NAAC Criterion-I

Key Indicator – 1.1.3

Syllabus copies of the courses highlighting the focus on employability/ entrepreneurship/ skill development along with their course outcomes

1.1.3 Evidences

Central University of Himachal Pradesh, Dharamshala, Kangra

DEPARTMENT OF ENVIRONMENT SCIENCE

INDEX

Department of Environmental Science

School of Earth and Environmental Sciences

Booklet of Course Contents
For
M.Sc. Environmental Science Program

हिमाचल प्रदेश केंद्रीय विश्वविद्यालय

(2009 अधिनियम केन्द्रीय विश्वविद्यालय के तहत स्थापित)

धर्मशाला, जिला काँगड़ा-176,215

Central University of Himachal Pradesh

(Established under Central Universities Act 2009)

Dharamshala, District Kangra, Himachal Pradesh-176215

Programs Offered

Currently the Department is offering M.Sc. programme in Environmental Science and Ph.D. programme in same subject

Objectives of the Department

- To provide quality education and training in Environmental Sciences
- To pursue and facilitate research and development activities
- To establish working linkages with industry and undertake collaborative projects which offer long-term interaction opportunities with academia and industry
- To foster environmental awareness and promote the principles and practices of sustainable development.

Thrust Areas of Research

- Water Resources Management
- Geosciences
- Air quality monitoring
- Phytoremediation and Bioremediation
- Solid Waste Management
- Environmental Nanotechnology
- Environmental Pollution Monitoring and Analysis

Program Specific outcomes (PSO)

PSO-1: Knowledge about the natural resources, their status, importance and need for conservation

PSO-2: Understandings of natural disasters and their management approaches

PSO-3: Knowledge of environmental laws, acts, and standard for environmental compliance

Program outcomes (PO)

- Basic and applied knowledge on the structure and function of the Earth's Environment: Basic understanding of Lithosphere, Hydrosphere, Cryosphere, Atmosphere and Biosphere to find solution for the complex environmental problems.
- Environmental Monitoring: Knowledge of various techniques to monitor the quality of Air, Water and Soil of ambient environment.
- Environmental and Disaster Management: Ability to understand and mitigate issues related with environmental pollution and natural hazards.
- Environmental Impact Assessment: Basic knowledge on impact assessment related to industrialization, urbanization and other developmental activities.
- Problem analysis: Ability to analyze society related / applied research problem, design and execute experiments to find relevant solutions.
- Indian Traditional Knowledge: Understanding about the Indian traditional knowledge practiced from generations to address environmental issues sustainably.
- Advanced Usage of Technology: Application of advanced instrumentation tools, online resources with an understanding of the troubleshooting and limitations.
- Ethics: Commitment towards professional ethics and responsibilities as a social endeavor to bring harmony with nature.
- Lifelong learning: Scientific skills for industrial applications and entrepreneurship

On completing M.Sc. Programme, the students shall be able to realize following outcomes:

- Knowledge about the natural resources, their status, importance and need for conservation.
- 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
- Knowledge of biodiversity, forest and wildlife ecology for their conservation and management.
- Enhancement of creative and critical thinking, aesthetic sensibility, and analytical skills.
- Understanding of the chemical processes that govern the natural and disturbed environments. Waste management practices for the betterment of environment and well beings.
- Understanding of the emerging regional and global environmental issues and their mitigations.

- Understanding the Environmental Impact Assessment and its methodologies for Industries and Regulators.
- Fundamental knowledge of instrumental methods employed in analysis of environmental samples.
- Understandings of natural disasters and their management approaches
- Knowledge of environmental laws, acts, and standard for environmental compliance
- Apply knowledge about existing global frameworks and existing agreements and role of community in successful Disaster Risk Reduction
- Evaluate Disaster Management study including data search, analysis and presentation as a case study.
- Create Technological innovations in Disaster Risk Reduction: Advantages and problems
- Understanding of environmental biotechnology and its applications in environmental issues and other biotechnology applications.

Postgraduate Attributes

- On completion of the post graduate programme in Environmental Studies, students are expected to equip with the skills of creative, critical and rational thinking associated with Environmental Studies and its use for human society. The following attributes are expected from the students of M.Sc. Environmental Studies:
- Disciplinary Knowledge
- Creative and Critical Thinking
- Reflective Thinking
- Problem Solving
- Analytical Reasoning
- Communication Skills
- Research Skills
- Life Skills
- Multicultural Competence
- Moral and Ethical Values
- Life-long Learning
- Global Competency

List of Courses to be offered to Research Degree Students of the Department of Environmental Sciences

Course Type	Course Code	Course Name	Credits	Faculty
Compulsory Courses	ENV 617	Research Methodologies in Natural Sciences	4	All Faculty Members
	ENV 619*	Research and Publication Ethics	2	Prof. Deepak Pant
	ENV 620*	Indian Traditional Knowledge and Practice	2	Dr.Anurag Linda
	ENV 621*	Pedagogy of Teaching Learning Process	2	Faculty Member from the Department of Education
Elective Courses (At Least Two Courses for 8 Credits)	ENV 622*	Mechanism of Toxicity and Detoxification	4	Prof.Deepak Pant
	ENV 623*	Advances in Environmental Pollution and Environmental Engineering	4	Dr. Ankit Tandon
	ENV 624*	Advances in Water Resources Management	4	Dr.Anurag Linda

*Courses need to get approved in the next meeting of Board of Studies of the Department of Environmental Science

List of Courses to be offered to M.Sc. Environmental Science Students of the Department of Environmental Sciences

Proposed structure of courses to be offered in the Department of Environmental Sciences as per new Choice Bases Credit System (CBCS).Courses to be offered in the M.Sc. Environmental Sciences (semester I and III; July 2020-Dec.2020):

SemesterI		
Total Credits	**Major Courses**	***Credits**
	ENV 401 – Introduction to Ecology	**2**
	ENV 402a – Introduction to Earth Processes	**2**
	ENV 403 –Environmental Chemistry	**4**
	ENV 501- Environmental Pollution and Human Health	**2**
	ENV 516- Atmospheric Science	**2**
Minor Courses		
	ENV 411- Waste Management	**2**
	ENV 503- Environmental Legislations National and international	**2**
Vocational/ Skills		
	ENV 445- Environmental Chemistry Laboratory	**2**
	ENV 418- Ecology Laboratory	**2**
Indegenous Knowledge system		
	ENV 508a- Indian Tradation and Environmental Ethics	**2**

Semester II		
Total Credits	**Core-Compulsory Courses**	***Credits**
	ENV 408-Biodiversity and wildlife Management	**2**
	ENV 411 -Waste Management	**2**
	ENV 424-Fundamentals of Remote Sensing	**2**
	ENV 432-Introduction to Statistical Techniques	**4**
	ENV 436-Environmental Science Laboratory -II	**2**
	ENV 501-Environmental Pollution and Human Health	**2**
	ENV 422-Basics of Natural Resource	**2**
	ENV 508-Environmental Ethics	**2**
	ENV 553-Environmental Thermodynamics	**2**

Semester III		
Total Credits	**Core-Compulsory Courses**	***Credits**
	ENV 412 – Analytical Techniques	**2**
	ENV 571 - Remote Sensing and GIS Lab	**2**

	ENV 531 – Toxicology Laboratory	**2**
Core Open/ Elective Open		
	ENV 404- Energy and Environments	**2**
	ENV 503- Environmental Legislations National and International	**2**
	Elective Specialization	
	ENV 564- Near Surface Geophysics	**4**
	ENV 582- Atmospheric Chemistry and Physics	**4**
	ENV 586- Nano techniques and Applications in Environment	**4**
	ENV 557- Bio-resources and Environmental Biotechnology	**4**
	ENV 509- Glaciology	**4**

Semester IV		
Total Credits	**Core-Compulsory Courses**	***Credits**
	ENV575- M.Sc Dissertation	**6**
Core Open/ Elective Open		
	ENV 536- Disaster Management	**2**
	ENV 583- Soil Science	**2**
	Env 428- Himalayan Geology	**2**
	Elective Specialization	
	ENV 509- Glaciology	**4**
	ENV 588-Advanced Environmental Technology	**4**
	ENV 586- Nano techniques and Applications in Environment	**4**
	ENV 561 Bio-resources and Environmental Biotechnology	**4**
	ENV 610-Applied Biotechnology and Bioremediation	**4**

Detail Syllabus of M.Sc. Environmental Sciences

[Faculties can modify the content as per their convenience and requirement]

SEMESTER- I

ENV 401: Introduction to Ecology [2 Credits]

Course Code: ENV 401

Course Name: Introduction to Ecology

Credits Equivalent: 2 Credits (One credit is equivalent to 10 hours of lectures / organised classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objectives: The course is designed to:

- Introduce students to know the basic ecological principles.
- The students will acquire knowledge/skill development to explore the functional and Structural aspects of different ecosystems.
- Explore the concepts related to establish ecological balance in Nature.

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% (Breakup is following)
    a. Assignment/Quiz/Term Paper: 20%
    b. Presentation/Seminar/Field work: 20%
    c. Practical: 60%

Course Contents:

UNIT (I) **4 hrs**

Scope of Ecology and Environmental Science, Historical aspects of Ecology, Major landmarks in Ecology.

UNIT (II) **4 hrs**

Ecosystem concept, Biotic and Abiotic components, Structure and Functions of Ecosystem.

UNIT (III) **4 hrs**

Food Chains, Food Webs, Energy Flow, Pyramids of Energy number and biomass, Factors affecting Productivity, methods of measurements of Productivity.

UNIT (IV) **4 hrs**

Biogeochemical Cycling of Carbon Oxygen, Nitrogen and Phosphorus.

