gas emissions and industrial effluent discharge.		
	Reduction of greenhouse gases emissions				
	Minimization of effluent discharge				
WEEK-3	Maintenance of clean air quality		Chandrappa, R., & Kulshrestha, U. (2016). Sustainable Air Pollution Management: Theory and Practice. Springer. Chapter 3: Industrial Air Pollution Management (pp. 55–90)		
	Industrial growth and pollution management				
	Management of toxic trace elements and organic compounds				
WEEK-4	Recycling technologies		Aravind et al. (2021). Chapter 4: Recycling Technologies and Circular Economy (pp. 91–132)		
	Waste to energy				
	Circular economy				
WEEK-5	Internal solutions (process changes, raw materials change etc.)		Das, T. K. (2005). Toward Zero Discharge. Wiley. Chapter 2: Internal Process Optimization (pp. 35–68)		
	Zero liquid discharge				
	Materials recovery in industrial processes				
WEEK-6	Process external solutions, product changes and other		Das, T. K. (2005). Chapter 4: Process Modification and Material Recovery (pp. 103–145)		
	Organic and re-useable raw materials				
	Estimation and quantification raw materials				
WEEK-7	Agricultural waste into useable products		Assignment: Prepare a report on converting agricultural waste into		
	Use of plastics in road carpeting				

	Bioenergy and biofuel production	<i>useful products and renewable energy resources.</i>
WEEK-8	Advantages and disadvantages using different strategies	Zimmer, M. (2019). Chapter 6: Cleaner Production Strategies (pp. 109–142)
	Process management	
	Product design and material selection as components of Cleaner Production development	
MID TERM EXAMINATION		
WEEK-9	Learning methods and techniques of pollution prevention during production	Assignment: Develop a pollution prevention strategy for a selected manufacturing industry.
	Process internal solutions and external solutions in order to minimize air pollutions	
	Emissions of VOCs and flue gases from energy production.	
WEEK-10	Advantages and disadvantages of different methods	Das, T. K. (2005). Chapter 6: Process Integration and Cleaner Production (pp. 181–225)
	Pollution prevention and cleaner production awareness plan for effluents	
	Process internal solutions and external solutions	
WEEK-11	Constructed wetlands	Filho, L., & Witschel (2020). Clean Water and Sanitation. Springer. Selected Chapters on Constructed Wetlands and Sustainable Technologies (pp. 88–132)
	Zigzag technology in brick kiln	
	Bio-pesticides and bio-fertilizers	
WEEK-12	Recycling of electronic waste	Assignment: Evaluate electronic waste recycling and the use of indigenous raw materials in sustainable industrial production.
	Natural dyes and environmental sustainability	
	Use of indigenous raw material in industries	
WEEK-13	Solar energy	Leal Filho et al. (2021). Chapter 9: Renewable Energy and Life Cycle Assessment (pp. 221–268)
	Wind energy	
	Life-cycle assessment	
WEEK-14	Advantages and disadvantages of different methods	Zimmer, M. (2019). Chapter 8: Environmental Management Strategies (pp. 165–198)
	Passive environmental strategies	
	Reactive environmental strategies	
WEEK-15	Onsite Vs. end-of-pipe approaches	Assignment: Prepare a comparative case study of Cleaner Production practices in textile and chemical industries.
	Case studies of various industries, including:	
	Textile & Chemical industries	
WEEK-16	Automobile	Recent research articles from Journal of Cleaner Production, Resources, Conservation & Recycling, and Cleaner Environmental Systems.
	Leather	
	Paper, packaging, and allied industries	
FINAL TERM EXAMINATION		
TEXT BOOKS AND READING MATERIAL		
1. SpringerLink (Online service), Aravind, J., Kamaraj, M., Prashanthi Devi, M., & Rajakumar, S. (2021). <i>Strategies and tools for pollutant mitigation: Avenues to a cleaner environment</i>. Springer. 2. SpringerLink (Online service), Leal Filho, W., Azul, A. M., Brandli, L., Özuyar, P. G., & Wall, T. (2021). <i>Affordable and clean energy</i>. Springer. 3. Filho, L., & Witschel. (2020). <i>Clean Water and Sanitation</i>. Springer International Publishing. 4. Zimmer, M. (2019). <i>Solutions for a cleaner, greener planet: Environmental chemistry</i>. 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.

TEACHING – LEARNING STRATEGIES

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Program	MS Environmental Sciences	Course Code	ENSC-714	Credit hours	03
Course Title	SUSTAINABLE DEVELOPMENT				
COURSE INTRODUCTION					
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.					
LEARNING OUTCOMES					
By the end of this course the students will learn:					
• 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					
COURSE CONTENTS			Assignments / Readings		
WEEK-1	Introduction to sustainable development		Atepor, L., & Sackey, S. (2021). Sustainable Education and Development. Springer. Chapter 1: Introduction to Sustainable Development (pp. 1–24)		
	Definitions and history of sustainable development				
	Rio Declaration on environment and development				
WEEK-2	Concept of sustainability in developing countries		Jacques, P. (2015). Sustainability: The Basics. Routledge. Chapter 2: Dimensions and Principles of Sustainability (pp. 21–48)		
	Contemporary debate on development and environmental sustainability				
	Economic and social development together				
WEEK-3	Poverty and wealth, social inequality		Assignment: Evaluate the contribution of education, health, and governance towards achieving sustainable development.		
	Rethinking the socio-economic system				
	Social development: crises and solutions				
WEEK-4	The environmental challenges		Miralles, I., & Garcia, J. L. (2017). Environmental and Economic Impact on Sustainable Development. WIT Press.		
	Urban environmental planning and management				
	Environment and sustainable development in practice				
WEEK-5	Environmental problems in urban areas and their underlying causes		Assignment: Review the role of international organizations in promoting sustainable development.		
	Climate change and sustainability				
	Climate change: adaptation and mitigation				
WEEK-6	International treaties and conventions		Mojekwu et al. (2021). Chapter 5: Climate Change and Sustainable Development (pp. 95–128)		
	Threats to developing countries; adaptation responses and plans				
	Developing countries and energy crisis				
WEEK-7	Climate change mitigation and adaptations		Assignment: Develop a disaster risk reduction framework for a climate-vulnerable community.		
	Climate change and vulnerable societies				
	Climate change and urban heat crisis				
WEEK-8	Flood control strategies		Jacques, P. (2015).		

	Early warning systems	Chapter 5: Sustainable Consumption and Production (pp. 101–132)
	Increasing temperature & agricultural vanities	
MID TERM EXAMINATION		
WEEK-9	Food Security and Safety	Muralidharan, K. (2021). Chapter 7: Sustainable Food Systems (pp. 161–194)
	Sustainable food security a political imperative and challenge	
	Food losses and waste vs. food Security	
WEEK-10	Source reduction—Reduce waste and losses	Brebbia et al. (2017). Chapter 6: Waste Management and Resource Recovery (pp. 141–176)
	Waste to energy	
	Biofuel and bioenergy	
WEEK-11	Waste management	Assignment: Evaluate municipal solid waste management practices in a selected Pakistani city and recommend sustainable improvements.
	Waste recycling	
	Waste treatment technologies	
WEEK-12	Sustainable agriculture	Assignment: Prepare a comparative study of sustainable agriculture and smart city initiatives.
	Sustainable cities	
	Sustainable organizations	
WEEK-13	Sustainability challenges	Sharma, T. (2015). Chapter 7: Stakeholder Participation and Monitoring Systems (pp. 153–186)
	Stakeholders involvement	
	Monitoring and evaluation systems	
WEEK-14	Sustainability and International obligations	Assignment: Compare the objectives and implementation mechanisms of three international sustainability agreements.
	Treaties and agreements	
	Enforcement of rule & regulations	
WEEK-15	Sustainability and legislation challenges	Brebbia et al. (2017). Chapter 10: Sustainability Challenges in Technology, Management and Legislation (pp. 251–292)
	Sustainability and technology challenges	
	Sustainability and management challenges	
WEEK-16	Future perspectives	UNESCO. Education for Sustainable Development (ESD): Learning Objectives (Selected Readings).
	Future perspectives on the prosperity of mankind	
	Education for sustainable development	
FINAL TERM EXAMINATION		
TEXT BOOKS AND READING MATERIAL		
1. Mojekwu, J. N., Thwala, W., Aigbavboa, C., Atepor, L., & Sackey, S. (2021). <i>Sustainable Education and Development</i>. Springer. 2. Muralidharan, K. (2021). <i>Sustainable Development and Quality of Life: Through Lean, Green and Clean Concepts</i>. Springer Nature. 3. Brebbia, C. A., Miralles I. and Garcia, J. L. (2017). <i>Environmental and Economic Impact on Sustainable Development</i>. WIT PRESS, UK. 4. Mal, S., Singh, R. B., & Huggel, C. (2017). <i>Climate change, extreme events and disaster risk reduction: Towards sustainable development goals</i>. Springer. 5. Jacques, P. (2015). <i>Sustainability: the basics</i>. Routledge. 6. Sharma T. (2015). <i>Global Environmental Governance</i>. Random Publications		
Further Reading As suggested by the Instructor.		

