Central University of Himachal Pradesh

Shahpur Campus

Department of Environmental Sciences

Program Specific Outcomes (Pso's)

Program Outcomes (Po's)

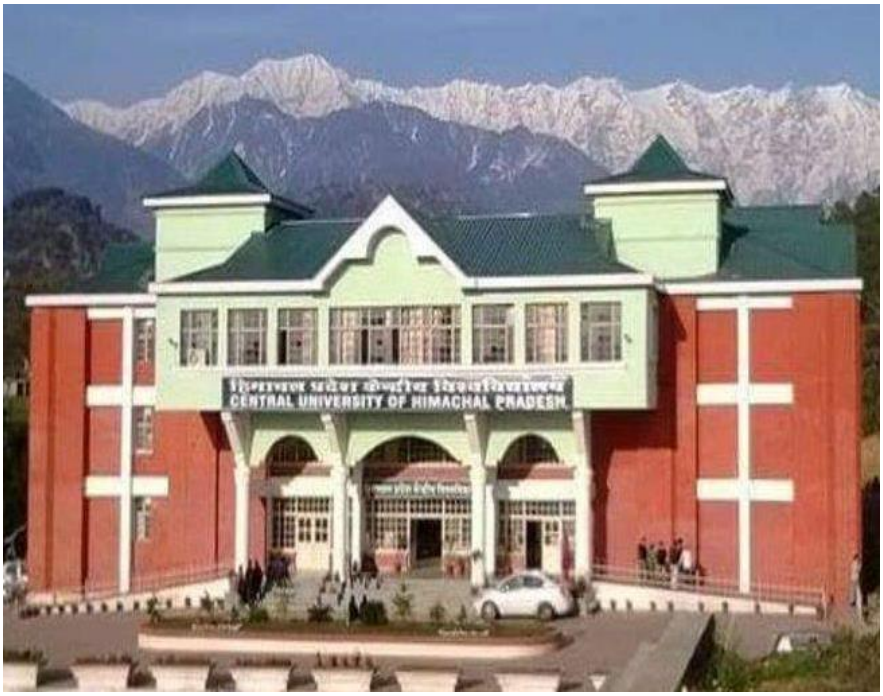
Course Outcomes & Course Contents

of

Master of Science in Environmental Sciences

(MSc Environmental Science)

School of Earth and Environmental Sciences



Programme Specific Outcomes of Master of Science in Environmental Sciences

PSO[1]- To enhance students' ability to understand and mitigate environmental issues

PSO[2]- To augment the acumen to analyse geological and environmental research problems of social relevance

PSO[3]- To ensure lifelong learning on scientific skills for industrial applications and entrepreneurship

Programme Outcomes of Master of Science in Environmental Sciences

PO[1] - To develop in-depth knowledge on the structure and function of the global environment

PO[2]- To inculcate a harmonious relationship between nature and human being

PO[3]- To foster a culture of indigenous traditional knowledge for sustainable future

PO[4]- To make them committed towards professional ethics

Course contents and their significance faculty wise

1. Prof. A. K. Mahajan

<table>
<tr><td colspan="8">Prof. A.K. Mahajan</td></tr>
<tr><td></td><td colspan="5"></td><td colspan="2"></td></tr>
<tr><td>Course No:</td><td colspan="5">Course Name:
Research and Publication Ethics</td><td colspan="2">Course Code: ENV 618</td></tr>
<tr><td rowspan="2">Batch:

2021-2023</td><td rowspan="2">Programme:

M.Sc. Environmental Sciences</td><td rowspan="2">Semester:

II</td><td>L</td><td>T</td><td>P</td><td>Credits</td><td>Contact Hrs. per Week: 2</td></tr>
<tr><td>2</td><td>0</td><td>0</td><td>2</td><td>Total Hrs.: 30</td></tr>
<tr><td colspan="3" rowspan="2">Total Evaluation Marks: 100
Mid-Term: 25
End-Term: 75
CIA: 25s</td><td colspan="5"></td></tr>
<tr><td colspan="5">Pre-requisite of course: Basic knowledge of Physics Chemistry and Biology along with geology</td></tr>
<tr><td>Course Objectives</td><td colspan="7">The course is designed to aware student with the ethical issues and misconduct related to the research and equant students with research steps to be followed for undertaking research activity in their Ph.D programme in concordance with UGC guidelines. Student will have hands on session to identify misconduct and predatory publications. Tutorial classes and assignments will help them to check plagiarism in the documents and to understand its implications in their thesis writing and research article preparation and publications.</td></tr>
</table>

Course Outcomes:	After completing this course, student is expected to learn the following: **CO^1** : Student will be in a position to start his research with right spirit. **CO^2** : Development of his/her writing skill. **CO^3** : Enhance in report writing **CO^4** : Understand how to identify plagiarism using different software's and its implications in their research carrier. **CO^5** : Understand different software's to be used in research data collections/indexing references data citations and research metrics.
Attendance Requirement:	Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.
Evaluation Criteria:	**1.** Mid Term Examination: 20% **2.** End Term Examination: 60% **3.** Continuous Internal Assessment : 20%

COURSE SYLLABUS

Unit No.	Contents	Contact Hrs.
I	Introduction to philosophy: definition, nature and scope, concept, branches Ethics: definition, moral philosophy, nature of moral judgements and reactions	4
II	Ethics with respect to science and research Intellectual honesty and research integrity Scientific misconducts: Falsification, Fabrication, and Plagiarism (FFP) Redundant publications: duplicate and overlapping publications, salami slicing Selective reporting and misrepresentation of data	5
III	Publication ethics: definition, introduction and importance Best practices/standards setting initiatives and guidelines: COPE, WAME, etc. Conflicts of interest Publication misconduct: definition, concept, problems that lead to unethical behaviour and vice versa, types Violation of publication ethics, authorship and contributor ship Identification of publication misconduct, complaints and appeals Predatory publishers and journals	7
IV	Open access publications and initiatives SHERPA/RoMEO online resource to check publisher copyright & self-archiving policies Software tool to identify predatory publications developed by SPPU Journal finder/journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer Journal Suggested, etc.	4
V	Publication Misconduct	

Suggested Readings:

1. Bird, A. (2006).Philosophy of Science.Routledge.
2. MacIntyre, Alasdair (1967) A Short History of Ethics. London.
3. P. Chaddah, (2018) Ethics in Competitive Research: Do not get scooped; do not get plagiarized, ISBN:978-9387480865
4. National Academy of Sciences, National Academy of Engineering and Institute of Medicine. (2009). On Being a Scientist: A Guide to Responsible Conduct in Research: Third Edition. National Academies Press.
5. Resnik, D. B. (2011). What is ethics in research & why is it important. National Institute of Environmental
6. Health Sciences, 1-10. Retrieved from https://www.niehs.nih.gov/research/resources/bioethics/whatis/index.cfm
7. Beall, J. (2012). Predatory publishers are corrupting open access. Nature, 489(7415), 179-179. https://doi.org/10.1038/489179a
8. Indian National Science Academy (INSA), Ethics in Science Education, Research and Governance(2019), ISBN: 978-81-939482-1-7. http://www.insaindia.res.in/pdf/Ethics_Book.pdf

Course Outcomes (COs) Mapping with POs and PSOs

All the courses together must cover all the POs (and PSOs). For a course we map the COs to POs through the CO-PO matrix and to PSOs through the CO-PSO matrix as shown below. The various correlation levels are:
"-" indicates there is **no** correlation
"1" – Slight (**Low**) Correlation
"2" – Moderate (**Medium**) Correlation
"3" – Substantial (**High**) Correlation

Programme Specific Outcomes of Master of Science in Environmental Sciences

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Programme Outcomes of Master of Science in Environmental Sciences

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PO^3- To foster a culture of indigenous traditional knowledge for sustainable future
PO^4- To make them committed towards professional ethics

Course Articulation Matrix of ENV 618 – Research and Publication Ethics

PSOs/ POs	PSO^1	PSO^2	PSO^3	PO^1	PO^2	PO^3	PO^4
CO^1	1	2	1	1	3	2	2
CO^2	1	2	2	3	2	2	3
CO^3	1	2	3	2	2	2	3
CO^4	2	3	3	2	2	2	3
CO^5	3	3	3	3	3	3	2

1: *Partially Related* **2:** *Moderately Related* **3:** *Highly Related*

Course No:	**Course Name:** **Earthquake awareness**				**Course Code: ENV 437**		
Batch: 2020-2022	**Programme:** M.Sc. Environmental Sciences	**Semester:** II	**L** 2	**T** 0	**P** 0	**Credits** 2	**Contact Hrs. per Week: 2** **Total Hrs.: 30**
Total Evaluation Marks: 100 Mid-Term: 25 End-Term: 75 CIA: 25s							
	Pre-requisite of course: Basic knowledge of Physics Chemistry and Biology along with geology						
Course Objectives	Trends for disaster losses are increasing rapidly, and earthquake disasters are among the highest threats. Projected losses are unsustainable, and there must be greater emphasis placed on mitigation of hazards, as opposed to the traditional approach that placed most emphasis on response and recovery. This course is intended to help create a new generation of earthquake hazard managers who are better informed and better prepared to make decisions, obtain relevant information, and better understand how to make effective impacts on reduction of earthquake hazards. Since the students are from different field i.e. sciences and Humanities group so the information is provided accordingly.						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO^1** : Inculcate the culture of measurements amidst the student. **CO^2** : To aware the students and in turn their parents to how to know about the intensity of an earthquake. **CO^3** : To make them understand the impact of any earthquake by goining through this course **CO^4** : How to have safer world in earthquake prone region. To work in association with UNO and related NGO'S working in earthquake awareness programmes. **CO^5** : To get employment in national/state disaster management authorities .						
Attendance Requirement:	Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.						
Evaluation Criteria:	**1.** Mid Term Examination: 20% **2.** End Term Examination: 60% **3.** Continuous Internal Assessment : 20%						

COURSE SYLLABUS

Unit No.	**Contents**	**Contact Hrs.**
I	Introduction: purpose of course, requirements Causes of Earthquakes: basic cause of earthquakes Distribution of Earthquakes: where earthquakes tend to occur	4
II	Characteristics of Earthquakes: measuring sizes of earthquakes, etc. How to measure an earthquake magnitude and intensity. What are different magnitude scales like Richter scale, body wave	4

	magnitude, surface wave magnitude and moment magnitude. What are different intensity scales explain ach intensity scale i.e. Rossi Forel scale, MMI Intensity scale, MSK-64 intensity scale and EMS -98 scale. Earthquake Research and Information: Why is earthquake research important for hazard reduction, what do we know and what are the contemporary research issues (prediction, etc.)?	
III	The Nature and Effects of Earthquake Hazards: How earthquake hazards are unique and what affects they produce	2
IV	Seismic zonation of India, criteria for seismic zonation, different seismic zoning map of India. Awareness and preparedness: public awareness, awareness derives earthquake preparedness, medical preparedness, disaster management plans and schedule for awareness activities. Disaster Phases and Earthquake Policies: review of earthquake disaster phases and history and current status of earthquake policy.	4
V	Mitigation: what mitigation involves, typical mitigation procedures, and the importance of this concept what mitigation involves, typical mitigation procedures, and the importance of this concept. Earthquake Disaster Response and Recovery: a brief on overview and basic principles and issues associated with earthquake response and recovery. Nature of Earthquake Disaster Vulnerability: what factors affect earthquake vulnerability and why is there a growing trend for disaster losses? Community participation for outreach programme.	6

Suggested Readings:

1. Srivastava H.N. 2004.Earthquakes, Forecasting and Mitigation Natioanl Book Trust pub. 399p
2. NDMA Report: Earthquake disaster guidelines 48p http://www.ndma.gov.in/en/guidelines.html
3. GSI 1992. Uttarkashi Earthquake October, 20, 1991. Geol. Surv. Spec. Publ. 30 Case histories of Uttarkashi earthquake .
4. Sharma K.K, et al., 2006. Environmental Geohazards: Science and society Research India press. 455pp.
5. Notes to be provided by the teachers from time to time. As the topic does not have one books for all lectures.

Course Outcomes (COs) Mapping with POs and PSOs

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PO^4- To make them committed towards professional ethics

Course Articulation Matrix of ENV 437 – Earthquake awareness

PSOs/ POs	PSO[1]	PSO[2]	PSO[3]	PO[1]	PO[2]	PO[3]	PO[4]
CO[1]	1	2	1	1	3	2	2
CO[2]	2	2	2	3	2	2	3
CO[3]	2	2	3	2	2	2	2
CO[4]	2	3	3	2	2	2	3
CO[5]	3	3	3	3	3	3	2

1: *Partially Related* **2:** *Moderately Related* **3:** *Highly Related*

Course No:	**Course Name:** **Disaster Management**				**Course Code: ENV 536**		
Batch: 2020-2022	**Programme:** M.Sc. Environmental Sciences	**Semester:** II	**L** 2	**T** 0	**P** 0	**Credits** 2	**Contact Hrs. per Week: 2** **Total Hrs.: 30**
Total Evaluation Marks: 100 Mid-Term: 25 End-Term: 75 CIA: 25s							
	Pre-requisite of course: Basic knowledge of Physics Chemistry and Biology along with geology						
Course Objectives	• Understand different natural and manmade disasters • Explore the reason of its origin and the possible antidotes so that it can dwindle to some extent. • Implement environmentally sound strategies in this concern						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO^1** : Explain disaster management theory (cycle, phases, risk, crisis, emergency, disasters, and resilience). **CO^2** : Compare hazards, disasters and associated natural phenomena and their interrelationships, causes and their effects - developing humanitarian Assistance before and after disaster **CO^3** : Compare anthropogenic hazards, disasters and associated activities and their interrelationships of the subsystems - Green House Effect, Global warming, Causes and their effects and development of humanitarian assistance before and after disaster **CO^4** : Apply knowledge about existing global frameworks and existing agreements and role of community in successful Disaster Risk Reduction **CO^5** : Evaluate DM study including data search, analysis and presentation as a case study. Create Technological innovations in Disaster Risk Reduction: Advantages and problems						
Attendance Requirement:	Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.						
Evaluation Criteria:	**1.** Mid Term Examination: 20% **2.** End Term Examination: 60% **3.** Continuous Internal Assessment : 20%						

COURSE SYLLABUS

Unit No.	Contents	Contact Hrs.
I	Introduction to Disaster Management, Farmer curve showing significance and frequency of different natural disaster, Scope and Objectives of Disaster Management, Disaster Managers, Elements of Disaster Management	4
II	Concepts and Terms in Disaster Management,Natural Disasters ,Man-made Disasters, Disaster Victim, Disaster Relief Systems, Phases of Disaster Response, Phases of Relief Operations, Case study of Kashmir Flood 2014.	4

III	The Hyogo Framework for Action 2005-2015: Building the Resilience of Nations, and Communities to Disasters : Case study of earthquake disaster and landslide disaster	2
IV	The Tools and Methods of Disaster Management, Prevention and Mitigation Tools, Preparedness Tools, Tools of Post-Disaster Management, Case studies	4
V	Technologies of Disaster Management, Mapping, Aerial Photography and Remote Sensing Communications, Information Management, Logistics, Epidemiology	6

Suggested Readings:

1. Harsh K. Gupta, (2004): Disaster management, Universities Press, ISBN: 9788173714566
2. R.B. Singh, (2000): Disaster Management, Rawat Publication, New Delhi.
3. H.K. Gupta (2003): Disaster Management, Universities Press, India, ISBN: 9788173714566
4. Satender, (2003): Disaster Management in Hills, Concept Publishing Co., New
5. Delhi,ISBN: 9788180690143
6. Bhandani, R.K., (2000): An overview on Natural & Manmade Disaster & their Reduction, CSIR, New Delhi.
7. Gupta, (2001): Manuals on Natural Disaster management in India, National Centre
8. for Disaster Management, IIPA, New Delhi, 2001

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Programme Outcomes of Master of Science in Environmental Sciences

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PO^4- To make them committed towards professional ethics

Course Articulation Matrix of ENV 536 – Disaster Management

PSOs/ POs	PSO^1	PSO^2	PSO^3	PO^1	PO^2	PO^3	PO^4
CO^1	1	2	1	1	3	2	1
CO^2	2	2	2	3	2	2	3
CO^3	3	2	3	3	3	2	2
CO^4	2	3	3	2	2	2	3
CO^5	3	3	3	3	3	3	3

1: *Partially Related* **2:** *Moderately Related* **3:** *Highly Related*

Course No:	**Course Name:** **Himalayan Geology**				**Course Code: ENV 536**		
Batch: 2020-2022	**Programme:** M.Sc. Environmental Sciences	**Semester:** II	**L** 2	**T** 0	**P** 0	**Credits** 2	**Contact Hrs. per Week: 2** **Total Hrs.: 30**
Total Evaluation Marks: 100 Mid-Term: 20 End-Term: 60 CIA: 20		**Pre-requisite of course:** Basic knowledge of Physics Chemistry and Biology along with geology					

Course Objectives	The course is intended to provide a holistic approach to study the surficial features and the processes with emphasis on Himalayan region. The subject will serve as a dynamic and physical based account of the processes at planets surface with an integrated approach involving the principles of geomorphology and sedimentology. The student will deal with different aspects of Himalayan Geology and how Himalaya has been originated and formed. How they have been shaped to the present form. The student will analyze and integrate the physical features, field methodology, and interpretation of structural and tectonic features to conclude how Himalaya has been formed.
Course Outcomes:	After completing this course, student is expected to learn the following: **CO^1** : The student will understand how Himalayan has been formed Learning about different river system how they have been originated from Himalayan and why Himalaya is named as Third pole. **CO^2** : Will understand different rock type and how they have been formed and what the relationship between different rock types is. What is the role of tectonics in generating earthquake in Himalayan region? **CO^3** : How sediments are deposited and how river are changing their course after years and what could be their consequences. Learning about the sedimentary flux: origin, transport and deposition. **CO^4** : Learning about the geomorphic and sedimentological processes related to fluvial, coastal, aeolian, and glacial regimes. **CO^5**: Learning about the environmental changes and its impact on surface processes and landforms.
Attendance Requirement:	Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.
Evaluation Criteria:	**1.** Mid Term Examination: 20% **2.** End Term Examination: 60% **3.** Continuous Internal Assessment : 20%

COURSE SYLLABUS

Unit No.	Contents	Contact Hrs.
I	Introduction, importance and significance of Himalaya, their morphology, What is faults, folds, their definitions and their types and classifications.	4
II	Internal structure of Earth, Internal structure of Earth, fundamental characteristics of crust, mantle, core; fundamentals on rock-forming minerals; weathering and erosion of rocks and minerals. Concept of plate tectonics, types of plate boundaries, features of convergent and divergent boundaries, causes of plate motion, dynamic evolution of continental and oceanic crust, Sea floor spreading, morphological features of ocean floor.	4

III	Sedimentary rocks their types and classification, metamorphic rocks their classifications. Geosynclines: Classification and evolution of Geosyncline, causes of subsidence and upliftment.	4
IV	Origin of Himalaya, different phases in evolution of Himalaya. Study of major groups and formations of Himalaya, lithology and thrust boundaries – HFF (Himalayan frontal fault), MBT(main boundary thrust), MCT(main central thrust), STD(south Tibetan detachment), indo-Tsangpo suture zone.	4
V	Earth's Earthquake seismology, palaeoseismology, seismites, Seismology: seismic waves, intensity and isoseismic lines, earthquake belts. Earthquake zones of India, Seismograph, causes of earthquake in Himalaya.	4

Suggested Readings:

1. Condie, K.C. (1984). Plate Tectonics & crustal Evolution. Pregamon Press, London.
2. A.K., Biyani, (2007), Dimensions of Himalayan Geology.
3. Earth: Introduction to Physical Geology, Fifth addition. Prentice Hall Pub.
4. The Geology of earthquake by Robert Yeats, Kerry Sieh and Clarence R. Allen Oxford University Press.
5. Geology of India and Burma M.S. Krishnan 1968 addition, Higginbothams (p) limited
6. Earthquake (forcasting and mitigation) by H.N. Srivastava , National Book Trust, India

Course Outcomes (COs) Mapping with POs and PSOs

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Course Articulation Matrix of ENV 428 – Himalayan Geology

PSOs/ POs	PSO^1	PSO^2	PSO^3	PO^1	PO^2	PO^3	PO^4
CO^1	2	2	2	1	2	2	1
CO^2	2	2	2	3	2	2	3
CO^3	3	2	3	2	3	2	2
CO^4	2	3	3	2	2	2	3
CO^5	3	3	3	3	3	3	3

1: *Partially Related* **2:** *Moderately Related* **3:** *Highly Related*

Course No:	**Course Name:** **Near Surface Geophysics**				**Course Code: ENV 564**		
Batch: 2020-2022	**Programme:** M.Sc. Environmental Sciences	**Semester:** IV	**L** 4	**T** 0	**P** 0	**Credits** 4	**Contact Hrs. per Week: 4** **Total Hrs.: 60**
Total Evaluation Marks: 200 Mid-Term: 50 End-Term: 100 CIA: 50							
	Pre-requisite of course: Basic knowledge of Physics Chemistry and Biology along with geology						
Course Objectives	The student will identify which geophysical methods are used by industry and academia to solve environmental problems, as most of the sub-surface methods are being used in geotechnical industry for characterizing the near surface sediments. The idea of having general exposure of students in mainly two geophysical techniques i.e. seismic methods (active and passive) and Ground penetration Radar so that they can have basic knowledge and about field configurations. The students will also be exposed to Instruments in the field as the University has Micro tremor system and 24 channel engineering seismograph. Under the specialized project the student will process the data using seismic data analysis software. The student will also summarize and critique recent publications in the fields of engineering and environmental geophysics.						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO^1** : Understand the fundamental concepts that result in the variation of seismic velocities and earth resistivity at or near the surface of the earth. **CO^2** : How sediments are deposited and how river are changing their course after years and what could be their consequences. Learning about the sedimentary flux: origin, transport and deposition. **CO^3** : To inculcate to relate the interpretation of the geophysical information to local geology and structure. Through a sequence of laboratory exercises in conjunction with intensive field projects the students learn by doing. **CO^4** : Besides learning the methodologies, the projects teach the students how to work in groups, both for data collection and analysis and interpretation and reporting. **CO^5** : While there are tests, these are entirely "take home" requiring the students to work through processing and interpretation problems. These are designed to provide a foundation for the processing and interpretation of the information collected from the field projects.						
Attendance Requirement:	Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.						
Evaluation Criteria:	**1.** Mid Term Examination: 20% **2.** End Term Examination: 60% **3.** Continuous Internal Assessment : 20%						

COURSE SYLLABUS

Unit No.	Contents	Contact Hrs.
I	Definition of hazards, General introduction to landslide hazard, earthquakes, flash floods and floods.Plate tectonics theory, continental drift theory, Transverse and longitudinal division of Himalaya.Introduction to Applied Geophysics: what are applied and environmental geophysics, matching geophysical methods to applications, planning a geophysical survey, planning survey and survey constraints, survey design, optimum configuration?	8

	Introduction to Applied Seismology, Introduction, seismic waves, their path of propagations, seismic intensity, magnitude, macroseismic scales and general introduction to seismographs	
II	Seismic Refraction Surveying: Introduction, General principles, Snells law, Field survey arrangements, geometry of refracted ray paths, Interpretational methods, applications and case histories. Seismic Reflection Surveying Introduction, reflection survey general considerations, reflection principles, Direct wave, refracted wave, critical distance and overtaking distance, T-D curves two layer case and three layer case.	8
III	Introduction to Shear wave methods: Spectral analysis of surface waves (SASW); Continuous surface waves methods (CSWS) and Cross hole methods Multichannel analysis of surface waves (MASW), active and passive seismic methods, field configuration, optimum field configuration, source receiver geometry, data acquisition, data analysis using seismic surfseis software, dispersion analysis, data interpretation and its applications.	8
IV	Introduction to Ground Penetration Radar (GPR), Principle of GPR, , propagation of radiowaves, dielectric properties of earth material, modes of data acquisition, data processing, interpretational techniques and Applications of GPR.	8
V	Site Amplification: What is site response, Site response studies, and application of MASW in site response, Shake analysis, its applications, Cases study, training of students in Grapher and Surfer	8

Suggested Readings:

1. An introduction to applied and Environmental Geophysics by John M. Reynolds Wiley-Blackwell publications
2. Principles of applied Geophysics by D.S.Parasnis Springer publications
3. Telford, W.M. et.al. Applied Geophysics: Cambridge publication
4. Geotechnical Earthquake Engineering by Sreven L. Kramer
5. Earthquakes (forecasting and mitigation by H.N. Srivastava
6. Recent advances in Earthquake geotechnical Engineering and microzonation by AtilaAnsal, 2004

Course Outcomes (COs) Mapping with POs and PSOs

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PO[4]- To make them committed towards professional ethics

Course Articulation Matrix of ENV 428 – Himalayan Geology

PSOs/ POs	PSO[1]	PSO[2]	PSO[3]	PO[1]	PO[2]	PO[3]	PO[4]
CO[1]	2	1	2	1	1	2	1
CO[2]	2	2	2	3	2	2	3
CO[3]	3	2	3	2	3	3	2
CO[4]	3	3	3	2	2	2	3
CO[5]	3	3	3	3	3	3	3

1: *Partially Related* **2:** *Moderately Related* **3:** *Highly Related*

Course No:	**Course Name:** **Site Amplification**				**Course Code: ENV 607**		
Batch: 2020-2022	**Programme:** Ph.D. Environmental Sciences	**Semester:** I	**L** 2	**T** 0	**P** 0	**Credits** 2	**Contact Hrs. per Week: 2** **Total Hrs.: 30**
Total Evaluation Marks: 100 Mid-Term: 25 End-Term: 75 CIA: 25							
	Pre-requisite of course: Basic knowledge of Physics Chemistry and Biology along with geology						
Course Objectives	The student will understand how different building and structures will behave during strong ground motion identify. The basic idea of providing this course to students of Ph.D aspirant is to undertake research in the field of earthquake risk assessment and to take part in Indian endeavors for disaster risk reduction as a goal of India mission for risk reduction under Sendai framework 2015-30. The student will analyze and integrate the physical theory, field methodology, and interpretation of each method with geologic and engineering information to solve problems using real data sets. The student will also summarize and critique recent publications in the fields of engineering and environmental geophysics.						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO^1** : Understand the concept of seismic velocities and earth resistivity **CO^2** : The students will understand the importance of site amplification in seismic risk reduction **CO^3** : To understand topics to choose research problem for undertaking research in the direction of disaster risk reduction **CO^4** : Will enable them to work in any geotechnical company **CO^5** : To undertake research in the field of seismic microzonation, which is a prestigious project of Govt. of India						
Attendance Requirement:	Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.						
Evaluation Criteria:	**4.** Mid Term Examination: 20% **5.** End Term Examination: 60% **6.** Continuous Internal Assessment : 20%						

COURSE SYLLABUS

Unit No.	Contents	Contact Hrs.
I	What is seismic hazard, what are different stages for seismic hazard analysis, seismic source, recurrence relations, attenuation relations, effects of local soil conditions and NEHRP classification	4
II	Influence of scales on site amplification and impact studies, Different macroseismic scales and how they have developed since the development of first scale of Rossi Forel intensity scale, Modified Mercalliscale , MSK-64 intensity scale and EMS -98 European macroseismic scale.	4
III	On which factors the strong Ground effects depends, Effects of earthquake source, transfer media, interaction between the building and soil, effect on depth of the source, effect of distance, near	4

	source and far source effects and basin response effect	
IV	What are the parameters on which site amplification depends, How to measure the stiffness of the soil? What are different factor responsible for site amplification from near and far source. Different geophysical methods like Multichannel Analysis of surface waves and Microtremor method used to measure stiffness of the soil and frequency of the soil.	4
V	Methods to measure site effects Standard spectral ration technique (SSR), Generalized Inversion Scheme Technique (GIS), Coda wave technique, Horizontal to Vertical Spectral Ration Technique (HVSR), site effects in horizontally layered soil deposits, one dimensional response of soil column.	4

Course Outcomes (COs) Mapping with POs and PSOs

All the courses together must cover all the POs (and PSOs). For a course we map the COs to POs through the CO-PO matrix and to PSOs through the CO-PSO matrix as shown below. The various correlation levels are:
"-" indicates there is **no** correlation
"1" – Slight (**Low**) Correlation
"2" – Moderate (**Medium**) Correlation
"3" – Substantial (**High**) Correlation

Programme Specific Outcomes of Master of Science in Environmental Sciences

PSO^1- To enhance students' ability to understand and mitigate environmental issues
PSO^2- To augment the acumen to analyse geological and environmental research problems of social relevance
PSO^3- To ensure lifelong learning on scientific skills for industrial applications and entrepreneurship

Programme Outcomes of Master of Science in Environmental Sciences

PO^1- To develop in-depth knowledge on the structure and function of the global environment
PO^2- To inculcate a harmonious relationship between nature and human being
PO^3- To foster a culture of indigenous traditional knowledge for sustainable future
PO^4- To make them committed towards professional ethics

Course Articulation Matrix of ENV 428 – Himalayan Geology

PSOs/ POs	PSO^1	PSO^2	PSO^3	PO^1	PO^2	PO^3	PO^4
CO^1	3	2	2	3	3	3	3
CO^2	3	3	2	3	2	2	3
CO^3	3	2	3	2	3	3	3
CO^4	3	3	3	2	3	2	3
CO^5	3	3	3	3	3	3	3

1: *Partially Related* **2:** *Moderately Related* **3:** *Highly Related*

Course No:	**Course Name:** **Seismology**				**Course Code: ENV 608**		
Batch:	**Programme:**	**Semester:**	**L**	**T**	**P**	**Credits**	**Contact Hrs. per Week: 2**
2020	Ph.D. Environmental Sciences	I	2	0	0	2	**Total Hrs.: 30**
Total Evaluation Marks: 100 Mid-Term: 20 End-Term: 60 CIA: 20		**Pre-requisite of course:** Basic knowledge of Physics Chemistry and Biology along with geology					
Course Objectives	The student will understand how different building and structures will behave during strong ground motion identify. The basic idea of providing this course to students of Ph.D aspirant is to undertake research in the field of earthquake risk assessment and to take part in Indian endeavors for disaster risk reduction as a goal of India mission for risk reduction under Sendai framework 2015-30. The student will analyze and integrate the physical theory, field methodology, and interpretation of each method with geologic and engineering information to solve problems using real data sets. The student will also summarize and critique recent publications in the fields of engineering and environmental geophysics.						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO^1** : Understand the concept of seismic wave propagation **CO^2** : The students will understand the importance of site amplification in seismic risk reduction **CO^3** : To understand topics to choose research problem for undertaking research in the direction of disaster risk reduction **CO^4** : Will enable them to work in any geotechnical company **CO^5** : To undertake research in the field of seismic microzonation, which is a prestigious project of Govt of India						
Attendance Requirement:	Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.						
Evaluation Criteria:	**1.** Mid Term Examination: 20% **2.** End Term Examination: 60% **3.** Continuous Internal Assessment : 20%						

COURSE SYLLABUS

Unit No.	Contents	Contact Hrs.
I	What is an earthquake, how does it occurs, distribution of earthquake in India and where do earthquake tends to occurs. What is elastic rebound theory, how the earthquake is measured in terms of magnitude and Intensity.	4
II	Characteristics of Earthquakes: measuring sizes of earthquakes, etc. What are different magnitude scales likes Richter scale, body wave magnitude, surface wave magnitude and moment magnitude. What are different intensity scale explain ach intensity scale i.e. Rossi Forel scale, MMI Intensity scale, MSK-64 intensity scale and EMS-98 scale how intensity scale can be correlated with magnitude scale.	4

III	Seismology and plate tectonics, plate configuration as derived from seismicity pattern, inference of plate dynamics form focal mechanism studies, and what is asperity or seismic gap concept in seismology.	4
IV	Quantification of earthquakes, Magnitude energy and intensity; basic principles of seismic rating, magnitude calibration, relation between magnitude and intensity and magnitude and energy; principal significance of earthquakes magnitude.	4
V	Seismic zonation of India, criteria for seismic zonation, different seismic zoning map of India awareness and preparedness; public awareness, awareness' derives earthquake preparedness, medical preparedness management plans and schedule for awareness activities. Disaster Phase and Earthquake Policies: review of earthquake disaster phases and history and current.	4

Course Outcomes (COs) Mapping with POs and PSOs

All the courses together must cover all the POs (and PSOs). For a course we map the COs to POs through the CO-PO matrix and to PSOs through the CO-PSO matrix as shown below. The various correlation levels are:
"-" indicates there is **no** correlation
"1" – Slight (**Low**) Correlation
"2" – Moderate (**Medium**) Correlation
"3" – Substantial (**High**) Correlation

Programme Specific Outcomes of Master of Science in Environmental Sciences

PSO^1- To enhance students' ability to understand and mitigate environmental issues
PSO^2- To augment the acumen to analyse geological and environmental research problems of social relevance
PSO^3- To ensure lifelong learning on scientific skills for industrial applications and entrepreneurship

Programme Outcomes of Master of Science in Environmental Sciences

PO^1- To develop in-depth knowledge on the structure and function of the global environment
PO^2- To inculcate a harmonious relationship between nature and human being
PO^3- To foster a culture of indigenous traditional knowledge for sustainable future
PO^4- To make them committed towards professional ethics

Course Articulation Matrix of ENV 428 – Himalayan Geology

PSOs/ POs	PSO^1	PSO^2	PSO^3	PO^1	PO^2	PO^3	PO^4
CO^1	2	2	1	3	1	2	2
CO^2	2	3	2	3	2	2	3
CO^3	3	2	3	2	3	3	3
CO^4	2	3	3	2	3	2	3
CO^5	3	3	3	3	3	3	3

1: *Partially Related* **2:** *Moderately Related* **3:** *Highly Related*

Course No:	**Course Name: Environmental Geophysics**				**Course Code: ENV 559**		
Batch:	**Programme:**	**Semester:**	**L**	**T**	**P**	**Credits**	**Contact Hrs. per Week: 2**
2020-2022	M.Sc. Environmental Sciences	II	2	0	0	2	**Total Hrs.: 30**
Total Evaluation Marks: 100 Mid-Term: 25 End-Term: 50 CIA: 25							
	Pre-requisite of course: Basic knowledge of Physics Chemistry and Biology along with geology						
Course Objectives	The student will identify which geophysical methods are used by industry and academia to solve environmental and geotechnical problems. The student will analyze and integrate the physical theory, field methodology, and interpretation of each method with geologic and engineering information to solve problems using real data sets. The student will also summarize and critique recent publications in the fields of engineering and environmental geophysics.						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO^1** : understand the fundamental concepts that result in the variation of seismic velocities and earth resistivity at or near the surface of the earth **CO^2** : After completing this course, student is expected to learn the following: to use various geophysical instruments including ground penetration radar, Seismic exploration for site characterisation and exploration, engineering seismometers (primarily for reflections and refraction surveys) both active and passive methods design, conduct and complete a total field project involving these methodologies **CO^3** : Will be able to relate the interpretation of the geophysical information to local geology and structure. Through a sequence of laboratory exercises in conjunction with intensive field projects the students learn by doing. **CO^4** : Besides learning the methodologies, the projects teach the students how to work in groups, both for data collection and analysis and interpretation and reporting. **CO^5** : While there are tests, these are entirely "take home" requiring the students to work through processing and interpretation problems. These are designed to provide a foundation for the processing and interpretation of the information collected from the field projects.						
Attendance Requirement:	Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.						
Evaluation Criteria:	**1.** Mid Term Examination: 20% **2.** End Term Examination: 60% **3.** Continuous Internal Assessment : 20%						

COURSE SYLLABUS

Unit No.	Contents	Contact Hrs.
I	Introduction to Hazards definition of hazards, introduction to landslide hazard, earthquakes, flash floods and floods, a brief on longitudinal and transverse division of Himalayan. Introduction to Applied Geophysics: what are applied and environmental geophysics, matching geophysical methods to applications, planning a geophysical survey, planning survey and survey	2

	constraints, survey design, optimum configuration?	
II	Seismic Refraction Surveying: Introduction, General principles, Snells law, Field survey arrangements, Interpretational methods, applications and case histories. Seismic Reflection Surveying Introduction, reflection survey general considerations, reflection principles, reflection data processing using surfseis software (pre-processing, data filtering using muting technique- a practical, dispersion analysis and 1-D profiling and 2-D profiling.	4
III	Introduction to different methods i.e. Spectral analysis of surface waves (SASW); Continuous surface waves methods (CSWS) and Cross hole method Multichannel analysis of surface waves (MASW), active and passive seismic methods, field configuration, optimum field configuration, source receiver geometry, data acquisition, data analysis using seismic surfseis software, dispersion analysis, data interpretation and its applications.	4
IV	Introduction to Ground Penetration Radar (GPR), Principle of GPR, propagation of radiowaves, dielectric properties of earth material, modes of data acquisition, data processing, interpretational techniques and Applications of GPR	4
V	What is site response, Site response studies, and application of MASW in site response, Shake analysis, its applications? Hand on Practice: Training of students in Grapher and Surfer	4

Suggested Readings:-

1. An introduction to applied and Environmental Geophysics by John M. Reynolds Wiley-Blackwell publcations
2. Principles of applied Geophysics by D.S.Parasnis Springer publications
3. Telford, W.M. et.al. Applied Geophysics: Cambridge publication
4. Geotechnical Earthquake Engineering by Sreven L. Kramer
5. Earthquakes (forecasting and mitigation by H.N. Srivastava
6. Recent advances in Earthquake geotechnical Engineering and microzonation by AtilaAnsal, 2004.