UNIT (V) **4 hrs**

Species interaction, completion, Mutualism, Parasitism, predator Prey relations, Ecological Successions, Climax communities.

TEXT BOOKS

1. **Odum**E P 1996**. Fundamentals of Ecology.** Natraj Publishers, Dehradun, pp 574; ISBN: 81-85019-55-X.
2. **Veena** 2009. **Understanding Ecology**. Discovery Publishing House Pvt. Ltd., pp 344; ISBN: 978-81-8356-456-4.
3. **Juneja**, J 2009. **Advances in Historical Ecology**. Cyber Tech. Publications, pp 296; ISBN: 978-81-7884-417-6.

REFERENCE BOOKS

Allaby M. **Ecology Facts**.

Vanx P C. **Ecology**

Sanders W K. **Biosphere**.Ecology in Practice.

Benson. **Ecology**.**Ecosystem**

Hare G O. **Soils vegetation**, **Ecosystem**.

ENV 402a: Introduction to Earth Processes **[2 Credits]**

Credits Equivalent: 2 Credits (One credit is equivalent to 10 hours of lectures / organised classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objectives: The course is designed the following skill developments of the students:

1. To introduce the students to basics of the earth structure and its physical, chemical and biological characteristics.
2. To introduce the students to various earth processes that are operating inside the earth and their role in shaping and evolution of earth.
3. Introduction with the 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 such as geochemical cycling of elements and climatic 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:

1. Mid Term Examination: 25%
2. End Term Examination: 50%
3. Continuous Internal Assessment : 25% (Breakup is following)
    a. Assignment/Quiz/Term Paper: 20%
    b. Presentation/Seminar/Field work: 20%
    c. Practical: 60%

Course Contents:

UNIT I **(2 hrs)**

- Earth Science as a subject and its various disciplines

- Evolution of various branches of Earth Science

UNIT II **(4 hrs)**

- Modern theories on the origin of the Earth and other planetary bodies and Primary differentiation of the earth.
- Different theories of origin and evolution of the earth.
- MultilayerStructure of Earth
- An overview on different rock types and mineral groups

UNIT III **(5 hrs)**

- Origin of magma and magmatic rocks
- Temperature, pressure and fluids inside the earth and metamorphic rocks.
- Weathering and erosion processes and their role in elemental redistribution
- Sediment transport and deposition through running water, wind and glaciers and formation of sedimentary rocks and various landforms

UNIT IV **(6 hrs)**

- Theory of Plate tectonics and its implications in understanding mountain building and sea floor spreading processes
- Formation of oceans, continents and mountains
- Distribution of earthquake and volcanic activity across the globe

UNIT V ` **(3 hrs)**

- Land-ocean interaction and biogeochemical cycling
- Paleogeography and palaeoclimate

TEXT BOOKS

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 ISBN10: 0195032888 / ISBN 13: 9780195032888.

4. **Aldiya** K. S 2010. **The Making Of India Geodynamic Evolution.** Macmillan India Ltd, ISBN 13: 9780230328334

REFERENCE BOOKS

1. **Mahapatra** G.B 2011. **Textbook Of Geology** CBS publications, ISBN 8123900139; ISBN-13-9788123900131.
2. **The Changing Earth: Exploring Geology and Evolution.** 4th edition, Brooks/Cole Publishing Co; **ISBN-10**: 0495010200;**ISBN-13**: 978-0495010203
3. Fluvial Processes in Geomorphology. Dover Publications, **ISBN-10**:0486685888**;ISBN-13**:978-0486685885
4. **Burbank** D W and **Anderson** R S 2000.Tectonic Geomorphology. 1st edition Wiley-Blackwell, **ISBN-10:** 0632043865; **ISBN-13:** 978-0632043866
5. **Subramanian** V. **A Textbook in Environmental Science**. Narosa Publishers,**ISBN13**:978-0849324086.
6. Valdiya K S. Environmental Geology, Indian Context. **Tata McGraw-Hill Pub Co.** ISBN 10: **0074519719 / 0-07-451971-9;**ISBN 13: **9780074519714**
7. **Kumar** R 1985. **Fundamentals Of Historical Geology And Stratigraphy Of India.** Wiley Eastern**, ISBN** 0852267452, 9780852267455.

ENV 403 Environmental Chemistry [2 Credits]

Credits Equivalent: 4 Credits (One credit is equivalent to 10 hours of lectures / organised classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objectives: The course is designed for the knowledge and following skill development of the students:

1. introduce students to the fundamental concepts of analytical techniques environmental chemistry;

2. provide knowledge about various kinds of quantitative techniques;
3. introduce about computation of analytical results, significant figures, concept of error, precision and accuracy, standard deviation, rejection of doubtful values.

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% (Breakup is following)
    a. Assignment/Quiz/Term Paper: 20%
    b. Presentation/Seminar/Field work: 20%
    c. Practical: 60%

Course Contents:

UNIT I: (12 hrs)

Stochiometry, Gibbs' energy, chemical Potential, chemical equilibrium acid base reactions, Solubility product, solubility of gases in water, the carbonate system, Unsaturated and saturated hydrocarbons, radio nuclides.

UNIT II: (8 hrs)

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.

UNIT III: (4 hrs)

Water Chemistry: Chemistry of water, Concept of DO, BOD, COD, Sedimentation coagulation, filtration , redox potential.

UNIT IV: **(4 hrs)**

Soil Chemistry: Inorganic and organic components of soil, Nitrogen pathways and NPK in soils.

UNIT IV: **(12 hrs)**

Main and transition metals Chemistry, Metal- Ligand concept and its implication towards biochemistry of metals.

TEXT BOOKS:

1. Manahan, Stanley E. "FRONTMATTER"*Environmental Chemistry* Boca Raton: CRC Press LLC, 2000.
2. A K De Environmental Chemistry 4th Edition, New Age International (P) Ltd., New Delhi 110 002.

REFERENCE BOOKS:

1. Jayaraman, J., Laboratory Manual In Biochemistry, New Age International (P) Limited.
2. Puri Sharma & Kalia, Principles of Inorganic Chemistry, S. Chand and company, N Delhi.
3. Keith Bucher, Global Climate, Wiley, New York 1976.
4. J. Heichlen, Atmospheric Chemistry, Academic Press, New York 1976.
5. Levin, Aerosol pollution impact on precipitation. New York Springer, 2009.
6. Rao,M N Air pollution, New Delhi: TMH, 2010.
7. Bali, J.S Bioindustrial watershed management. New Delhi: JCS, 2005.

ENV 501 Environmental Pollution and Human Health 2 Credits

Course Objectives& outcome of the course:

The course is designed to enhance following skills:

- Introduce students to know kinds and causes of Environmental pollution in the twenty-first century.
- Acquire knowledge of adverse effects of pollution on Human Health.
- Discuss the detailed biological mechanism on how pollutants affect human/animal health

- Explore the concepts related to monitoring and assessment of environmental pollution and Human Health.
- Find the way out and Governmental Policies around the globe.

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 the examination.

Course Contents:

UNIT (I): **5hrs**

Brief introduction about environmental pollutants and their detrimental effects. Endocrine Disrupting Chemicals [Phthalate, Bisphenol A, lindane ,Dioxins & furans, Poly-chlorinated biphenyls (PCBS), Atrazine, Penta chloro phenol(PCP), DDT and metabolites , Nonylphenol (NP), drugs, heavy metals (arsenic, lead, cadmium , mercury)]: sources, uses, health effect with detail biological mechanism [e.g. Hormone Mimicry, Blocking Hormone Receptors, Altering Hormone Metabolism].

UNIT (II): **5hrs**

Radiation and Human Health, different sources of the exposure of Radiation to human beings- atomic, ultraviolet, electromagnetic radiation. Impacts of Radiation on Human Health. Basic mechanism of radiation's effect on human health.

UNIT (III): **5hrs**

Water Pollution and Human Health. Pollution by microplastic, microbeads, microfibers: Sources, distribution, environmental impact.Effect of microplastic in ocean health and mechanism of pollution. Deleterious Effect in the food chain, on Plankton and corals health. Ocean pollution- a threat to human health. Way out and Governmental Policies.

UNIT IV **5hrs**

Heavy metal contamination: sources, uses, health effect with detailed biological mechanism.

Suggested Readings

1. Mahajan, S.P. Pollution Control in Process industries. Tata Mc Graw Hill Pub. Co Ltd. New Delhi.
2. Rao, C.S. 2009. Environmental Pollution Control Engineering. Wiley Eastern Ltd., New Delhi

REFERENCE LITERATURES

1. C. Frye et. al. 2012, Endocrine disrupters: a review of some sources, effects, and mechanisms of actions on behavior and neuro-endocrine systems. *J Neuroendocrinol*. January; 24(1): 144–159.
2. Shinji Fushiki. 2013. Radiation hazards in children – Lessons from Chernobyl, Three Mile Island and Fukushima-Review. *Brain & Development*, 35, 220–227.
3. Magda Havas. Biological Effects of Low Frequency Electromagnetic Fields. CHAPTER 10, *Electromagnetic Environments and Health in Buildings.* Spon Press, London, 535 pp.
4. Stephen A Stansfeld and Mark P Matheson. 2003. Noise pollution: non-auditory effects on health. *British Medical Bulletin*;; 68: 243–257.
5. Bates, D.V. 1980.The health effects of Pollution. J Respire. Dis. 1 : 29-37
6. De Gruigle, F.R. 1997.Health Effects from solar UV radiations. Radiation Protection Dosimetry. 72:177-196.

ENV 516- Atmospheric Science [2Credits]

Credit Equivalent: 2 Credits (1 Credit is equivalent to 10 hours of theory (Classroom activity) and 5 hours of practical (Laboratory work).

