



INDIRA GANDHI UNIVERSITY, MEERPUR, REWARI

(A state University Established under Haryana Act No. 29 of 2013)

Proceeding of the meeting of the Post Graduate Board of Studies & Research

A meeting of Post Graduate Board of Studies & Research (PGBOS&R) was held online on 04.08.2026 at 11:00 AM on <https://meet.google.com/qxk-ehrv-wtq>

The following members attend the meeting:

1. Dr. Suman Nagpal, Associate Professor
2. Dr. Sunil Kumar, M.D.U., Rohtak
3. Dr. Ramesh Kumar, Chairperson

Chairperson
Outside Expert
Special Invite

The agenda items are as under: -

Agenda 1: To approve the Modified M. Sc. Environmental Sciences Scheme and Syllabus of Department of Environmental Sciences as per new Format for Course Curriculum of IGU.

The M. Sc.(EVS) Scheme & Syllabus of Department of Environmental Sciences as per new Format for Course Curriculum of IGU for implementation w.e.f 2026-27 was presented by the Chairperson, Department of Environmental Sciences, IGU, Meerpur to the experts for the potential approval.

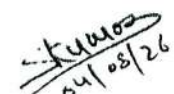
- a. The content of the Scheme & Syllabus of Department of Environmental Sciences as per new Format for Course Curriculum was examined and consent was given to adopt the w.e.f 2026-27 onwards for the degree of M.Sc. (Environmental Sciences)

Agenda 2: To approve the panel of Examiner and paper setter for M.Sc. (Environmental Sciences)

The panel of Examiner and paper setter for M.Sc. (Environmental Sciences) was presented by the Chairperson, Department of Environmental Sciences, IGU, Meerpur to the experts for the potential approval.

- a. The Members suggested to add some experts name in the list, the name of suggested experts have been added in final Panel of Examiner/paper setter, the consent was given for approval of the same for session 2026-27


(Suman)


(Sunil Kumar)


(Ramesh Kumar)

**INDIRA GANDHI UNIVERSITY,
MEERPUR- REWARI, HARYANA (122502)**

(A State University Established under Haryana Act No.29 of 2013)
(Recognized u/s 12(B)& 2(f) of UGC Act, 1956)

www.igu.ac.in



Syllabus and Scheme of Examination

(in accordance with National Educational Policy 2020)

for

Post Graduate Programme

In

M.Sc. Environmental Sciences

Scheme P (Framework 2)

Effective from Academic Session 2026-2027

Department of Environmental Sciences

Faculty of Life Sciences

Indira Gandhi University,

Meerpur - Rewari (122502)

Haryana, India

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Department of Environmental Sciences
List of Experts for Practical Examinations
M.Sc. (Environmental Sciences)
w.e.f. session 2026-27

Sr. No	Lab Course	Name & Contact Details
1.	Lab Course-I (Based on CC1 & CC2)	1. Dr. Mona Sharma, Professor Department of Environmental Studies, CUH, Mahendergarh. Email-mona@cuh.ac.in Contact No.- 9991956470
		2. Dr. Sunil Kumar, Professor, Department of Environmental Science MDU, Rohtak. Email-sunilevs@yahoo.com Contact No.- 9466256869
		3. Prof. Samander Singh Kaushik Dept. of Biotechnology, MDU, Rohtak Email- samanderkaushik@gmail.com Contact No.- 9017733717
		4. Dr. Renuka Gupta, Professor Department of Environmental Sciences J.C. Bose YMCA University Faridabad Email- renukagupta@jcboseust.ac.in Contact No.- 9999692469
		5. Dr. Rajesh Kumar, Professor, Department of Environmental Sciences GJUS&T, Hisar. E-mail - 9034043909 Contact No.- rajeshlohchab@gjust.org
2.	Lab Course-II (Based on CC3 & CC4)	1. Dr. Rajesh Kumar, Professor, Department of Environmental Sciences GJUS&T, Hisar. E-mail - 9034043909 Contact No.- rajeshlohchab@gjust.org

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		2. Dr. Renuka Gupta, Professor Department of Environmental Sciences J.C. Bose YMCA University Faridabad Email-renukagupta@jcboseust.ac.in Contact No.- 9999692469
		3. Prof. Samander Singh Kaushik Centre for Biotechnology, MDU, Rohtak Email- samanderkaushik@gmail.com Contact No.- 9017733717
		4. Dr. Jagriti Narang Associate Professor Jamia Hamdard Delhi Email-jagritinarang@jamiahamdard.ac.in Contact No 9315361479
		5. Dr. Mona Sharma, Professor Department of Environmental Studies, CUH, Mahendergarh. Email-mona@cuh.ac.in Contact No.- 9991956470
3.	Lab Course-III (Based on CC5 & CC6)	1. Dr. Jagriti Narang Associate Professor Jamia Hamdard Delhi Email-jagritinarang@jamiahamdard.ac.in Contact No 9315361479
		2. Dr. Sunil Kumar, Professor, Department of Environmental Science MDU, Rohtak. Email-sunilevs@yahoo.com Contact No.- 9466256869
		3. Dr. Samander Singh Kaushik, Professor, Centre for Biotechnology, MDU, Rohtak Email- samanderkaushik@gmail.com Contact No.- 9017733717
		4. Dr. Mona Sharma, Professor Department of Environmental Studies, CUH, Mahendergarh. Email-mona@cuh.ac.in Contact No.- 9991956470
		5. Dr. Suman Singh, Principal, Scientist, CSIR- CSIO Chandigarh