Course Outcomes (COs) Mapping with POs and PSOs

All the courses together must cover all the POs (and PSOs). For a course we map the COs to POs through the CO-PO matrix and to PSOs through the CO-PSO matrix as shown below. The various correlation levels are:

"-" indicates there is **no** correlation
"1" – Slight (**Low**) Correlation
"2" – Moderate (**Medium**) Correlation
"3" – Substantial (**High**) Correlation

Programme Specific Outcomes of Master of Science in Environmental Sciences

PSO[1]- To enhance students' ability to understand and mitigate environmental issues
PSO[2]- To augment the acumen to analyse geological and environmental research problems of social relevance
PSO[3]- To ensure lifelong learning on scientific skills for industrial applications and entrepreneurship

Programme Outcomes of Master of Science in Environmental Sciences

PO[1]- To develop in-depth knowledge on the structure and function of the global environment
PO[2]- To inculcate a harmonious relationship between nature and human being
PO[3]- To foster a culture of indigenous traditional knowledge for sustainable future
PO[4]- To make them committed towards professional ethics

Course Articulation Matrix of ENV 559 – Environmental Geophysics

PSOs/ POs	PSO^{1}	PSO^{2}	PSO^{3}	PO^{1}	PO^{2}	PO^{3}	PO^{4}
CO^{1}	2	2	2	3	1	2	2
CO^{2}	2	3	2	3	2	2	2
CO^{3}	3	2	3	2	3	3	3
CO^{4}	3	3	3	3	3	2	3
CO^{5}	3	3	3	3	3	3	3

1: *Partially Related* **2:** *Moderately Related* **3:** *Highly Related*

Course No:	**Course Name:** **Geo-Engineering**				**Course Code: ENV 521**		
Batch: 2021-2023	**Programme:** M.Sc. Environmental Sciences	**Semester:** II	**L** 2	**T** 0	**P** 0	**Credits** 2	**Contact Hrs. per Week: 2** **Total Hrs.: 30**
Total Evaluation Marks: 100 Mid-Term: 25 End-Term: 50 CIA: 25		**Pre-requisite of course:** Basic knowledge of Physics Chemistry and Biology along with geology					
Course Objectives	The student will deal with different geo-engineering techniques are used by industry and academia to solve environmental problems. The student will analyze and integrate the physical theory, field methodology, and interpretation of each method with geologic and engineering information to solve problems using real data sets. The student will also summarize and critique recent publications in the fields of engineering and environmental geophysics.						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO^1** : The student will understand how to measure physical properties of the soil. Student will understand how to identify landslide zones **CO^2**: After completing this course, student is expected to learn the following: Students will know how the tunnel as being constructed and what are the issues and problem in tunnel construction as geological perspective. Students will understand how to identify sites for dams construction **CO^3** : The course will enable the student to prepare an environmental impact assessment report while being serving as Environmentalist **CO^4** : The course will enable the student to prepare an environmental impact assessment report while being serving as Environmentalist **CO^5** : Can help engineers in the field due to their basic knowledge in the construction activities related to geological and environmental issues in the project.						
Attendance Requirement:	Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.						
Evaluation Criteria:	**4.** Mid Term Examination: 20% **5.** End Term Examination: 60% **6.** Continuous Internal Assessment : 20%						

COURSE SYLLABUS

Unit No.	Contents	Contact Hrs.
I	Importance of geology in civil engineering: geological properties of rocks used in civil engineering- porosity, density, absorption. Effects of load imposed on rocks and stones - compressive stress and strength of rocks, tensile stress, tensile strength, and elasticity of rocks. Geological properties of stones and road materials	2
II	Geological considerations in construction of dams, its parts and its types. Silting and de-silting of dam reservoirs. Types of bridges and tunnels and geological considerations for construction of	4

	tunnels and Bridges.	
III	Landslides and classification, its causes and effects.Slope ,slope angle, and slope analysis, angle of repose.	4
IV	Problems of ground water in engineering projects. Geo technical study of Bhakra Nangal projects.	4
V	Instrumentation in Geo-engineering like Standard penetration test, Spectral analysis of surface waves and Multichannel analysis of surface waves for shear wave velocity/ stiffness of the soil column and their applications Case studies with type example.	4

Suggested Readings:-

1. Parbin Singh: Engineering and General Geology. KatsonPubl House
2. Sharma, P.V., (1986). Geophysical Methods in Geology. Elsevier, London
3. Kryine, D.H. and Judd, W.R. (1998). Principles of Engineering Geology, CBS Edition, Delhi.
4. Valdiya, K.S., (1987). Environment Geology-Indian Context. Tata Mcgraw Hill. N.Delhi.
5. Geotechnical earthquake Engineering by Kamer S.L. 2003. Prentice Hall Publ.

Course Outcomes (COs) Mapping with POs and PSOs

All the courses together must cover all the POs (and PSOs). For a course we map the COs to POs through the CO-PO matrix and to PSOs through the CO-PSO matrix as shown below. The various correlation levels are:
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Programme Specific Outcomes of Master of Science in Environmental Sciences

PSO^1- To enhance students' ability to understand and mitigate environmental issues
PSO^2- To augment the acumen to analyse geological and environmental research problems of social relevance
PSO^3- To ensure lifelong learning on scientific skills for industrial applications and entrepreneurship

Programme Outcomes of Master of Science in Environmental Sciences

PO^1- To develop in-depth knowledge on the structure and function of the global environment
PO^2- To inculcate a harmonious relationship between nature and human being
PO^3- To foster a culture of indigenous traditional knowledge for sustainable future
PO^4- To make them committed towards professional ethics

Course Articulation Matrix of ENV 559 – Environmental Geophysics

PSOs/ POs	PSO^1	PSO^2	PSO^3	PO^1	PO^2	PO^3	PO^4
CO^1	2	2	1	2	1	2	2
CO^2	3	3	2	3	2	2	2
CO^3	3	3	3	2	3	3	3
CO^4	3	3	3	3	3	2	3
CO^5	3	3	3	3	3	3	3

1: *Partially Related* **2:** *Moderately Related* **3:** *Highly Related*

2. Prof. Deepak Pant

Prof. Deepak Pant							
Course No:	**Course Name:** Waste Management				**Course Code: ENV 411**		
Batch: 2021-2023	**Programme:** M.Sc. Environmental Sciences	**Semester:** II	**L** 2	**T** 0	**P** 0	**Credits** 2	**Contact Hrs. per Week: 2** **Total Hrs.: 30**
Total Evaluation Marks: 100 Mid-Term: 20 End-Term: 60 CIA: 20		**Pre-requisite of course:** Basic knowledge of environment and household goods. Basic understanding of the environment and sustainable techniques.					
Course Objectives	To provide the basic knowledge of waste management and involve Chemistry and its associated applications.						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1**: Basic understanding of biodegradable solid waste **CO2**:Basic understanding of hospital and pharmacutical waste **CO3**:Basic understanding of non-biodegradable solid waste **CO4**:Skills for developing sustainable methods **CO5**:Development of the skill of the management plans **CO6**:Skill development towards hybrid methods						
Attendance Requirement:	Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.						
Evaluation Criteria:	**1.** Mid Term Examination: 20% **2.** End Term Examination: 60% **3.** Continuous Internal Assessment : 20%						

COURSE SYLLABUS

Unit No.	**Contents**	**Contact Hrs.**
I	**BIODEGRADABLE SOLID WASTE** **[Course Outcome (s) No. :1 and 5]** Biodegradable solid waste: Chemical composition and classification: Source and generation: Health hazards: Management Techniques	7
II	**NON-BIODEGRADABLE SOLID WASTE** **[Course Outcome (s) No. :2 and 5]** Non-Biodegradable Solid waste: Sources, generation, chemical composition, classification of plastic waste and its management: Sources, generation, chemical composition, classification of e-waste and its management.	8

III	**HOSPITAL AND PHARMACEUTICAL WASTE** **[Course Outcome (s) No. :3** and**5]** Hospital and Pharmaceutical Waste: Classification: Source and generation: Health hazards: Management Techniques	8
IV	**WASTE MINIMIZATION TECHNOLOGIES** **[Course Outcome (s) No. :4 and 6]** Waste minimization technologies: Reuse/ recycling of different types of waste: Metal recovery from waste using chemical, biological and hybrid techniques.	7

Suggested Readings:

1. D. Pant, D. Joshi, M. K. Upreti and R. K. Kotnala, Chemical and Biological Extraction of Metals Present in E Waste: A Hybrid Technology, Waste Management, Elsevier Science, Vol. 32, pg. 979-990, 2012.
2. D. Pant, R. Singh, S. Kumar, Management of Waste Poly Vinyl Chloride (PVC) through Chemical Modification, ScInd Res., Vol. 71, pg. 181-186, 2012.
3. D. Pant, Waste Management in Small Hospitals Trouble for Environment, Environmental Monitoring and Assessment, Springer, 2011.
4. D. Pant, Pharmaceutical Waste Management, Lambart Academic, 2011.
5. D. Pant, Electronic Waste Management Lambart Academic Publishing, 2010.
6. Frank Kreith, Handbook of Solid Waste Management, McGraw-Hill, Inc., New Delhi, 1994.
7. M. Roy III. Harrison, Pollution; Causes, Effects and Control. The Royal Society of Chemistry, Cambridge, 1994.
8. John R. Holmes, Practical Waste Management, John Wiley & Sons, New York/Singapore, 1983.

Course Outcomes (COs) Mapping with POs and PSOs

All the courses together must cover all the POs (and PSOs). For a course we map the COs to POs through the CO-PO matrix and to PSOs through the CO-PSO matrix as shown below. The various correlation levels are:
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"1" – Slight (**Low**) Correlation
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"3" – Substantial (**High**) Correlation

Programme Specific Outcomes of Master of Science in Environmental Sciences

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Programme Outcomes of Master of Science in Environmental Sciences

PO^1- To develop in-depth knowledge on the structure and function of the global environment
PO^2- To inculcate a harmonious relationship between nature and human being
PO^3- To foster a culture of indigenous traditional knowledge for sustainable future
PO^4- To make them committed towards professional ethics

Course Articulation Matrix of ENV 411 – Waste Management

PSOs/ POs	PSO^1	PSO^2	PSO^3	PO^1	PO^2	PO^3	PO^4
CO^1	2	3	3	2	3	2	2
CO^2	3	2	2	3	2	2	3
CO^3	3	2	3	2	2	3	3
CO^4	3	3	3	2	2	2	3
CO^5	3	3	3	3	3	3	3

1: *Partially Related* **2:** *Moderately Related* **3:** *Highly Related*

Course No:	**Course Name:** **Toxicity Lab**				**Course Code:**		
Batch: 2021-2023	**Programme:** M.Sc. Environmental Sciences	**Semester:** III	**L** 2	**T** 0	**P** 0	**Credits** 2	**Contact Hrs. per Week: 2** **Total Hrs.: 30**
Total Evaluation Marks: 100 Mid-Term: 25 End-Term: 50 CIA: 25							
		Pre-requisite of course: Basic knowledge of various chemicals for household purposes					
Course Objectives	To provide the basic knowledge of toxic substance and involving Chemistry for its management						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1**: Basic understanding of chemistry of toxic substance **CO2**: Basic understanding of physical techniques involved for toxic substance **CO3**: Basic understanding of food adulteration **CO4**: Basic understanding of environmental toxicant **CO5**: Development of the skills for the management **CO6**: Skill development towards management						
Attendance Requirement:	Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.						
Evaluation Criteria:	**1.** Mid Term Examination: 20% **2.** End Term Examination: 60% **3.** Continuous Internal Assessment : 20%						

COURSE SYLLABUS

Unit No.	Contents	Contact Hrs.
I	**PRACTICAL EXPOSURE** **[Course Outcome (s) No. :1]** ● About the identification of toxic substance; ● Management techniques for toxic substance	4
II	**PHYSICAL PROPERTIES OF TOXIC** **[Course Outcome (s) No. :2]** ● Experiment based on physical properties of toxic substance on the basis of vapour pressure, vapour density and solubility	6
III	**IDENTIFICATION OF TOXIC SUBSTANCES IN FOOD SAMPLE.** **[Course Outcome (s) No. :3, 5** and **6]** ● Acids, ● Aldehydes ● Amines ● Dioxins ● Ethers	10

	• Cyanides	
IV	**TOXICITY ISSUE** **[Course Outcome (s) No. : 4, 5 and 6]** • Arsenic • Cadmium • Lead • Mercury • Carbon monoxide	10

Suggested Readings:

1. C. N. Madu, Environmental Planning and management, Imperial College Press, 2015.
2. Healtth Hazards of Environmental Arsenic Poisoning, Imperial College Press, 2014.
3. T. F. Yen, Chemical Processes for Environmental Engineering, Imperial College Press, 2013.
4. H. K. Moffatt and Shuckburgh, Environmental Hazards, Imperial College Press, 2011.
5. P. Patnaik, A Comprehensive Guide to the Hazardous Properties of Chemical Substances (3rd ed.) John Wiley & Sons, Inc., Hoboken, New Jersey, 2007.
6. C. Oloman, Material and Energy Balance for Engineers and Environmentalist, Imperial College Press, 2005.
7. L. C. Batty and K. B. Hallberg, Ecology of Industrial Pollution, Cambridge University press, New Delhi, 2004.

Course Outcomes (COs) Mapping with POs and PSOs

All the courses together must cover all the POs (and PSOs). For a course we map the COs to POs through the CO-PO matrix and to PSOs through the CO-PSO matrix as shown below. The various correlation levels are:
"-" indicates there is **no** correlation
"1" – Slight (**Low**) Correlation
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Programme Outcomes of Master of Science in Environmental Sciences

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PO^3- To foster a culture of indigenous traditional knowledge for sustainable future
PO^4- To make them committed towards professional ethics

Course Articulation Matrix of Toxicity lab

PSOs/ POs	PSO^1	PSO^2	PSO^3	PO^1	PO^2	PO^3	PO^4
CO^1	1	2	2	2	2	2	2
CO^2	2	2	2	3	2	2	3

CO^3	2	2	3	2	2	3	3
CO^4	3	3	3	2	2	2	3
CO^5	3	3	3	3	3	3	3

1: *Partially Related* **2:** *Moderately Related* **3:** *Highly Related*

Course No:	**Course Name:** Carbon Management				**Course Code: ENV 577**		
Batch:	**Programme:**	**Semester:**	**L**	**T**	**P**	**Credits**	**Contact Hrs. per Week: 2**
2021-2023	M.Sc. Environmental Sciences	II	2	0	0	2	**Total Hrs.: 30**
Total Evaluation Marks: 100 Mid-Term: 25 End-Term: 50 CIA: 25							
	Pre-requisite of course: Basic knowledge of carbon credit. Basic understanding of the plant, carbon sources and pools.						
Course Objectives	To provide the basic knowledge of carbon management and involved Chemistryandbiology with its associated applications.						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1**: Basic understanding of general carbon problem with climate change **CO2**: Basic understanding of carbon storage **CO3**: Basic understanding of chemical methods for carbon management **CO4**: Basic understanding of biological methods for carbon management						
Attendance Requirement:	Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.						
Evaluation Criteria:	**1.** Mid Term Examination: 20% **2.** End Term Examination: 60% **3.** Continuous Internal Assessment : 20%						

COURSE SYLLABUS

Unit No.	Contents	Contact Hrs.
I	**Introduction of carbon management** **[Course Outcome (s) No. :1]** Background concepts, Change in carbon pools, management plans are focused on (a) minimizing emission (b) maximizing environmentally sound reuse, reduce and recycling; (c) effective treatment and (d) converting carbon into valuable products with atom economy.	7
II	**Chemical Methods for carbon management** **[Course Outcome (s) No. :2 and 3]** Various chemical reaction involved in carbon management like as Kolbe-Schmitt, Carboxylation, cyclization, polymerization, amination, Boudouard reaction, Friedel-Crafts acylation, Reductive hydrogenation, photochemical and Formato-metal complex reactions, Carbon capture from adsorbents, Membrane based separation	8
III	**Biological Methods for carbon management** **[Course Outcome (s) No. :2**and**4]** Biological sequestration relates to the use of higher plants and micro-organisms, Microbial electrosynthesis, Symbiosis (in *vivo* associations of plant and microbes). Chemical-biological Hybrid modification	4

IV	**Carbon capture and Utilization** **[Course Outcome (s) No. : 2]** Carbon capture and Utilization; biotechnological interventions for carbon dioxide capture and utilization, options for mitigating methane emissions, carbon sequestration and organic farming	7

Suggested Readings:

1. D Pant, A Nadda, K KPantAdvances in Carbon Capture and Utilization (Springer Nature), 2021, ISBN 978-981-16-0638-0.
2. Giri, A., & Pant, D. (2018). Carbon Management and Greenhouse Gas Mitigation Reference Module in Materials Science and Materials Engineering. doi:10.1016/b978-0-12-803581-8.11041-0.
3. Giri, A., Chauhan, S., Sharma, T., Nadda, A., & Pant, D. (2021). Recent Advances in Enzymatic Conversion of Carbon Dioxide into Value-Added Product. Advances in Carbon Capture and Utilization, 313-326.
4. Sharma, T., Bhardwaj, R., Bhardwaj, R., Giri, A., Pant, D., &Nadda, A. K. (2021). Progresses in Bioenergy Generation from CO 2: Mitigating the Climate Change. In Advances in Carbon Capture and Utilization (pp. 297-312). Springer, SingaporeD. Pant, Electronic Waste Management Lambart Academic Publishing, 2010

Course Outcomes (COs) Mapping with POs and PSOs

All the courses together must cover all the POs (and PSOs). For a course we map the COs to POs through the CO-PO matrix and to PSOs through the CO-PSO matrix as shown below. The various correlation levels are:
"-" indicates there is **no** correlation
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"2" – Moderate (**Medium**) Correlation
"3" – Substantial (**High**) Correlation

Programme Specific Outcomes of Master of Science in Environmental Sciences

PSO^1- To enhance students' ability to understand and mitigate environmental issues
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PO^4- To make them committed towards professional ethics

Course Articulation Matrix of ENV 577: Carbon Management

PSOs/ POs	PSO^1	PSO^2	PSO^3	PO^1	PO^2	PO^3	PO^4
CO^1	2	2	2	2	2	2	1
CO^2	2	2	2	3	2	2	3
CO^3	3	2	3	3	3	3	3
CO^4	3	3	3	3	3	2	3
CO^5	3	3	3	3	3	3	3

1: *Partially Related* **2:** *Moderately Related* **3:** *Highly Related*

Course No:	**Course Name:** Toxic and Hazardous Waste Management				**Course Code: ENV 523**		
Batch:	**Programme:**	**Semester:**	**L**	**T**	**P**	**Credits**	**Contact Hrs. per Week: 4**
2021-2023	M.Sc. Environmental Sciences	IV	4	0	0	4	**Total Hrs.: 60**
Total Evaluation Marks: 200 Mid-Term: 50 End-Term: 100 CIA: 50							
	Pre-requisite of course: Basic difference in various toxic and Hazardous substances , Chemicals present around us.						
Course Objectives	To provide the basic knowledge of toxicity and hazardous behaviours of various chemical substances						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1**: Basic understanding of various waste in terms of toxicity. **CO2**: Basic understanding physical properties of toxic waste. **CO3**: Toxicity assessment of various chemicals. **CO4**: Basic understanding of carcinogenic substances and bio hazards.						
Attendance Requirement:	Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.						
Evaluation Criteria:	**1.** Mid Term Examination: 20% **2.** End Term Examination: 60% **3.** Continuous Internal Assessment : 20%						

COURSE SYLLABUS

Unit No.	Contents	Contact Hrs.
I	**Toxic Properties of Chemical Substances** **[Course Outcome (s) No. :1]** • Pathway of entry; • Detoxication • Bioactivation.	10
II	**Physical properties of toxic and hazardous waste** **[Course Outcome (s) No. :2 and 3]** Chemical pollutant, its oxidation, hydrolysis, biodegradation, groundwater contamination, and overall persistence in the environment related to the following studies: • Vapour pressure • Vapour density • Solubility.	10

III	**Toxic and hazardous characteristic various organic chemicals** **[Course Outcome (s) No. :2** and **4]** • Acids • Aldehydes • Amines • Dioxins • Ethers • Cyanides	16
IV	**CANCER-CAUSING CHEMICALS** **[Course Outcome (s) No. : 2]** • Concept of carcinogenesis, Mechanism of chemical carcinogens, Human carcinogens • Common Toxic, and Flammable Gases including: • Hydrogen, Carbon mono and dioxide, Nitrogen Oxide • Biochemical aspects ofArsenic, Cadmium, Lead, Mercury, Carbon monoxide	14
V	**Hazardous Properties** **[Course Outcome (s) No. : 4]** • Insecticides • Asbestos, • Flyash, • Ozone and PAN pesticides,	10

Suggested Reading

1. P. Patnaik, A Comprehensive Guide to the Hazardous Properties of Chemical Substances (III Ed.) John Wiley & Sons, Inc., Hoboken, New Jersey
2. H. K. Moffatt and Shuckburgh, Environmental Hazards, Imperial College Press. (ISBN 978-981-4313-28-5)

Suggested Additional Readings

1. L. C. Batty and K. B. Hallberg, Ecology of Industrial Pollution, Cambridge University press, New Delhi.
2. C. Oloman, Material and Energy Balance for Engineers and Environmentalist, Imperial College Press. (ISBN 978-1-84816-368-3).
3. T. F. Yen, Chemical Processes for Environmental Engineering, Imperial College Press. (ISBN 978-1-86094-759-9).
4. C. N. Madu, Environmental Planning and management, Imperial College Press. (ISBN 978-1-86094-671-4).
5. Healtth Hazards of Environmental Arsenic Poisoning, Imperial College Press. (ISBN 978-981-4291-81-1).