Vision

Atmospheric science is an applied discipline that is concerned with the structure and evolution of the Earth's atmosphere and with the wide range of phenomena that occur within them. Atmospheric science represents a particular fusion of elements of physics and chemistry. This course will serve to introduce the student to the fundamental principles upon which the atmospheric processes are based and to provide an elementary description and interpretation of the wide range of atmospheric phenomena.

Atmospheric science is a multifaceted subject dealing with several disciplines such as oceanography, meteorology, geology, biology, chemistry, physics and other disciplines to understand Atmospheric processes as an integrated system. An increasing number of scientists are devoting their research to understand the earth processes to address the issues like global warming, sea-level rise, climate change and so on. As all these above mentioned issues are of global significance and in a way or other are linked to the earth system sciences, a sound knowledge (material, processes and their interaction) of the subject would certainly help in developing strategies to meet these challenges.

Objectives

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

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:

Mid-term Examination: 25%

End-term Examination: 50%

Continuous Internal Assessment: 25%

Course contents

Unit 1: Vertical Structure and Composition (4 Hours)

- Chemical Composition
- The State of the Atmosphere
- Atmospheric Density and Pressure
- Hydrostatic Balance

Unit 2: Atmospheric Thermodynamics (4 Hours)

- The Ideal Gas Law and First Law of Thermodynamics
- Concept of Air Parcel and Lapse Rates
- Atmospheric Stability
- Mixing Height and Inversion

Unit 3: Atmospheric Energy Balance (4 Hours)

- 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

Unit 4: Atmospheric Chemistry (4 Hours)

- Thermo-chemical and Photo-chemical Reactions
- Chemistry of Stratosphere, Stratospheric Ozone Depletion
- Chemistry of Troposphere, Acid Rain
- Atmospheric Aerosols, Atmospheric Trace Gases

Unit 5: Atmospheric Dynamics (4 Hours)

- Pressure Belts and Winds
- Pressure Gradient Force
- Coriolis Force, Centrifugal Force, Frication,
- Global Circulation

Suggested Readings:

Murry L. Salby (2012): Physics of the Atmosphere and Climate, **Cambridge University Press**, ISBN: 978-0521767187

Kevin E. Trenberth (2010): Climate System Modeling, **Cambridge University Press**, ISBN: 978-0521128377

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

John Green (2011): Atmospheric Dynamics, **Cambridge University Press,** ISBN: 978-0521249751

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

Mark Z. Jacobson (2005): Fundamentals of Atmospheric Modeling, **Cambridge University Press,** ISBN: 978-0521548656

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

ENV 411 - Waste Management [2Credits]

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 develop the following skills :

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:Skilldevelopment towards hybrid methods

COURSE SYLLABUS:

UNIT 1 :BIODEGRADABLE SOLID WASTE

[Course Outcome (s) No. :1 and 5]

Biodegradable solid waste: Chemical composition and classification: Source and generation: Health hazards: Management Techniques

UNIT 2:**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.

UNIT 3: **HOSPITAL AND PHARMACEUTICAL WASTE**

[Course Outcome (s) No. :3 and**5]**

Hospital and Pharmaceutical Waste: Classification: Source and generation: Health hazards: Management Techniques

UNIT 4: **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.

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.

John R. Holmes, Practical Waste Management, John Wiley & Sons, New York/Singapore, 1983.

ENV 503 -Environmental Legislations National and international [2Credits]

Credits Equivalent: 2 Credits (One credit is equivalent to 10 hours of lectures / organized classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objectives: The course is designed to enhance the skills of students in the following field:

- To familiarize the students with fundamental right to clean environment and duties.
- The students will realize and underline the need for environmental legislations, and legislative powers of the Parliament.
- Students will acquire knowledge about different Environmental legislations at national level and conventions/protocols/treaties for conservation of Environment at international level.
- Students will learn about the Environmental legislation enforcement authorities, Environmental dispute redress bodies and the International Organizations for Conservation of Environment.

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%

a. Assignment: 10%
b. Class Test: 5%
c. Presentation: 10%

COURSE CONTENT

UNIT (I) **1 hrs**

1. Introduction to Environmental Law, Powers of the Parliament to legislate Environmental legislations.
2. Status of Environmental legislations in India: Enumeration of Environmental legislations.

UNIT (II) **4 hrs**

Legislation enforcement authorities under:

1. The **Environmental** water (Prevention and Control of Pollution) Act, 1974 – composition, powers and functions.
2. The Air (Prevention and Control of Pollution) Act, 1981 – composition, powers and functions.
3. The Environment (Protection) Act, 1986 – powers, EIA Notification, 2006.

UNIT (III) **5 hrs**

Environmental legislations and dispute redress bodies in India:

1. The Wildlife (Protection) Act, 1972: Objectives, National Board for Wildlife (NBWL)
2. The Forest (Conservation) Act, 1980: Objectives and Mechanism.
3. The Biological Diversity Act, 2002: Objectives, National Biodiversity Authority.
4. National Green Tribunal- Composition and jurisdiction

UNIT (IV) **2 hrs**

1. International Organizations for Conservation of Environment: UNEP, WWF, IUCN, IGBP.

UNIT (V) **8 hrs**

International Environmental Conventions, Protocols and Treaties:

1. Ramsar Convention on Wetlands.
2. United Nations Conventions and Protocols on Climate Change, Ozone depletion, Biodiversity,

Forest and Agenda -21.

TEXTBOOKS

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

REFERENCE BOOKS

1. S. Diwan and A. Rosencranz, 2005, Environmental Laws and Policy in India.
2. Mallick, M. R. (Justice) 2010. Environmental Laws, Professional Book Publisher New Delhi
3. Rana S. V. S. 2005, Essentials of Ecology and Environmental Science, Prentice Hall of India Pvt. Ltd. New Delhi.

ENV 508a -Environmental Ethics [2Credits]

Course Objectives & outcome of the course:

Ethics are a broad way of thinking about what constitutes a good life and how to live one. They address questions of right and wrong, making good decisions, and the character or skills development for the necessary to live a good life. Applied ethics address these issues with a special emphasis on how they can be lived out practically. Environmental ethics apply ethical thinking to the natural world and the relationship between humans and the earth. Environmental ethics are a key feature of environmental studies, but they have application in many other fields as human society grapples in a more meaningful way with pollution, resource degradation, the threat of extinction, and global climate disruption.

The learning goals are:

1. to understand the essential features of moral or ethical thinking; To become acquainted with concepts and methods of philosophical ethics that apply to issues regarding mankind's dealings with the natural world.

2. to learn about the important and distinguishing characteristics in environmental ethics;
3. to develop the skills to recognize and deploy moral discourse for leadership in environmental fields.
4. to understand what kinds of environmental problems lead us to follow environmental ethics and to critically assess alternative approaches to, and defenses of, a code of responsibility to nature.
5. to give some future direction towards the protection and ethical use of the environment
6. To offer the student a repertory of resources and skills with which to formulate his/her own environmental ethic and to articulate and defend these ideas with clarity, consistency, and coherence.

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 the examination.

Course Contents:

Unit I **8hrs**

Environmental Ethics: Definition. Principles. Need of the subject at present time. Moral standing. Human responsibilities towards nature, environment, and other species. Anthropocentric ethics, intrinsic and instrumental values. Our relationship with nature/environment. Vital questions to be asked.Thinking with Ethics.

UNIT II **4 hrs**

The social construction of nature.Human impact on the environment. Examining both the nature of the issues and their causes. Earth overshoot day. Environmental ethics and society.Relevance of Environmental ethics to environmental protection.

UNIT III **4 hrs**

The state of the World Environment: Significant global environmental issues. Examining both the nature of the issues and their causes. Recent incidents due toclimate change and its effect.Effect and consequences of climate change on Ecosystems andBiodiversity. Climate migration.

UNIT IV **4hrs**

Responsibility towards the Environment.International and National efforts for Environment Protection. Sustainable living.

Suggested Readings

1. Kimberly K Smith. 2018. Exploring environmental ethics - an introduction. Springer.

2. Dale Jamieson. 2008. Ethics and the Environment- an introduction. Cambridge University Press

General recommended reading in environmental ethics

1. Callicott, J.B., 1997. Earth's Insights: A Multicultural Survey of Ecological Ethics from the Mediterranean Basin to the Australian Outback University of California Press, Berkeley.

2. DesJardins, J.R., 2006. Environmental Ethics: An Introduction to Environmental Philosophy. Wadsworth, Belmont, California.

3. Martin-Schramm, J.B. and Stivers, R.L., 2003. Christian Environmental Ethics: A Case Method Approach. Orbis, Maryknoll, New York.

ENV 445- Environmental Chemistry Laboratory [4 Credits]

ENV 418- Ecology Laboratory [4 Credits]

SEMESTER- II

ENV 408 - Biodiversity and wildlife Management [4 Credits]

Credits Equivalent: 2 Credits (One credit is equivalent to 10 hours of lectures / organised classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objectives: The course is designed to:

- Introduce students to know kinds, distribution significance and use of Biodiversity and wildlife.
- The students will acquire skills and knowledge to study, save and conserve Biodiversity and Wildlife.
- Explore the concepts related to identification, monitoring and assessment of Biodiversity and Wildlife.

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% (Breakup is following)
    a. Assignment/Quiz/Term Paper: 20%
    b. Presentation/Seminar/Field work: 20%
    c. Practical: 60%

Course Contents:

UNIT I **4 hrs**

Concepts of Biodiversity, Levels of Biodiversity, Mega Diversity areas, Hot Spots of the Biodiversity, Biodiversity Resources in Himachal Pradesh, Dependence on Biodiversity.