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		Email-ssingh@csio.res.in Contact No.- 9216903510
		6. Dr. Renuka Gupta, Professor Department of Environmental Sciences J.C. Bose YMCA University Faridabad Email- renukagupta@jcboseust.ac.in Contact No.- 9999692469
4.	Lab Course-IV (Based on CC6 & CC7)	1. Dr. Renuka Gupta, Professor Department of Environmental Sciences J.C. Bose YMCA University Faridabad Email- renukagupta@jcboseust.ac.in Contact No.- 9999692469
		2. Dr. Asha Gupta, Professor Department of Environmental Sciences GJUS&T, Hisar Email- gupta06amit@gmail.com Contact No.- 01274-254900
		3. Dr. Mona Sharma, Professor Department of Environmental Studies, CUH, Mahendergarh. Email- mona@cuh.ac.in Contact No.- 9991956470
		4. Prof. Neeraj Dilbaghi Chairman, Dept. of Bio & Nanotechnology, GJUS&T, Hisar Email- ndnano@gjust.org Contact No. – 9466402891
		5. Prof. Rani Devi Dean, Faculty of Lifesciences, Gurugram University, Gurugram Email: ranidevi@cdu.ac.in Contact no. 9650063661
5.	Lab Course-V (Based on CC9 & CC10)	1. Dr. Rani Devi, Professor, Department of Environmental Sciences Gurugram University, Gurugram Email: ranidevi@cdu.ac.in Contact no. 9650063661

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		2. Dr. Renuka Gupta, Professor Department of Environmental Sciences J.C. Bose YMCA University Faridabad Email-renukagupta@jcboseust.ac.in Contact No.- 9999692469
		3. Dr. Samander Singh Kaushik, Professor Centre for Biotechnology, MDU, Rohtak Email- samanderkaushik@gmail.com Contact No.- 9017733717
		4. Dr. Bifender Singh, Professor Dept. of Biotech, CUH, Mahendergarh Email: ohlenbs@cuh.ac.in Contact no. 9896342891
		5. Dr. Rajesh Dhankhar Professor, Department of Environmental Sciences MDU, Rohtak Email- rajeshdhankar.EVS@mdurohtak.ac.in Contact no. 9896457705
6.	Lab Course-VI (Based on DEC-1 & DEC-2)	1. Dr. Meenakshi Nandal Professor Department of Environmental Sciences MDU, Rohtak Email- meenakshi.env.sc@mdurohtak.ac.in Contact no. 9416380668
		2. Dr. Renuka Gupta, Professor Department of Environmental Sciences J.C. Bose YMCA University Faridabad Email-renukagupta@jcboseust.ac.in Contact No.- 9999692469
		3. Prof. Bifender Singh Dept. of Biotech, CUH, Mahendergarh Email: ohlenbs@cuh.ac.in Contact no. 9896342891
		4. Dr. Sunil Kumar, Professor, Department of Environmental Science MDU, Rohtak. Email-sunilevs@yahoo.com Contact No.- 9466256869

		5. Dr. Rani Devi, Professor, Department of Environmental Sciences Gurugram University, Gurugram Email: ranidevi@edlu.ac.in Contact no. 9650063661
7.	Lab Course-VII (Based on CC11 & CC12)	1. Dr. Renuka Gupta, Professor Department of Environmental Sciences J.C. Bose YMCA University Faridabad Email-renukagupta@jcboseust.ac.in Contact No.- 9999692469 2. Dr. Rachna Bhaterla Professor Department of Environmental Science MDU, Rohtak Email- rachna.env.sc@mdurohtak.ac.in Contact No. 9254645473 3. Dr. Rajesh Dhankhar Professor, Department of Environmental Sciences MDU, Rohtak Email- rajeshdhankar.EVS@mdurohtak.ac.in Contact no. 9896457705 4. Prof. Samander Singh Kaushik Centre for Biotechnology, MDU, Rohtak Email- samanderkaushik@gmail.com Contact No.- 9017733717 5. Prof. Sudesh Kumar Yadav Director, CSIR-Institute of Himalayan Bioresource Technology, Palampur, HP Email- director.ihbt@csir.res.in Contact no. 9418050116
8.	Lab Course-VIII (Based on DEC-3 & DEC-4)	1. Dr. Asha Gupta, Professor Department of Environmental Sciences GJUS&T, Hisar Email- gupta06amit@gmail.com Contact No.- 01274-254900 2. Dr. Sunil Kumar, Professor, Department of Environmental Science MDU, Rohtak.