Course Outcomes (COs) Mapping with POs and PSOs

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PSO[3]- To ensure lifelong learning on scientific skills for industrial applications and entrepreneurship

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PO[2]- To inculcate a harmonious relationship between nature and human being
PO[3]- To foster a culture of indigenous traditional knowledge for sustainable future
PO[4]- To make them committed towards professional ethics

Course Articulation Matrix of ENV 523: Toxic and Hazardous Waste Management

PSOs/ POs	PSO1	PSO2	PSO3	PO1	PO2	PO3	PO4
CO1	1	2	2	2	2	2	1
CO2	1	2	2	3	2	2	3
CO3	2	2	2	3	3	3	2
CO4	3	3	3	3	3	2	3
CO5	3	3	3	3	3	3	3

1: *Partially Related* **2:** *Moderately Related* **3:** *Highly Related*

3. Dr. Ankit Tandon

<table>
<tr><td colspan="8">Dr. Ankit Tandon</td></tr>
<tr><td></td><td colspan="5"></td><td colspan="2"></td></tr>
<tr><td>Course No:</td><td colspan="4">Course Name:
Atmospheric Science</td><td colspan="3">Course Code: ENV 516</td></tr>
<tr><td>Batch:

2021-2023</td><td>Programme:

M.Sc. Environmental Sciences</td><td>Semester:

I</td><td>L

2</td><td>T

0</td><td>P

0</td><td>Credits

2</td><td>Contact Hrs. per Week: 2
Total Hrs.: 30</td></tr>
<tr><td colspan="2">Total Evaluation Marks: 100
Mid-Term: 20
End-Term: 60
CIA: 20</td><td colspan="6">Pre-requisite of the course: Basic knowledge of the physics, chemistry and physical geography.</td></tr>
<tr><td>Course Objectives</td><td colspan="7">1. The Earth’s Atmosphere- an overview
2. Understanding physical structure and chemical composition of the Earth’s Atmosphere
3. Understanding the fundamental physical and chemical processes responsible for the mass and energy transport in the Earth’s Atmosphere</td></tr>
<tr><td>Course Outcomes:</td><td colspan="7">After the successful completion of this course, the student will be able to
CO¹:Understand the structure and composition of the Earth’s atmosphere
CO²:Apply the knowledge of basic science to discern atmospheric dynamics
CO³:Identify the status of ambient atmosphere
CO⁴:Learn the importance of the Sun – the Earth geometry
CO⁵:Familiar with the ongoing process of air quality deterioration</td></tr>
<tr><td>Attendance Requirement:</td><td colspan="7">Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75 percent attendance is a must failing which a student may not be permitted to appear in examination.</td></tr>
<tr><td>Evaluation Criteria:</td><td colspan="7">1. Mid Term Examination: 20%
2. End Term Examination: 60%
3. Continuous Internal Assessment : 20%</td></tr>
<tr><td colspan="8">COURSE SYLLABUS</td></tr>
<tr><td>Unit No.</td><td colspan="6">Contents</td><td>Contact Hrs.</td></tr>
<tr><td>I</td><td colspan="6">Vertical Structure and Composition
[Course Outcome (s) No. : 1]
Chemical Composition; The State of the Atmosphere; Atmospheric Density and Pressure; Hydrostatic Balance</td><td>6</td></tr>
<tr><td>II</td><td colspan="6">Atmospheric Thermodynamics
[Course Outcome (s) No. : 1 and 2]
The Ideal Gas Law and First Law of Thermodynamics; Concept of Air Parcel and Lapse Rates; Atmospheric Stability; Mixing Height and Inversion</td><td>6</td></tr>
<tr><td>III</td><td colspan="6">Atmospheric Energy Balance
[Course Outcome (s) No. : 2 and 3]
Electromagnetic Radiations, Black Body Radiation; The Solar Constant and the Budget of Solar Radiation; Terrestrial Radiation, The Earth’s Radiative Energy Balance; Green House Effect</td><td>6</td></tr>
</table>

IV	**Atmospheric Chemistry** **[Course Outcome (s) No. :5]** Thermo-chemical and Photo-chemical Reactions; Chemistry of Stratosphere, Stratospheric Ozone Depletion; Chemistry of Troposphere, Acid Rain; Atmospheric Aerosols, Atmospheric Trace Gases	6
V	**Atmospheric Dynamics** **[Course Outcome (s) No. :2 and4]** Pressure Belts and Winds; Pressure Gradient Force; Coriolis Force, Centrifugal Force, Frication; Global Circulation	6

Text Books:

Wallace John M. Jr., Peter V. Hobbs (2006): Atmospheric Science: An Introductory Survey, 2nd Edition, **Academic Press**,ISBN: 978-0127329512

John H. Seinfeld, Spyros N. Pandis(2006)**:** Atmospheric Chemistry and Physics, **John Wiley & Sons Inc.,** ISBN: 978-0-471-72018-8

Suggested Readings:

Frederick K. Lutgens, Edward J. Tarbuck(2010)**:** The Atmosphere: An Introduction To Meteorology, **Phi (Prentice-hall New Arrivals)**, ISBN: 978-8120344150

Barbara J. Finlayson-Pitts, Pitts James N. JR., James N. Pitts Jr. (1999)**:** Chemistry of the Upper and Lower Atmosphere: Theory, Experiments, and Applications, **Academic Press** ISBN: 978-0122570605

Course Outcomes (COs) Mapping with POs and PSOs

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PO^4- To make them committed towards professional ethics

Course Articulation Matrix of ENV 516 – Atmospheric Science

PSOs/ POs	PSO^1	PSO^2	PSO^3	PO^1	PO^2	PO^3	PO^4
CO^1	1	2	2	1	3	3	2
CO^2	1	1	3	1	3	2	3
CO^3	1	2	2	1	2	2	3
CO^4	1	1	3	1	3	2	3
CO^5	1	2	2	1	2	3	2

1: *Partially Related* **2:** *Moderately Related* **3:** *Highly Related*

Course No:	**Course Name:** Basics of Climate Change				**Course Code: ENV 447**		
Batch:	**Programme:**	**Semester:**	**L**	**T**	**P**	**Credits**	**Contact Hrs. per Week: 2**
2021-2023	M.Sc. Environmental Sciences	I	2	0	0	2	**Total Hrs.: 30**
Total Evaluation Marks: 100 Mid-Term: 20 End-Term: 60 CIA: 20	**Pre-requisite of the course:** Basic knowledge of Physics, chemistry, biology and geography						
Course Objectives	1. Understand the Erath's Climate System and distinguish between natural climate variability and anthropogenic climate change. 2. Familiarize the concept of Green House Effect, Radiative Forcing and Climate Sensitivity. **3.** Explore the different phases of climate variability in the past and observation of present era of Global Climate Change.						
Course Outcomes:	After the successful completion of this course, the student will be able to **CO^1**: To know about the structure and various components constituting the Earth's Climate System. **CO^2**: To distinguish between climate variability and climate change. **CO^3**: To understand Natural and Human Drivers of Climate Change. **CO^4**: To comprehend the roles of atmospheric aerosols and gases in the present process of Climate Change. **CO^5**: Familiar with the observations of climate change in the various spheres of the Earth'sconcept of atmospheric dynamics						
Attendance Requirement:	Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75 percent attendance is a must failing which a student may not be permitted to appear in examination.						
Evaluation Criteria:	**1.** Mid Term Examination: 20% **2.** End Term Examination: 60% **3.** Continuous Internal Assessment : 20%						

COURSE SYLLABUS

Unit No.	Contents	Contact Hrs.
I	**The Climate System: an overview** **[Course Outcome (s) No. : 1, 2]** Weather Vs Climate; Components of the Climate System; The Driving Forces of Climate; Climate Parameters and Data-sets available to study Climate Change; Observed Natural Vs Anthropogenic Climate Change	8
II	**Natural and Human Drivers of Climate Change** **[Course Outcome (s) No. :3]** The Sun and the Earth Geometry; Milankovitch Cycles, Solar Constant; The Effect Temperature of the Earth; Green House Effect; The concept of Radiative Forcing and Climate Sensitivity	7
III	**Radiative effects of Aerosol and Gases** **[Course Outcome (s) No. : 3]** Greenhouse gases; Halocarbon radiative forcing; Radiative forcing due to stratospheric ozone changes; Tropospheric Aerosols: Direct forcing due to Sulphate aerosols and Soot aerosols; Indirect forcing due to effect of aerosols on cloud properties,	8

IV	**Observations of Changes in Climate** **[Course Outcome (s) No. : 4]** Atmospheric Changes: Instrumental Record; Changes in the Ocean: Instrumental Record; Changes in the Cryosphere: Instrumental Record; A Palaeoclimatic Perspective; Extreme Weather Events	7

Suggested Readings:

1. Intergovernmental Panel on Climate Change (1995), Climate Change 1995: The Science of Climate Change, Edited by J.T. Houghton, L.G. MeiraFilho, B.A. Callander, N. Harris, A. Kattenberg and K. Maskell, Cambridge University Press, ISBN: 0 521 56436 0
2. Intergovernmental Panel On Climate Change (2007), Specifications of Climate Change 2007 - The Physical Science Basis, Cambridge University Press, ISBN: 9780521705967
3. John H. Seinfeld, Spyros N. Pandis: Atmospheric Chemistry and Physics, John Wiley & Sons, Inc., ISBN: 978-0-471-72018-8

Course Articulation Matrix of ENV 447 – Basics of Climate Change

PSOs/ POs	PSO^1	PSO^2	PSO^3	PO^1	PO^2	PO^3	PO^4
CO^1	1	1	2	1	2	3	2
CO^2	1	2	3	1	3	2	3
CO^3	1	1	2	1	2	3	3
CO^4	1	2	3	1	3	2	3
CO^5	1	1	2	1	2	3	2

1: *Partially Related* **2:** *Moderately Related* **3:** *Highly Related*

Course No:	**Course Name:** Introduction to Statistical Techniques				**Course Code: ENV 432**		
Batch:	**Programme:**	**Semester:**	**L**	**T**	**P**	**Credits**	**Contact Hrs. per Week: 4**
2021-2023	M.Sc. Environmental Sciences	II	4	0	0	4	**Total Hrs.: 60**
Total Evaluation Marks: 200 Mid-Term: 40 End-Term: 120 CIA: 40	**Pre-requisite of the course:** Basic knowledge of the mathematics.						
Course Objectives	**1.** Organizing and presenting the data **2.** Comprehend the descriptive statistics **3.** Understanding the process of sampling and hypothesis testing						
Course Outcomes:	After the successful completion of this course, the student will be able to **CO[1]**: Understand organizing and presenting the data **CO[2]**: Apply the knowledge of basic descriptive statistics to describe the data **CO[3]**: Identify the distribution pattern of data **CO[4]**: Learn the process of sampling and hypothesis testing **CO[5]**: Familiar with the concept of correlation between variables						
Attendance Requirement:	Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75 percent attendance is a must failing which a student may not be permitted to appear in examination.						
Evaluation Criteria:	**1.** Mid Term Examination: 20% **2.** End Term Examination: 60% **3.** Continuous Internal Assessment : 20%						

COURSE SYLLABUS

Unit No.	Contents	Contact Hrs.
I	**Variables and Frequency Distributions** **[Course Outcome (s) No. : 1]** Population and Sample; Variables: Discrete and Continuous; Raw Data, Arrays and Frequency Distributions; Histograms and Frequency Polygons; Relative-Frequency Distributions, Cumulative-Frequency Distributions and Ogives	12
II	**Descriptive Statistics** **[Course Outcome (s) No. : 2]** Mean, Median and Mode; Root Mean Square; Quartiles, Deciles, and Percentiles; Range and IQR; Standard Deviation and Variance; Skewness and Kurtosis	12
III	Probability and Probability Distribution **[Course Outcome (s) No. : 3]** Elementary Probability Theory and Probability Distribution; Probability Distributions: Binomial, Normal, and Poisson Distributions	12

IV	Sampling Theory and Hypothesis Testing **[Course Outcome (s) No. : 4]** Elementary Sampling Theory, Statistical Estimation Theory, Hypothesis testing, Confidence levels, Type-I and Type-II Errors; Student's t-test, Analysis of Variance, $\chi 2$ test	16
V	Correlation and Linear Regression **[Course Outcome (s) No. : 1 and 5]** Correlation and Linear Regression Correlation and Linear regression	8

Text Books:

1. Murray J. Spiegel, Larry J. Stephens: Schaum's Outline of Statistics (Schaum's Outlines), 5th Edition, McGraw-Hill Education, ISBN: 978-0071822527
2. John C. Davis: Statistics and Data Analysis in Geology, 3rd Edition, John Wiley & Sons, Inc., ISBN: 978-0471172758

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Course Articulation Matrix of ENV 432 –Introduction to Statistical Techniques

PSOs/ POs	PSO^1	PSO^2	PSO^3	PO^1	PO^2	PO^3	PO^4
CO^1	1	2	2	1	2	3	2
CO^2	1	1	3	1	3	2	2
CO^3	1	2	2	1	2	3	3
CO^4	1	1	3	1	2	2	3
CO^5	1	2	2	1	2	3	2

1: *Partially Related* **2:** *Moderately Related* **3:** *Highly Related*

Course No:	**Course Name:** Atmospheric Chemistry and Physics				**Course Code: ENV 582**		
Batch:	**Programme:**	**Semester:**	**L**	**T**	**P**	**Credits**	**Contact Hrs. per Week: 4**
2021-2023	M.Sc. Environmental Sciences	III	4	0	0	4	**Total Hrs.: 60**
Total Evaluation Marks: 200 Mid-Term: 40 End-Term: 120 CIA: 40	**Pre-requisite of the course:** Atmospheric Science ENV 516						
Course Objectives	**1.** Grasp the chemical processes taking place in the Earth's atmosphere **2.** Comprehend the physics of atmospheric processes **3.** Understanding the basics of atmospheric dynamics						
Course Outcomes:	After the successful completion of this course, the student will be able to **CO^1**: Understand the chemistry of troposphere and stratosphere **CO^2**: Apply the knowledge of basic physics to describe the atmospheric processes **CO^3**: Know the composition, sources and transformational processes of atmospheric aerosols **CO^4**: Learn transfer and distribution pattern of solar radiation **CO^5**: Familiar with the concept of atmospheric dynamics						
Attendance Requirement:	Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75 percent attendance is a must failing which a student may not be permitted to appear in examination.						
Evaluation Criteria:	**1.** Mid Term Examination: 20% **2.** End Term Examination: 60% **3.** Continuous Internal Assessment : 20%						

COURSE SYLLABUS

Unit No.	Contents	Contact Hrs.
I	**Chemistry of Troposphere:** **[Course Outcome (s) No. : 1]** Chemistry of Nitrogen in troposphere: Sources and chemistry of NOx and NOy, Chemistry of Sulphur in troposphere: Sources and chemistry of SOx, Chemistry of Carbon in troposphere: Sources and chemistry of CO, CO_2, CH_4 and Non-methane Hydro Carbons, Chemistry of Oxygen in troposphere: ODD oxygen chemistry, formation of Ozone and OH* radicals Chemistry of Stratosphere: Chapman Mechanism for the Stratospheric Ozone Chemistry, NOx Cycles and HOx Cycles, Halogen Cycles, Reservoir Species and Coupling of the Cycles, Ozone Layer Depletion and Ozone Hole	12
II	**Atmospheric Aerosols:** **[Course Outcome (s) No. : 2]** Physical Properties of Atmospheric Aerosols, Chemical Composition of Atmospheric Aerosols, Interaction of light with particles, Role of Atmospheric aerosols in Global Climate Change	12
III	Atmospheric Thermodynamics: **[Course Outcome (s) No. : 3]** Gas Laws: Virtual Temperature, The Hydrostatic Equation: Geopotential, Scale Height and the Hypsometric Equation, The First Law of Thermodynamics: Joule's Law, Specific Heats, Enthalpy, Adiabatic Processes: Concept of an Air Parcel, The Dry Adiabatic Lapse Rate, Potential Temperature, Thermodynamic Diagrams, Water Vapor in Air: Moisture Parameters,	12

	Latent Heats, The Saturated Adiabatic Lapse Rate, Normand's Rule, Static Stability: Unsaturated Air, Saturated Air, Conditional and Convective Instability	
IV	Atmospheric Radiative Transfer: **[Course Outcome (s) No. : 4]** Blackbody Radiation: The Planck Function, Wien's Displacement Law, The Stefan–Boltzmann Law, Kirchhoff's Law, The Greenhouse Effect, Physics of Scattering and Absorption and Emission: Scattering by Air Molecules and Particles, Absorption by Particles, Absorption and Emission by Gas Molecules, Radiative Transfer in Planetary Atmospheres: Beer's Law, Reflection and Absorption by a Layer of the Atmosphere, Absorption and Emission of Infrared Radiation in Cloud-Free Air, Radiation Balance at the Top of the Atmosphere	12
V	Atmospheric Dynamics: **[Course Outcome (s) No. : 1 and 5]** Dynamics of Horizontal Flow: Apparent Forces, Real Forces, The Horizontal Equation of Motion: The Geostrophic Wind, The Effect of Friction, The Gradient Wind, The Thermal Wind, The Atmospheric General Circulation, The Kinetic Energy Cycle: The Atmosphere as a Heat Engine	12

Text Books:

Wallace John M. Jr., Peter V. Hobbs (2006): Atmospheric Science: An Introductory Survey, 2nd Edition, **Academic Press**,ISBN: 978-0127329512

John H. Seinfeld, Spyros N. Pandis(2006)**:** Atmospheric Chemistry and Physics, **John Wiley & Sons Inc.,** ISBN: 978-0-471-72018-8

Barbara J. Finlayson-Pitts, Pitts James N. JR., James N. Pitts Jr. (1999)**:** Chemistry of the Upper and Lower Atmosphere: Theory, Experiments, and Applications, **Academic Press** ISBN: 978-0122570605

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Course Articulation Matrix of ENV 582 – Atmospheric Chemistry and Physics