UNIT II **4 hrs**

Loss of of Biodiversity, Monitoring and Invetorization of Biodiversity, Alpha, Beta and Gamma diversities. Shanon Index. Biodiversity data base in Himalayas, Threat Categorization of Biodiversity, Documenation of Biodiversity.

UNIT III **4 hrs**

Modern Techniques of Measurement and Assessment of Biodiversty, Economics of Biodiversity, Uses of Biodiversity (including folk and traditional uses).

UNIT IV **4 hrs**

EX-SITU Conservation methods of Biodiversity, *IN-SITU* Conservation methods of Biodiversity, Protected areas Networks

UNIT V **4 hrs**

Wildlife distribution at National and Global level, Wildlife trade, Wildlife Sanctuaries, National Parks, Biosphere Reserves, Tiger Projects, Elephant Projects Crocodile Projects

TEXT BOOKS

1. **Khan, T.I.2001.** Global Biodiversity and Environmental Conservation.Pointer Publisher. Jaipur
2. **Kotwal, P.C. and Banerjee, S. 1998.** Biodiversity Conservation – in managed forests & protected areas. Agro Botanica Publishers & Distributors. PP.227. ISBN: 81-87167-00-9.
3. **Ramkrishnam, N. 2006.** Biodiversity in Indian Scenarios. Daya Publishing House, New Delhi. PP.338. ISBN: 81-7035-443-9.

REFERENCE BOOKS

1. **Agarwal, K.C. 1998.** Biodiversity. Agro Botanica, Bikaner. PP. 150.
2. **Agarwal, S.K. et.al. 1996**. Biodiversity and Environment. A.P.H. Publishing Corporation. PP.351. ISBN: 81-7024-740-3.
3. **Biswas, S. 2007.** Biodiversity Conservation (A genetic approach). Oxford Book Company. PP. 347. ISBN : 81-89473-01-8.

4. **Chakraborty, S. 2004.** Biodiversity. Pointer Publishers. PP. 136. ISBN: 81-7132-384-7.
5. **Chaudhari, A.B. and Sarkar, D.D. 2002.** Biodiversity Endangered (India's threatened wildlife and medicinal plants). Scientific Publishers, Jodhpur, India. PP. 359. ISBN: 81-7233-312-9.
6. **Dhyani, S.N. 1994.** Wildlife Management. Rawat Publications, Jaipur (Raj.). PP. 258. ISBN: 81-7033-242-5.
7. **Ildos, A.S. and Bardelli, G.G**. The Great National Parks of the World. Om Book Service, New Delhi. PP.320. ISBN: 81-87107-06-5.

ENV 411 - Waste Management [4 Credits]

Credit Equivalent: 4 Credits (One credit is equivalent to 10 hours of lectures / organised classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objectives: The course is designed to:

- Understand nature of human induced environmental pollutions like waste, its significance,
- Sources, compositions and types.
- Initiate initiatives for integrated/sustainable waste management options.

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% (Breakup is following)
    a. Assignment/Quiz/Term Paper: 20%
    b. Presentation/Seminar/Field work: 20%

c. Practical: 60%

Course Contents:

Unit 1 **(4 hrs)**

Biodegradable solid waste

- Chemical composition and classification.
- Source and generation
- Health hazards
- Management Techniques

Unit 2 **(8 hrs)**

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.

Unit 3 **(4 hrs)**

Hospital and Pharmaceutical Waste

- Classification.
- Source and generation
- Health hazards
- Management Techniques

Unit 4 **(4 hrs)**

Waste minimization technologies

- Reuse/ recycling of different types of waste
- Metal recovery from waste using chemical, biological and hybrid techniques

TEXT BOOKS:

1. Kreith, Frank (ed.) (1994) Handbook of Solid Waste Management, McGraw-Hill, Inc., New Delhi.
2. Pant D., Electronic Waste Management Lambart Academic Publishing 2010 (ISBN 978-3-8433-8336-3)
3. Pant D., Pharmaceutical Waste Management Lambart Academic Publishing 2011 (ISBN 978-3-8454-4089-7)

REFERENCE BOOKS

1. Holmes, John R. (ed.) (1983) Practical Waste Management, John Wiley & Sons, New York/Singapore.
2. III. Harrison, M. Roy (ed.) (1995) Pollution; Causes, Effects and Control. The Royal Society of Chemistry, Cambridge cb4 4wf.

RESEARCH PAPER:

1. Pant D.:"Waste Management in Small Hospitals Trouble for Environment" (2011) Environmental Monitoring and Assessment (Springer) DOI: 10.1007/s10661-011-2276-3.
2. Pant D., Joshi D., Upreti M. K. and Kotnala R. K. "Chemical and biological Extraction of Metals Present in E waste: A Hybrid Technology" (2012) Waste Management (Elsevier Science) 32,979-990.
3. Pant D, Singh R., Kumar S "Management of Waste Poly Vinyl Chloride (PVC) through Chemical Modification" (2012) J Sc Ind Res 71, 181-186

ENV 424- Fundamentals of Remote Sensing [4 Credits]

Credits Equivalent: 2 Credits (One credit is equivalent to 10 hours of lectures / organised classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objectives: This is a skill development course and is designed to:

- Introduce the basics of Remote Sensing
- cover its various components and the use 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: 25%
5. End Term Examination: 50%
6. Continuous Internal Assessment : 25% (Breakup is following)
    a. Assignment/Quiz/Term Paper: 20%
    b. Presentation/Seminar/Field work: 20%
    c. Practical: 60%

Course Contents:

UNIT I **4 hrs**

What is Remote Sensing, Electromagnetic Radiation, Electromagnetic Spectrum, Interactions with the Atmosphere, Radiation – Target, Passive vs. Active Sensing, Characteristics of Images

UNIT II **4 hrs**

Sensors on the Ground, in the air, in Space, Satellite Characteristics, Pixel Size and Scale, Different Resolutions, Cameras and Aerial Photography, Different Satellites, Other Sensors

UNIT III **4 hrs**

Radar Basic, Viewing Geometry & Spatial Resolution, Airborne vs Spaceborne Radars, Airborne & Spaceborne Radar Systems

UNIT IV **4 hrs**

Image Analysis: Visual interpretation, Digital processing, Preprocessing, Enhancement, Transformations, Classification, Integration

UNIT V **4 hrs**

Applications: Agriculture, Glaciology, Forestry, Geology, Hydrology, Sea Ice, Land Cover, Biomass Mapping, Oceans & Coastal

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.

ENV 432- Introduction to Statistical Techniques [4 Credits]

ENV 434 - Fundamentals of Ecology and Environment [4 Credits]

ENV 436- Environmental Science Laboratory -II

Course Name: Environmental Science Laboratory -II

Course content: Field oriented experiments

- Use of Global Positioning system (GPS) in the field, mapping of different geological features and preparation of any map using GPS Lab-2 AL

- Cross section preparation of geological features in the field -------Lab-2 AKM

- Measurement of dip and strike in the field----------Lab-2 AKM

ENV 501- Environmental Pollution and Human Health [4 Credits]

Credits Equivalent: 2 Credits (One credit is equivalent to 10 hours of lectures / organised classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objectives: The course is designed to enhance the knowledge and provide the students the skill for employability :

- Introduce students to know kinds and causes of Environmental pollution in twenty first century.
- The students will acquire knowledge of of adverse effects of pollution on Human Health.
- Explore the concepts related to monitoring and assessment of Environmental pollution and Human Health.

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% (Breakup is following)

a. Assignment/Quiz/Term Paper: 20%

b. Presentation/Seminar/Field work: 20%

c. Practical: 60%

Course Contents:

UNIT I **4 hrs**

Radiation and Human Health, different sources of exposure of Radiation to human beings, Impacts of Radiation on Human Health.

UNIT II **4 hrs**

Thermal Pollution and Human Heath, Magnitude of Thermal Pollution in India, Coal based and Gas based thermal pollution.

UNIT III **4 hrs**

Noise Pollution Sources and Magnitude, Noise Standards, Biomedical aspects of Noise Pollution

UNIT IV **4 hrs**

Air Pollution and Human Health, Types of Air Pollutants, Sources of emissions of Air Pollutants and impacts on Human Health

UNIT V **4 hrs**

Water Pollution and Human Health, Types and Sources of Water Pollution, Water Pollution Standards, Water related and Water based diseases.

TEXTBOOKS

3. Mahajan, S.P. Pollution Control in Process industries.Tata Mc Graw Hill Pub. Co Ltd. New Delhi.
4. Rao, C.S. 2009. Environmental Pollution Control Engineering. Wiley Eastern Ltd., New Delhi

REFERENCE BOOKS

1. BATES, D.V. 1980.The health effects of Pollution. J Respire. Dis. 1 : 29-37

2. Benitez, J.1993.Process Engineering and Design for Air Pollution Control.Prentice Hall. New Jersy, USA
3. De Gruigle, F.R. 1997.Health Effects from solar UV mediations.Radiation Protection Dosimetry. 72:177-196.
4. Gamble, J.F. and Lewis, R.J.1996. Health and Respirable Particulate, air Pollution a casual or statistical association. Env. Health Perspective. 104:838-850.

ENV 434 - Fundamentals of Ecology and Environment [4 Credits]

UNIT I: SCOPE AND INTRODUCTION

Ecology- Scope, Subdivisions, major landmarks in Ecology, levels of organization hierarchy; Organisms and Environment-Holocoenotic nature of environment: Abiotic components (climatic and topographic factors), Biotic components (positive interactions-Mutualism, commensalism, proto-cooperation; Negative interactions-Exploitation, Antibiosis, competition).