TEACHING – LEARNING STRATEGIES

- Lecture based examination
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Program	MS Environmental Sciences	Course Code	ENSC-715	Credit hours	03
Course Title	ENVIRONMENTAL RISK ASSESSMENT AND MANAGEMENT				
COURSE INTRODUCTION					
This course will provide the understanding about assessment of human and ecological health risks from environmental stresses and various risk management approaches.					
LEARNING OUTCOMES					
By the end of this course the students will learn: • 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					
COURSE CONTENTS				Assignments / Readings	
WEEK-1	Unit-I: Foundations of Risk Science Introduction to Environmental Risk Assessment (ERA)			Read page 1-7 in Robson e al. (2022)	
	Historical perspective of human health risk from environmental chemicals				
	Key definitions: The "whats, whys, and hows" of risk science				
WEEK-2	Hazard Identification and characterizing toxic properties			Read page 8-15 in Robson et al. (2022)	
	Dose-Response Assessment: Establishing potency and thresholds				
	Exposure Assessment: Pathways, duration, and magnitude				
WEEK-3	Risk Quantification and Characterization for human populations			Read “Role of Epidemiology in Environmental Health Research” by Wil Lieberman-Cribbin and Emanuela Taioli in Robson et al. (2022)	
	Epidemiology and its role in environmental risk assessment				
	Uncertainty analysis in human health risk modeling				
WEEK-4	Unit-II: Ecological Integrity and Biosecurity Principles of Ecological Risk Assessment (EcoRA)			Read page 75-85 in Asante-Duah (2017)	
	Risk assessment to ecological systems from chemical pollutants				
	Risks from biological introductions (excluding GMOs)				
WEEK-5	Assessing risks to ecosystems from Genetically Modified Organisms (GMOs)			Read page 59 in Robson et al. (2022)	
	Assessing risks to human health from Genetically Modified Organisms				
	Comparative analysis of chemical vs. biological risk factors				
WEEK-6	Retrospective assessment: Analyzing past environmental damage			Study the eco-epidemiology model scenarios in Chapter 6 of Dalezios (2017) focusing on retrospective data collection.	
	Eco-epidemiology: Investigating causes of ecological decline				
	Ecological monitoring and long-term data collection				

WEEK-7	Unit-III: Industrial Process Safety Evaluation of the likelihood of major industrial accidents	Read Chapters 4 & 5 in Muralikrishna & Manickam (2017) regarding safety paradigms, hazard zones, and plant failure rate modeling.
	Accident modeling and consequence analysis in chemical plants	
	Risk-based safety management systems for industrial processes	
WEEK-8	Unit-IV: Natural Disaster Dynamics Introduction to natural hazards and risk analysis	Sketch an emergency response flow chart for a cascading hazard event (e.g., flood causing chemical plant failure) using Dalezios (2017) Chapter 9.
	Management strategies for floods, landslides, and seismic events	
	Integrated risk management: Linking natural and man-made disasters	
MID TERM EXAMINATION		
WEEK-9	Unit-V: Global Policy & Legislation	Read Chapter 7 in Pritchard (2014) regarding cross-border environmental standards and statutory risk benchmarks.
	Risk assessment in legislation: Global standards	
	Application of risk assessment in policy in developed countries	
	Challenges of risk-based policy in developing countries	
WEEK-10	The psychology of risk: Perceptions and human behavior	Read Chapters 6 in Greenberg (2017) addressing public cognitive biases during risk communication and economic evaluation methods.
	Communicating uncertainty to the public and stakeholders	
	The economics of risk: Cost-benefit analysis and valuation	
WEEK-11	Corporate Chemical Management: A risk-based approach	Complete the product life-cycle risk assignment found in Chapter 12 of Muralikrishna & Manickam (2017).
	Environmental risk assessment in business operations	
	A framework for sustainable product development	
WEEK-12	Unit-VI: Risk Assessment of Aquatic systems	Read Chapter 10 in Dalezios (2017) on hydraulic transport formulas, pollutant dilution, and mixing zones in municipal aquatic bodies.
	Risk assessment for water treatment and disposal systems	
	Contaminant transport modeling in aquatic environments	
	Risk management strategies for safe drinking water supply	
WEEK-13	Risk assessment and management in the exploitation of the seas	Draft a risk mitigation framework for offshore drilling projects using structural criteria from Muralikrishna & Manickam (2017).
	Protecting marine biodiversity from offshore industrial risks	
	Risk assessment and management for inland water bodies	
WEEK-14	Environmental risk assessment in development programs	Review the Environmental Impact and Social Policy readings from Chapter 3 of Pritchard (2014).
	The experience of the World Bank in managing project risks	
	Environmental and Social Frameworks (ESF) in large-scale projects	
WEEK-15	Unit VII: Risk Communication	Read Chapter 11 in Greenberg (2017) on transparency protocols, ethical constraints, and community engagement principles during structural failures.
	Principles and strategies of effective Risk Communication	
	Crisis communication and community engagement	
	Ethical considerations in sharing environmental risk data	
WEEK-16	Comparing assessed risks against societal "Acceptable Risk" criteria.	Write a policy brief applying the Precautionary Principle to a resource allocation scenario using Mohapatra (2002) Chapter 8
	Understanding its application in environmental management when scientific certainty is lacking.	
	Ranking environmental risks to optimize resource allocation for mitigation.	
FINAL TERM EXAMINATION		

TEXT BOOKS AND READING MATERIAL

1. Robson, M. G., Toscano, W. A., Meng, Q., & Kaden, D. A. (Eds.). (2022). Risk assessment for environmental health. CRC Press.
2. Asante-Duah, K. (2017). Public Health Risk Assessment for Human Exposure to Chemicals. Netherlands: Springer Netherlands.
3. Dalezios, N. R. (2017). *Environmental hazards: methodologies for risk assessment and management*. IWA Publishing, London.
4. Greenberg, R. M. (2017). *Explaining Risk Analysis: Protecting health and the environment*. Routledge, New York.
5. Muralikrishna, I. V. and Manickam, V. (2017). *Environmental Management Science and Engineering for Industry*. BS Publications, Oxford.
6. Pritchard, P. (2014). *Environmental Risk Management*. Earthscan, USA.
7. Mohapatra, R. (2002). *Occupational Health Hazards and Remedies*. Jaypee Brothers Medical Publishers Pvt. Ltd., India.

Assorted Research Papers

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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Program	MS Environmental Sciences	Course Code	ENSC-716	Credit hours	03
Course Title	ENVIRONMENTAL MANAGEMENT SYSTEM AND INTEGRATED MANAGEMENT SYSTEM				
COURSE INTRODUCTION					
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.					
LEARNING OUTCOMES					
By the end of this course the students will learn: - 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.					
COURSE CONTENTS			Assignments / Readings		
WEEK-1	Unit-1: Introduction to EMS		Read Chapter 1 in Schaltegger et al. (2017) regarding the intersection of industrial scalability and environmental systems.		
	Introduction of EMS and its core principles				
	Sustainable development and management frameworks				
	Industry and environment: Interaction and impacts				
WEEK-2	Legislation and environment since the industrial revolution		Review the historical timeline and international treaty matrix in Chapter 2 of Krishna et al. (2017).		
	Global environmental policy evolution				
	General and environmental risk management				
WEEK-3	World trade organization (WTO) and environmental management		Critique a case study on trade-related environmental disputes using baseline data from Chapter 3 of Schaltegger et al. (2017).		
	Environmental performance indicators and management				
	Characteristics of successful Environmental Management Systems				
WEEK-4	The Benefits and competitive advantages of EMS		Read the systematic cost-benefit framework in Camilleri (2022) focusing on the strategic corporate drivers for ISO 14001 certification.		
	Alignment of EMS with corporate social responsibility				
	Overcoming initial hurdles in EMS adoption				
WEEK-5	Unit-2: Environmental Resource Management		Read Chapters 1 & 2 in Goodland et al. (2019) on managing ecosystem capacities, agricultural stressors, and corporate ethics.		
	Introduction of Environmental resource management and Scope				
	Ethical, economics, and legal aspects of resource use				
	Stakeholder identification: Public, private, and civil sectors				
WEEK-6	Quality management systems and environmental synergy		Build an industrial waste audit questionnaire using data mapping tools from Chapter 5 of Krishna et al. (2017).		
	Resource efficiency and waste minimization strategies				
	Data collection methods for resource auditing				
WEEK-7	Eco-Management and Audit Scheme (EMAS)				

	Comparison between EMAS and international standards	Read Chapters 3 & 4 in Kuhre (2018) comparing structural differences, auditing cycles, and reporting rules of EMAS vs. ISO 14001.
	Registration, verification, and environmental statements	
WEEK-8	Review of Resource Management applications	Analyze the agro-industrial resource allocation case studies from Chapter 5 of Goodland et al. (2019).
	Strategic planning for resource conservation	
	Case studies on stakeholder engagement	
MID TERM EXAMINATION		
WEEK-9	Unit-3: Applications of EMS	Read Chapters 8 & 9 in Krishna et al. (2017) regarding chemical separation, effluent parameters, and facility mass balance metrics.
	Applications of EMS in industrial process flow charts	
	EMS and effluent Generation: Composition and analysis	
	Primary, secondary, and tertiary treatment of effluents	
WEEK-10	EMS Case Study: Sugar and Dairy industries	Draft an input-output process flow diagram for either a paper or steel facility using the parameters in Chapter 11 of Krishna et al. (2017).
	EMS Case Study: Pulp, Paper, and Steel Mills	
	EMS Case Study: Electroplating and Oil Refineries	
WEEK-11	Benchmarking industrial environmental performance	Read Chapter 6 in Schaltegger et al. (2017) on structural benchmarking indices and modern waste valorization technologies.
	Industrial waste-to-energy conversion models	
	Role of technology in industrial EMS applications	
WEEK-12	Unit-4: Organizational Responsibility	Read Chapters 6 & 7 in Kuhre (2018) defining corporate leadership duties, internal accountability structures, and emergency planning.
	Country legislation and its impact on corporate EMS	
	Organizational responsibility and leadership commitment	
	Emergency Operation Plan (EOP) and Management Programs	
WEEK-13	Monitoring and measuring environmental parameters	Develop a comprehensive 15-point internal audit checklist for an EMS system based on Kuhre (2018) Chapter 10.
	EMS Internal vs. External (Third-party) Audits	
	Safety audits and the corporate environmental plan	
WEEK-14	Unit-5: Organizational Theory and Barriers	Read Chapters 1, 2, & 3 in Culley (2019) on cross-functional training, standardizing matrices, and overcoming cultural resistance to IMS
	Organizational theory and identifying systemic barriers	
	Small and Medium Enterprises (SMEs): EM strategies	
	Integrated approach: ISO 9001, 14001, and 45001	
WEEK-15	Theory and practices of Integrated Management Systems (IMS)	Outline a consolidated dual audit protocol checking for both ISO 9001 and ISO 14001 markers using Culley (2019) Chapter 6.
	Auditing practices of the integrated management system	
	EMS and IMS budgeting and financial planning	
WEEK-16	Unit-6: Environmental Management Planning Policy	Read Chapter 12 in Kuhre (2018) on formalizing corrective action loops and documenting root-cause determinations.
	Environmental Aspects, Impacts, and Planning Policy	
	Structure, responsibility, and Emergency preparedness	
	Monitoring, Measurement, and Corrective Action protocols	
FINAL TERM EXAMINATION		