		<u>Email-sunilevs@yahoo.com</u> Contact No.- 9466256869
		3. Dr. Rajesh Dhankhar Professor, Department of Environmental Sciences MDU, Rohtak Email- rajeshdhankar.EVS@mdurohtak.ac.in Contact no. 9896457705
		4. Dr. Renuka Gupta, Professor Department of Environmental Sciences J.C. Bose YMCA University Faridabad Email-<u>renukagupta@jcboseust.ac.in</u> Contact No.- 9999692469
		5. Prof. Anubha Kaushik ,Former Head of Faculty School of Environment Management Guru Gobind Singh Indraprasth University Email- aks.es.10@gmail.com Contact No. -9654947305
9.	Dissertation	1. Prof. Neeraj Dilbaghi Dept. of Bio & NanoTech, GJUS&T, Hisar Email-ndnano@ gjust.org Contact No. - 9466402891
		2. Prof. Samander Singh Kaushik Centre for Biotechnology, MDU, Rohtak Email -samanderkaushik@gmail.com Contact No.- 9017733717
		3. Dr. Rajesh Dhankhar Professor, Department of Environmental Sciences MDU, Rohtak Email- rajeshdhankar.EVS@mdurohtak.ac.in Contact no. 9896457705
		4. Dr. Mona Sharma, Professor Department of Environmental Studies, CUH, Mahendergarh. Email-mona@cuh.ac.in Contact No.- 9991956470
		5. Prof. Vijay Kumar Dept. of Biochemistry, MDU, Rohtak E-mail - vksiwach@yahoo.co.in

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		6. Dr. Rani Devi, Professor, Department of Environmental Sciences Gurugram University, Gurugram Email: ranidevi@edlu.ac.in Contact no. 9650063661




 Chairperson
 Dept. of Environmental
 Sciences

Panel of Examiners for Paper Setter and Evaluator for
Environmental Sciences

M.Sc. 1st - 4th Semester

(2026-27)

Course Code & Nomenclature	Panel of Internal Expert	Panel of External Experts
Ecology & Natural Resources (26L6.0-EVS-101)	1. Dr. Suman Nagpal, Associate Professor, IGU, Meerpur, Rewari. 9971807110 suman.evs@igu.ac.in	1. Prof. Rajesh Dhankhar Professor MDU, Rohtak 9896457705 rajeshdhankar.EVS@mdurohtak.ac.in 2. Dr. Meenakshi Nandal Professor MDU, Rohtak 9416380668 meenakshi.env.sc@mdurohtak.ac.in 3. Prof. Samander Kaushik Professor MDU, Rohtak 09017733717 samanderkaushik@gmail.com
Environmental Pollution, Health & Safety (26L6.0- EVS-102)	1. Dr. Suman Nagpal, Associate Professor, IGU, Meerpur, Rewari. 9971807110 suman.evs@igu.ac.in	1. Dr. Mona Sharma, Professor, CUH, Mahendergarh. 9991956470 mona@cuh.ac.in 2. Dr. Sunil Kumar, Professor, MDU, Rohtak. 9466256869 sunilevs@yahoo.com 3. Dr. Rajesh Kumar, Professor, GJUS&T, Hisar. 9034043909 rajeshlohehab@gjust.org
Fundamentals of Data Analytics 26L6.0- EVS-103	1. Dr. Suman Nagpal, Associate Professor, IGU, Meerpur, Rewari. 9971807110 suman.evs@igu.ac.in	1. Prof. Rajesh Dhankhar Professor MDU, Rohtak 9896457705 rajeshdhankar.EVS@mdurohtak.ac.in 2. Dr. Meenakshi Nandal Professor MDU, Rohtak 9416380668 meenakshi.env.sc@mdurohtak.ac.in





		3. Prof. Samander Kaushik Professor MDU, Rohtak 09017733717 samanderkaushik@gmail.com
Atmosphere and Global Climate Change 26L6.0- EVS-104	1. Dr. Suman Nagpal, Associate Professor, IGU, Meerpur, Rewari. 9971807110 suman.evs@igu.ac.in	1. Prof. Asha Gupta, Professor, GJUS&T, Hisar. 01274-254900 gupta06amit@gmail.com 2. Dr. Mona Sharma, Professor, CUH, Mahendergarh. 9991956470 mona@cu.ac.in 3. Dr. Renuka Gupta Professor J.C.Bose YMCA University Fridabad 9999692469 renukagupta@jcbouseust.ac.in
Industrial Water & Wastewater Treatment 26L6.0-EVS-201	1. Dr. Suman Nagpal, Associate Professor, IGU, Meerpur, Rewari. 9971807110 suman.evs@igu.ac.in	1. Dr. Sunil Kumar, Professor, MDU, Rohtak. 9466256869 sunilevs@yahoo.com 2. Dr. Renuka Gupta Professor J.C.Bose YMCA University Faridabad 9999692469 renukagupta@jcbouseust.ac.in 3. Dr. Jagriti Narang Associate Professor Jamia Hamdard Delhi 9315361479 jagritinarang@jamiahamdard.ac.in
Tool and Techniques 26L6.0- EVS-202	1. Dr. Suman Nagpal, Associate Professor, IGU, Meerpur, Rewari. 9971807110 suman.evs@igu.ac.in	1. Dr. Suman Singh, Principal, Scientist, CSIR- CSIO Chandigarh 9216903510 ssingh@csio.res.in 2. Dr. Jitender Singh Laura Professor MDU, Rohtak 9813167341 jitender.env.sc@mdurohtak.ac.in 3. Dr. Praveen Sharma Professor GJUS&T, Hisar 9416474881 parveensharma@gjust.org
Environmental Microbiology & Biotechnology 26L6.0- EVS-203	1. Dr. Suman Nagpal, Associate Professor, IGU, Meerpur, Rewari. 9971807110 suman.evs@igu.ac.in	1. Dr. Rana Pratap Singh Professor CU, Lucknow 9889121823 dr.ranapratap59@gmail.com 2. Dr. Anu Gupta Assistant Professor GJUS&T, Hisar