PSOs/ POs	PSO^1	PSO^2	PSO^3	PO^1	PO^2	PO^3	PO^4
CO^1	1	2	2	1	2	3	2
CO^2	1	1	3	1	3	2	2
CO^3	1	3	2	1	2	2	3

CO[4]	1	2	3	1	3	2	3
CO[5]	1	1	2	1	2	3	2

1: *Partially Related* **2:** *Moderately Related* **3:** *Highly Related*

Course No:	**Course Name:** Environmental Pollution and Environmental Engineering				**Course Code: ENV 568**		
Batch: 2021-2023	**Programme:** M.Sc. Environmental Sciences	**Semester:** IV	**L** 4	**T** 0	**P** 0	**Credits** 4	**Contact Hrs. per Week: 4** **Total Hrs.: 60**
Total Evaluation Marks: 200 Mid-Term: 40 End-Term: 120 CIA: 40		**Pre-requisite of the course:**ENV403, ENV516					
Course Objectives	**1.** Grasp the basic science behind Air and Water Pollution **2.** Comprehend the scientific tools to abate the problem of Air and Water Pollution **3.** Understanding the basics of climate change and geo-engineering						
Course Outcomes:	After the successful completion of this course, the student will be able to **CO[1]**: Understand the sources and processes of air and water pollution **CO[2]**: Know the basic physics and chemistry to understand the quantum of environmental pollution **CO[3]**: Learn various pollution monitoring techniques **CO[4]**: Apply the knowledge of environmental chemistry and physics to control the pollution at different levels **CO[5]**: Familiar with the concept of climate change and geo-engineering						
Attendance Requirement:	Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75 percent attendance is a must failing which a student may not be permitted to appear in examination.						
Evaluation Criteria:	**1.** Mid Term Examination: 20% **2.** End Term Examination: 60% **3.** Continuous Internal Assessment : 20%						

COURSE SYLLABUS

Unit No.	Contents	Contact Hrs.
I	**Mass and Energy Transfer:** **[Course Outcome (s) No. : 1]** Concentrations and other units of measure, Material Balance, Thermodynamics, Chemical Equilibrium	12
II	**Air, Water and Their Impurities:** **[Course Outcome (s) No. : 2]** Air and the Atmosphere, Water and the Hydrosphere, Water Pollutants, Air Pollutants	12
III	**Air Quality Engineering:** **[Course Outcome (s) No. : 3]** Air Pollutant Emissions and Controls, Pollutant generation by combustion: Motor vehicle emissions, Treatment Technologies: Particle control devices, Absorption for gaseous pollutant	12

IV	**Water Quality Engineering:** **[Course Outcome (s) No. : 4]** Water Quality Regulations and Treatment Systems, Physical Treatment Methods, Chemical and Physicochemical Treatment Methods, Biological Waste Water Treatment	12
V	**Global Climate Change and Geo-engineering:** **[Course Outcome (s) No. : 1 and 5]** Green House Effect, Radiative Forcing, Global warming Potential, Global Energy Balance, Global Warming, Climate Change, Mitigation Strategies, Geo-engineering	12

Text Books:

Ela, Wendell P., Masters, Gilbert M., 2014, Introduction to environmental engineering and science, Pearson new international edition, third edition. ISBN: 9781292038179

Clair Sawyer, Perry McCarty, Gene Parkin, 2002, McGraw HillChemistry for Environmental Engineering and Science. ISBN: 9780072480665

P. AarneVesilind, Susan M. Morgan, Lauren G. Heine, 2009, Introduction to Environmental Engineering , Third Edition, CL-Engineering, ISBN: 9780495295839

Course Outcomes (COs) Mapping with POs and PSOs

All the courses together must cover all the POs (and PSOs). For a course we map the COs to POs through the CO-PO matrix and to PSOs through the CO-PSO matrix as shown below. The various correlation levels are:
"-" indicates there is **no** correlation
"1" – Slight (**Low**) Correlation
"2" – Moderate (**Medium**) Correlation
"3" – Substantial (**High**) Correlation

Programme Specific Outcomes of Master of Science in Environmental Sciences

PSO^1- To enhance students' ability to understand and mitigate environmental issues
PSO^2- To augment the acumen to analyse geological and environmental research problems of social relevance
PSO^3- To ensure lifelong learning on scientific skills for industrial applications and entrepreneurship

Programme Outcomes of Master of Science in Environmental Sciences

PO^1- To develop in-depth knowledge on the structure and function of the global environment
PO^2- To inculcate a harmonious relationship between nature and human being
PO^3- To foster a culture of indigenous traditional knowledge for sustainable future
PO^4- To make them committed towards professional ethics

Course Articulation Matrix of ENV 568 – Environmental Pollution and Environmental Engineering

PSOs/ POs	PSO^1	PSO^2	PSO^3	PO^1	PO^2	PO^3	PO^4
CO^1	1	2	2	1	2	3	2
CO^2	1	1	3	1	3	2	1
CO^3	1	2	2	1	2	3	3
CO^4	1	1	3	1	3	2	3
CO^5	1	2	2	1	2	3	1

1: *Partially Related* **2:** *Moderately Related* **3:** *Highly Related*

4. Dr. Subhankar Chaterjee

<table>
<tr><td colspan="8">Dr. Subhankar Chatterjee</td></tr>
<tr><td colspan="2"></td><td colspan="4"></td><td colspan="2"></td></tr>
<tr><td colspan="2">Course No:</td><td colspan="4">Course Name:
Analytical Techniques</td><td colspan="2">Course Code: ENV 412</td></tr>
<tr><td>Batch:</td><td>Programme:</td><td>Semester:</td><td>L</td><td>T</td><td>P</td><td>Credits</td><td>Contact Hrs. per Week: 2</td></tr>
<tr><td>2021-2022</td><td>M.Sc. Environmental Sciences</td><td>III</td><td>2</td><td>0</td><td>0</td><td>2</td><td>Total Hrs.: 30</td></tr>
<tr><td colspan="3">Total Evaluation Marks: 100
Mid-Term: 20
End-Term: 60
CIA: 20</td><td colspan="5">Pre-requisite of course: Basic knowledge of analytical techniques used in Biosciences and Chemistry.</td></tr>
<tr><td>Course Objectives</td><td colspan="7">1. To provide the basic knowledge of principle and applications of chromatographytechniques
2. To understand liquid and Gas Chromatography - Mass spectrometry .</td></tr>
<tr><td>Course Outcomes:</td><td colspan="7">After completing this course, student is expected to learn the followings:
CO¹: Introduction to Chromatography
CO²: High Performance Liquid Chromatography
CO³:Gas Chromatography
CO⁴: Liquid and Gas Chromatography - Mass spectrometry</td></tr>
<tr><td>Attendance Requirement:</td><td colspan="7">Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.</td></tr>
<tr><td>Evaluation Criteria:</td><td colspan="7">1. Mid Term Examination: 20%
2. End Term Examination: 60%
Continuous Internal Assessment : 20%</td></tr>
<tr><td colspan="8">COURSE SYLLABUS</td></tr>
<tr><td colspan="8"></td></tr>
<tr><td>Unit No.</td><td colspan="6">Contents</td><td>Contact Hrs.</td></tr>
<tr><td>I</td><td colspan="6">[Course Outcome (s) No. :1
• Basic principle of Analytical techniques.
• Different types of Chromatography techniques and their applications.
• Thin layer Chromatography – Basic principle, methodology, application.
• Hands on training</td><td>5</td></tr>
<tr><td>II</td><td colspan="6">[Course Outcome (s) No.:2]
• Basic Principle, Methodology, Application.
• Discussion with examples based on published research papers.
• Hands-on-training.</td><td>5</td></tr>
<tr><td>III</td><td colspan="6">[Course Outcome (s) No. :3]
• Basic Principle, Methodology, Application.
• Discussion with examples based on published research papers.
• Hands-on-training</td><td>5</td></tr>
</table>

IV	**[Course Outcome (s) No. :4]** • Basic Principle, Methodology, Application. • Discussion with examples based on published research papers.	**5**

Suggested Readings:

1. Handbook of Thin-Layer Chromatography, 2003. 3rd Edition; Edited By Joseph Sherma, Bernard Fried. CRC Press.
2. HPLC Basics- Fundamentals of Liquid Chromatography (HPLC); Courtesy of Agilent Technologies, Inc.
3. Shimadzu fundamental guides to LC-MS
4. Agilent LC-MS primer
5. Waters HPLC-UHPLC notebook.
6. Principles of Gas Chromatography- Physical Methods in Chemistry and Nano Science Archer J.P. Martin and Anthony T. James. The Open Courses Library.
7. https://bookauthority.org/books/best-chromatography-books

Course Outcomes (COs) Mapping with POs and PSOs

All the courses together must cover all the POs (and PSOs). For a course we map the COs to POs through the CO-PO matrix and to PSOs through the CO-PSO matrix as shown below. The various correlation levels are:
"-" indicates there is **no** correlation
"1" – Slight (**Low**) Correlation
"2" – Moderate (**Medium**) Correlation
"3" – Substantial (**High**) Correlation

Programme Specific Outcomes of Master of Science in Environmental Sciences

PSO[1]- To enhance students' ability to understand analytical techniques
PSO[2]- To augment the acumen to determinevarious pollutants in environment.
PSO[3]- To ensure lifelong learning on scientific skills for industrial applications.

Programme Outcomes of Master of Science in Environmental Sciences

PO[1]- To develop in-depth knowledge on the principle chromatography
PO[2]- To understand their application in industries
PO[3]- To foster knowledge for sustainable future
PO[4]- To make them committed towards professional ethics

Course Articulation Matrix of ENV 412 – Analytical Techniques

PSOs/ POs	PSO1	PSO2	PSO3	PO1	PO2	PO3	PO4
CO1	2	3	3	2	2	3	2
CO2	2	2	2	3	3	2	2
CO3	3	2	3	3	2	2	3
CO4	3	3	3	3	2	2	2
CO5	2	3	3	3	2	3	2

1: *Partially Related***2:** *Moderately Related* **3:** *Highly Related*

Course No:	**Course Name:** **Bioresources and Environmental Biotechnology**				**Course Code: ENV 557**		
Batch: 2021-2022	**Programme:** M.Sc. Environmental Sciences	**Semester:** III	**L** 4	**T** 0	**P** 0	**Credits** 4	**Contact Hrs. per Week: 4** **Total Hrs.: 40**
Total Evaluation Marks:200 Mid-Term: 50 End-Term: 100 CIA: 50		**Pre-requisite of course:**Depth knowledge of biotechnology, bioremediation and environmental applications.					
Course Objectives	• Introduce concept of biotechnology and its role in development and sustainability • Give in-depth knowledge related to modern techniques in biotechnology. • Give a brief concept how to improve our environment in future by using biotechnology.						
Course Outcomes:	After completing this course, student is expected to learn the followings: **CO^1**: Bioresources **CO^2**: Bioremediation **CO^3**: Recombinant DNA Technology. **CO^4**: Genetic Engineering						
Attendance Requirement:	Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.						
Evaluation Criteria:	**1.** Mid Term Examination: 25% **2.** End Term Examination: 50% **3.** Continuous Internal Assessment :25%						

COURSE SYLLABUS

Unit No.	Contents	Contact Hrs.
I	**[Course Outcome (s) No. :1** Bioresources- importance of bacteria, fungi as bioresourses; their beneficial effect and mechanism of action; Introduction to Environmental biotechnology- definition, scope; role of biotechnology in development and sustainability	**10**
II	**[Course Outcome (s) No. 2]** Bioremediation: Environmental Xenobiotics and human health; principles of bioremediation; TOL plasmid pathway; aerobic and anaerobic microbial degradation processes; degradation of benzene, toluene, xylene, biphenyl and degradation pathways.	**12**

III	**[Course Outcome (s) No. :3]** Recombinant DNA technology: Early discoveries, restriction endonucleases, ligases, modification enzymes, DNA and RNA markers, cloning and expression vectors (plasmids, bacteriophage, phagmids, cosmids, artificial chromosomes), selection of recombinant clones, CDNA synthesis and cloning (mRNA enrichment, reverse transcription, DNA primers, linkers, adaptors and their chemical synthesis, library construction and screening).	**12**
IV	**[Course Outcome (s) No. :4]** Genetic engineering: Release of genetically engineered microorganisms, genetically modify corps-safety and environmental risks.	**6**

Suggested Readings:

1. 1Comprehensive Biotechnology, Vol 4, M. Moo-young (Ed. In Chief) pergamon, press, Oxford.
2. An Introduction to environmental biotechnology, AK Challerre, prentice Hall publication, New Delhi
3. An Introduction to Environmental Biotechnology by Milton Wainwright: Kluwer, Academic Press, 1999.
4. Environmental biotechnology theory and Application by G.M. Evans and J.C. Furlong, John Wiley and sons, 2004.
5. Environmental biotechnology, SK Agarval, APH publ. House, New Delhi-2006.
6. Mohapatra. P. K., 2006, Text Book of Environmental Biotechnology. I K International.
7. Waste water treatments (5th edition) M N Roa and A K Dutta, Oxford IBH Publ. Co. Pvt. Ltd., New Delhi-2003.
8. Rittman, B. E., and McCarty, P. L., 2001, Environmental Biotechnology. Principles and applications. McGraw-Hill, New York.
9. Olguin, E., Sanchez, G. and Hernandez, E., 1999, Environmental biotechnology and cleaner bioprocesses, Taylor & Francis, London.
10. Glazer AN, Nikaido H. (1994) Microbial Biotechnology – Fundamentals of Applied Microbiology, WH Freeman and Company, New York.
11. Bio-remediation Technologies, Technomic Publishing Co., USA. S.K. Sikdur& R.L. Irvine.

Course Outcomes (COs) Mapping with POs and PSOs

All the courses together must cover all the POs (and PSOs). For a course we map the COs to POs through the CO-PO matrix and to PSOs through the CO-PSO matrix as shown below. The various correlation levels are:
"-" indicates there is **no** correlation
"1" – Slight (**Low**) Correlation
"2" – Moderate (**Medium**) Correlation
"3" – Substantial (**High**) Correlation

Programme Specific Outcomes of Master of Science in Environmental Sciences

PSO^1- To enhance students' ability to understand bioresources
PSO^2- To apply the principle of bioremediation for the treatment of various environmental pollutants.
PSO^3- To enhance the knowledge and applications of biotechnology.

Programme Outcomes of Master of Science in Environmental Sciences

PO^1- To develop basic knowledge in bioresources.
PO^2- To understand bioremediation of various environmental pollutants.
PO^3- To enhance the knowledge and applications of biotechnology.
PO^4- To study advance techniques in genetic engineering.

Course Articulation Matrix of ENV 557 – Bioresources and Environmental Biotechnology

PSOs/ POs	PSO1	PSO2	PSO3	PO1	PO2	PO3	PO4

CO1	2	3	3	3	3	2	3
CO2	2	2	2	3	2	2	3
CO3	3	2	3	2	2	3	3
CO4	3	3	3	3	3	2	3
CO5	2	3	3	3	3	2	3

1: *Partially Related* **2:** *Moderately Related* **3:** *Highly Related*

5. Dr. Anurag Linda

Dr. Anurag Linda							
Course No:	**Course Name:** **Introduction to Earth Processes**				**Course Code: ENV 402a**		
Batch: 2021-2023	**Programme:** M.Sc. Environmental Sciences	**Semester:** I	**L** 2	**T** 0	**P** 0	**Credits** 2	**Contact Hrs. per Week: 2** **Total Hrs.: 30**
Total Evaluation Marks: 100 Mid-Term: 20 End-Term: 60 CIA: 20		**Pre-requisite of course:** Basic knowledge of environment, science and physical geography.					
Course Objectives	**1.** To provide the basic knowledge of the earth structure and its processes and their role in shaping and evolution of earth **2.** To understand the different physical, chemical and biological components of ocean.						
Course Outcomes:	After completing this course, student is expected to learn the followings: **CO^1**: Understating the origin of earth and atmosphere and scope of earth science in environmental management. **CO^2**: Understanding the earth structure and its physical, chemical and biological characteristics. **CO^3**: To know the various tectonic processes those are operating inside the earth , that is helpful in understanding the distribution of earthquake. Volcanism, tsunami etc **CO^4**: Basic understanding of surface geological processes (weathering, erosion etc) and their use in understanding geochemical cycling of elements and their role in maintaining the earth surface temperature and associated phenomenon. **CO^5**: Will know the processes associated with ocean movements and its implications.						
Attendance Requirement:	Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.						
Evaluation Criteria:	**4.** Mid Term Examination: 20% **5.** End Term Examination: 60% Continuous Internal Assessment : 20%						

COURSE SYLLABUS

Unit No.	**Contents**	**Contact Hrs.**
I	**[Course Outcome (s) No. :1** • Introduction to Earth Science • Evolution of various branches of Earth Science • Earth as a dynamic system • Earth, Man and Environment	**7**
II	**[Course Outcome (s) No.:1 and 2]** • Different theories of origin and evolution of the earth	**8**

	• Origin of atmosphere, water and life • Geological time scale • Primary differentiation and multilayer structure of Earth	
III	**[Course Outcome (s) No. :2, 3 and 4]** • An overview on different rock types • Different mineral groups • Continental Drift hypothesis • Theory of Plate tectonics • Mountain building and sea floor spreading processes • Distribution of earthquake and volcanic activity across the globe	**8**
IV	**[Course Outcome (s) No. :5]** • Hypsography of the continents and ocean floor –continental shelf, slope, rise and abyssal plains. • Physical and chemical properties of sea water and their spatial variations. • Ocean currents, waves and tides.	**7**

Suggested Readings:

1. Keller E A 2010. Environmental Geology. 9th Edition, Prentice Hall, ISBN-13: 978-0321643759.
2. Duff P M and Duff D 1993. Holmes Principles of Physical Geology. 4th Edison, Stanley Thornes, ISBN 0748743812, 9780748743810.
3. Tank, R W. Environmental Geology. Oxford University Press ISBN 10: 0195032888 / ISBN 13: 9780195032888.
4. Press & Siever 2007: Understanding Earth W. H. Freeman and Company, ISBN: 0-7167-6682-
5. Tom Garrison 2009: Essentials of Oceanography, Fifth Edition ISBN-13: 978-0-495-55531-5,ISBN-10: 0-495-55531-2
6. The Changing Earth: Exploring Geology and Evolution. 4th edition, Brooks/Cole Publishing Co; ISBN-10: 0495010200; ISBN-13: 978-0495010203
7. Fluvial Processes in Geomorphology. Dover Publications, ISBN-10: 0486685888; ISBN-13: 978-0486685885
8. Subramanian V. A Textbook in Environmental Science. Narosa Publishers, ISBN13:978-0849324086.
9. Valdiya K S. Environmental Geology, Indian Context. Tata McGraw-Hill Pub Co. ISBN 10: 0074519719 / 0-07-451971-9;ISBN 13: 9780074519714

Course Outcomes (COs) Mapping with POs and PSOs

All the courses together must cover all the POs (and PSOs). For a course we map the COs to POs through the CO-PO matrix and to PSOs through the CO-PSO matrix as shown below. The various correlation levels are:

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"1" – Slight (**Low**) Correlation
"2" – Moderate (**Medium**) Correlation
"3" – Substantial (**High**) Correlation

Programme Specific Outcomes of Master of Science in Environmental Sciences

PSO^1- To enhance students' ability to understand and mitigate environmental issues
PSO^2- To augment the acumen to analyse geological and environmental research problems of social relevance
PSO^3- To ensure lifelong learning on scientific skills for industrial applications and entrepreneurship

Programme Outcomes of Master of Science in Environmental Sciences

PO^1- To develop in-depth knowledge on the structure and function of the global environment
PO^2- To inculcate a harmonious relationship between nature and human being
PO^3- To foster a culture of indigenous traditional knowledge for sustainable future
PO^4- To make them committed towards professional ethics

Course Articulation Matrix of ENV 402a – Introduction to Earth Processes

PSOs/ POs	PSO^1	PSO^2	PSO^3	PO^1	PO^2	PO^3	PO^4

CO[1]	2	3	3	1	3	2	2
CO[2]	2	2	2	3	2	2	3
CO[3]	3	2	3	2	2	3	3
CO[4]	3	3	3	2	2	2	3
CO[5]	3	3	3	3	3	2	2

1: *Partially Related* **2:** *Moderately Related* **3:** *Highly Related*

Course No:	**Course Name:** **Fundamental of Remote Sensing**				**Course Code: ENV 424**		
Batch: 2021-2023	**Programme:** M.Sc. Environmental Sciences	**Semester:** II	**L** 2	**T** 0	**P** 0	**Credits** 2	**Contact Hrs. per Week: 2** **Total Hrs.: 30**
Total Evaluation Marks: 100 Mid-Term: 20 End-Term: 60 CIA: 20							
	Pre-requisite of course: Basic knowledge of Physics Chemistry and Biology along with geology						
Course Objectives	To provide the basic knowledge of Remote Sensing and its application to address various environmental issues and management of natural resources						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO^1**: Basic understanding of Remote Sensing and its uses in environmental monitoring **CO^2**: It will make the student to understand the different processes and platforms of remote sensing and different elements of remote sensing **CO^3**: Microwave remote sensing and its different uses in environmental science **CO^4**: A basic understanding of different types of resolutions of satellite sensors **CO^5**: Application of remote sensing to address various environmental issues and management of natural resources						
Attendance Requirement:	Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.						
Evaluation Criteria:	**4.** Mid Term Examination: 20% **5.** End Term Examination: 60% **6.** Continuous Internal Assessment : 20%						

COURSE SYLLABUS

Unit No.	Contents	Contact Hrs.
I	**[Course Outcome (s) No. :1** • What is Remote Sensing and its different elements • Use of remote sensing in environmental monitoring • Electromagnetic Radiation, Electromagnetic Spectrum, Interactions with the Atmosphere • Passive vs. Active Sensing	4
II	**[Course Outcome (s) No. 2 and 3]** • Different platforms used in remote sensing: Ground, air and space • Satellite Characteristics, Pixel Size and Scale, Different Resolutions • Cameras and Aerial Photography, Different Satellites, Other Sensors • Characteristics of Images	6

III	**[Course Outcome (s) No.: 3 and 4]** • Introduction to microwave remote sensing • Radar Basic, Viewing Geometry & Spatial Resolution • Airborne vs Spaceborne Radars • Image Analysis: Visual interpretation & Digital analysis, Elements of visual interpretation.	6
IV	**[Course Outcome (s) No. : 5]** • Applications: Agriculture, Glaciology, Forestry, Geology, Hydrology, Sea Ice, Land Cover, Oceans & Coastal	6

Suggested Readings:

1. Lillesand & Keifer, (2011): Remote Sensing & Image Interpretation, John Wiley & Sons, ISBN: 9788126532230.
2. James B.Campbell,(2007): Introduction to Remote Sensing, Taylor & Francis, ISBN: 9780415416887.
3. J.R.Jensen, (2009): Remote Sensing of the Environment, Pearsons education Pub. ISBN: 9788131716809.
4. George Joseph, (2005): Fundamental of Remote Sensing, University Press, India, ISBN: 9788173715358.
5. Bruce Grubbs, (2005): Basic Essentials Using GPS, Falcon Press Publishing, ISBN: 9780762734214.