TEXT BOOKS AND READING MATERIAL

1. Camilleri, M. A. (2022). The rationale for ISO 14001 certification: A systematic review and a cost-benefit analysis. *Corporate Social Responsibility and Environmental Management*, 29(4), 1067-1083.
2. Goodland, R. J., Watson, C., & Ledec, G. (2019). *Environmental management in tropical agriculture*. CRC Press.
3. Culley, W. C. (2019). *Environmental and quality systems integration*. CRC Press.
4. Kuhre, W. L. (2018). *ISO 14001 Certification: Environmental Management System*. Prentice-Hall.
5. Krishna, I. M., Manickam, V., Shah, A., & Davergave, N. (2017). *Environmental management: science and engineering for industry*. Butterworth-Heinemann.
6. 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.

TEACHING – LEARNING STRATEGIES

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Program	MS Environmental Sciences	Course Code	ENSC-717	Credit hours	03
Course Title	POPULATION DYNAMICS AND ENVIRONMENT				
COURSE INTRODUCTION					
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.					
LEARNING OUTCOMES					
By the end of this course the students will learn: • 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					
COURSE CONTENTS				Assignments / Readings	
WEEK-1	Introduction to Population dynamics			Anderson (2015), World Population Dynamics Chapter 1: Population Growth and Demographic Data (pp. 1–32)	
	Demographic data				
	Population: Historic review and future trends				
WEEK-2	Fertility concepts and trends, age and sex structure, birth cohorts			Anderson (2015) Chapter 3: Fertility, Family Structure and Population Change (pp. 61–95)	
	Fertility issues, problems and policies				
	Marriage and family				
WEEK-3	Mortality and Morbidity			Banerjee et al. (2020) Chapter 4: Mortality, Migration and Urbanization (pp. 91–128)	
	Migration and urbanization				
	Poverty and welfare (Effects of sex, race, and other characteristics on status attainment)				
WEEK-4	Population and religious prospects			James (2019) Chapter 2: Population and Social Change (pp. 33–70)	
	Population and cultural prospects				
	Population and modern prospects				
WEEK-5	financial problems of the classes in society			Anderson (2015) Chapter 5: Population Growth Theories (pp. 129–165)	
	Population growth				
	Theories of Malthus Marx				
WEEK-6	The demographic transition			Assignment: Evaluate demographic transition stages of selected countries.	
	Examination of the effect of overpopulation on the world today				
	Population resources, environment and food				
WEEK-7	Population size and environment			Assignment: Population distribution and environmental pressure assessment.	
	Population distribution and environment.				
	Population composition and environment,				
WEEK-8	Population growth and climate change,			Arizpe et al. (2019) Chapter 5: Population Growth and Climate Change (pp. 121–160)	
	Population growth and land use change				
	Poverty population-environment linkages				

MID TERM EXAMINATION		
WEEK-9	Population distribution and environment.	James (2019) Chapter 6: Population, Land Use and Environment (pp. 181–220)
	Population composition and environment,	
	Population growth and climate change,	
WEEK-10	Population growth and land use change	Arizpe et al. (2019) Chapter 7: Poverty and Development Linkages (pp. 201–242)
	Poverty population-environment linkages	
	Population and development	
WEEK-11	Integrating environment and development	Assignment: Pakistan’s biocapacity and resource consumption evaluation.
	Population dynamics and environment in Pakistan,	
	Pakistan’s Bio capacity, resource consumption & crisis.	
WEEK-12	Human population and life style changes	Assignment: Urban growth and food security assessment.
	Urbanization and industrialization	
	Food security and safety challenges	
WEEK-13	Human population and growing agriculture	James (2019) Chapter 9: Population and Human Development (pp. 301–346)
	Human population and healthcare challenges	
	Human population and pandemics	
WEEK-14	Human population and natural resources exploitation	Assignment: Evaluate population growth impacts on energy demand.
	Human population and growing energy demands	
	Industrial growth and sustainable development	
WEEK-15	Government responses	Assignment: Develop a sustainable population stabilization framework.
	Individual attitudes and perceptions,	
	Sustainable approach to population stabilization	
WEEK-16	Global responses	UN Population Division Reports and Pakistan Population Policy Documents
	Situation in Pakistan	
	Future trends and strategies to overcome population growth	
FINAL TERM EXAMINATION		
TEXT BOOKS AND READING MATERIAL		
1. Banerjee, A., Jana, N. C., & Mishra, V. K. (2020). <i>Population Dynamics in Contemporary South Asia: Health, Education and Migration</i>: Springer Singapore. 2. Oro, D. (2020). <i>Perturbation, Behavioural Feedbacks, and Population Dynamics in Social Animals: When to Leave and Where to Go</i>: Oxford University Press. 3. Arizpe, L., Stone, M. P., Major, D., & Stone, P. (2019). <i>Population And Environment: Rethinking The Debate</i>: Taylor & Francis. 4. James, H. (2019). <i>Population, Development, and the Environment: Challenges to Achieving the Sustainable Development Goals in the Asia Pacific</i>: Springer Singapore. 5. Gardiner, S. M., & Thompson, A. (2017). <i>The Oxford Handbook of Environmental Ethics</i>: Oxford University Press. 6. Iannelli, M., & Milner, F. (2017). <i>The Basic Approach to Age-Structured Population Dynamics: Models, Methods and Numerics</i>: Springer Netherlands. 7. Baudot, B. S., & Moomaw, W. R. (2016). <i>People and their Planet: Searching for Balance</i>: Palgrave Macmillan UK. 8. Anderson, B. A. (2015). <i>World Population Dynamics: An Introduction to Demography</i>: Pearson.		

TEACHING – LEARNING STRATEGIES

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Program	MS Environmental Sciences	Course Code	ENSC-718	Credit hours	03
Course Title	WASTE REDUCTION AND RECYCLING				
COURSE INTRODUCTION					
The course Waste Reduction and Recycling provides students with a comprehensive understanding of how waste is generated, managed, and minimized in modern societies. With increasing environmental challenges such as pollution, resource depletion, and climate change, effective waste management has become essential for sustainable development. This course introduces the fundamental concepts of waste reduction, including the principles of Reduce, Reuse, Recycle and Recover (4Rs) . Students will explore different types of waste such as municipal, industrial, hazardous, and electronic waste and examine their environmental and health impacts.					
LEARNING OUTCOMES					
By the end of this course the students will learn:					
<					

WEEK-8	General Laws	Assignment: Compare waste-to-energy technologies including incineration, gasification and pyrolysis.
	Special Laws	
	International Laws	
MID TERM EXAMINATION		
WEEK-9	Development Drivers	Tchobanoglous & Kreith (2002). Chapter 10: Landfilling and Landfill Design (pp. 301–352)
	Industrialization Impact	
	Urban Growth	
WEEK-10	Source Separation Systems	Pichtel (2014). Chapter 10: Hazardous Waste Recycling and Treatment (pp. 257–296)
	Paper & Glass Recycling	
	Plastic & Metal Recycling	
WEEK-11	Electronic Waste Recycling	Assignment: Evaluate plastic waste management challenges and propose sustainable alternatives.
	Biodegradable Waste Recycling	
	Composting	
WEEK-12	Soil Amendment from Bio-waste	Assignment: Prepare a case study demonstrating circular economy practices in developed and developing countries.
	Benefits of Recycling	
	Recycling as Waste Reduction Option	
WEEK-13	Life Cycle Analysis (LCA)	Assignment: Conduct a cost-benefit analysis of a municipal recycling program.
	Importance of LCA	
	Environmental Impact Assessment	
WEEK-14	Thermal Treatment (Incineration, Autoclaving)	Review recent innovations in electronic waste recycling, lithium-ion battery recycling and plastic upcycling technologies.
	Chemical Treatment (Filtration, Flotation)	
	Coagulation & Centrifugation	
WEEK-15	Solidification/Stabilization	Pichtel (2014). Chapter 12: Waste Management Policies and Regulations (pp. 329–370)
	Biological Treatment (Anaerobic Digestion)	
	Biological Treatment(composting)	
WEEK-16	Recovery of energy	World Bank (2018). What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050.
	Recovery of nutrients	
	Zero Waste policy	
FINAL TERM EXAMINATION		
TEXT BOOKS AND READING MATERIAL		
1. Reddy, P. J. (2019). <i>Energy recovery from municipal solid waste by thermal conversion technologies</i>. CRC Press. 2. Ghosh, S. K. (2019). <i>Waste Valorisation and Recycling</i>. Springer. 3. Rao, M. N., Sultana, R., Kota, S. H., Shah, A., & Davergave, N. (2016). <i>Solid and hazardous waste management: science and engineering</i>. Elsevier Publishing. 4. Connett, P. (2013). <i>The zero-waste solution: untrashing the planet one community at a time</i>. Chelsea Green Publishing. 5. Pichtel, J. (2005). <i>Waste management practices: municipal, hazardous, and industrial</i>. CRC press. 6. Cheremisinoff, N. P. (2003). <i>Handbook of solid waste management and waste minimization technologies</i>. Butterworth-Heinemann.		