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		01662263129 <u>Anu339@gjust.org</u> 3. Dr. Renuka Gupta Professor J.C.Bose YMCA University Faridabad 9999692469 renukagupta@jcboseust.ac.in
Application of Remote Sensing and Geographic Information System 26L6.5- EVS-301	1. Dr. Suman Nagpal, Associate Professor, IGU, Meerpur, Rewari. 9971807110 suman.evs@igu.ac.in	1. Dr. Babita Khosla, Associate Professor, MDU, Rohtak 9991222344 babitakhosla.env.sc@mdurohtak .ac.in 2. Prof. Asha Gupta, Professor, GJUS&T, Hisar. 01274-254900 gupta06amit@gmail.com 3. Dr. Mona Sharma, Professor, CUH, Mahendergarh. 9991956470 mona@cuh.ac.in
Environmental Toxicology 26L6.5- EVS-302	1. Dr. Suman Nagpal, Associate Professor, IGU, Meerpur, Rewari. 9971807110 suman.evs@igu.ac.in	1. Dr. Suman Singh, Principal, Scientist, CSIR- CSIO Chandigarh 9216903510 ssingh@csio.res.in 2. Dr. Jitender Singh Laura Professor MDU, Rohtak 9813167341 jitender.env.sc@mdurohtak.ac.i n 3. Dr. Samita Chaudhary Professor KU, Kurukshetra 09812856432 smitachaudhry11@gmail.com
Environmental Hazards & Disasters Management 26L6.5- EVS-303	1. Dr. Suman Nagpal, Associate Professor, IGU, Meerpur, Rewari. 9971807110 suman.evs@igu.ac.in	1. Prof. Rajesh Dhankhar Professor MDU, Rohtak 9896457705 rajeshdhankar.EVS@mdurohta k.ac.in 2. Dr. Meenakshi Nandal Professor MDU, Rohtak 9416380668 meenakshi.env.sc@mdurohtak. ac.in 3. Prof. Samander Kaushik Professor MDU, Rohtak 09017733717 samanderkaushik@gmail.com
Environmental Resource Economics	1. Dr. Suman Nagpal, Associate Professor,	1. Dr. Anita Singh Kirrolia Assistant Professor GJUS&T,

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26L6.5 EVS-304	IGU, Meerpur, Rewari. 9971807110 suman.evs@igu.ac.in	Hisar 9050417740 <u>anitikirrolia@gmail.com</u> 2. Dr. Pratima Solanki Assistant Professor JNU, Delhi 011- 26704740 <u>partima@mail.jnu.ac.in</u> 3. Dr. Babita Khosla Associate Professor MDU, Rohtak 9991222344 <u>babitakhosla.env.sc@mdurohhta</u> <u>k.ac.in</u>
Bioinformatics 26L6.5- EVS-305	1. Dr. Suman Nagpal, Associate Professor, IGU, Meerpur, Rewari. 9971807110 suman.evs@igu.ac.in	1. Dr. Babita Khosla Associate Professor MDU, Rohtak 9991222344 <u>babitakhosla.env.sc@mdurohhta</u> <u>k.ac.in</u> 2. Dr. Sitender Pal Professor GJUS&T, Hisar 09416787003 <u>i_pal2k1@yahoo.com</u> 3. Dr. Mona Sharma Professor CUH, Mahendergarh 9991956470 <u>mona@cuha.ac.in</u> 4. Prof. Rajesh Dhankhar Professor MDU, Rohtak 9896457705 <u>rajeshdhankar.EVS@mdurohtak</u> <u>ac.in</u>
26L6.5- EVS-306	1. Dr. Suman Nagpal, Associate Professor, IGU, Meerpur, Rewari. 9971807110 suman.evs@igu.ac.in	1. Prof. Rajesh Dhankhar Professor MDU, Rohtak 9896457705 <u>rajeshdhankar.EVS@mdurohta</u> <u>k.ac.in</u> 2. Dr. Meenakshi Nandal Professor MDU, Rohtak 9416380668 <u>meenakshi.env.sc@mdurohtak</u> <u>ac.in</u> 3. Prof. Samander Kaushik Professor MDU, Rohtak 09017733717 <u>samanderkaushik@gmail.com</u>
Environmental impact Assessment 26L6.5- EVS-401	1. Dr. Suman Nagpal, Associate Professor, IGU, Meerpur, Rewari.	1. Dr. Rachina Bhateria, Professor MDU, Rohtak 9254645473 <u>rachina.env.sc@mdurohtak.ac.in</u>