UNIT II: POPULATION ECOLOGY

Population characteristics-Population Size and Density, Dispersion, Age structure, Natality, Mortality and Life Tables; population dynamics and concept of carrying capacity; Regulation of population growth.

UNIT III: COMMUNITY ECOLOGY

Community concept and brief classification, community characteristic, characters used to describe community structure- analytical, qualitative and synthetic characters, methods of community studies, species diversity α, β and ϒ); concept of ecological niche- types, ecotone & edge effect.

UNIT IV: COMMUNITY DEVELOPMENT

Ecological succession-concept, causes and trends; Basic types of succession, General process of succession, Hydrosere, Lithosere, Heterotrophic succession, Ecosystem Development, concept of climax, Biome.

UNIT V: ECOSYSTEM ORGANIZATION AND MANAGEMENT

Concept of Ecosystem, Trophic structure of ecosystem, Examples of Ecosystem-A pond and an Old field or grassland ecosystem, Ecological pyramids-Pyramids of number, biomass and energy, Productivity of Ecosystem-Primary, Secondary and Net Productivity, Grazing and detritus food chains, Food web, Energy flow in ecosystem (simplified energy flow diagram depicting three trophic levels in a linear food chain), Biodiversity hot spots-Concept, brief introduction to biodiversity hot spots of India.

ENV 560 – Meteorology and Climatology [4 Credits]

Unit 1: Composition, Structure and Thermodynamics

- Chemical Composition
- The State of the Atmosphere
- Atmospheric Density and Pressure
- Hydrostatic Balance
- The Ideal Gas Law and First Law of Thermodynamics
- Concept of Air Parcel and Lapse Rates
- Atmospheric Stability, Mixing Height and Inversion

Unit 2: Atmospheric Energy Balance and Dynamics

- 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
- Pressure Belts and Winds
- Pressure Gradient Force, Coriolis Force, Centrifugal Force, and Frictional Force
- Geostrophic and gradient winds, thermal wind
- Global Circulation

UNIT 3: Climate Variability and Climate Modeling

- Low frequency climate variability: MJO (Madden-Julian oscillation), ENSO, QBO (quasi-biennial oscillation) and sunspot cycles
- Basic principles of General Circulation Modelling

UNIT 4: Climatology

- Latitudinal and Seasonal Variation of Insolation
- Temperature, Pressure, Wind Belts, Humidity
- Classification of Climates – Koppen's and Thornthwaite's scheme of classification.

Unit 5: Weather Systems

- Extratropical Cyclones: Air Masses, Fronts, Jet Streams,
- Tropical Cyclones: Structure, Thermodynamics, and Dynamics, Genesis and Life Cycle,
- Cloud Formation: Condensation Nuclei, Growth of Cloud Drops and Ice-Crystals, Cloud Classification,
- Precipitation mechanisms: artificial precipitation, hail suppression, fog and cloud – dissipation,
- Indian Monsoon: El-Nino and ENSO

ENV 435 - Environmental Sciences Laboratory – I [2 Credits]

Course Name: Environmental Science Laboratory -I

Course Objectives: Skill Development

Introduce students to different geological problem, The students will acquire knowledge to map any geological feature in the field explore the functional and Structural aspects different tectonic features, Learn different sampling and measurement techniques, Will also learn use of GPS in the field and prepare map of any region.

Course content: Field oriented experiments

- Field work in and around Dharmshala for Reading of toposheets ------Lab-1 AKM
- Identification of different structures in the field ----------Lab-1 AKM
- Identification of minerals and rocks in the field---------- Lab-1 Al
- Sampling techniques for geological samples----------Lab-1 Al

SEMESTER- III

ENV 412 – Analytical Techniques [2 Credits]

Credits Equivalent: 2 Credits (One credit is equivalent to 10 hours of lectures / organised classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objectives: The course is designed to:

1. introduce students to the fundamental concepts of analytical techniques environmental monitoring;
2. provide knowledge and skills about various kinds of quantitative techniques;

3. Skill development in computation of analytical results, significant figures, concept of error, precision and accuracy, standard deviation, rejection of doubtful values.

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% (Breakup is following)
    a. Assignment/Quiz/Term Paper: 20%
    b. Presentation/Seminar/Field work: 20%
    c. Practical: 60%

Course Contents:

UNIT I **(4 hrs)**

Computation of analytical results, significant figures, concept of error, precision and accuracy, standard deviation, rejection of doubtful values with special reference to volumetric and gravimetric analysis, calibration of analytical equipments.

UNIT II **(4 hrs)**

Methods of expressing concentrations, primary and secondary standards. Theory and indicators for neutralizations, oxidation- reduction, precipitation titration.

UNIT III **(4 hrs)**

Method of gravimetric analysis, physical gravimetry, thermogravimetry and combustion analysis, precipitative gravimetric analysis, electrodeposition.

UNIT IV **(4 hrs)**

Complexometric titrations Complexometric methods using EDTA, principle of complexometric titrations, chelating agents, indicators, titrations with disodium edetate.

UNIT V **(4 hrs)**

Nonaqueous titrations General discussion and principle of titrations in non-aqueous media, aprotic, protophil protogenic and amphiprotic solvents. Titrations with perchloric acid, potassium methoxide and tetrabutyl ammonium hydroxide.

TEXT BOOKS

1. G.H. Jeffery, J. Bassett. J. Mendham and R.C. Denney Vogel's Text Book of Quantitative Chemical Analysis 5th ed., ELBS, U.K. 1989.
2. Keneth & A. Connors, A Text Book of Analysis, 3rd ed. Wiley interscience Singapore, 1982.
3. **e- book**: Pant D., Lab Manual Quantitative Analytical Method Book Rix Publication www.bookrix.com

REFERENCE BOOKS

1. Christian,Gary D. Analytical chemistry.-- New.Delhi: Wiley, 2004.
2. Shrivastava, M. L. Bioanalytical techniques.-- New.Delhi: Narosa, 2008.
3. Quevauviller P. and Thompson K. C., Analytical Methods for Drinking Water: Advances in Sampling and Analysis, John Wiley & Sons, Ltd. ISBN: 0-470-09491-5.
4. Harvey D. Modern Analytical Chemistry, McGraw-Hill Higher Education, New Delhi

ENV 571 - Remote Sensing and GIS Lab **[2 Credits]**

Course outcome: Skill development Laboratory

ENV 531 – Toxicology/Toxicity Laboratory **[2 Credits]**

Course Objectives:*To provide the basic knowledge of toxic substance and involvingChemistryfor 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:Skilldevelopment towards management

COURSE SYLLABUS:

UNIT 1: PRACTICAL EXPOSURE [Course Outcome (s) No. :1]

- About the identification of toxic substance;
- Management techniques for toxic substance

Unit 2: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

Unit 3IDENTIFICATION OF TOXIC SUBSTANCES IN FOOD SAMPLE. [Course Outcome (s) No. :3, 5and6]

- Acids,
- Aldehydes
- Amines
- Dioxins
- Ethers
- Cyanides

Unit 4**TOXICITY ISSUE [Course Outcome (s) No. :4, 5 and 6]**

- Arsenic
- Cadmium
- Lead
- Mercury
- Carbon monoxide

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.

ENV 503- Environmental Legislations National and International [2 Credits]

Credits Equivalent: 2 Credits (One credit is equivalent to 10 hours of lectures / organized classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objectives: The course is designed:

- To familiarize the students with fundamental right to clean environment and duties.
- The students will realize and underline the need for environmental legislations, and legislative powers of the Parliament.
- Students will acquire knowledge about different Environmental legislations at national level and conventions/protocols/treaties for conservation of Environment at international level.
- Students will learn about the Environmental legislation enforcement authorities, Environmental dispute redress bodies and the International Organizations for Conservation of Environment.

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:

7. Mid Term Examination: 25%

8. End Term Examination: 50%

9. Continuous Internal Assessment : 25%

d. Assignment: 10%
e. Class Test: 5%
f. Presentation: 10%

COURSE CONTENT

UNIT (I) **1 hrs**

1. Introduction to Environmental Law, Powers of the Parliament to legislate Environmental legislations.

2. Status of Environmental legislations in India: Enumeration of Environmental legislations.

UNIT (II) **4 hrs**

Legislation enforcement authorities under:

1. The **Environmental** water (Prevention and Control of Pollution) Act, 1974 – composition, powers and functions.
2. The Air (Prevention and Control of Pollution) Act, 1981 – composition, powers and functions.
3. The Environment (Protection) Act, 1986 – powers, EIA Notification, 2006.

UNIT (III) **5 hrs**

Environmental legislations and dispute redress bodies in India:

1. The Wildlife (Protection) Act, 1972: Objectives, National Board for Wildlife (NBWL)
2. The Forest (Conservation) Act, 1980: Objectives and Mechanism.
3. The Biological Diversity Act, 2002: Objectives, National Biodiversity Authority.
4. National Green Tribunal- Composition and jurisdiction

UNIT (IV) **2 hrs**

1.International Organizations for Conservation of Environment: UNEP, WWF, IUCN, IGBP.

UNIT (V) **8 hrs**

International Environmental Conventions, Protocols and Treaties:

1. Ramsar Convention on Wetlands.
2. United Nations Conventions and Protocols on Climate Change, Ozone depletion, Biodiversity, Forest and Agenda -21.

TEXTBOOKS

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

REFERENCE BOOKS

1.S. Diwan and A. Rosencranz, 2005, Environmental Laws and Policy in India.

2.Mallick, M. R. (Justice) 2010. Environmental Laws, Professional Book Publisher New Delhi

3.Rana S. V. S. 2005, Essentials of Ecology and Environmental Science, Prentice Hall of India Pvt. Ltd. New Delhi.