TEACHING – LEARNING STRATEGIES

- Lecture based examination
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ASSIGNMENTS – TYPE AND NUMBER WITH CALENDAR

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ASSESSMENT AND EXAMINATIONS:

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Program	MS Environmental Sciences	Course Code	ENSC-719	Credit hours	02
Course Title	ADVANCED INDUSTRIAL WASTEWATER TREATMENT (THEORY)				
COURSE INTRODUCTION					
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.					
LEARNING OUTCOMES					
By the end of this course the students will learn: - 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					
COURSE CONTENTS				Assignments / Readings	
WEEK-1	Industrial wastewater sources, characteristics and pollution load				
	Differences between industrial and municipal wastewater				
WEEK-2	Physical, chemical and biological parameters (BOD, COD, TSS, heavy metals)				
	Process selection criteria and treatment system evaluation				
WEEK-3	Preliminary treatments (equalization, neutralization, screening)				
	Oil-water separation, dissolved air flotation (DAF)				
WEEK-4	Waste minimization (source reduction, cleaner production)				
	Monitoring, discharge standards and regulatory compliance				
WEEK-5	Biological treatments (activated sludge, trickling filters)				
	Nutrient removal (nitrification, denitrification, phosphorus removal)				
WEEK-6	Advanced processes (membranes, adsorption, electrocoagulation)				
	Advanced oxidation processes (Fenton, UV, Ozone, photocatalysis)				
WEEK-7	Process integration and hybrid treatment systems				
	Zero Liquid Discharge (ZLD) concepts and applications				
WEEK-8	Emerging technologies and future trends				
	Course review and final project presentation				
MID TERM EXAMINATION					
WEEK-9	Industrial wastewater sources, characteristics and pollution load				
	Differences between industrial and municipal wastewater				
WEEK-10	Physical, chemical and biological parameters (BOD, COD, TSS, heavy metals)				
	Process selection criteria and treatment system evaluation				
WEEK-11	Preliminary treatments (equalization, neutralization, screening)				
	Oil-water separation, dissolved air flotation (DAF)				
WEEK-12	Waste minimization (source reduction, cleaner production)				

	Monitoring, discharge standards and regulatory compliance		
WEEK-13	Biological treatments (activated sludge, trickling filters)		
	Nutrient removal (nitrification, denitrification, phosphorus removal)		
WEEK-14	Advanced processes (membranes, adsorption, electrocoagulation)		
	Advanced oxidation processes (Fenton, UV, Ozone, photocatalysis)		
WEEK-15	Process integration and hybrid treatment systems		
	Zero Liquid Discharge (ZLD) concepts and applications		
WEEK-16	Emerging technologies and future trends		
	Industrial wastewater sources, characteristics and pollution load		
FINAL TERM EXAMINATION			
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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TEXT BOOKS AND READING MATERIAL			
1. SpringerLink, Muthu, S. S. (2021). <i>Advances in textile waste water treatments</i> . Springer.			
2. Filho, L., & Witschel. (2020). <i>Clean Water and Sanitation</i> . Springer International Publishing.			
3. Chen, J., Luo, J., Luo, Q., Pang, Z., & Group, C. E. P. (2018). <i>Wastewater treatment: Application of new functional materials</i> . China Environment Publishing Group; Walter de Gruyter.			
4. PALCI EBSCO books & Sen, T. K. (2015). <i>Physical, chemical and biological treatment processes for water and wastewater</i> . Nova Science Publishers, Inc.			
5. Hammer, M. J., & Hammer, M. J. (2012). <i>Water and wastewater technology</i> (7th ed.). Pearson/Prentice Hall.			

Program	MS Environmental Sciences	Course Code	ENSC-719	Credit hours	01
Course Title	ADVANCED INDUSTRIAL WASTEWATER TREATMENT (PRACTICAL)				
COURSE INTRODUCTION					
This laboratory based course is comprised of most commonly applied wastewater treatment technologies and suitable industrial waste treatment applications.					
LEARNING OUTCOMES					
By the end of this course the students will learn: - 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					
COURSE CONTENTS					Assignments / Readings
WEEK-1	Laboratory safety, introduction to instruments and protocols				
WEEK-2	Sampling techniques and preservation methods				
WEEK-3	Preparation of synthetic industrial wastewater				
WEEK-4	Measurement of parameters (pH, turbidity, TDS, COD, BOD)				
WEEK-5	Pollution load calculations (flow rate, kg/day)				
WEEK-6	Analysis of real industrial wastewater samples				
WEEK-7	Coagulation/flocculation experiments (jar test)				
WEEK-8	Adsorption studies using activated carbon/nanomaterials				
MID TERM EXAMINATION					
WEEK-9	Biological treatment demonstration				
WEEK-10	Membrane filtration/RO demonstration				
WEEK-11	AOP experiments (ozonation, UV/H ₂ O ₂)				
WEEK-12	Tertiary treatment techniques				
WEEK-13	Wastewater recycling and reuse evaluation				
WEEK-14	Industrial visit and treatment plant observation				
WEEK-15	Data analysis, interpretation and presentation				
WEEK-16	Quiz/ assignment / Lab Manual				
FINAL TERM EXAMINATION					
TEXT BOOKS AND READING MATERIAL					
1. SpringerLink, Muthu, S. S. (2021). <i>Advances in textile waste water treatments</i> . Springer. 2. Filho, L., & Witschel. (2020). <i>Clean Water and Sanitation</i> . Springer International Publishing. 3. Chen, J., Luo, J., Luo, Q., Pang, Z., & Group, C. E. P. (2018). <i>Wastewater treatment: Application of new functional materials</i> . China Environment Publishing Group; Walter de Gruyter. 4. PALCI EBSCO books & Sen, T. K. (2015). <i>Physical, chemical and biological treatment processes for water and wastewater</i> . Nova Science Publishers, Inc. 5. Hammer, M. J., & Hammer, M. J. (2012). <i>Water and wastewater technology</i> (7th ed.). Pearson/Prentice Hall.					

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Program	MS Environmental Sciences	Course Code	ENSC-720	Credit hours	03
Course Title	COASTAL ENVIRONMENT AND MANAGEMENT				
COURSE INTRODUCTION					
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.					
LEARNING OUTCOMES					
By the end of this course the students will learn: 1. Students will develop an understanding and importance of Coastal and Marine resources 2. Students will learn about the concepts and importance of Coastal and Marine Ecosystems 3. Students will have the overview of Environmental issues in coastal and marine ecosystems 4. They will have the understanding about Integrated Coastal Zone Management to safeguard coastal and marine ecosystems/resources					
COURSE CONTENTS				Assignments / Readings	
WEEK-1	Basic definitions and Introduction to coastal area coastal resources			Wang (2020), Ch. 1 (pp. 1–32)	
	Overview of coastal management concepts and principle				
	important tools for coastal management				
WEEK-2	An overview of coastal resources, boundaries, and offshore areas of Pakistan			Wang (2020), Ch. 2 (pp. 33–68)	
	Wetlands along Pakistan coast				
	RAMSAR sites along Pakistan Coast				
WEEK-3	An overview on living resources and natural marine ecosystems			Assignment: Mangrove ecosystem assessment.	
	Introduction and importance of Mangroves				
	Threats to Mangroves forests in Pakistan				
WEEK-4	Introduction and importance Coral reefs			Assignment: Coral reef conservation review.	
	Significance of Biotic communities				
	Nonliving Marine Resources				
WEEK-5	Potential energy from Tides, Waves, and Ocean Thermal Energy			Wang (2020), Ch. 5 (pp. 121–154)	
	Coastal fish and birds populations				
	Coastal areas as stopover sites in birds flyways				
WEEK-6	Overview to coastal landforms and classification			Liang & Zhang (2018), Ch. 2 (pp. 45–70)	
	Rocky coasts				
	Reef coasts				
WEEK-7	Beach and barriers coasts			Assignment: Comparative analysis of estuaries and deltas	
	Deltas and estuaries				
	Muddy coasts				
WEEK-8	Age, tectonic settings, Sea levels, Sediment Supply, Hydrodynamic Energy levels			Ahlhorn (2017), Ch. 4 (pp. 81–112)	
	Coastal areas and continental shelves				
	Coastal encroachments,				
MID TERM EXAMINATION					

WEEK-9	Introduction to marine and coastal pollution	FRID & CASWELL (2016), Ch. 2 (pp. 29–58)
	Chronic and acute inorganic and organic marine pollutants	
	Ocean waste disposals and its implications	
WEEK-10	Eutrophication	Assignment: Coastal erosion and seawater intrusion report.
	Coastal erosion and accretion	
	Seawater Intrusion	
WEEK-11	Impact of coastal pollution on coastal resources and amenities	Assignment: Climate change vulnerability assessment.
	Climate change impacts on coastal zones	
	Coastal human settlements and their impacts	
WEEK-12	An overview to integrated coastal management practices	Ahlhorn (2017), Ch. 6 (pp. 145–188)
	Marine pollution control and mitigation measurements in coastal zones	
	Management of Beaches & Coastal Hazards	
WEEK-13	Beach erosion and water quality control, Copping with Beach Erosion	Zanuttigh et al. (2014), Ch. 8 (pp. 211–265)
	Guarding People and Property against Natural Hazards	
	Oil spills contingency plan and combating techniques	
WEEK-14	Policy, legislation and institutional arrangement for costal management	Assignment: GIS-based coastal mapping exercise.
	Applications of GIS in coastal management	
	Green turtle conservation in Pakistan; a success story	
WEEK-15	Management on Mangrove/study cases	Assignment: Comparative ecosystem management review.
	Management on Coral reef /study cases	
	Management on Seagrass/ study cases	
WEEK-16	Management on Coastal fisheries and coastal aquaculture /study cases	Pakistan Coastal Fisheries Reports
	Coastal management and socio-economic implications	
	Community inclusion in coastal areas management	
FINAL TERM EXAMINATION		
TEXT BOOKS AND READING MATERIAL		
1. Wang, Y. (2020). <i>Coastal and marine environments</i>. 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). <i>Integrated coastal zone management: Status, Challanges and prospects</i>. Springer Vieweg. 4. FRID, C., & CASWELL, B. A. (2016). <i>Marine Pollution</i>. Oxford University Press. 5. Zanuttigh, B., Nicholls, R. J., Vanderlinden, J., Thompson, R. C., & Burcharth, H. F. (2014). <i>Coastal risk management in a changing climate</i>. Butterworth-Heinemann.		
TEACHING – LEARNING STRATEGIES		

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.