Course Outcomes (COs) Mapping with POs and PSOs

All the courses together must cover all the POs (and PSOs). For a course we map the COs to POs through the CO-PO matrix and to PSOs through the CO-PSO matrix as shown below. The various correlation levels are:
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"1" – Slight (**Low**) Correlation
"2" – Moderate (**Medium**) Correlation
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Programme Specific Outcomes of Master of Science in Environmental Sciences

PSO^1- To enhance students' ability to understand and mitigate environmental issues
PSO^2- To augment the acumen to analyse geological and environmental research problems of social relevance
PSO^3- To ensure lifelong learning on scientific skills for industrial applications and entrepreneurship

Programme Outcomes of Master of Science in Environmental Sciences

PO^1- To develop in-depth knowledge on the structure and function of the global environment
PO^2- To inculcate a harmonious relationship between nature and human being
PO^3- To foster a culture of indigenous traditional knowledge for sustainable future
PO^4- To make them committed towards professional ethics

Course Articulation Matrix of ENV 424 – Fundamentals of Remote Sensing

PSOs/ POs	PSO^1	PSO^2	PSO^3	PO^1	PO^2	PO^3	PO^4
CO^1	1	2	2	1	3	2	2
CO^2	1	2	2	3	2	2	3
CO^3	3	2	3	2	2	3	3
CO^4	3	3	3	2	2	2	3
CO^5	3	3	3	3	3	2	2

1: *Partially Related* **2:** *Moderately Related* **3:** *Highly Related*

Course No:	**Course Name:** **Environmental Geo Science Lab**				**Course Code:** **ENV 444**		
Batch: 2021-2023	**Programme:** M.Sc. Environmental Sciences	**Semester:** II	**L** 2	**T** 0	**P** 2	**Credits** 2	**Contact Hrs. per Week: 4** **Total Hrs. 60**
Total Evaluation Marks: 100 End-Term: 75 CIA: 25		**Examination Duration:** 3 Hrs.					
		Pre-requisite of course: Basic knowledge of Remote Sensing and its Application, Geo Science					
Course Objectives	**1.** To provide the basic experimental knowledge of instruments used in Geosciences **2.** To learn different techniques for analysing geo-data						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO[1]**: Identification of different structures on earth surface and its mapping **CO[2]**: Understanding different types of processes resulting in the formation of different types of crustal rocks and its identification **CO[3]**: Basic understanding of GPS and its use in environmental monitoring **CO[4]**: Knowledge of different types of isolines including toposheets and contour maps. **CO[5]**: Proficiency in using Google Earth images for change detection analysis.						
Attendance Requirement:	Students are expected to attend all lectures/practical in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.						
Evaluation Criteria:	**1.** End Term Examination: 75% **2.** Continuous Internal Assessment : 25%						

COURSE SYLLABUS

Experiment No.	Contents	Contact Hrs.
I	**[Course Outcome (s) No. : 1]** Identification of Dip and Strike on the field using Brunton compass	8
II	**[Course Outcome (s) No. : 2]** Identification of Rock Sample in the field and in Hand specimen	8
III	**[Course Outcome (s) No. : 3]** Identification of point, line and area features using GPS	8
IV	**[Course Outcome (s) No. :4]** Study of SOI Toposheet	4
V	**[Course Outcome (s) No. :4]** Drawing crossectional profile using contour maps	4
VI	**[Course Outcome (s) No. : 5]** Change detection analysis using Google Earth Images.	8

Suggested Readings:

1. http://www.geo.utexas.edu/courses/420k/PDFs/Brunton_Compass_09.pdf
2. Charles A. Sorrell (Author), George F. Sandström (Illustrator) 2001: Rocks and Minerals: A Guide to Field Identification (Golden Field Guide f/St. Martin's Press), ISBN: 1582381240
3. George Joseph, (2005): Fundamental of Remote Sensing, University Press, India, ISBN: 9788173715358.
4. Bruce Grubbs, (2005): Basic Essentials Using GPS, Falcon Press Publishing, ISBN: 9780762734214

Course Outcomes (COs) Mapping with POs and PSOs

All the courses together must cover all the POs (and PSOs). For a course we map the COs to POs through the CO-PO matrix and to PSOs through the CO-PSO matrix as shown below. The various correlation levels are:
"-" indicates there is **no** correlation
"1" – Slight (**Low**) Correlation
"2" – Moderate (**Medium**) Correlation
"3" – Substantial (**High**) Correlation

Programme Specific Outcomes of Master of Science in Environmental Sciences

PSO^1- To enhance students' ability to understand and mitigate environmental issues
PSO^2- To augment the acumen to analyse geological and environmental research problems of social relevance
PSO^3- To ensure lifelong learning on scientific skills for industrial applications and entrepreneurship

Programme Outcomes of Master of Science in Environmental Sciences

PO^1- To develop in-depth knowledge on the structure and function of the global environment
PO^2- To inculcate a harmonious relationship between nature and human being
PO^3- To foster a culture of indigenous traditional knowledge for sustainable future
PO^4- To make them committed towards professional ethics

Course Articulation Matrix of ENV 444 – Environmental Geosciences Lab

PSOs/ POs	PSO^1	PSO^2	PSO^3	PO^1	PO^2	PO^3	PO^4
CO^1	1	2	3	1	3	2	2
CO^2	2	2	2	3	2	3	3
CO^3	3	2	3	2	2	3	3
CO^4	3	3	3	2	2	2	3
CO^5	3	3	3	3	3	2	2

1: *Partially Related* **2:** *Moderately Related* **3:** *Highly Related*

Course No:	**Course Name:** **Water Resource Conservation in Hilly Region**				**Course Code: ENV 441**		
Batch: 2021-2023	**Programme:** M.Sc. Environmental Sciences	**Semester:** II	**L** 2	**T** 0	**P** 0	**Credits** 2	**Contact Hrs. per Week: 2** **Total Hrs.: 30**
Total Evaluation Marks: 100 Mid-Term: 20 End-Term: 60 CIA: 20		**Pre-requisite of course:** Basic knowledge of water resource, soil science, geology and meteorology					
Course Objectives	To provide the basic knowledge of water resource management and its movement through the hydrological cycle in the Himalaya						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO^1**: Basic understanding of water resource status in the Himalayan Region **CO^2:** Basic understanding of the distribution of surface and groundwater resources in the Himalaya **CO^3:** Basic understanding of basic concepts and methods for rain water conservation in the Himalayan region in the Himalaya **CO^4:** Different techniques for revival of Himalayan spring. **CO^5:** Skill development towards different structures as well as some of the traditional practices prevalent in the Himalaya for sustainable agriculture.						
Attendance Requirement:	Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.						
Evaluation Criteria:	**1.** Mid Term Examination: 20% **2.** End Term Examination: 60% **3.** Continuous Internal Assessment : 20%						

COURSE SYLLABUS

Unit No.	Contents	Contact Hrs.
I	**[Course Outcome (s) No.:1]** • Water as a resource and its usage in evolution of history • Water Resources development Scenario in the Himalaya and its environmental impact • Brief outline of historic development in the Himalaya and its impact on natural drainage pattern • Indian Water Scenario with respect to different season's in the hills and plains.	4
II	**[Course Outcome (s) No. : 1 and 2]** • Distribution of surface and ground water resources: dimension and challenges • Land use and Land Cover change, Hydrological cycle and its impact in the local hydrology	4

	• Water supply-demand management in the hills • Environmental impact due to overexploitation of water resources and urgency of sustainable water resource management	
III	**[Course Outcome (s) No. :2,3 and 4]** • Groundwater and its contaminations • Aquifer structure and types • Aquifer capacity • Determining aquifer flow velocity-Darcy Law • Integrated water resource management (IWRM) and virtual water	6
IV	**[Course Outcome (s) No. : 3,4 and 5]** • Water harvesting techniques in the hilly region • Artificial ground water recharge techniques and designs: With special reference to spring revival • Snow harvesting, roof top harvesting and dew drop harvesting • Sustainable agriculture and irrigation in the hills.	6

Suggested Readings:

1. Patel, A. S., Shah, D. L., (2007): Water Management: Conservation, Harvesting and Artificial Recharge, New Age International, ISBN: 9788122422245.
2. (2001): Standard Guidelines for Artificial Recharge of Ground Water, EWRI/ASCE 34-01 illustrated ed Edition, American Society Of Civil Engineers, ISBN: 9780784405482.
3. Huisman, L., (1982): Artificial Groundwater Recharge (Monographs and surveys in water resources engineering) ISBN: 9780273085447.
4. CGWB, (2007): Manual on artificial recharge of ground water, Ministry of Water Resources, Central Ground Water Board.Govt. of India.
5. UNEP, (2009): Rainwater Harvesting: A Lifeline for Human Well-Being, United Nations Environment Programme, ISBN: 9789280730197.
6. Heather Kinkade-Levario, (2007): Design for Water: Rainwater Harvesting, Stormwater Catchment, and Alternate Water Reuse, New Society Publishers, ISBN: 9780865715806.
7. Piyoosh Rautela, M. L. Dewan, (2007): Water Resources in The Himalayas: Harvesting, Tradition and Change, Concept Publishing, ISBN: 9788170228042.
8. Ljiljana Baird, (2011): How to 'Harvest' Water: The Art of Saving Water, National Trust, ISBN: 9781907892004

Course Outcomes (COs) Mapping with POs and PSOs

All the courses together must cover all the POs (and PSOs). For a course we map the COs to POs through the CO-PO matrix and to PSOs through the CO-PSO matrix as shown below. The various correlation levels are:

"-" indicates there is **no** correlation
"1" – Slight (**Low**) Correlation
"2" – Moderate (**Medium**) Correlation
"3" – Substantial (**High**) Correlation

Programme Specific Outcomes of Master of Science in Environmental Sciences

PSO[1]- To enhance students' ability to understand and mitigate environmental issues
PSO[2]- To augment the acumen to analyse geological and environmental research problems of social relevance
PSO[3]- To ensure lifelong learning on scientific skills for industrial applications and entrepreneurship

Programme Outcomes of Master of Science in Environmental Sciences

PO[1]- To develop in-depth knowledge on the structure and function of the global environment
PO[2]- To inculcate a harmonious relationship between nature and human being

PO^3- To foster a culture of indigenous traditional knowledge for sustainable future
PO^4- To make them committed towards professional ethics

Course Articulation Matrix of ENV 441 – Water Resource Management in Hilly region

PSOs/ POs	PSO^1	PSO^2	PSO^3	PO^1	PO^2	PO^3	PO^4
CO^1	2	3	3	1	3	2	2
CO^2	2	2	2	3	2	2	3
CO^3	2	2	3	2	2	3	3
CO^4	3	3	3	2	2	2	3
CO^5	3	3	3	3	3	2	2

1: *Partially Related* **2:** *Moderately Related* **3:** *Highly Related*

Course No:	**Course Name:** **Remote Sensing and GIS Lab**				**Course Code:** **ENV 571**		
Batch: 2020-2022	**Programme:** M.Sc. Environmental Sciences	**Semester:** III	**L** 2	**T** 0	**P** 0	**Credits** 2	**Contact Hrs. per Week: 4** **Total Hrs.: 60**
Total Evaluation Marks: 100 Mid Term: 25 End-Term: 50 CIA: 25		**Examination Duration:** 3 Hrs.					
		Pre-requisite of course: Basic knowledge of Remote Sensing & GIS and its Application					
Course Objectives	To provide the basics of Remote Sensing and is application to address the various environmental issues and management of natural resources						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO[1]**: Basic understanding of Topographic maps and the use of GPS. **CO[2]**: How to download different satellite images from different platforms for scientific work. **CO[3]**: The use of Geographical Information System (GIS), their various components and how these tools can be used for environmental studies. **CO[4]**: The use of GIS for change detection analysis that can be further used for natural resource management and conservation. **CO[5]**: Different uses of GIS for natural hazard zonation and its management.						
Attendance Requirement:	Students are expected to attend all lectures/practical in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.						
Evaluation Criteria:	**1.** Mid Term Examination: 25% **2.** End Term Examination: 50% **3.** Continuous Internal Assessment : 25%						

COURSE SYLLABUS

Unit No.	Contents	Contact Hrs.
I	**[Course Outcome (s) No. :1]** • Use of GPS in environmental monitoring • Study of different Toposheet	10
II	**[Course Outcome (s) No. :2]** • Visual interpretation of satellite images (Google Earth Images) • Image digitization • Georeferencing of Toposheets and Images	10

III	**[Course Outcome (s) No. : 3 and 4]** • Creating buffer zones • Classification of images • Change detection analysis	10
IV	**[Course Outcome (s) No. : 5]** • Landslide zonation of an area • Flood zonation of an area • Calculation of Mass balance of a glacier using remote sensing	10

Suggested Readings:

1. Lillesand & Keifer, (2011): Remote Sensing & Image Interpretation, John Wiley & Sons, ISBN: 9788126532230.
2. James B.Campbell,(2007): Introduction to Remote Sensing, Taylor & Francis, ISBN: 9780415416887.
3. J.R.Jensen, (2009): Remote Sensing of the Environment, Pearsons education Pub. ISBN: 9788131716809.
4. George Joseph, (2005): Fundamental of Remote Sensing, University Press, India, ISBN: 9788173715358.
5. Bruce Grubbs, (2005): Basic Essentials Using GPS, Falcon Press Publishing, ISBN: 97807627342.

Course Outcomes (COs) Mapping with POs and PSOs

All the courses together must cover all the POs (and PSOs). For a course we map the COs to POs through the CO-PO matrix and to PSOs through the CO-PSO matrix as shown below. The various correlation levels are:
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"2" – Moderate (**Medium**) Correlation
"3" – Substantial (**High**) Correlation

Programme Specific Outcomes of Master of Science in Environmental Sciences

PSO[1]- To enhance students' ability to understand and mitigate environmental issues
PSO[2]- To augment the acumen to analyse geological and environmental research problems of social relevance
PSO[3]- To ensure lifelong learning on scientific skills for industrial applications and entrepreneurship

Programme Outcomes of Master of Science in Environmental Sciences

PO[1]- To develop in-depth knowledge on the structure and function of the global environment
PO[2]- To inculcate a harmonious relationship between nature and human being
PO[3]- To foster a culture of indigenous traditional knowledge for sustainable future
PO[4]- To make them committed towards professional ethics

Course Articulation Matrix of ENV 571 – Remote Sensing and GIS Lab

PSOs/ POs	PSO[1]	PSO[2]	PSO[3]	PO[1]	PO[2]	PO[3]	PO[4]
CO[1]	2	2	2	1	3	2	2
CO[2]	2	2	2	3	2	2	3
CO[3]	3	2	3	2	2	3	3
CO[4]	3	3	3	2	2	2	3
CO[5]	3	3	3	3	3	2	2

1: *Partially Related* **2:** *Moderately Related* **3:** *Highly Related*

Course No:	**Course Name:** Energy and Environment				**Course Code: ENV 404**		
Batch:	**Programme:**	**Semester:**	**L**	**T**	**P**	**Credits**	**Contact Hrs. per Week: 2**
2020-2022	M.Sc. Environmental Sciences	III	2	0	0	2	**Total Hrs.: 30**
Total Evaluation Marks: 100 Mid Term: 25 End-Term: 50 CIA: 25			**Pre-requisite of course:** Basic knowledge of environment and science				
Course Objectives	To provide the basic knowledge of the green concepts and sustainable technology to reduce environment degradation						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO^1**: Basic understanding of the concept of green and sustainable technology **CO^2**: Basic knowledge to address the issues of sources of renewable and non-renewable energy and other environmental effects related to energy extraction **CO^3**: Basic understanding of many complex issues involved in energy extraction, conversion, and consumption. **CO^4**: Basic knowledge of the issues related to energy and environment. **CO^4**: Environment friendly engines used in transportation sector.						
Attendance Requirement:	Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.						
Evaluation Criteria:	**1.** Mid Term Examination: 25% **2.** End Term Examination: 50% **3.** Continuous Internal Assessment : 25%						

COURSE SYLLABUS

Unit No.	Contents	Contact Hrs.
I	**[Course Outcome (s) No. :1** • Sun as source of energy • Solar radiation and its spectral characteristics • Fossil fuels: classification, composition, physiochemical characteristics and energy content of coal, petroleum and natural gas.	3
II	**[Course Outcome (s) No.:2]** • Concept of renewable and nonrenewable energy sources • Basic principles of generation of energy from Solar, Wind, Geothermal and Ocean • Growing energy need, Energy use pattern and future need projection in different parts of the world and its impact on the environment.	7

III	**[Course Outcome (s) No. :3 and 4]** • Environmental implication of energy use: exponential increase in energy consumption and projected future demands, CO_2 emissions, global warming • Environmental degradation due to energy production and utilization • Strengths for adopting Green Technology and Challenges for Green Technology Adoptions • Concept of Green Buildings	4
IV	• Introduction to two stroke and four stroke engines • Recent developments in transportation sector: Electric, hybrid and solar powered vehicles • Other green technologies: hydroponics, water efficient irrigation systems, Smart grids etc	6

Suggested Readings:

1. Roger A. Hinrichs, Merlin H. Kleinbach (2012), Energy: Its Use and the Environment [Paperback], International Edition of 5th Revised Edition, Thomson Brooks, ISBN-13: 978-1111990831
2. Robert A. Ristinen, Jack P. Kraushaar (2005), Energy and the Environment, 2nd Edition (Paperback), John Wiley & Sons, ISBN-13: 978-0471739890
3. Peter E. Hodgson (2010), Energy, the Environment and Climate Change (Hardcover), Imperial College Press, ISBN-13: 978-1848164154
4. John Coad, (2011): Green Technology, Raintree, ISBN: 9781410942814.
5. Sage Publications, (2011): Green Technology: An A-To-Z Guide, The Sage Reference Series on Green Society: Toward a Sustainable Future, ISBN: 9781412996921.
6. Alexis Madrigal, (2011): Powering the Dream: The History and Promise of Green Technology, Da Capo Press, ISBN: 9780306818851.
7. Springer 2011: Green It: Technologies and Applications, ISBN: 9783642221781.