ENV 564- Near Surface Geophysics [4 Credits]

Course Objective

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 Goals and Outcome

Students should be able to:

- understand the fundamental concepts that result in the variation of seismic velocities and earth resistivity at or near the surface of the earth
- Skill Development:
  - 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
  - To 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.
  - Besides learning the methodologies, the projects teach the students how to work in groups, both for data collection and analysis and interpretation and reporting.
- 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:

- Mid Term Examination: 25%
- End Term Examination: 50%

- Continuous Internal Assessment : 25% (Breakup is following)

Course Contents

Unit I

Hazards definition of hazards, introduction to landslide hazard, earthquakes, flash floods and floods Himalayan orogeny, Structure and Tectonics 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

Introduction to Applied Seismology: Introduction, seismic waves, Raypath geometry in layered ground, reflection and refraction of obliquely incident rays, Critical reflection, diffraction, seismic energy source detection and recording of seismic waves, geophones and accleraometers, seismographs

Unit II

Seismic Refraction Surveying: Introduction, General principles, Snellslaw, Field survey arrangements, geometry of refracted ray paths, Interpretational methods, applications and case histories.

Seismic Reflection Surveying Introduction, reflection survey general considerations, reflection principles, reflection data processing (pre-processing, static correction, convolution and deconvolution, stacking, filtering and migration

Unit III

Introduction to Shear wave methods: 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.

Unit 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

Unit 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, SHAKE softwares

Books Recommended:

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 Atila Ansal, 2004

ENV 557- Bio-resources and Environmental Biotechnology[4 Credits]

Credits Equivalent: 4 Credits (One credit is equivalent to 10 hours of lectures / organised classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objectives and outcomes:

The course is designed to:

- Introduce concept of biotechnology and its role in development and sustainability
- Give in-depth knowledge and skills related to modern techniques in biotechnology.
- Give a brief concept how to improve our environment in future by using biotechnology.

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.

UNIT I **10 hrs**

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.

UNIT II **10 hrs**

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.

UNIT III **12 hrs**

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).

UNIT IV **8 hrs**

Genetic engineering: Release of genetically engineered microorganisms, genetically modify corps-safety and environmental risks.

Suggested Readings

1. Comprehensive Biotechnology, Vol 4, M. Moo-young (Ed. InChief) pergamon, press, Oxford.
2. An Introduction to environmental biotechnology, AK Challerre, prentice Hall publication, New D elhi
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., Ne w 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.

ENV 509

ENV 509- Glaciology [4 Credits]

Credit Equivalent: 4 Credits (One credit is equivalent to 10 hours of lectures / organised classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objectives: The course is designed to develop skills of the students:

1. Introduce the subject (Glaciology) to students and various approaches of glaciology, different variants of glacial systems and morphology and structures of glaciers.
2. Study glacial processes and associated landforms and their significance.
3. Understand glacial erosion and various hydrological processes
4. Make student acquainted with the Recent researches in the field of Glaciers and their use in water resources and palaeoclimatic studies

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% (Breakup is following)
   b. Assignment/Quiz/Term Paper: 20%
   b. Presentation/Seminar/Field work: 20%
   c. Practical: 60%

Course Contents:

UNIT I **(8 hrs)**

- Glaciology-an overview
- Approaches to Glaciology
- Glacier systems-
- Structure and morphology of glaciers

UNIT II **(10 hrs)**

- Glacial erosion, Landscape evolution and different glacial landforms
- Mass balance and glacier dynamics
- Englacial and subglacial process

UNIT III **(6 hrs)**

- Glacier hydrology dealing mainly with snow and melt water chemistry
- Glacier and water resources

UNIT IV **(12 hrs)**

- Recent advances in Glaciology
- Glaciers and climate change
- Glacier Hazards
- Glaciers in relation to palaeoclimate studies

UNIT V **(4 hrs)**

- Studies carried out on Indian Glaciers
- Indian efforts on Polar Research (Arctic and Antarctic scientific expeditions)

TEXT BOOKS

1. **Sharp** R P 1988. **Living Ice: Understanding Glaciers and Glaciations**. Cambridge University Press, ISBN 13 9780521330091**.**
2. **Hubbard** B and **Glasser** N F 2005**. Field Techniques in Glaciology and Glacial Geomorphology.** John Wiley & sons, Inc, ISBN 978-0-470-84426-7
3. Bennett M M and Neil F. Glasser N F 2009. **Glacial Geology: Ice Sheets and Landforms,** 2nd Edition**.** John Wiley & sons, Inc, ISBN: 978-0-470-51691-1

REFERENCE BOOKS

1. **Raina** V K **Glaciers the Rivers of Ice**. **Geological Society of India,** ISBN 8185867739 (81-85867-73-9)
2. **Hambrey** M J and **Alean** J 2004. **Glacial Environments.** 2nd Edition Cambridge University Press, ISBN 0-521-82808- 2
3. **David M. M and Attig J W 1999.** Glacial Processes, Past and Present. *Issue 337 of Special Papers* Geological Society of America, ISBN 081372337X, 9780813723372
4. Knight P G 2009. Glacier science and environmental change. Wiley-Blackwell, ISBN 978-1-4051-9653-6
5. Cuffey and Paterson 2010. The Physics of Glaciers. 4th Edition, Academic Press, ISBN: 9780123694614
6. **Fletcher** N. **The Chemical Physics of Ice**. Cambridge Monographs on Physics, ISBN-13: 978-0521075978

ENV 531 - Toxicity Laboratory [2 Credits]

Course Objectives:*To provide the basic knowledge of toxic substance and involvingChemistryfor 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 skillsfor the management

CO6:Skill development towards management

COURSE SYLLABUS:

UNIT 1: PRACTICAL EXPOSURE [Course Outcome (s) No. :1]

- About the identification of toxic substance;
- Management techniques for toxic substance

Unit 2: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

Unit 3IDENTIFICATION OF TOXIC SUBSTANCES IN FOOD SAMPLE. [Course Outcome (s) No. :3, 5and6]

- Acids,
- Aldehydes
- Amines
- Dioxins
- Ethers
- Cyanides

Unit 4**TOXICITY ISSUE [Course Outcome (s) No. :4, 5 and 6]**

- Arsenic
- Cadmium
- Lead
- Mercury
- Carbon monoxide

Suggested Readings:

8. C. N. Madu, Environmental Planning and management, Imperial College Press, 2015.
9. Healtth Hazards of Environmental Arsenic Poisoning, Imperial College Press, 2014.
10. T. F. Yen, Chemical Processes for Environmental Engineering, Imperial College Press, 2013.
11. H. K. Moffatt and Shuckburgh, Environmental Hazards, Imperial College Press, 2011.

12. P. Patnaik, A Comprehensive Guide to the Hazardous Properties of Chemical Substances (3rd ed.) John Wiley & Sons, Inc., Hoboken, New Jersey, 2007.
13. C. Oloman, Material and Energy Balance for Engineers and Environmentalist, Imperial College Press, 2005.
14. L. C. Batty and K. B. Hallberg, Ecology of Industrial Pollution, Cambridge University press, New Delhi, 2004.

ENV 524 - Environmental Impact Assessment [2 Credits]

UNIT – 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, EIA Notification, 2006

UNIT – II

EIA guidelines 1994, notification Govt of India, Forecasting Environmental Changes, Impact assessment methodologies, generalized approach to impact analysis, procedure for reviewing Environmental impact analysis and statement.

UNIT – III

Guidelines for Environmental Audit, Introduction to Environmental planning, Base line information and Prediction (land, water, atmosphere end energy), Landuse policy for India.

UNIT – IV

Urban Planning for india, Rural Planning and landuse pattern, concept and statergies of sustainable development, cost benefit analysis, Environmental priorities in India and sustainable development.

ENV 571 - Remote Sensing and GIS Lab [2 Credits]

Laboratory Experiments based on the course ENV 424 to be taught in Semester-II

ENV 411 – Waste Management [2 Credits]

UNIT I: Classification of waste

Solid waste, liquid waste, Biodegradable and non biodegradable solid waste, Hospital and Pharmaceutical Waste, E-waste: Sources, generation, chemical composition, classification, Health hazards, Environmental impacts

UNIT II: Waste minimization technologies

Framework for Solid Waste Management; Reuse/ recycling of Reuse and Recycling of different types of waste: Recycling of waste paper, plastics, landfill, other management techniques

UNIT II:Waste Water Management

Technological Options at Household Level Management, Kitchen Garden with Piped and without Piped Root Zone System, Leach Pit.

UNIT IV:Technological Options at Community Level Management

Sustainable technologies of waste management at Panchayat Level and local level; Case studies, opportunities in waste management.

ENV 573 -Water Resource Management [2 Credits]

Unit I

Brief outline of historic development, Water usage in evolution of history, Water Resources Development Scenario, Global and Indian Water Scenario

Unit II

World water resources: dimension and challenges, Hydrological cycle, Global water supply-demand management, Environmental impacts and water resource management

Unit III

Groundwater, structures of aquifers, Aquifer capacity, Determining aquifer flow velocity-Darcy Law

Integrated water resource management (IWRM) and virtual water

Unit IV

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

ENV 412- Analytical Technique [2 Credits]

Course Objectives& outcome of the course:

The course is designed to:

- Introduce students about different state of the art analytical techniques
- Discuss in details about different technical aspects of the instrumentation.
- Discuss the basic concept about the techniques and detailed applications

- Discuss in details about different trouble shooting of the instrumentation
- Give hands-on training so that they can apply and use the instrumentation and techniques in their future endeavor.

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 the examination.