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Environmental Laws, Policies & Ethics 26L6.5- EVS-402	1. Dr. Suman Nagpal, Associate Professor, IGU, Meerpur, Rewari. 9971807110 suman.evs@igu.ac.in	1. Dr. Suman Singh, Principal, Scientist, CSIR- CSIO Chandigarh 9216903510 ssingh@csio.res.in 2. Dr. Jitender Singh Laura Professor MDU, Rohtak 9813167341 jitender.env.sc@mdurohtak.ac.in 3. Dr. Praveen Sharma Professor GJUS&T, Hisar 9416474881 parveensharma@gjust.org
Environment, Energy and Safety Audit 26L6.5-EVS-403	1. Dr. Suman Nagpal, Associate Professor, IGU, Meerpur, Rewari. 9971807110 suman.evs@igu.ac.in	1. Dr. Mona Sharma, Professor, CUH, Mahendergarh. 9991956470 mona@cuh.ac.in 2. Dr. Sunil Kumar, Professor, MDU, Rohtak. 9466256869 sunilevs@yahoo.com 3. Dr. Rajesh Kumar, Professor, GJUS&T, Hisar. 9034043909 rajeshlohchab@gjust.org
Nano for Sustainable Energy 26L6.5- EVS-404	1. Dr. Suman Nagpal, Associate Professor, IGU, Meerpur, Rewari. 9971807110 suman.evs@igu.ac.in	1. Dr. Suman Singh, Principal, Scientist, CSIR- CSIO Chandigarh 9216903510 ssingh@csio.res.in 2. Dr. Jitender Singh Laura Professor MDU, Rohtak 9813167341 jitender.env.sc@mdurohtak.ac.in 3. Dr. Rachna Bhateria, Professor MDU, Rohtak 9254645473 rachna.env.sc@mdurohtak.ac.in

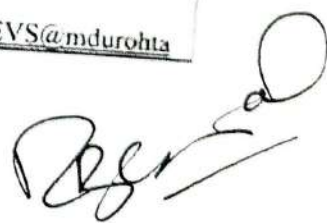
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Environmental Nanotechnology 26L6.5- EVS-405	1. Dr. Suman Nagpal, Associate Professor, IGU, Meerpur, Rewari. 9971807110 suman.evs@igu.ac.in	1. Dr. Rachna Bhateria, Professor MDU, Rohtak 9254645473 rachna.env.sc@mdurohtak.ac.in 2. Dr. Samander Kaushik, Professor MDU, Rohtak 09017733717 samanderkaushik@gmail.com 3. Dr. Mona Sharma Professor CUH, Mahendergarh 9991956470 mona@cuh.ac.in
Nanoscience Environment and Life 26L6.5- EVS-410	1. Dr. Suman Nagpal, Associate Professor, IGU, Meerpur, Rewari. 9971807110 suman.evs@igu.ac.in	1. Dr. Suman Singh, Principal, Scientist, CSIR- CSIO Chandigarh 9216903510 ssingh@csio.res.in 2. Dr. Jitender Singh Laura Professor MDU, Rohtak 9813167341 jitender.env.sc@mdurohtak.ac.in 3. Prof. Rajesh Dhankhar Professor MDU, Rohtak 9896457705 rajeshdhankar.EVS@mdurohtak.ac.in
Environmental Occupational Hazards 26L6.5- EVS-411	1. Dr. Suman Nagpal, Associate Professor, IGU, Meerpur, Rewari. 9971807110 suman.evs@igu.ac.in	1. Dr. Suman Singh, Principal, Scientist, CSIR- CSIO Chandigarh 9216903510 ssingh@csio.res.in 2. Dr. Jitender Singh Laura Professor MDU, Rohtak 9813167341 jitender.env.sc@mdurohtak.ac.in 3. Prof. Samander Kaushik Professor MDU, Rohtak 09017733717 samanderkaushik@gmail.com
Environmental Quality Monitoring & Analysis 26L6.5- EVS-412	1. Dr. Suman Nagpal, Associate Professor, IGU, Meerpur, Rewari. 9971807110	4. Prof. Rajesh Dhankhar Professor MDU, Rohtak 9896457705 rajeshdhankar.EVS@mdurohtak.ac.in





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Sum

Dr. Meenakshi Nandal

VISION AND MISSION OF THE UNIVERSITY

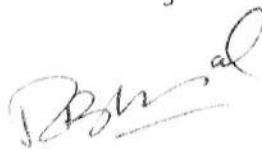
VISION

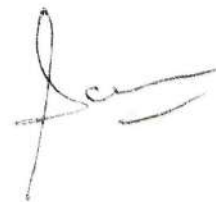
To be a globally renowned university, recognized for excellence in teaching, innovative research, and welfare of the society, imbining the spirit of "*Vasudhaivkutumbkam*".