Program	MS Environmental Sciences	Course Code	ENSC-721	Credit hours	03
Course Title	URBAN ECOLOGY				
COURSE INTRODUCTION					
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.					
LEARNING OUTCOMES					
By the end of this course the students will learn: - 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.					
COURSE CONTENTS				Assignments / Readings	
WEEK-1	Unit-1: Concepts of Urban Ecology			Read the introductory historical synthesis in <i>McDonnell & Niemelä (2011)</i> tracing urban ecology from early sociology to modern spatial science.	
	Theories of urban ecology and historical development				
	Linkages between ecology and sustainable urbanism				
	Evolution of urban ecosystems and ecological theory				
WEEK-2	Concepts of Eco-cities and their implementation			Reading: Read Chapters 1 & 2 in <i>James & Douglas (2023)</i> analyzing metabolic fluxes and the environmental realities of structural concentration.	
	Smart cities: Technology and environmental integration				
	Compact cities: Density and resource efficiency				
WEEK-3	Challenges and opportunities of urban growth			Assignment: Analyze the land-use change vectors of a peri-urban landscape based on structural metrics detailed in Chapter 2 of <i>Forman (2014)</i> .	
	Rural-urban migration and ecological impacts				
	Dynamics of peri-urban growth and land-use change				
WEEK-4	Global trends in urbanization and sustainability			Reading: Read Chapter 3 in <i>Kotsila et al. (2023)</i> exploring structural spatial exclusions and resource consumption patterns across urban growth models.	
	Resource consumption patterns in modern cities				
	Policy frameworks for sustainable urban growth				
WEEK-5	Unit-2: Green Spaces, Bio-diversity Conservation and Conflicts			Reading: Read Chapters 1–3 in <i>Ossola & Niemelä (2018)</i> on structural vegetation design and canopy health challenges across varying socio-economic zones.	
	Urban greens: Challenges and choices for management				
	Human-nature interactions in urban environments				
	Urban forest management and ecosystem services				
WEEK-6	Bio-diversity conservation conflicts in urban areas			Assignment: Map out a wildlife corridor blueprint across a fragmented landscape using the core patch-corridor matrix rules from <i>Forman (2014)</i> .	
	Habitat fragmentation and invasive species management				
	Urban wildlife corridors and connectivity				

WEEK-7	Spatial dimensions of urban ecology	Reading: Study the spatial analytics, remote sensing techniques, and GIS landscape mapping exercises outlined in Chapter 4 of <i>Richter & Weiland (2012)</i> .
	Mapping urban biodiversity and green infrastructure	
	Remote sensing applications in urban ecological study	
WEEK-8	Community-led green space management initiatives	Assignment: Critique a local community forestry program against the socio-ecological equity models highlighted in Kotsila et al. (2023).
	Socio-ecological benefits of urban vegetation	
	Financing and maintaining urban green assets	
MID TERM EXAMINATION		
WEEK-9	Unit-3: Urban Environmental Challenges Industrial ecology and the concept of symbiosis	Reading: Read Chapters 5 & 6 in <i>Kirsten (2016)</i> focusing on aerosol dynamics, acoustic barriers, and modern atmospheric emission monitoring.
	Management of air quality in dense urban centers	
	Noise pollution: Sources, impacts, and mitigation	
WEEK-10	Urban water ecological challenges and hydrology	Reading: Read Chapter 6 in <i>James & Douglas (2023)</i> detailing macro-hydrological shifts, peak runoff calculus, and cooling effects of water bodies
	Stormwater management and sustainable drainage (SuDS)	
	Urban heat island effect and its environmental impact	
WEEK-11	Unit-4: Impact Analysis and Ecological Footprint Analysis Environmental Impact Analysis (EIA) for urban projects	Reading: Review the technical frameworks for Strategic Environmental Assessments (SEA) within municipal boundaries in Chapter 7 of <i>Richter & Weiland (2012)</i> .
	Social Impact Analysis (SIA) in city planning	
	Strategic Environmental Assessment (SEA) frameworks	
WEEK-12	Environmental Impact Analysis (EIA) for urban projects	Assignment: Conduct a mock screening step for a major transit project based on the urban EIA methodologies outlined in <i>Richter & Weiland (2012)</i> .
	Social Impact Analysis (SIA) in city planning	
	Strategic Environmental Assessment (SEA) frameworks	
WEEK-13	Unit-5: Urban Planning and Human Well-being Human health issues in cities: Physical and mental	Reading: Read Chapters 8 & 9 in <i>Kirsten (2016)</i> tracking epidemiological footprints, spatial configurations, and public mental fatigue in concrete zones.
	Urban planning and its role in air pollution control	
	Urban structure and impacts on human and wildlife	
WEEK-14	Urban planning and human health interventions	Assignment: Draft a biophilic redevelopment concept paper for an industrial park utilizing design philosophies from Chapter 11 of <i>Ossola & Niemelä (2018)</i> .
	Designing walkable and active urban environments	
	Biophilic design and psychological well-being	
WEEK-15	Unit-6: Climate Change, Mitigation and Adaptation Climate modifications in cities and local microclimates	Reading: Read Chapter 12 in <i>Forman (2014)</i> regarding adaptive architecture, wind tunnel minimization, and structural sea-level mitigation.
	Managing climate change challenges in urban centers	
	Adaptation measures to make cities climate-resilient	
WEEK-16	Mitigation measures for carbon-neutral cities	Assignment: Construct an urban climate hazard risk matrix for a coastal city using vulnerability equations found in <i>James & Douglas (2023)</i> .
	Future predictions and ecological risk assessment	
	Preventive measures and disaster risk management	
FINAL TERM EXAMINATION		

TEXT BOOKS AND READING MATERIAL

1. Kotsila, P., Anguelovski, I., García-Lamarca, M., & Sekulova, F. (2023). *Injustice in urban sustainability: ten core drivers* (p. 170). Taylor & Francis.
2. James, P., & Douglas, I. (2023). *Urban ecology: an introduction*. Routledge.
3. Ossola, A. and Niemelä, J. (2018). *Urban Biodiversity; From Research to Practice*, Routledge, New York
4. Kirsten M. (2016). *Ecology of Urban Environments*, John Wiley & Sons Ltd. West Sussex.
5. Forman, R. T. (2014). *Urban ecology: science of cities*. Cambridge University Press.
6. Richter M. and Weiland, U., (2012). *Applied Urban Ecology*. Wiley-Blackwell, UK.
7. McDonnell, M. J., & Niemelä, J. (2011). *The history of urban ecology*. *Urban ecology*,

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:

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.

Program	MS Environmental Sciences	Course Code	ENSC-722	Credit hours	03
Course Title	BIOLOGICAL CONSERVATION				
COURSE INTRODUCTION					
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:					
LEARNING OUTCOMES					
By the end of this course the students will learn:					
- 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.					
COURSE CONTENTS				Assignments / Readings	
WEEK-1	Significance of Biological conservation			Reading: Read Chapters 1 & 2 in <i>Sher & Primack (2019)</i> defining the triple tiers of diversity alongside functional ethical groundings.	
	Biodiversity at Species, genetic and ecosystem levels				
	Biological population and communities				
WEEK-2	Past and current state of our planet			Reading: Read Chapters 1 & 3 in <i>Van Dyke & Lamb (2020)</i> addressing historical extinction timelines, planetary shifts, and baseline definitions.	
	Significance of biodiversity conservation in modern time				
	Biological complexity and sustainability				
WEEK-3	Speciation, species and their significance			Assignment: Complete the extinction rate calculation problem set using models from Chapter 4 of Cardinale et al. (2019).	
	Extinction of species and ecosystem balance				
	Reduction extinction rate in modern time				
WEEK-4	Estimating biodiversity			Reading: Study the biogeographic distribution mechanisms and indices (\$H'\$ and \$D\$) in Chapter 5 of Cardinale et al. (2019).	
	Global pattern and drivers of biodiversity				
	Species richness, evenness and ecosystem balance				
WEEK-5	Biodiversity and ecosystem functioning			Assignment: Build an economic valuation model for an ecosystem service (e.g., local wetland filtration) utilizing methods from <i>Sher & Primack (2019)</i> Chapter 4.	
	Structure and function of biological diversity				
	Ecosystem services and ecological economies				
WEEK-6	IUCN-Redlist and conservation priorities			Reading: Review international legislative architectures, listing criteria, and enforcement gaps from Chapter 8 of <i>Van Dyke & Lamb (2020)</i> .	
	CITIES agreement and conservation of endangered species				
	Conventions on biodiversity and conservation				
WEEK-7	Habitat loss			Reading: Read Chapter 6 in Cardinale et al. (2019) on Edge Effects, corridor isolation dynamics, and extraction thresholds.	
	Habitat fragmentation and degradation				
	Overexploitation				
WEEK-8	Invasive species and conservation biology			Assignment: Write an invasive species management brief detailing	
	Diseases and conservation biology				