UNIT I: Introduction to Chromatography

Basic principle of Analytical techniques. Different types of Chromatography techniques and their applications. Thin layer Chromatography – Basic principle, methodology, application.

UNIT II: High Performance Liquid Chromatography

Basic Principle, Methodology, Application. Discussion with examples based on published research papers.

UNIT III: Gas Chromatography

Basic Principle, Methodology, Application. Discussion with examples based on published research papers.

UNIT IV: Liquid and Gas Chromatography - Mass spectrometry

Basic Principle, Methodology, Application. Discussion with examples based on published research papers.

Suggested Readings

1. Handbook of Thin-Layer Chromatography, 2003.3rd Edition; Edited By Joseph Sherma, Bernard Fried. CRC Press.

2. HPLC Basics- Fundamentals of LiquidChromatography (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

ENV 503 – Environmental Legislation: National & International [2 Credits]

Unit I

Introduction to Environmental Law, Powers of the Parliament to legislate Environmental legislations. Status of Environmental legislations in India: Enumeration of Environmental legislations.

Unit II

The Environmental water (Prevention and Control of Pollution) Act, 1974, The Air (Prevention and Control of Pollution) Act, 1981, The Environment (Protection) Act, 1986 – powers.

Unit III

The Wildlife (Protection) Act, 1972: Objectives, National Board for Wildlife (NBWL), The Forest (Conservation) Act, 1980: Objectives and Mechanism. The Biological Diversity Act, 2002: Objectives, National Green Tribunal- Composition and jurisdiction

Unit IV

Organizations for Conservation of Environment: UNEP, WWF, IUCN, Ramsar Convention on Wetlands, United Nations Conventions and Protocols on Climate Change, Agenda -21.

ENV 564–Near Surface Geophysics [2 Credits]

Course Objective

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 Goals and Outcome

Students should be able to:

- understand the fundamental concepts that result in the variation of seismic velocities and earth resistivity at or near the surface of the earth
- 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
- 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.
- Besides learning the methodologies, the projects teach the students how to work in groups, both for data collection and analysis and interpretation and reporting.
- 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:

- Mid Term Examination: 25%
- End Term Examination: 50%
- Continuous Internal Assessment : 25% (Breakup is following)

Course Contents

Unit I

Hazards definition of hazards, introduction to landslide hazard, earthquakes, flash floods and floods Himalayan orogeny, Structure and Tectonics 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

Introduction to Applied Seismology: Introduction, seismic waves, Raypath geometry in layered ground, reflection and refraction of obliquely incident rays, Critical reflection, diffraction, seismic energy source detection and recording of seismic waves, geophones and accleraometers, seismographs

Unit II

Seismic Refraction Surveying: Introduction, General principles, Snellslaw, Field survey arrangements, geometry of refracted ray paths, Interpretational methods, applications and case histories.

Seismic Reflection Surveying Introduction, reflection survey general considerations, reflection principles, reflection data processing (pre-processing, static correction, convolution and deconvolution, stacking, filtering and migration

Unit III

Introduction to Shear wave methods: 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.

Unit 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

Unit 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, SHAKE softwares

Books Recommended:

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 Atila

Ansal, 2004

ENV 557- Bio-resources and Environmental Biotechnology [4 Credits]

UNIT I

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;

UNIT II

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.

UNIT III

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).

UNIT IV

Genetic engineering: Release of genetically engineered microorganisms, genetically modify corps-safety and environmental risks.

ENV 582 : Atmospheric Chemistry and Physics [4 Credits]

Unit I

Chemistry of Troposphere: 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

Unit II

Atmospheric Aerosols : Physical Properties of Atmospheric Aerosols, Chemical Composition of Atmospheric Aerosols, Interaction of light with particles, Role of Atmospheric aerosols in Global Climate Change

Unit III

Atmospheric Thermodynamics: 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, Latent Heats, The Saturated Adiabatic Lapse Rate, Normand's Rule, Static Stability: Unsaturated Air, Saturated Air, Conditional and Convective Instability

Unit IV

Atmospheric Radiative Transfer: 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

Unit V

Atmospheric Dynamics: 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

ENV 404 - Energy and Environment [2 Credits]

Unit I: Introduction to Energy and Environment

The concept of energy and environment, Sun as source of energy, Solar radiation and its spectral characteristics, Fossil fuels: definition, formation, classification, composition, physiochemical characteristics and energy content of coal, petroleum and natural gas.

Unit II: Sustainable Energy Resources

Concept of renewable and nonrenewable energy sources, Basic principles of generation of energy , Solar Energy: solar cells, solar concentrators, active and passive heating of buildings, green generators , Wind Energy: the concept of wind and air, types of wind mills and its parts, calculation of power produced by wind mills, Geothermal Energy: different sources of geothermal energy, direct and indirect uses, different types of geothermal electric plants, Energy from oceans: different types of ocean movements, energy from tides, currents and waves, OTEC: working and different types. Growing energy need, Energy use pattern and future need projection in different parts of the world and its impact on the environment.

Unit III: Green Technologies

Strengths for adopting Green Technology and Challenges for Green Technology Adoptions, 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, Concept of Green Buildings: design, energy efficiency, sustainability etc.

Unit IV Recent advances

Introduction to internal combustion engines: two stroke and four stoke engines, its efficiency, recent developments in IC engines, Recent developments in transportation sector: Electric, hybrid and solar powered vehicles, other green technologies: hydroponics, water efficient irrigation systems, Smart grids, Farm automation etc.

ENV 443–Basics of Climate Change (SD) [2 Credits]

Unit I The Climate System: an overview

- 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

Unit II: Human and Natural Drivers of Climate Change:

- 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

Unit III: Radiative effects of Aerosol and Gases:

- 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,
- Stratospheric Aerosols

Unit IV: Observations of Changes in Climate:

- Atmospheric Changes: Instrumental Record,
- Changes in the Ocean: Instrumental Record,
- Changes in the Cryosphere: Instrumental Record,
- A Palaeoclimatic Perspective,
- Extreme Weather Events

Semester- IV

ENV575-	**M.Sc Dissertation**	**[6 Credits]**

ENV 536- Disaster Management [2 Credits]

Credits Equivalent: 2 Credits (One credit is equivalent to 10 hours of lectures / organised classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objectives: The course is designed for skill development of students:

- 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

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: 25%
5. End Term Examination: 50%
6. Continuous Internal Assessment : 25% (Breakup is following)
    d. Assignment/Quiz/Term Paper: 20%
    e. Presentation/Seminar/Field work: 20%
    f. Practical: 60%

Course Contents:

Unit-1: **4 hrs**

- **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

Assignement-1: To prepare historical archive of Cyclone for last 20 years and their disastrous effects
Assignement-2: To prepare historical archive of Flood disaster in India for the last fifty years and their disastrous effect

Unit 2: **4 hrs**

- 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.

Assignment -3: list different earthquake of Himalayan region with their magnitude and explain the disastrous effect of 1905 Kangra earthquake

Unit-3 The Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters : Case *study of earthquake disaster and landslide disaster* **4 hrs**

Assignement-4 Write down about Yokahama strategy and plan of action for the safer world

Unit-4 **4 hrs**

- **The Tools and Methods of Disaster Management**
- Prevention and Mitigation Tools
- Preparedness Tools
- Tools of Post-Disaster Management
- Case studies

Assignment -5: write down different methods to be used for mitigation of landslide and earthquake disaster as a preparedness part of disaster management cycle.

Unit-5 **4 hrs**

- **Technologies of Disaster Management**
- Mapping
- Aerial Photography and Remote Sensing
- Communications

- Information Management
- Logistics
- Epidemiology

Suggested Readings:

Material prepared by teachers and the following reference will be useful

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 Delhi,** ISBN: 9788180690143
5. **Bhandani, R.K.,** (2000): An overview on Natural & Manmade Disaster & their Reduction, **CSIR, New Delhi.**
6. **Gupta**, (2001): Manuals on Natural Disaster management in India, National Centre for Disaster Management, IIPA, New Delhi, 2001

Env 428- Himalayan Geology [2 Credits]

Credits Equivalent: 2 Credits (One credit is equivalent to 10 hours of lectures / organised classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Aim: The main thing is to introduce the student to concepts and applications of geophysics to solving environmental and engineering problems.

How course activities and course structure help students achieve these goals:

The course is designed to give them the background knowledge and skills using several methods in order to encourage them to think about the utility of geophysics in the solution to problems of an environmental nature. The student will also summarize and critique recent publications in the fields of Himalayan geology.

Course Objective

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: Skill Development

- 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.
- 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?
- 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.
- Learning about the geomorphic and sedimentlogical processes related to fluvial, coastal, aeolian, and glacial regimes.
- 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:

4. Mid Term Examination: 25%
5. End Term Examination: 50%
6. Continuous Internal Assessment : 25% (Breakup is following)
a. Assignment/Quiz/Term Paper: 20%
b. Presentation/Seminar/Field work: 20%
c. Practical: 60%

Course content

Unit-1 Introduction, importance and significance of Himalaya, their morphology, What is faults, folds, their definitions and their types and classifications.
4 **hrs**

Unit-2 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.

Assignment:1 a) What do you understand by continental drift theory? Explain its pros and cons
b) What do you understand by plate tectonic theory and how this theory supports the formation of Himalaya
4 hrs

Unit-3 Sedimentary rocks their types and classification, metamorphic rocks their classifications. Geosynclines: Classification and evolution of Geosyncline, causes of subsidence and upliftment. 4 **hrs**

Assignment: 2 What do you understand by sedimentary rock and metamorphic, how they are formed and explain their texture with example.