MISSION

- To introduce and implement innovation in teaching and learning process matching up the global standards to strengthen academic delivery through curriculum design, teaching pedagogy and usage of ICT.
- To develop a mechanism that attracts talented, qualified and experienced faculty from across the globe for pursuing their academic and research careers at the University.
- To offer academic programs at UG, PG, doctoral, Post-Doctoral levels which are learner-centric, industry focused, and adhere to outcome based international models.
- To create an ambiance that is conducive for undertaking sponsored research, innovation and consultancy services to a wide spectrum of societal and industrial requirements while encouraging interdisciplinary approach of learning, team work, and research.
- To establish state of art centers of excellence in frontier areas of research and design innovation through industry collaboration to innovate and incubate the products and services.
- To establish smart campus and promote e-governance activities in the university for the digitally empowered society and knowledge economy.
- To provide a hygienic, modern, environment friendly and vivacious campus attuned to the urgent needs of Green Technology.
- To consider and implement norms, metrics, standards, procedures and benchmarks for assessing and improving the quality in every aspect of University system and achieve quality certifications by National and International bodies.
- To make society self-reliant by organizing various programmes including literacy, gender sensitization, health awareness, and dissemination of information about livelihood generation.


04/02/26





Details of Approvals

Council/Board	Date	Remark
Staff Council	29.07.2026	
Board of Studies	0408.2026	
Faculty	Faculty of Life Sciences	
Academic Council		
Year of implementation	2026-2027	

Chairperson
(Signature with Stamp)

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VISION AND MISSION OF THE DEPARTMENT

VISION

"A department that can effectively harness its multidisciplinary strength by imparting in-depth knowledge of scientific, technical, legal and social aspects of the environment to produce technologically adept Environmental post-graduates and researchers, that can address emerging challenges to sustainability for the betterment of society."

MISSION

- To impart training for capacity building to tackle various Environmental challenges in a sustainable manner.
- To provide holistic education to develop Environment leaders, policymakers, and solution seekers.
- To provide interdisciplinary and transformative research in the field of Environmental Science.
- To provide technological exposure to the students through industrial training programs/ Dissertations.
- To promote outreach activities for public awareness and societal benefit.

Sharma
04/08/26

Prasad

[Signature]

ABOUT THE PROGRAMME

Master of Science (M.Sc.) in Environmental Sciences

The **Master of Science (M.Sc.) in Environmental Sciences** is a four-semester postgraduate programme offered by the **Department of Environmental Sciences, Faculty of Life Sciences, Indira Gandhi University, Meerpur, Rewari**, in accordance with the **National Education Policy (NEP) 2020** and the **UGC Curriculum and Credit Framework for Postgraduate Programmes (CCFPG)**. The programme is designed to provide students with interdisciplinary knowledge, practical skills, research aptitude, and professional competence required to address contemporary environmental challenges at local, national, and global levels.

The curriculum integrates the principles of ecology, environmental chemistry, pollution control, environmental biotechnology, geospatial technologies, climate change, environmental laws and policies, sustainability, environmental ethics, data analytics, and emerging technologies. The programme emphasizes experiential learning through laboratory practicals, field visits, seminars, internships, project work, and research activities, enabling students to apply scientific knowledge for environmental conservation and sustainable development.

The programme adopts the **Choice Based Credit System (CBCS)** and **Learning Outcome-Based Curriculum Framework (LOCF)** to promote flexibility, multidisciplinary learning, academic mobility, skill development, innovation, and lifelong learning. It incorporates **Indian Knowledge Systems (IKS)**, environmental ethics, constitutional values, sustainable resource management, and the Sustainable Development Goals (SDGs), preparing graduates to contribute effectively towards environmental governance and sustainable societal development.

The curriculum is structured to develop analytical thinking, scientific temperament, problem-solving ability, communication skills, leadership qualities, entrepreneurship, and research competence. Post Graduates of the programme will be equipped for careers in academia, research institutions, government organizations, industries, environmental consultancy firms, pollution control boards, NGOs, international organizations, and environmental management agencies, besides pursuing higher studies and doctoral research.

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Programme Duration

- Duration: **Two Years (Four Semesters)**
- Mode: **Full-time**
- Total Credits: **104**
- Total Marks: **2600**
- Medium of Instruction: **English**

Programme Structure

The programme consists of:

- Core Courses (CC)
- Discipline-Centric Elective Courses (DEC)
- Practical/Practicum Courses (PP)
- Seminar
- Internship
- Open Elective Course (OEC)
- Constitutional, Human and Moral Values & Intellectual Property Rights (CHM)
- Employability and Entrepreneurship Course (EEC)
- Dissertation (where applicable)

The curriculum provides flexibility to pursue either:

- **Coursework-based Master's Degree (without Dissertation)**, or
- **Research-oriented Master's Degree (with Dissertation)** in accordance with the University regulations.

Internship

Every student shall successfully complete a **4-credit internship of 4–6 weeks** after the completion of Semester II. The internship may be undertaken in industries, research laboratories, government organizations, environmental consultancies, NGOs, universities, or other approved institutions for enhancing employability or developing research aptitude.

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Multiple Entry and Exit

The programme follows the Multiple Entry-Exit provisions of NEP 2020.

- A student exiting after successful completion of Semester I may be awarded the qualification as prescribed by the University under the prevailing NEP regulations.
- A student exiting after successful completion of Semester II and earning the prescribed credits shall be awarded a Post Graduate Diploma in Environmental Sciences.
- Successful completion of all four semesters and the prescribed credit requirements shall lead to the award of the Master of Science (M.Sc.) in Environmental Sciences.