	Forest fires and conservation biology	control mechanics for an aquatic ecosystem based on <i>Sher & Primack (2019)</i> Chapter 7.
MID TERM EXAMINATION		
WEEK-9	Climate Change and Biodiversity conservation	Reading: Read Chapters 2 & 3 in <i>Gillson (2015)</i> mapping historical paleo-ecological adaptation pathways against contemporary climate shifts.
	Climate change and species migrations	
	Climate change and shrinking ecosystems	
WEEK-10	Pollution and conservation biology	Reading: Read Chapter 8 in <i>Cardinale et al. (2019)</i> on bioaccumulation pathways and structural effects of persistent synthetic materials.
	Heavy metals and pesticides	
	Emerging pollutants; a major challenge for conservation	
WEEK-11	Conservation of species and genetic, species and ecosystem levels	Assignment: Solve spatial diversity indices comparing alpha, beta, and γ variations across test landscapes using formulas from <i>Sher & Primack (2019)</i> Chapter 3.
	Alpha, Beta and gamma diversity and biological conservation	
	Local, regional and transboundary conservation	
WEEK-12	In-situ and ex-situ conservation	Read Chapters 4 & 5 in <i>de Lima & Green (2017)</i> on community economic incentives, wild management, and the ethics of tourism.
	Conservation and keystone species	
	Trophy hunting and conservation of species	
WEEK-13	Protected areas and biological conservation	Read Chapters 11 & 12 in <i>Van Dyke & Lamb (2020)</i> addressing design criteria for reserves (SLOSS debate) and captive breeding rules.
	National Parks, wildlife Parks, sanctuaries	
	Zoos, aquaria and botanical gardens	
WEEK-14	RAMSAR convention and biodiversity conservation	Assignment: Draft an adaptive management blueprint for a wetland ecosystem utilizing case study frameworks from Chapter 6 of <i>Gillson (2015)</i> .
	RAMSAR sites of Pakistan and biodiversity	
	Indus dolphin game reserve; a case study	
WEEK-15	Snowplowed conservation in Pakistan	Reading: Study the behavioral monitoring protocols and wildlife telemetry systems detailed in Chapters 4 & 7 of <i>Berger-Tal & Saltz (2016)</i> .
	Mangrove conservation in Pakistan	
	Green turtle conservation in Pakistan	
WEEK-16	Human wildlife conflict	Assignment: Create a stakeholder consensus map resolving a localized human-predator conflict scenario using frameworks from <i>Berger-Tal & Saltz (2016)</i> .
	Biodiversity conservation and stakeholders	
	Legislation and policy making for biodiversity conservation	
FINAL TERM EXAMINATION		
TEXT BOOKS AND READING MATERIAL		
1. Van Dyke, F., & Lamb, R. L. (2020). <i>Conservation Biology: Foundations, Concepts, Applications</i>: Springer International Publishing. 2. Cardinale, B., Primack, R. B., Murdoch, J. D., & Murdoch, J. (2019). <i>Conservation Biology</i>: Oxford University Press. 3. Sher, A. A., & Primack, R. B. (2019). <i>An Introduction to Conservation Biology</i>: Oxford University Press, Incorporated. 4. de Lima, I. B., & Green, R. J. (2017). <i>Wildlife Tourism, Environmental Learning and Ethical Encounters: Ecological and Conservation Aspects</i>: Springer International Publishing. 5. Berger-Tal, O., & Saltz, D. (2016). <i>Conservation Behavior: Applying Behavioral Ecology to Wildlife Conservation and Management</i>: Cambridge University Press. 6. Gillson, L. (2015). <i>Biodiversity Conservation and Environmental Change: Using Palaeoecology to Manage Dynamic Landscapes in the Anthropocene</i>: Oxford University Press.		

TEACHING – LEARNING STRATEGIES

- Lecture based examination
- Presentation/seminars
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ASSIGNMENTS – TYPE AND NUMBER WITH CALENDAR

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- 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.

Program	MS Environmental Sciences	Course Code	ENSC-723	Credit hours	02
Course Title	HEALTH, SAFETY AND ENVIRONMENTAL MANAGEMENT (THEORY)				
COURSE INTRODUCTION					
This course is a foundation of Environment and Health & Safety covering all basic areas of this discipline.					
LEARNING OUTCOMES					
By the end of this course the students will learn:					
• Learn basic understanding of potential workplace safety and health and environmental hazards • Identify and demonstrate a working knowledge of the environmental and occupational health and safety regulations. • Conduct basic safety inspections using strategies that has been developed though hazard identification, job hazard analysis and risk assessment. • Review the principles for developing and implementing a successful occupational health and safety program and evaluation of a work site. • Identify the major historical events that influenced accident prevention activities in the pre/post industrial revolution. • 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.					
COURSE CONTENTS			Assignments / Readings		
WEEK-1	Unit-I: Introduction to Health, Safety and Environment		Reading: Hughes, P., & Ferrett, E. (2020). <i>Introduction to Health and Safety at Work: For the NEBOSH National General Certificate in Occupational Health and Safety</i> . Routledge. Page: 5-100. Assignment 1: Write a short report on the importance, scope, and evolution of Occupational Health & Safety (2–3 pages).		
	Introduction to occupational health and safety: definitions, scope and importance				
	History of health and safety: evolution of standards from Industrial Revolution to present				
WEEK-2	Industrial hygiene: recognition, evaluation and control of workplace hazards		Assignment 2: Prepare a timeline showing key milestones from the Industrial Revolution to ISO 45001.		
	Role of national and international agencies: ILO, WHO, OSHA, NIOSH				
WEEK-3	Elements of ILO-OSH 2001 and OHSAS 18001: key requirements and structure		Assignment 3: Identify workplace hazards (physical, chemical, biological) in a selected industry and suggest control measures.		
	Elements of ISO 45001: occupational health and safety management systems				
WEEK-4	Features and contents of OHS policy: development, implementation and review		Assignment 4: Write a comparative analysis of OHSAS 18001 and ISO 45001 standards.		
	Legal framework for occupational health and safety in Pakistan				
WEEK-5	Unit-III: Health and Safety Culture		Assignment 5: Conduct a survey (or case study) on safety culture in an organization or campus environment.		
	Concept and significance of health and safety culture in organizations				
	Factors influencing safety-related behavior and strategies for improvement				

WEEK-6	Principles and practice of risk assessment: hazard identification and risk evaluation	Assignment 6: Perform a basic risk assessment (hazard identification + risk matrix) for a laboratory or workshop.
	Hierarchy of controls: elimination, substitution, engineering, administrative and PPE	
WEEK-7	Unit-IV (continued): Specific Hazard Controls	Quiz 1
	Electrical safety: hazards, prevention and lockout/tagout procedures	
	Confined spaces: entry procedures, atmospheric testing and rescue planning	
WEEK-8	Physical and psychological health hazards and their risk control measures	Assignment 7: Apply hierarchy of controls to reduce hazards in a selected industrial scenario.
	Emergency preparedness and response planning	
MID TERM EXAMINATION		
WEEK-9	Unit-V: Inspection and Audit Systems	Assignment 8: Prepare an electrical safety checklist including LOTO (Lockout/Tagout) procedures.
	Workplace inspection systems: types, planning and reporting	
	Safety audits: internal and external audit procedures and outcomes	
WEEK-10	Incident reporting systems: near-miss reporting, investigation and root cause analysis	Assignment 9: Design an emergency response plan for chemical exposure or fire incident.
	Key performance indicators (KPIs) for health and safety management	
WEEK-11	Hazardous substances and health effects: chemical, biological and radiological hazards	Assignment 10: Conduct a mock workplace inspection checklist and report findings.
	Toxicology and the importance of Material Safety Data Sheets (MSDS/SDS)	
WEEK-12	Work at height: risk assessment, fall prevention and rescue procedures	Assignment 11: Collect and analyze SDS (Material Safety Data Sheets) for 3 industrial chemicals.
	Fire safety: fire triangle, classification, prevention and firefighting equipment	
WEEK-13	Ergonomics and musculoskeletal disorders: risk factors, assessment and control	Assignment 12: Identify ergonomic risks in office or factory work and propose improvements.
	Permit to work systems: hot work, cold work and excavation permit	
WEEK-14	Unit-VII: Environmental Management in HSE	Quiz 2
	Integration of environmental management into HSE systems	Quiz 3
	Environmental aspects and impacts in industrial operations	
WEEK-15	Waste management, chemical storage and spillage control in industrial settings	Assignment 13: Explain integration of environmental management into HSE systems with examples.
	HSE legislation in Pakistan: Factory Act, NEQS and environmental compliance	
WEEK-16	HSE management in construction sector	Assignment 14: Prepare a fire safety plan and fall protection strategy for construction work.
	HSE management in oil and gas, and manufacturing sectors in Pakistan	Assignment 15: Case study on HSE practices in oil & gas or construction sector in Pakistan.

TEXT BOOKS AND READING MATERIAL

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.

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.