Course Outcomes (COs) Mapping with POs and PSOs

All the courses together must cover all the POs (and PSOs). For a course we map the COs to POs through the CO-PO matrix and to PSOs through the CO-PSO matrix as shown below. The various correlation levels are:

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Programme Specific Outcomes of Master of Science in Environmental Sciences

PSO^1- To enhance students' ability to understand and mitigate environmental issues
PSO^2- To augment the acumen to analyse geological and environmental research problems of social relevance
PSO^3- To ensure lifelong learning on scientific skills for industrial applications and entrepreneurship

Programme Outcomes of Master of Science in Environmental Sciences

PO^1- To develop in-depth knowledge on the structure and function of the global environment
PO^2- To inculcate a harmonious relationship between nature and human being
PO^3- To foster a culture of indigenous traditional knowledge for sustainable future
PO^4- To make them committed towards professional ethics

Course Articulation Matrix of ENV 404 – Energy and Environment

PSOs/ POs	PSO^1	PSO^2	PSO^3	PO^1	PO^2	PO^3	PO^4
CO^1	2	3	1	1	2	2	2
CO^2	2	2	2	3	2	2	3

CO[3]	2	2	3	2	2	3	3
CO[4]	3	3	3	2	2	2	3
CO[5]	3	3	3	3	3	2	3

1: *Partially Related* **2:** *Moderately Related* **3:** *Highly Related*

Course No:	**Course Name:** Glaciology				**Course Code: ENV 509**		
Batch:	**Programme:**	**Semester:**	**L**	**T**	**P**	**Credits**	**Contact Hrs. per Week: 4**
2020-2022	M.Sc. Environmental Sciences	III	4	0	0	4	**Total Hrs.: 60**
Total Evaluation Marks: 100 Mid Term: 25 End-Term: 50 CIA: 25		**Pre-requisite of course:** Basic physics, chemistry, biology, geology					
Course Objectives	To provide the basic knowledge of toxicity and hazardous behaviours of various chemical substances						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO[1]**: Glacier as a source of fresh water resource in the Himalaya, Scope of glaciology, different variants of glacial systems, glacial morphology and structures of glaciers. **CO[2]**: Analysing glacier loss by field and remote sensing mass balance methods. **CO[3]**: Understanding of glacial hydrology that will be helpful in understanding the glacier in light of water resource management. **CO[4]**: The use of different instruments for studying glacier response with respect to climate change. **CO[5]** Recent developments in the field of glaciology and their use in quantifying water resources, palaeoclimate and climate change.						
Attendance Requirement:	Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.						
Evaluation Criteria:	**1.** Mid Term Examination: 50% **2.** End Term Examination: 100% **3.** Continuous Internal Assessment : 50%						

COURSE SYLLABUS

Unit No.	Contents	Contact Hrs.
I	**Glaciology Introduction** **[Course Outcome (s) No. :1]** • Types of glacier • Transformation of snow to ice • Conditions favourable for glacier formation • Glacier systems • Structure and morphology of glaciers • Glacial erosion • Landscape evolution and different glacial landforms	7

II	**Glacier Mass Balance and Processes** **[Course Outcome (s) No. :2 and 3]** • Surface mass balance • Mass balance variations of mountain glaciers • Englacial mass balance • Basal mass balance • Mass loss by calving • Methods of determining glacier mass balance.	6
III	**Glacier Hydrology** **[Course Outcome (s) No. :2** and **3]** • Surface hydrology • Englacial hydrology • Subglacial Hydrology • Runoff from glaciers • Methods of determining glacial runoff • Glacier and water resources	7
IV	**Recent Advances in Glaciology** **[Course Outcome (s) No. : 4 and 4]** • Glacial remote sensing • Reaction of glaciers to environmental changes • Glacier Hazards • Palaeo – climatology • Glacial surges • Different instruments used for studying glacier change	6
V	**Status of Glaciological Research** **[Course Outcome (s) No. : 5]** • A global overview • Indian scenario • Polar Research (Arctic and Antarctic scientific expeditions)	5

Suggested Readings:

1. Kurt M. Cuffey & W. S. B. Paterson, (2010): The Physics of Glaciers, Fourth Edition, Elsevier, ISBN No. 9780123694614.
2. Encyclopedia of Snow, Ice and Glaciers (2011): Springer, ISBN No. 9789048126415.
3. Robert Sharp: (1988): Glaciers, First Edition, Cambridge University Press, ISBN: 978-0521330091
4. Bryn Hubbard, Neil F. Glasser (2005): Field Techniques in Glaciology and Glacial Geomorphology, John Wiley & Sons.
5. M. J. Hambrey, Jürg Alean By M. J. Hambrey, Jürg Alean (2004): Glaciers ,Cambridge University Press.
6. David M. Mickelson, John W. Attig (1999): Glacial Processes Past and Present, Geological Society of America.
7. Matthew M. Bennett, Neil F. Glasser (2011): Glacial Geology: Ice Sheets and Landforms, John Wiley & Sons.
8. Peter G. Knight (2008): Glacier Science and Environmental Change, John Wiley & Sons.
9. Strahler Alan, Strahler Arthur (2007): Physical Geography, Wiley India Pvt Ltd.
10. Douglas I. Benn, David J. A. Evans (2010): Glaciers & Glaciation, Oxford University Press, USA.
11. M. J. Hambrey (1994) : Glacial Environments, UCL Press.
12. W. Kenneth Hamblin & Eric H. Christiansen (2003): Earth's Dynamic Systems (10th Edition), Prentice Hall.
13. Georg Kaser, Andrew Fountain and Peter Jansson (2003): A manual for monitoring the mass balance of mountain glaciers, IHP-VI, Technical Documents in Hydrology, No. 59, UNESCO, Paris.
14. Ostrem, G. & Brugman M (1991): Glacier mass balance measurements, a manual for field and office work, NHRI Science Report No. 4.

Course Outcomes (COs) Mapping with POs and PSOs

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Programme Specific Outcomes of Master of Science in Environmental Sciences

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Programme Outcomes of Master of Science in Environmental Sciences

PO^1- To develop in-depth knowledge on the structure and function of the global environment
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PO^3- To foster a culture of indigenous traditional knowledge for sustainable future
PO^4- To make them committed towards professional ethics

Course Articulation Matrix of ENV 509 – Glaciology

PSOs/ POs	PSO^1	PSO^2	PSO^3	PO^1	PO^2	PO^3	PO^4
CO^1	1	2	2	1	2	2	2
CO^2	2	2	2	2	2	2	3
CO^3	2	2	3	2	3	3	3
CO^4	3	3	3	2	3	3	3
CO^5	3	3	3	3	3	2	2

1: *Partially Related* **2:** *Moderately Related* **3:** *Highly Related*

Course No:	**Course Name:** Water Resources Management				**Course Code: ENV 573**		
Batch:	**Programme:**	**Semester:**	**L**	**T**	**P**	**Credits**	**Contact Hrs. per Week: 2**
2020-2022	M.Sc. Environmental Sciences	IV	2	0	0	2	**Total Hrs.: 30**
Total Evaluation Marks: 100 Mid Term: 25 End-Term: 50 CIA: 25			**Pre-requisite of course:** Basic science and geol ogy				
Course Objectives	To provide the basic knowledge of water resource management and its movement through the hydrological cycle						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO^1:** Water resource management in recent scenario and its movement through the hydrological cycle **CO^2:** Distribution of surface water and groundwater and its fate in different parts of the world. **CO^3:** Different laws that control water flow water in an aquifer. **CO^4:** Skills for developing different techniques for artificial recharge of ground water. **CO^5:** Skill development towards different structures as well as some of the traditional practices prevalent in this country for water conservation.						
Attendance Requirement:	Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.						
Evaluation Criteria:	**1.** Mid Term Examination: 25% **2.** End Term Examination: 50% **3.** Continuous Internal Assessment : 25%						

COURSE SYLLABUS

Unit No.	Contents	Contact Hrs.
I	**[Course Outcome (s) No. :1** • Brief outline of historic development • Water usage in evolution of history • Water Resources Development Scenario • Global and Indian Water Scenario	4
II	**[Course Outcome (s) No. 1 and 2]** • World water resources: dimension and challenges • Hydrological cycle • Global water supply-demand management • Environmental impacts and water resource management	4

III	**[Course Outcome (s) No. : 4]** • Groundwater • structures of aquifers • Aquifer capacity • Determining aquifer flow velocity-Darcy Law • Integrated water resource management (IWRM) and virtual water	6
IV	**[Course Outcome (s) No. : 5]** • Water harvesting techniques in hilly region • Artificial ground water recharge techniques and designs: artificial recharge techniques, direct methods, combination methods, ground water conservation techniques both modern and traditional • Snow harvesting, roof top harvesting and dew drop harvesting • Sustainable agriculture and irrigation	7

Suggested Readings:

1. Patel, A. S., Shah, D. L., (2007): Water Management: Conservation, Harvesting and Artificial Recharge, New Age International, ISBN: 9788122422245.
2. (2001): Standard Guidelines for Artificial Recharge of Ground Water, EWRI/ASCE 34-01 illustrated ed Edition, American Society Of Civil Engineers, ISBN: 9780784405482.
3. Huisman, L., (1982): Artificial Groundwater Recharge (Monographs and surveys in water resources engineering) ISBN: 9780273085447.
4. CGWB, (2007): Manual on artificial recharge of ground water, Ministry of Water Resources, Central Ground Water Board.Govt. of India.
5. UNEP, (2009): Rainwater Harvesting: A Lifeline for Human Well-Being, United Nations Environment Programme, ISBN: 9789280730197.
6. Heather Kinkade-Levario, (2007): Design for Water: Rainwater Harvesting, Stormwater Catchment, and Alternate Water Reuse, New Society Publishers, ISBN: 9780865715806.
7. Piyoosh Rautela, M. L. Dewan, (2007): Water Resources in The Himalayas: Harvesting, Tradition and Change, Concept Publishing, ISBN: 9788170228042.
8. Ljiljana Baird, (2011): How to 'Harvest' Water: The Art of Saving Water, National Trust, ISBN: 9781907892004

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Programme Outcomes of Master of Science in Environmental Sciences

PO^1- To develop in-depth knowledge on the structure and function of the global environment
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PO^3- To foster a culture of indigenous traditional knowledge for sustainable future
PO^4- To make them committed towards professional ethics

Course Articulation Matrix of ENV 573 – Water Resource Management

PSOs/ POs	PSO^1	PSO^2	PSO^3	PO^1	PO^2	PO^3	PO^4

CO[1]	2	1	3	2	3	2	2
CO[2]	2	1	2	3	2	2	3
CO[3]	2	2	3	2	2	3	3
CO[4]	2	3	3	2	2	2	3
CO[5]	3	3	3	3	3	2	2

1: *Partially Related* **2:** *Moderately Related* **3:** *Highly Related*

6. Dr. Dilbag Singh

<table>
<tr><td colspan="8">Dr. Dilbag Singh</td></tr>
<tr><td colspan="2"></td><td colspan="5"></td><td></td></tr>
<tr><td colspan="2">Course No:</td><td colspan="4">Course Name:
Research Methodology in Natural Sciences</td><td colspan="2">Course Code: ENV 617</td></tr>
<tr><td>Batch:</td><td>Programme:</td><td>Semester:</td><td>L</td><td>T</td><td>P</td><td>Credits</td><td>Contact Hrs. per Week: 4</td></tr>
<tr><td>2021-2023</td><td>Ph.D. Environmental Sciences</td><td>PhD</td><td>4</td><td>0</td><td>0</td><td>4</td><td>Total Hrs.: 60</td></tr>
<tr><td colspan="2">Total Evaluation Marks: 200
Mid-Term: 40
End-Term: 120
CIA: 40</td><td colspan="6">Pre-requisite of the course: Basic science, MS word and excel.</td></tr>
<tr><td>Course Objectives</td><td colspan="7">The course is designed to equant students with research steps to be followed for undertaking research activity in their Ph.D. program in concordance with UGC guidelines. Student should understand how to undertake research and collect data in the field by using different instruments and techniques. How to identify a problem by identify different research papers related to the problem in mind and then to make them understand how to search different research papers and identify the problem. The student should also understand defining and drafting a research proposal by undergoing this course.</td></tr>
<tr><td>Course Outcomes:</td><td colspan="7">After the successful completion of this course, the student will be able to
CO¹: Student will be in a position to understand basic of research and concepts in environmental sciences
CO²: Development of his/her analytical skill in environmental sciences to develop scientific skills.
CO³: Enhance in report writing skills for research.
CO⁴: Will enhance student’s skill different reference style for thesis / research papers.
CO⁵: Understand different methods to be used in research data collections.</td></tr>
<tr><td>Attendance Requirement:</td><td colspan="7">Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75 percent attendance is a must failing which a student may not be permitted to appear in examination.</td></tr>
<tr><td>Evaluation Criteria:</td><td colspan="7">1. Mid Term Examination: 20%
2. End Term Examination: 60%
3. Continuous Internal Assessment : 20%</td></tr>
<tr><td colspan="8">COURSE SYLLABUS</td></tr>
<tr><td>Unit No.</td><td colspan="6">Contents</td><td>Contact Hrs.</td></tr>
<tr><td>I</td><td colspan="6">Foundations of Research: Meaning, Objectives, Motivation, Utility. Concept of theory, empiricism, deductive and inductive theory, Characteristics of scientific method – Understanding the language of research – Concept, Construct, Definition, Variable. Research Process, Problem Identification & Formulation – Research Question – Investigation Question – Measurement Issues – Hypothesis – Qualities of a good Hypothesis –Null Hypothesis & Alternative Hypothesis. Hypothesis Testing – Logic & Importance</td><td>12</td></tr>
</table>

II	Research Design: Concept and Importance in Research, Exploratory Research Design, Concept, types and uses, Descriptive Research Designs, Experimental Design: Concept of Independent & Dependent variables, Qualitative research and Quantitative research, Concept of measurement, causality, generalization, replication, Levels of measurement – Nominal, Ordinal, Interval, Ratio.	12
III	Sampling: Concepts of Statistical Population, Sample, Sampling Frame, Sampling Error, Sample Size, Non Response. Characteristics of a good sample. Probability Sample – Simple Random Sample, Systematic Sample, Stratified Random Sample & Multi-stage sampling. Determining size of the sample – Practical considerations in sampling and sample size, Methods of field data collection – Primary data and secondary data, Survey methods used for data collections	12
IV	Summarising and exploring theenvironmental data using descriptive statistics:Organizing and summarizing information through construction of Graphs, Charts and tables and the calculation of various descriptive measures such as averages, measures of variation and percentile.Prediction and generalisation of inferences drawn from the environmental data:Drawing and measuring the reliability of conclusions through methods like hypothesis testing based on probability theory. Correlation and regression analysis	12
V	Paper Writing – Layout of a Research Paper, Journals in Computer Science, Impact factor of Journals, When and where to publish ? Ethical issues related to publishing, Plagiarism and Self-Plagiarism. Satellite data acquisition, Image processing and interpretation. Use of Encyclopedias, Research Guides, Handbook etc., Academic Databases.	12

Course Outcomes (COs) Mapping with POs and PSOs

All the courses together must cover all the POs (and PSOs). For a course we map the COs to POs through the CO-PO matrix and to PSOs through the CO-PSO matrix as shown below. The various correlation levels are:
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Programme Specific Outcomes of Master of Science in Environmental Sciences

PSO^1- To enhance students' ability to understand and mitigate environmental issues
PSO^2- To augment the acumen to analyse geological and environmental research problems of social relevance
PSO^3- To ensure lifelong learning on scientific skills for industrial applications and entrepreneurship

Programme Outcomes of Master of Science in Environmental Sciences

PO^1- To develop in-depth knowledge on the structure and function of the global environment
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PO^3- To foster a culture of indigenous traditional knowledge for sustainable future
PO^4- To make them committed towards professional ethics

Course Articulation Matrix of ENV 568 – Environmental Pollution and Environmental Engineering

PSOs/ POs	PSO^1	PSO^2	PSO^3	PO^1	PO^2	PO^3	PO^4
CO^1	2	3	3	1	3	2	3
CO^2	3	3	3	2	2	3	3

CO^3	2	2	3	3	2	2	3
CO^4	3	3	2	2	2	3	3
CO^5	2	2	2	3	3	3	3

1: *Partially Related* **2:** *Moderately Related* **3:** *Highly Related*

Course No:	**Course Name:** Nano-Techniques and Applications in Environment				**Course Code: ENV 586**		
Batch:	**Programme:**	**Semester:**	**L**	**T**	**P**	**Credits**	**Contact Hrs. per Week: 4**
2020-2022	M.Sc. Environmental Sciences	III	4	0	0	4	**Total Hrs.: 60**
Total Evaluation Marks: 100 Mid Term: 50 End-Term: 100 CIA: 50							
	Pre-requisite of course: Basic physics, chemistry, biology						

Course Objectives	The course is designed to aware student with the basic concept of nanotechnology. The course developed in such a way that they learn the different synthesis methodologies and details about the techniques used to characterize the nanomaterials. In the last different application of the nanomaterials as well as current research in the area of nanotechnology has been discussed.
Course Outcomes:	After completing this course, student is expected to learn the following: **CO^1**: Provide students with knowledge and general competence related to the nanotechnology.. **$CO^{2:}$** Build their foundation for research in Environmental nanotechnology. **CO^3**: Understanding of glacial hydrology that will be helpful in understanding the glacier in light of water resource management. **CO^4**: Equip themselves with different characterization techniques related to the nanotechnology. **CO^5** Build a strong foundation for future research work in a systematic manner in the field of nanotechnology.
Attendance Requirement:	Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.
Evaluation Criteria:	**4.** Mid Term Examination: 50% **5.** End Term Examination: 100% **6.** Continuous Internal Assessment : 50%

COURSE SYLLABUS

Unit No.	Contents	Contact Hrs.
I	**Introduction to nanomaterials** Properties of materials & nanomaterials, role of size in nanomaterials, 0D, 1D, 2D structures – Size Effects – Fraction of Surface Atoms – specific Surface Energy, Different classes of nanomaterials metal and semiconductor nanomaterials, quantum dots, wells and wires, molecule to bulk transitions bucky balls and carbon nanotubes.	7
II	**Physical method of synthesis of nanoparticles** High energy ball milling, melt mixing, physical vapour deposition, ionized cluster beam deposition, laser vapourization (Ablation), laser pyrolysis, sputter deposition, DC sputtering, properties of nanostructured material: optical, magnetic and chemical properties.	6
III	**Chemical Routes for Synthesis of Nanomaterials** Chemical precipitation and co-precipitation, chemical vapor deposition (CVD), nucleation and growth of nanoparticles, synthesis of metal and semiconductor nanoparticles by colloidal route, microemulsions, sol-gel method, microwave Synthesis, Introduction of biomaterials, synthesis using microorganisms, synthesis	7

	using plant extracts, synthesis of nanoparticles using DNA.	
IV	**Experimental Techniques** Scanning and Transmission electron microscopy, X-ray diffraction, X-ray Photoelectron spectroscopy, Energy dispersive X-ray analysis, Atomic force microscope, Raman Spectroscopy, UV-visible spectroscopy and Photoluminescence spectroscopy.	6
V	**Advanced nanomaterials** For chemical and biosensors, nanomedicine, drug delivery, cancer therapy, tissue repair, space, defense and engineering, dye sensitized photovoltaic solar cell (Grätzel Cell), organic (Polymer/Small Organic Molecules), photovoltaic cells, fuel cell hydrogen generation and storage, hybrid energy cells.	5

Suggested Readings:

1. Nanotechnology:Principles andPractices, Sulabha K. Kulkarni,
2. Introduction to nanotechnology: Charles P.Poole, Jr. Frank, J. Owens: Wiley India
3. Nanotechnology: Basic Science and Emerging Technologies, M.Wilson, K. Kannangara, G. Smith.
4. H. S. Nalwa (ed.), Encyclopedia of Nanoscience and Nanotechnology,American Scientific Publishers, Los Angeles (2004), Vol. 1–25.