Evaluation Scheme

The evaluation system comprises:

- Continuous Internal Assessment
- End Semester Examination
- Laboratory/Practical Examination
- Seminar Evaluation
- Internship Evaluation
- Dissertation Evaluation (where applicable)

The pattern of evaluation, grading, promotion, examination, moderation, and award of degrees shall be governed by the University Ordinances, Regulations, and NEP-2020 guidelines in force from time to time.

General Instructions

1. The programme shall be governed by the Academic Ordinances, Examination Regulations, CBCS, LOCF, and NEP-2020 guidelines of Indira Gandhi University, Meerpur, as amended from time to time.
2. The Department reserves the right to update the syllabus, practical exercises, field activities, recommended readings, and evaluation methods in accordance with advancements in Environmental Sciences and statutory requirements.


Head of Department


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3. Field visits, industrial visits, environmental surveys, seminars, workshops, expert lectures, and extension activities shall form an integral part of the curriculum.
4. The list of practical exercises may be modified by the Department depending upon the availability of laboratory facilities, instruments, field conditions, and emerging technologies.
5. The medium of instruction and examination shall ordinarily be English.
6. The award of credits shall be based on successful completion of all academic requirements as prescribed under the curriculum.
7. The programme encourages multidisciplinary learning, research, innovation, entrepreneurship, environmental stewardship, ethical values, and societal engagement in alignment with the objectives of NEP 2020 and sustainable development.

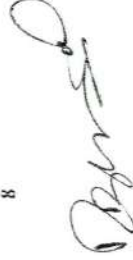
PASSING CRITERIA

A student shall be considered to have passed a course only if he/she secures:

1. **At least 40% marks in the End Semester Examination of the course.**
2. **At least 40% marks in the aggregate of Internal Assessment and End Semester Examination taken together.**
3. **In the case of Practical/Practicum, Seminar, Internship, Dissertation, and Viva-Voce, the student shall secure a minimum of 40% marks in the aggregate of the prescribed evaluation components.**

A student must successfully earn the prescribed credits in accordance with the provisions of the Curriculum and Credit Framework for Postgraduate Programmes (CCFPG), NEP 2020, and the regulations of Indira Gandhi University, Meerpur.

A student shall be awarded the Master of Science (M.Sc.) in Environmental Sciences upon successful completion of all programme.



ELIGIBILITY FOR EXAMINATION

A student shall be eligible to appear in the End Semester Examination only if he/she:

- Fulfills the minimum attendance requirement prescribed by the University and UGC.
- Satisfies all other academic requirements prescribed under the University Ordinances and Examination Regulations.

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PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

PEO1	Apply advanced knowledge of environmental sciences to understand, assess and solve environmental problems using scientific and interdisciplinary approaches.
PEO2	Demonstrate professional competence in environmental monitoring, pollution control, resource management, climate change mitigation, environmental impact assessment and sustainable development.
PEO3	Conduct independent research, generate scientific evidence, utilize modern analytical tools and contribute to innovation in environmental science and technology.
PEO4	Exhibit ethical values, leadership, teamwork, communication skills and environmental stewardship while serving society, industry and government organizations.
PEO5	Pursue lifelong learning, higher education, entrepreneurship and professional development to address emerging environmental challenges at national and global levels.

PROGRAMME LEARNING OUTCOMES (PLOs)

PLO 1	Knowledge	Acquire advanced theoretical and practical knowledge in environmental sciences, ecology, pollution control, climate science, biotechnology, environmental management and sustainability.
PLO 2	Research Aptitude	Design and conduct scientific investigations, formulate research problems, collect and analyze environmental data, and interpret research findings.
PLO 3	Communication	Communicate scientific information effectively through technical reports, presentations, publications and interactions with scientific and non-scientific communities.
PLO 4	Problem-Solving	Identify, analyze and develop sustainable solutions for complex environmental problems using scientific principles and interdisciplinary approaches.
PLO 5	Individual and Team Work	Work effectively as an individual as well as a member or leader of multidisciplinary teams in professional and research environments.
PLO 6	Investigation of Problems	Plan and execute laboratory experiments, field investigations, environmental monitoring and impact assessment using appropriate methodologies.
PLO 7	Modern Tool Usage	Use modern scientific instruments, analytical techniques, GIS, Remote Sensing, statistical software, bioinformatics and data analytics tools for environmental applications.
PLO 8	Scientific temperament	Apply scientific reasoning, critical thinking and evidence-based decision-making in environmental research and management.
PLO 9	Life-Long Learning	Recognize the need for continuous learning, skill enhancement and adaptation to emerging technologies and environmental challenges.
PLO 10	Ethics	Demonstrate professional ethics, environmental ethics, constitutional values and social responsibility in environmental decision-making.
PLO 11	Project Management	Plan, implement and manage environmental projects efficiently while considering financial, legal, technical and sustainability aspects.

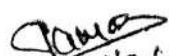
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PROGRAMME SPECIFIC OUTCOMES (PSOs) (If applicable)

PSO 1	Apply ecological principles and scientific knowledge to evaluate environmental systems, biodiversity, natural resources and ecosystem services for sustainable management.
PSO 2	Assess environmental pollution and employ appropriate monitoring, analytical techniques and pollution control technologies for air, water, soil and waste management.
PSO 3	Utilize modern environmental tools including GIS, Remote Sensing, environmental modelling, data analytics, molecular techniques and laboratory instrumentation for environmental analysis and research.
PSO 4	Develop sustainable solutions through environmental planning, climate change adaptation, environmental legislation, impact assessment, environmental auditing and policy implementation.