Program	MS Environmental Sciences	Course Code	ENSC-723	Credit hours	01
Course Title	HEALTH, SAFETY AND ENVIRONMENTAL MANAGEMENT (PRACTICAL)				
COURSE INTRODUCTION					
This course will provide practical knowledge of occupational Health Safety and environment using different instruments/strategies.					
LEARNING OUTCOMES					
By the end of this course the students will learn: - 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					
COURSE CONTENTS			Assignments / Readings		
WEEK-1	PPE identification and proper usage techniques		Write the name and functions of all equipment		
WEEK-2	Noise level monitoring using sound level meter		Performance/Monitoring		
WEEK-3	Measurement of light intensity and temperature		Performance/Monitoring		
WEEK-4	Humidity measurement and workplace comfort analysis		Performance/Monitoring		
WEEK-5	Hazard identification techniques (checklists, HAZID)		Case Study of any industry		
WEEK-6	Risk assessment (JHA, risk matrix)		Case Study/Make a plan		
WEEK-7	Emergency response planning and drills		Prepare a fire safety plan and fall protection strategy for construction work.		
WEEK-8	Fire safety training and evacuation drill		Performance/Monitoring		
MID TERM EXAMINATION					
WEEK-9	First aid and CPR techniques		Performance/Monitoring		
WEEK-10	Biological monitoring (air/water quality)		Making procedures		
WEEK-11	Workplace safety inspection practices		Prepare training and the use of equipment		
WEEK-12	Safety audit and reporting		Performance/Monitoring		
WEEK-13	Incident/accident investigation		Identify ergonomic risks in office or factory work and propose improvements.		
WEEK-14	Field visit to industry/site		Prepare an electrical safety checklist including LOTO (Lockout/Tagout) procedures.		
WEEK-15	Data analysis and presentation		Conduct a mock workplace inspection checklist and report findings.		
WEEK-16	Final practical examination		Prepare a sample incident report and define KPIs for HSE performance monitoring.		
FINAL TERM EXAMINATION					

TEXT BOOKS AND READING MATERIAL

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.

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.

Program	MS Environmental Sciences	Course Code	ENSC-724	Credit hours	03
Course Title	SUSTAINABLE AGRICULTURE				
COURSE INTRODUCTION					
This course includes the agricultural resources of Pakistan, Strategies to control soil erosion, Reduction of agricultural pollutants and sustainable farming system.					
LEARNING OUTCOMES					
By the end of this course the students will learn: • This course will provide the students with key concepts about sustainable agriculture • This Course 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					
COURSE CONTENTS				Assignments / Readings	
WEEK-1	Introduction			Power and Prasad (1997) Ch 1 Pp: 1-4 Farooq and Pisante (2019) Ch 1 pp: 3-26	
	Concept of sustainable agriculture				
	Threatened agricultural resources in Pakistan; soil, water and environment				
WEEK-2	Mitigation and Adaptation Measures			Wolf and Snyder (2003) Ch 1 pp: 1-15 Farooq and Pisante (2019) Ch 5 pp: 105-132	
	Agriculture problems in Pakistan and possible solutions				
	Sustaining soil resources				
WEEK-3	Global and Individual Responsibility in sustaining soil resources			Wolf and Snyder (2003) Ch 2 pp:19-37; Ch 3 pp:45-64	
	Organic farming				
	Benefits and common challenges of Organic Farming				
WEEK-4	Strategies to control soil erosion			Wolf and Snyder (2003) Ch. 7 pp:169-192	
	Agricultural and Structural Strategies				
	Soil natural amendments; sewage sludge and other organic wastes				
WEEK-5	Use of salt tolerant crops and varieties			Power and Prasad (1997) Ch 7 pp:95-113	
	Mechanisms for Salt Tolerance				
	Use of drought resistant crops				
WEEK-6	Characteristics and Adaptations			Farooq and Pisante (2019) Ch 6 PP: 133-166	
	Sustaining water resources				
	Control of water run-off				
WEEK-7	Key Methods of Evaporation Control			Farooq and Pisante (2019) Ch 6 PP: 133-166	
	Factors Affecting Control Efficacy				
	Reduction of water losses from deep percolation				

WEEK-8	Key Methods to Reduce Deep Percolation	Farooq and Pisante (2019) Ch 6 PP: 133-166
	Reducing deep percolation losses using geotextile sheets	
	Water conservation studies for Pakistan	
MID TERM EXAMINATION		
WEEK-9	Reduction of agricultural pollutants	Farooq and Pisante (2019) Ch 7PP: 167-212; Ch 8 PP:213-248
	Major Measures to Reduce Agricultural Pollution	
	Optimum use of agricultural chemicals, fertilizers	
WEEK-10	Multiple cropping, rotations	Power and Prasad (1997) Ch 8 Pp:118-161
	Common Cropping Systems & Examples	
	N-fixation	
WEEK-11	Alternate land uses	Power and Prasad (1997) Ch 20 pp:339-346
	Plant growth promotion	
	Cropping systems to sustain productivity	
WEEK-12	Strategies for Maximizing Productivity	Farooq and Pisante (2019) Ch 3 pp: 43-78
	Role of PGPR for plant growth promotion	
	Common PGPR Mechanisms:	
WEEK-13	Benefits to Sustainable Agriculture	Farooq and Pisante (2019) Ch 3 pp: 43-78
	Role of mycorrhizae for plant growth promotion	
	Sustainable farming system	
WEEK-14	Core Approaches and Techniques	Farooq and Pisante (2019) Ch 18 Pp: 557-586
	Principles and strategies for designing sustainable farming systems	
	Site specific technological options for sustainable crop production	
WEEK-15	Benefits to Sustainability	Tull (2011) Ch 1 pp:1-42
	Kitchen gardening	
	Benefits of a Kitchen Gardening	
WEEK-16	Precision agriculture	Srinivasan (2006) Ch 1 pp: 1-10
	Precision Agriculture for Crop and Livestock Farming	
	Precision Agriculture in Pakistan	
FINAL TERM EXAMINATION		
TEXT BOOKS AND READING MATERIAL		
1. Power, J. F., & Prasad, R. (1997). Soil fertility management for sustainable agriculture. CRC press. 2. Wolf, B., & Snyder, G. (2003). Sustainable soils: the place of organic matter in sustaining soils and their productivity. CRC Press. 3. Farooq, M., & Pisante, M. (Eds.). (2019). Innovations in sustainable agriculture. Cham: Springer. 4. Srinivasan, A. (Ed.). (2006). Handbook of precision agriculture: principles and applications. CRC press. 5. Tull, D. E. (2011). The Natural Kitchen: Your Guide to the Sustainable Food Revolution. ReadHowYouWant. com. 6. Shepard, M. (2013). <i>Restoration agriculture</i> (No. 631.584 S547r). Texas, US: Acres, 2013.		

TEACHING – LEARNING STRATEGIES

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ASSESSMENT AND EXAMINATIONS:

Sr. No.	Elements	Weightage	Details
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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.

Program	BS Environmental Sciences	Course Code	HQ-01	Credit hours	01
Course Title	UNDERSTANDING OF HOLY QURAN / FAHM-E-QURAN - II				
LEARNING OUTCOMES					
By the end of this course, students will be able to:					
1. Develop the ability to understand basic words of the Quran, phrases and sentences that do not contain verbs (unit 1 to 5 of Muallim ul Quran Book) and then sentences having present tense (first half of unit 6 of Muallim ul Quran Book). 2. Acquire a strong foundation for understanding long verses of the Quran with clarity. 3. Comprehend Quranic vocabulary, particles (operative & non operative particles), compounds (Adjective & Possessive compound), pronouns (singular & plural) and types of plural through hundreds of Quranic sentences. 4. Recognize and understand different styles of Quranic sentences, including nominal sentence, emphatic sentence, double emphatic sentence, negative sentence, interrogative sentence, oath –based sentences. 5. Strengthen understanding of fundamental Quranic linguistic styles, expressions and idioms. 6. Understand at least 30 to 40 % of each page of the holy Quran.					
COURSE CONTENTS					
Weeks	Lectures (1.5 hrs)	Units	Lessons	Assignments/Home Task	Linguistic Rules
1.	1.	1	1-6	Writing the meaning of Quranic words Lesson 1-8	Proper Noun Masculine & Feminine
	2.	1	9-14	Writing the meaning of Quranic words 9-14	Two kinds of plural Concept of {و} "And" Common Noun
2.	1.	1	15-17	Writing the meaning of Quranic words, phrases & translation of Sentences 15-17	Demonstrative Noun {This & That for Masculine (هَذَا هُنَا)} Demonstrative Noun {This & That for Feminine} (هَذِهِ هُنَا)
	2.	1	18-19 & Revision (Unit 1)	Writing the meaning of Quranic words , phrases & translation of Sentences 17-19 Quiz	Laam for emphasis (لَا لِمُؤْمِنٍ) (لَا لِمُؤْمِنٍ) Superlative Degree like أَكْبَرُ Revision of all Quranic Sentences
3.	1.	Unit 2	1-3	Writing the meaning of Quranic words, phrases & translation of Sentences 1-3	Emphatic Particle اِنَّ Preposition "For" (لِ) (لِ) Preposition (فِي)
	2.	2	4-6	Writing the meaning of Quranic words, phrases & translation of Sentences 4-6	Preposition (عَلَى مِنْهُ) (عَلَى مِنْهُ)

4.	1.	2	7- 9	Writing the meaning of Quranic words & translation of Sentences 7-9	Preposition (إلى) Absolute Negation Particle Exceptive Particle (لا النافية) (إلا) (ما النافية) (الجنس)
	2.	2	10-13 & Revision (Unit 2)	Writing the meaning of Quranic words, phrases & translation of Sentences 10-13 Quiz	Subordinating Conjunction (أن), Was (كان), Vocative Particle (هـ)