Unit-4 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 hrs**

Assignment 3: Draw neat and clean Geological Time Scale

Unit-5 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. 2 **hrs**

Recommended Books

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

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Courses offered before 2020

Course Code	Name of the course	Credit	Level	Prerequisite	Co – requisites
ENV121	Basics of Environmental Studies	2	1		For BSC
ENV122	Environmental Issues and Policies	2	1		For BSC
ENV 401	Introduction to Ecology	2	4		
ENV 402	Introduction to Earth Processing	2	4		
ENV 402a	Introduction to Earth Processes	2	4		
ENV 403	Environmental Chemistry	4	4		ENV 402
ENV 404	Energy and Environment	2	4		

ENV 405	MountainEcology	4	4		ENV 401
ENV 406	Water resources and water pollution	2	4		ENV 402
ENV 407	Soil Sciences and soil pollution	2	4		
ENV 408	Biodiversity and wildlife Management	2	4		ENV 401
ENV 409	Environmental Microbiology	2	4		ENV 410
ENV 410	Environmental Biotechnology	2	4	ENV 403	ENV 401/409/411
ENV 411	Waste Management	2	4		ENV 407
ENV 412	Analytical Techniques	2	4		
ENV 413	Natural Resource Conservation	4	4		ENV 401
ENV 414	Computer Applications and Statistical Techniques	4	4		ENV 423
ENV 415	Application of Remote Sensing & GIS in Natural Resource Management	4	4		ENV 402A
ENV 416	Introductory Environmental Economics	2	4		
ENV 417	Radiation and Environment	2	4		ENV 402/403
ENV 418	Ecology Lab	2	4		ENV 402/517
ENV 419	Geosciences Lab	2	4		ENV 401/402
ENV 420	Fundamentals of MountainEcology	2	4		
ENV 421	Municipal Solid Waste Management	2	4		ENV 411
ENV 422	Basics of Natural Resource Conservation	2	4		ENV 401
ENV 423	Basics of Computer Applications and Statistical Techniques	2	4		ENV 401/402
ENV 424	Fundamentals of Remote Sensing	2	4		ENV 401/402
ENV 425	Application of Remote Sensing &	2	4		ENV 402

	GIS				
ENV 427	Life cycle and Waste Projection	2	4		ENV 411/413
ENV 428	Himalayan Geology	2	4		
ENV 429	Himalayan Ecology	2	4		
ENV 430	Environmental Biology	2	4		
ENV431	Environmental Data Analysis	4	4		
ENV432	Introduction to Statistical Techniques	4	4		
ENV433	Computer applications in Environmental Sciences	4	4		
ENV434	Fundamentals of Ecology and Environment	4	4		
ENV435	Environmental Sciences Laboratory – I	2	4		
ENV436	Environmental Sciences Laboratory – II	2	4		
ENV437	Earthquake awareness	2	4		
ENV 438	Environment and Society	2	4		
ENV 439	Principles of Biodiversity and Wildlife Conservation	2	4		
ENV 440	Microbes and sustainable development	2	4		
ENV 441	Water resource Conservation in Hilly Region	2	4		
ENV 442	Adaptation of Climate change	2	4		
ENV 443	Basics of climate change	2	4		
ENV 501	Environment Pollution and Human Health	2	5	ENV 406/407	ENV 417
ENV 502	Natural Hazard and	4	5		

	Disaster Management				
ENV 503	Environmental Legislation National and International	2	5		
ENV 504	Field work and Dissertation	4	5		
ENV 505	Ecological Engineering	4	5		
ENV 506	Environmental Movements	4	5		
ENV 507	Traditional Knowledge and Environmental conservation	4	5		
ENV 508	Environmental Ethics	2	5		
ENV 509	Glaciology	4	5	ENV 420	
ENV 510	Applications of Mathematical Modelling & Ground Water Management	4	5		
ENV 511	Rain Water Harvesting and Artificial Recharge in Hilly Region	4	5		
ENV 512	Documentation and Management of Invasive Species	4	5		
ENV 513	Inventorization of species	4	5		
ENV 514	Energy uses and its implications for H.P. State	4	5		
ENV 515	International Environmental Policies	4	5	ENV 406/407	
ENV 516	Atmospheric Science	2	5		
ENV 517	Earth System Science	2	5	ENV 402	
ENV 518	Environmental Technology and Governance	2	5		
ENV 519	Biogeography	2	5		
ENV 520	Geo Informatics	2	5		
ENV 521	Geo Engineering	2	5		
ENV 522	Ecosystem Diversity	4	5	ENV 401/408	ENV 512
ENV 523	Toxic and Hazardous	4	5	ENV 411	

	Waste Management				
ENV 524	Environmental Impact Assessment	2	5		
ENV 525	Environmental Geochemistry	2	5		
ENV 526	Soil Fertility and farmland Geology	2	5		
ENV 527	Environmental Toxicology	2	5	ENV 411	ENV 523
ENV 528	Nanotechniques and Environment	2	5	ENV 412	ENV 523/410
ENV 529	Green Chemistry and Environment	2	5	ENV 412	
ENV 530	Analytical Techniques for Air, Water, Soil and Plant Lab	4	5	ENV 412	
ENV 531	Toxicology lab	2	5	ENV 412	
ENV 532	Industrial Training/Field Work/project	4	5		
ENV 533	Micrometeorology and Plant Productivity	2	5	ENV 516	
ENV 534	Green Technologies and Market	2	5	ENV 529	
ENV 535	Natural Hazard	2	5	ENV 402/517	
ENV 536	Disaster Management	2	5	ENV 402/517	ENV 535
ENV 537	Environmental Engineering	2	5		
ENV 538	Impacts of Environmental Movements	2	5		
ENV 539	Indigenous Traditional Knowledge and Environmental conservation	2	5		
ENV 540	Water Harvesting in Hilly Regions	2	5		ENV 510
ENV 541	Techniques of Artificial Water Recharge in Hilly Regions	2	5		
ENV 542	Documentation of Exotic Species	2	5		

ENV 543	Documentation of Native Species	2	5		
ENV 544	Methods and Technology of Inventorization of species	2	5		
ENV 545	Fundamentals of Energy Budgeting	2	5		
ENV 546	Renewable and Non-Renewable Energy Potential In HP State	2	5		
ENV 547	Contemporary Environmental Issues	2	5	ENV 406/407/417	
ENV 548	Introduction to Environmental Impact Assessment	2	5	ENV 402/517/	
ENV 549	Advances in Environmental Impact Assessment	2	5		
ENV 550	Microbial Ecology	2	5		
ENV 551	Ecosystem Dynamics	2	5		
ENV552	Analytical Technique (Physical Science)	2	5		
ENV 553	Environmental Thermodynamics	2	5	ENV 403	
ENV 554	Environmental Conservation and sustainable development	4	5		
ENV 555	Emerging ethical issues for Nano Technology in Environment	2	5		ENV 528
ENV 556	Carbon cycling and its management in the environment	2	5	ENV 403	
ENV 557	Bio-resources and Environmental Biotechnology	4	5		
ENV 558	Applied Microbiology	4	5		
ENV 559	Environmental Geophysics	2	5	ENV 402/517/521/424/425/535/536	ENV 521
ENV 560	Meteorology and Climatology	4	5		
ENV 561	Science of Climate Change	4	5	ENV 402/560/517/	
ENV 562	Analytical	2	5		

	Techniques (Biological Sciences)				
ENV 563	Earth Science and its Processes	4	5		
ENV564	Near Surface Geophysics	4	5		
ENV565	Sustainable Technologies	4	5	ENV534	
ENV566	Introduction to Marine Environment	4	5		
ENV567	Environmental Monitoring and assessment	4	5		
ENV568	Environmental Pollution and Environmental Engineering	4	5		
ENV569	Environmental Pollution and Health issues	4	5		
ENV570	Microbial Technology and Sustainable Development	4	5		
ENV571	Remote sensing and GIS lab	2	5		
ENV572	Land use planning	2	5		
ENV573	Water resource management	2	5		
ENV574	Bio Analytical Techniques	4	5		
ENV575	MSC Dissertation	6	5		
ENV576	Introduction to environmental system analysis	2	5		
ENV577	Carbon management	2	5		
ENV578	Introduction to Glaciology	2	5		
ENV 579	Recent trends in Environmental Biotechnology	2	5		
ENV 580	Recent trends in Glaciology	2	5		
ENV 581	Methods in Scientific Research	4	5		
ENV 582	Atmospheric Chemistry and	4			

	Physics				
ENV 583	Soil Science	2			
ENV 584	Oceanography	4			
ENV 599	Dissertation (M.Phil.)	20	6		
ENV 601	Geochemistry – Biogeochemical Cycles	4	6		
ENV 602	Spectroscopy and Chromatography Techniques	4	6	ENV 412	ENV 403
ENV 603	Advances in ecology and environment	4	6		
ENV 604	Earth Systems Dynamics and Processes	4	6		
ENV 605	Traditional and Contemporary Waste Treatment technologies	4	6	ENV 41	ENV 523
ENV 606	Geomorphology	4	6		
ENV 607	Site amplification	2	6		
ENV 608	Seismology	2	6		
ENV 609	Environmental Xenobiotics- source, distribution and health effect	4	6		
ENV 610	Applied biotechnology and Bioremediation	4	6		
ENV 611	Atmospheric Chemistry	2	6		
ENV 612	Application of GPR	4	6		
ENV 613	Atmospheric Physics	2	6		
ENV 614	Advanced Waste Management Techniques	2			
ENV 615	Advance Microbial Technologies	2			
ENV 616	Advance Bioremediation Techniques	2			
ENV 617	Research Methodologies in Natural Sciences	4			
ENV 699	Thesis (Ph.D.)	60	6		