Course Outcomes (COs) Mapping with POs and PSOs

All the courses together must cover all the POs (and PSOs). For a course we map the COs to POs through the CO-PO matrix and to PSOs through the CO-PSO matrix as shown below. The various correlation levels are:
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Programme Specific Outcomes of Master of Science in Environmental Sciences

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Programme Outcomes of Master of Science in Environmental Sciences

PO^1- To develop in-depth knowledge on the structure and function of the global environment
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PO^3- To foster a culture of indigenous traditional knowledge for sustainable future
PO^4- To make them committed towards professional ethics

Course Articulation Matrix of ENV 586 – Nano-Techniques and Applications in Environment

PSOs/ POs	PSO^1	PSO^2	PSO^3	PO^1	PO^2	PO^3	PO^4
CO^1	3	3	3	3	2	3	3
CO^2	2	2	3	2	3	3	3
CO^3	2	2	3	3	2	3	2
CO^4	2	2	3	2	2	3	2
CO^5	3	3	3	3	3	3	3

1: *Partially Related* **2:** *Moderately Related* **3:** *Highly Related*

Course No:	**Course Name:** Environmental Chemistry				**Course Code: ENV 403**		
Batch:	**Programme:**	**Semester:**	**L**	**T**	**P**	**Credits**	**Contact Hrs. per Week: 4**
2020-2022	M.Sc. Environmental Sciences	III	4	0	0	4	**Total Hrs.: 60**
Total Evaluation Marks: 100 Mid Term: 50 End-Term: 100 CIA: 50			**Pre-requisite of course:** Basic physics, chemistry, biology				
Course Objectives	The course deals with the fundamentals and critical analysis of chemical processes one encounter in the field of Environmental Sciences/ Engineering. It helps to learnapplication of equilibrium equations and material balance equations to calculate conditions in environmental systems at equilibrium using the concept of components.Use of chemical equilibrium in the field of solubility of gases in liquids. The information about the hydrocarbons and its effects on the environment.Application of fundamental aspects of thermodynamics to describe equilibrium conditions in environmental systems. Knowledge of important terminology for nuclear chemistry, like fission and fusion process, its merits and demerits. Brief description about the soil chemistry and heavy metals chemistry.						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO^1**: Demonstrate knowledge of chemical and biochemical principles of fundamental environmental processes in air, water, and soil. **$CO^{2:}$** Recognize different types of toxic substances & responses and analyze toxicological information. Apply basic chemical concepts to analyze chemical processes involved in different environmental problems (air, water & soil) **CO^3**: Understanding of glacial hydrology that will be helpful in understanding the glacier in light of water resource management. **CO^4**: Describe water purification and waste treatment processes and the practical chemistry involved. **CO^5:** Describe causes and effects of environmental pollution by energy industry and discuss some mitigation strategies.						
Attendance Requirement:	Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.						
Evaluation Criteria:	**1.** Mid Term Examination: 50% **2.** End Term Examination: 100% **3.** Continuous Internal Assessment : 50%						

COURSE SYLLABUS

Unit No.	Contents	Contact Hrs.
I	Fundamentals of Environmental Chemistry: Classification of elements, Stoichiometry, Gibbs' energy, chemical potential, chemical kinetics, chemical equilibria, solubility of gases in water, Henry's law, the carbonate system, unsaturated and saturated hydrocarbons.	10

II	Chemical compositions of Air: Classification of elements, chemical speciation, Particles, Ions and radicals in atmosphere, chemical processes for formation of inorganic and organic particulate matter, thermo chemical and photochemical reaction in atmosphere Oxygen and Ozone chemistry, chemistry of air pollutants, photochemical smog.	10
III	Basics of nuclear chemistry, Nuclear energy - fission and fusion, Nuclear fuels, Nuclear reactor – principles and types, artificial radioactivity, radioisotopes, Water Chemistry: Chemistry of water, Concept of DO, BOD, COD.	10
IV	Soil Chemistry: Inorganic and organic components of soil, Nitrogen pathways and NPK in soils,Toxic chemicals: Pesticides and their classification and effects, Biochemical aspects of heavy metals (Hg, Cd, Pb, Cr) and metalloids (As, Se). CO, O3, PAN, VOC and POP, carcinogens in the air.	14

Suggested Readings:

1. Water Chemistry, M. Benjamin, Waveland Press, Long Grove, Illinois, 2010 (ISBN 1577666674).
2. Water Chemistry: An Introduction to the Chemistry of Natural and Engineered Aquatic Systems, Patrick L. Brezonik, William A. Arnold, Oxford University Press, New York, 2011.
3. Aquatic Chemistry, 3rd Edition, W. Stumm, J.J. Morgan, John Wiley and Sons, New York, 1996. 4- Aquatic Surface Chemistry, W. Stumm (Ed), John Wiley and Sons, New York, 1987.

Course Outcomes (COs) Mapping with POs and PSOs

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Programme Outcomes of Master of Science in Environmental Sciences

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Course Articulation Matrix of ENV 586 – Nano-Techniques and Applications in Environment

PSOs/ POs	PSO^1	PSO^2	PSO^3	PO^1	PO^2	PO^3	PO^4
CO^1	2	2	3	3	3	3	2
CO^2	3	2	3	3	2	3	3
CO^3	3	3	3	2	3	3	3
CO^4	2	2	3	3	2	3	2
CO^5	2	2	3	3	3	3	3

1: *Partially Related* **2:** *Moderately Related* **3:** *Highly Related*

Course No:	**Course Name:** Environmental Legislation: National and International				**Course Code: ENV 503**		
Batch:	**Programme:**	**Semester:**	**L**	**T**	**P**	**Credits**	**Contact Hrs. per Week: 2**
2021-2023	M.Sc. Environmental Sciences	II	2	0	0	2	**Total Hrs.: 30**
Total Evaluation Marks: 100 Mid-Term: 25 End-Term: 50 CIA: 25							
	Pre-requisite of course: Basic knowledge of Physics Chemistry and Biology along with geology						
Course Objectives	The indelible impact of environment on the lives of people is overwhelming. The current scenario is particularly compounded by multitudinal issues as rampant air and water pollutions, climate change, loss of biodiversity and the like that has contributed to immense problems of environment and health care as well as raised the inevitable question of survival of life itself on earth. Apart from an overview of the vast subject matter, a substantive understanding in the gradual evolution of pertinent themes in environment shall be imparted so that the student is not only conversant with the overall framework of environmental law but also becomes acquainted with fundamental concepts of basic themes. The basic objective is to familiarize the concept and scope of environmental law and also of its particular dominant issues so as to become a value addition in learning and to ignite academic/research interest, eventually.						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO^1** : Learning about the developments in international environmental law and the fundamental principles that have emerged. **CO^2** : Exposition about the human right to environment and constitutional framework governing environment in selected countries, including India. Comprehending the statutory and regulatory mechanisms pertaining to environment in India. **CO^3** : Understanding judicial response to environmental issues in India.Knowing about importance of public participation through Right to information, Public Interest Litigation and other remedies in preserving and protecting environment. **CO^4** : Studying the role of international/ national environmental institutions, NGOs, civil society and community involvement in promoting the cause of environment. **CO^5** : Understanding the emerging environmental issues as ozone depletion, climate change, energy crisis, nuclear issues, waste accumulation, marine ecology etc. and the viability of posited solutions.						
Attendance Requirement:	Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.						
Evaluation Criteria:	**1.** Mid Term Examination: 20% **2.** End Term Examination: 60% **3.** Continuous Internal Assessment : 20%						

COURSE SYLLABUS

Unit No.	**Contents**	**Contact Hrs.**

I	**Environmental legislations In India** • Introduction to Environmental Law • Powers of the Parliament to enact Environmental legislations • Status of Environmental legislations in India	3
II	**Legislation Enforcement Authorities Prescribed under Different Acts** • The Environmental water (Prevention and Control of Pollution) Act, 1974 Central, State and Joint Boards for the prevention and control of air pollution- constitution, powers • and functions • The Air (Prevention and Control of Pollution) Act, 1981: Central and State Boards for the prevention and control of water pollution - constitution, powers and functions • The Environment (Protection) Act, 1986: Central Government- powers and functions, EIA Notification, 2006	3
III	**Environmental Legislations and dispute redress Bodies prescribed under different Acts** • The Wildlife (Protection) Act, 1972 objectives; National Board for Wildlife (NBWL) • The Forest (Conservation) Act, 1980 (with amendments made in 1988); Forest (Conservation) Rules. 2003 (with amendments made m 2004). • The Biological Diversity Act, 2002: National Biodiversity Authority, State Biodiversity Board. • National Green Tribunal Act, 2010	5
IV	**International environmental organization** • United Nations Environment Programme (UNEP) • World Wide Fund for Nature (WWF) • International Union for Conservation of Nature (IUCN)	3
V	**International environmental conventions/ protocols/ treaties** 6 hrs • Ramsar Convention on Wetlands • United Nations Conventions and Protocols on Climate Change, Ozone depletion. Biodiversity and forest • Agenda-21	6

Suggested Readings:

1. Environmental Laws, 2005. Universal law Publishing
2. S C. Santra, 2005. Environmental Science, New Central Book Agency (P) Ltd 8/1 Chintamoni Das lane. Kolkata- 700009
3. S. Oiwan and A. Rosencranz, 2005, Environmental Laws and Policy In India.
4. Mallick, M H (Justice) 2010 Environmental Laws, Professional Book Publisher New Delhi.
5. Rana S. V. S 2005, Essentials of Ecology and Environmental Science, Prentice Hall of India Pvt. Ltd. New Delhi.

Course Outcomes (COs) Mapping with POs and PSOs

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PO[4]- To make them committed towards professional ethics

Course Articulation Matrix of ENV 503 – Environmental Legislation: National and International

PSOs/ POs	PSO[1]	PSO[2]	PSO[3]	PO[1]	PO[2]	PO[3]	PO[4]
CO[1]	3	3	2	3	3	2	3
CO[2]	3	2	3	3	3	3	2
CO[3]	3	3	2	3	2	3	2
CO[4]	3	3	3	3	2	3	3
CO[5]	3	2	3	3	2	3	3

1: *Partially Related* **2:** *Moderately Related* **3:** *Highly Related*

Course No:	**Course Name:** Environmental Impact Assessment				**Course Code: ENV 547**		
Batch:	**Programme:**	**Semester:**	**L**	**T**	**P**	**Credits**	**Contact Hrs. per Week: 2**
2021-2023	M.Sc. Environmental Sciences	II	2	0	0	2	**Total Hrs.: 30**
Total Evaluation Marks: 100 Mid-Term: 25 End-Term: 75 CIA: 25							
							Pre-requisite of course: Basic knowledge of Physics Chemistry and Biology along with geology

Course Objectives	Environmental Impact Assessment (EIA) is a process of evaluating the likely environmental impacts of a proposed project or development, taking into account inter-related socio-economic, cultural and human-health impacts, both beneficial and adverse. EIA is basically a tool used to assess the positive and negative environmental, economic and social impacts of a project. This is used to predict the environmental impacts of a project in the pre-planning stage itself so that decisions can be taken to reduce the adverse impacts. In this course students will develop basic understanding of the history, need, structure, process, involved methods and challenges. Students will also learn criteria for selecting method for impact assessment, overview of methods, parameters for public participation ad technique for writing reports.
Course Outcomes:	After completing this course, student is expected to learn the following: **CO^1**: To critically examine assumptions inherent in impact assessment. **CO^2**: To provide students with the knowledge and professional skills necessary to enable them to undertake environmental impact assessment. **CO^3**: To identify and explore impact assessment fields and approaches. **CO^4** : To familiarize students with a variety of professional tools used in predicting environmental impacts. **CO^5** : To encourage students to develop their own perspectives on impact assessment and to be able to relate this to other subject areas and to their wider understanding.
Attendance Requirement:	Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.
Evaluation Criteria:	**1.** Mid Term Examination: 20% **2.** End Term Examination: 60% **3.** Continuous Internal Assessment : 20%

COURSE SYLLABUS

Unit No.	Contents	Contact Hrs.
I	Introduction to EIA, Purposes of EIA, Steps in EIA process, Hierarchy in EIA, Environment impact statement (EIS) and Environmental management plan, Impact indicators, Evolution of EIA, Evolution of EIA worldwide, Evolution of EIA in India	5
II	EIA guidelines 1994, notification Govt of India, Forecasting Environmental Changes, Impact assessment	5

	methodologies, generalized approach to impact analysis, procedure for reviewing Environmental impact analysis and statement.	
III	Guidelines for Environmental Audit, Introduction to Environmental planning, Base line information and Prediction (land, water, atmosphere end energy), Landuse policy for India.	5
IV	Urban Planning for india, Rural Planning and landuse pattern, concept and strategies of sustainable development, cost benefit analysis, Environmental priorities in India and sustainable development.	5

Suggested Readings:

1. Wathern P., "Environmental Impact Assessment: Theory and Practice",Routledge Publishers,1990
2. Marriott B., "Environmental Impact Assessment: A Practical Guide",McGraw-Hill Publication,1997
3. Shrivastava A.K., Baxter Nicola, Grimm Jacob, "Environmental Impact Assessment", APH Publishers, 2003
4. Anjaneyulu Y., Manickam Valli, "Environmental Impact Assessment Methodologies", CRC Press 2011
5. Glasson J., Therivel Riki, Chadwick Andrew, "Introduction to Environmental Impact Assessment", Oxford Brookes University 2012/ 4th edition

Course Outcomes (COs) Mapping with POs and PSOs

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PO^4- To make them committed towards professional ethics

Course Articulation Matrix of ENV 524 – Environmental Impact Assessment

PSOs/ POs	PSO^1	PSO^2	PSO^3	PO^1	PO^2	PO^3	PO^4
CO^1	3	3	2	3	3	2	3
CO^2	3	2	3	3	3	3	2
CO^3	3	3	2	3	2	3	2
CO^4	3	3	3	3	2	3	3
CO^5	3	2	3	3	2	3	3

1: *Partially Related* **2:** *Moderately Related* **3:** *Highly Related*

Course No:	**Course Name:** **Contemporary Environmental Issues**				**Course Code: ENV 547**		
Batch: 2021-2023	**Programme:** M.Sc. Environmental Sciences	**Semester:** II	**L** 2	**T** 0	**P** 0	**Credits** 2	**Contact Hrs. per Week: 2** **Total Hrs.: 30**
Total Evaluation Marks: 100 Mid-Term: 25 End-Term: 75 CIA: 25							
	Pre-requisite of course: Basic knowledge of Physics Chemistry and Biology along with geology						
Course Objectives	This interdisciplinary course examines a broad range of contemporary global environmental issues, such as biodiversity, pollution, population growth, and global warming, and focuses on how those big issues might affect us locally. It develops students' environmental literacy and enables them to take part in informed debate and action. Disciplinary knowledge enables students to develop a comprehensive understanding of various facets of life forms, ecological processes and how humans have impacted them during the Anthropocene era. It also develops a critical thinking capability to identify relevant environmental issues, analyze the various underlying causes, evaluate the practices and policies, and develop framework to make informed decisions.						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO^1** : Gaining in-depth knowledge on natural processes that sustain life and govern economy. **CO^2** : Predicting the consequences of human actions on the web of life, global economy and quality of human life. **CO^3** : Developing critical thinking for shaping strategies (scientific, social, economic and legal) for environmental protection and conservation of biodiversity, social equity and sustainable development. **CO^4** : Acquiring values and attitudes towards understanding complex environmental economic-social challenges, and participating actively in solving current environmental problems and preventing the future ones. **CO^5** : Adopting sustainability as a practice in life, society and industry.						
Attendance Requirement:	Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.						
Evaluation Criteria:	**1.** Mid Term Examination: 20% **2.** End Term Examination: 60% **3.** Continuous Internal Assessment : 20%						

COURSE SYLLABUS

Unit No.	Contents	Contact Hrs.
I	Environmental Education and Awareness, Environmental Ethics and Global Imperatives, Global Environmental problems- Acid rain, ozone depletion, Agenda-21, Global Warming and Climate Change	4
II	National Action Plan on Climate Change, National Solar Mission, National Water Mission, National Mission for Enhanced Energy Efficiency, Sustainable Habitat, Sustaining the Himalayan Ecosystem, A Green India, Sustainable Agriculture and Strategic Knowledge on Climate Change.	6

III	Current Environmental issue in India, Desertification and its Control, Vehicular Pollution and Urban Air Quality, Waste Land and their Reclamation, Epidemiological Issue (e.g. Goitre, Fluorosis, Arsenic),National River Conservation Plan, Ganga Action Plan and NAMAMI GANGE.	6
IV	Carbon Sequestration, Types of Sequestration, Carbon credit, Rain Water Harvesting, Ground Water Recharge in Rural and Urban Areas, Wet Land Ecosystem, National Wetland Conservation Program (NWCP), Ramsar Convention.	6
V	Project Tiger, Project Elephant, Indian Rhino Vision 2020, Sea Turtle Project, The Crocodile Conservation Project, Eutrophication and Restoration of Indian Lakes.	

Suggested Readings:

1. Contemporary Environmental Issues by Slattery Michael
2. Global Environmental Issues by Frances Harris
3. Environmental Issues in India: A Reader by Mahesh Rangarajan

Course Outcomes (COs) Mapping with POs and PSOs

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PO^4- To make them committed towards professional ethics

Course Articulation Matrix of ENV 547 – Contemporary Environmental Issues

PSOs/ POs	PSO^1	PSO^2	PSO^3	PO^1	PO^2	PO^3	PO^4
CO^1	3	3	3	2	3	2	3
CO^2	3	3	2	3	3	2	2
CO^3	3	3	2	3	2	3	2
CO^4	3	3	3	3	2	3	3
CO^5	3	2	3	3	2	3	3

1: *Partially Related* **2:** *Moderately Related* **3:** *Highly Related*