5.	1.	Unit 3	1+2	Writing the meaning of Quranic phrases 1+2	Quranic Adjective Compounds (صفة وموصوف)
	2.	3	3+5	Writing the meaning of Quranic phrases & translation of sentences 3+5	Quranic Possessive Construction (مضاف ومضاف إليه)
6.	1.	3	6+7	Writing the meaning of Quranic phrase translation of sentences 6+7	Quranic Possessive Construction (مضاف ومضاف إليه)
	2.	3	8+10 & Revision (Unit 3)	Writing the meaning of Quranic phrase & translation of sentences 8+10 Quiz	Active Participle (اسم الفاعل), Passive Participle (اسم المفعول), Dual (مثنى)
7.	1.	Unit 4	1+2	Writing the meaning of Quranic phrase & translation of sentences 1+2	Personal Pronoun He (هو) (المتصل) Possessive Pronoun His (له) (المتصل)
	2.	4	3+4	Writing the meaning of Quranic phrase & translation of sentences 3+4	Possessive Pronoun with prepositions like في بيته Pronoun "His" with prepositions like له، منه، فيه
8.	1.	4	5+8	Writing the meaning of Quranic sentences 5+8	Personal Pronoun You (أنت) (المتصل) Possessive Pronoun Your (لك) (المتصل) Possessive Pronoun with prepositions like في بيتك Pronoun "your" with prepositions like لك، منك، قبك
	2.	Mid Term			

B.	1.	4	9-12	Writing the meaning of Quranic phrases & sentences 9-12	Personal Pronoun She (هي) (المتن) Possessive Pronoun Her (ها) (المتن) Possessive Pronoun with prepositions like في بيتها Pronoun "Her" with prepositions like لَهَا
	2.	4	13-16	Writing the meaning of Quranic phrases & sentences 13-16	Personal Pronoun I (أنا) (المتن) Possessive Pronoun Her (ي) (المتن) Possessive Pronoun with prepositions like في بيتي Pronoun "My" with prepositions like لِي
D.	1.	4	17 & Revision Unit 4	Revision of all Quranic sentences of Unit 4 Quiz	Adverb (حال)
	2.	Unit 5	1-2	Writing the meaning of Quranic phrases & sentences 1-2	Masculine Plural جميع المذكر السالم و جمع المذكر السالم المسوق بحرف العر
1.	1.	5	3-4	Writing the meaning of Quranic phrases & sentences 3-4	Possessive Construction with Plurals جميع المذكر السالم المسوق بالإضافة
	2.	5	5-6	Writing the meaning of Quranic phrases, sentences & verses 5-6	Personal Pronoun They (هم) (المتن) Possessive Pronoun Their (هم) (المتن)
2.	1.	5	7-8	Writing the meaning of Quranic phrases, sentences & verses 7-8	Possessive Pronoun with prepositions like في بيتهم Pronoun "Their" with prepositions like لَهُم
	2.	5	9-11	Writing the meaning of Quranic phrases, sentences & verses 9-11	Personal Pronoun You (أنتم) (المتن) Possessive Pronoun Your (كم) (المتن) Possessive Pronoun with prepositions

					في بيتكم like
3.	1.	5	12-14	Writing the meaning of Quranic phrases & sentences & verses 12-14	Pronoun "Your" with prepositions like لكم Personal Pronoun We (نحن) Possessive Pronoun Our (لنا)
	2.	5	15-16	Writing the meaning of Quranic sentences & verses 15-16	Possessive Pronoun with prepositions like في بيتنا Pronoun "Our" with prepositions like لنا
4.	1.	5	17-18	Writing the meaning of Quranic sentences & Verses 17-18	Demonstrative Pronoun These, Those (هؤلاء أولئك)
	2.	5	19-23	Writing the meaning of Quranic sentences & Verses 19-23	ما / إنا، إن / إنا، إنا، ليس، ما، (أنا، أن، بـ، كل (أنا، أنيس، اليوم، يومك، سبحان، مايلهما، قر، إن، بش، نعم، كلا، ما أنراك، حسنة، أظن بـ، معبر، مرحب، دنيا، تميز)
5.	1.	5	Revision Unit 5	Quiz	
	2.	5	1-3 (till Page 16)	Writing the meaning of Quranic Verbs & Translation of Quranic Sentences & Verses (1-3)	Introduction of Present Tense (القول المضارع) & Verbal Sentence (جمله فعلية) Present Tense القول المضارع صيغة المفرد يعلم
6.	1.	6	3 (From Page 17) & 4-5	Translation of Quranic Sentences & Verses 3-5	Present Tense القول المضارع صيغة المفرد يعلم
	2.	6	6	Translation of Quranic Sentences & Verses	Present Tense القول المضارع صيغة الجمع يعلمون

FINAL TERM EXAMINATION

TEACHING – LEARNING STRATEGIES

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ASSESSMENT AND EXAMINATIONS:			
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3.	Final Assessment	40%	Written examination at the end of the semester. It is mostly
TEXT BOOKS AND READING MATERIAL			
1. Paper book: All volumes are available in printed book form. 2. Tutorial videos: Teaching video of each lesson available on YouTube. 3. Confirmation Videos: A complete series of confirmation videos of all lessons is available in which the student can confirm his answers. 4. A flipbook: A flipbook edition is also accessible. 5. Helping material: Helping material for the teachers like quizzes, question papers and images is available on website.			

Program	BS Environmental Sciences	Course Code	HQ-02	Credit hours	01
Course Title	UNDERSTANDING OF HOLY QURAN / FAHM-E-QURAN - II				
LEARNING OUTCOMES					
By the end of this course, students will be able to:					
1. Directly comprehend hundreds of Quranic sentences & verses. 2. Understand at least 80 to 85 % of each page of the holy Quran. 3. Understand common verses across different Quranic topics. 4. Achieve proficiency in the basic and advance linguistic aspects of the Arabic language. 5. Understand the difference between Quranic verbs in various forms, such as present, past and imperative. 6. Develop the ability to understand long verses of the holy Quran independently and then comprehend their interpretation.					
COURSE CONTENTS					
Weeks	Lectures	Units	Lessons	Assignments/Home Task	
1.	1.	6	6	Understanding & Translation of Verses	Present Tense صيغة جمع مذكر غائب مثل يعبدون
	2.	6	7-8	Understanding & Translation of Verses	Present Tense صيغة جمع مذكر غائب مثل يعبدون
2.	1.	6	9-10	Understanding & Translation of Verses	Present Tense صيغة مفرد مذكر مخاطب (تعبد) وجمع مذكر مخاطب (تعبدون)
	2.	6	11-12	Understanding & Translation of Verses	Present Tense صيغة جمع مذكر مخاطب (تعبدون)
3.	1.	6	13	Understanding & Translation of Verses	صيغة المتكلم (أعبد) Present Tense صيغة جمع المتكلم (نعبد)
	2.	6	14-15	Understanding & Translation of Verses	Negative Imperative صيغة المفرد وصيغة الجمع , لا تعبد، لا تعبدوا
4.	1.	6	16-17	Understanding & Translation of Verses	Conditional Sentences & masdar moawal (مصدر مؤول)
	2.	6	18-19	Understanding & Translation of Verses	Laam uttaleel (لام التعليل) & Laam ul jhood(لام الجحود)
5.	1.	6	20-21	Understanding & Translation of Verses	Present with object pronouns & Passive Voice
	2.	6	Revision (Unit 6)	Quiz	

6.	1.	Unit 7	1 (sec 1-3)	Understanding & Translation of Verses	Past Tense صيغة المفرد للماضي
	2.	6	1 (Sec 4-5)	Understanding & Translation of Verses	Past Tense صيغة المفرد للماضي
7.	1.	6	1 (Sec 5-6)	Understanding & Translation of Verses	Past Tense صيغة المفرد للماضي
	2.	6	1 (Sec 7-9)	Understanding & Translation of Verses	Past Tense صيغة المفرد للماضي
8.	1.	7	Revision	Understanding & Translation of Verses QUIZ	Past Tense صيغة المفرد للماضي
	2.	MID TERM			
9.	1.	7	2 (sec 1-2)	Understanding & Translation of Verses	Past Tense صيغة الجمع للماضي
	2.	7	2 (sec 3)	Understanding & Translation of Verses	Past Tense صيغة الجمع للماضي
10.	1.	7	2 (sec 4-5)	Understanding & Translation of Verses	Past Tense صيغة الجمع للماضي
	2.	7	2 (sec 6-7)	Understanding & Translation of Verses	Past Tense صيغة الجمع للماضي
11.	1.	7	3 (sec 1-2)	Understanding & Translation of Verses	Past Tense صيغة الجمع للمتكلم
	2.	7	3 (sec 2-3)	Understanding & Translation of Verses	Past Tense صيغة الجمع للمتكلم
12.	1.	7	3 (sec 3-4)	Understanding & Translation of Verses	Past Tense صيغة الجمع للمتكلم
	2.	7	3 (sec 4-5)	Understanding & Translation of Verses	Past Tense صيغة الجمع للمتكلم
13.	1.	7	4 (sec 1-2-3)	Understanding & Translation of Verses	Past Tense صيغة الجمع للمخاطب
	2.	7	4 (sec 4-5)	Understanding & Translation of Verses	Past Tense صيغة الجمع للمخاطب
14.	1.	7	5-6	Understanding & Translation of Verses Quiz	Past Tense صيغة المتكلم والمخاطب
	2.	7	7	Understanding & Translation of Verses	Past Tense صيغة المؤنث للماضي
15.	1.	7	8	Understanding & Translation of Verses	Passive Voice (Past Tense) فعل مجهول للمفرد
	2.	7	9	Understanding & Translation of Verses	Passive Voice (Past Tense) فعل مجهول للجمع
16.	1.	8	1-4	Understanding & Translation of Verses	Imperative Verb for singular فعل الأمر للمفرد
	2.	7	5-8	Understanding & Translation of Verses	Imperative Verb for plural فعل الأمر للجمع
FINAL TERM EXAMINATION					

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ENSC-727: THESIS (BASED ON ORIGINAL RESEARCH (06 Credit hr)