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Scheme of Examination for Postgraduate Programme	
Subject	M.Sc. Environmental Sciences
Total number of Semesters	04
Total Marks	2600
Total Credit	104
Framework	2
Scheme	P (as per PG ordinance)

Dr. P. S. S. S.

Example of Scheme P

Semester	Course Type	Course Code*	Nomenclature of course	Theory(T) Practical(P)	Credits		Contact hours per week L: Lecture P: Practical T: Tutorial To: Total					Internal Assessment Marks	End Term Examination Marks	Total Marks	Examination Hours
1	CC-1	26L6.0-EVS-101	Ecology & Natural Resources	T	4	26	To	L	T	P	To	30	70	100	3
	CC-2	26L6.0- EVS-102	Environmental Pollution, Health & Safety	T	4		4	0	0	4	4				
	CC-3	26L6.0- EVS-103	Fundamentals of Data Analytics	T	4		4	0	0	4	4				
	CC-4	26L6.0- EVS-104	Atmosphere and Global Climate Change	T	4		4	0	0	4	4				
	PC-1	26L6.0- EVS-105	Practicum-I	P	4		0	0	8	8	8				
	PC-2	26L6.0- EVS-106	Practicum-II	P	4		0	0	8	8	8				
	SEM	26L6.0- EVS-107	Seminar(as per university guidelines)	S	2		0	0	0	2	2				
2	CC-5	26L6.0-EVS-201	Industrial Water & Wastewater Treatment	T	4	26	4	0	0	4	4	30	70	100	3
	CC-6	26L6.0- EVS-202	Tool and Techniques	T	4		4	0	0	4	4				
	CC-7	26L6.0- EVS-203	Environmental Microbiology & Biotechnology	T	4		4	0	0	4	4				
	CC-8	26L6.0- EVS-204	Solid & Hazardous Waste Management	T	4		4	0	0	4	4				
	PC-3	26L6.0- EVS-205	Practicum-III	P	4		0	0	8	8	8				
	PC-4	26L6.0- EVS-206	Practicum-IV	P	4		0	0	8	8	8				
	CHM	26L6.0- CHM- 201	Constitutional, Human and Moral Values and IPR	T	2		2	0	0	2	2				

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Internship	26L6.0-EVS-207	An internship course of 4 Credits of 4-6 weeks duration during summer vacation after 2 nd semester is to be completed by every student. Internship can be either for enhancing the employability or for developing the research aptitude.	50	50	100	
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If a student takes exit after the successful completion of first two semesters after earning 56 Credits, then a Post Graduate Diploma in "Environmental Sciences" will be awarded to that candidate.

3	CC-9	26L6.5- EVS-301	Application of Remote Sensing and Geographic Information System	T	4	26	4	0	0	4	30	70	100	3
	CC-10	26L6.5- EVS-302	Environmental Toxicology	T	4		4	0	0	4	30	70	100	3
	DEC-1	26L6.5- EVS-303	Environmental Hazards & Disasters Management	T	4		4	0	0	4	30	70	100	3
	DEC-2 (Any one)	26L6.5 EVS-304	Environmental Resource Economics	T	4		4	0	0	4	30	70	100	3
		26L6.5- EVS-305	Bioinformatics	T	4		4	0	0	4	30	70	100	3
		26L6.5- EVS-306	AI & Environment Management	T	4		4	0	0	4	30	70	100	3
	PC-5	26L6.5 EVS- 307	Practicum-V	P	4		0	0	8	8	30	70	100	3
	PC-6	26L6.5- EVS-308	Practicum-VI	P	4		0	0	8	8	30	70	100	3
	OEC	26L6.5- EVS-309	* Hydrology and Water Resources (*for the students of other than PG Programme M.Sc. Environmental Sciences) Students of PG Programme M.Sc. Environmental Sciences will choose from the pool of open elective offered by the university.	T	2		2	0	0	2	15	35	50	2
4	CC-11	26L6.5- EVS-401	Environmental impact Assessment	T	4	26	4	0	0	4	30	70	100	3
	CC-12	26L6.5- EVS-402	Environmental Laws, Policies & Ethics	T	4		4	0	0	4	30	70	100	3
	DEC-3 (Any one)	26L6.5-EVS-403	Environment, Energy and Safety Audit	T	4		4	0	0	4	30	70	100	3

	26L6.5- EVS-410	Nanoscience Environment and Life	T	4	4	0	0	4	30	70	100	3
DEC-4 (Anyone)	26L6.5- EVS-404	Nano for Sustainable Energy	T	4	4	0	0	4	30	70	100	3
	26L6.5- EVS-405	Environmental Nanotechnology	T	4	4	0	0	4	30	70	100	3
PC-7	26L6.5- EVS-406	Practicum-VII	P	4	0	0	8	8	30	70	100	3
PC-8	26L6.5- EVS-407	Practicum-VIII	P	4	0	0	8	8	30	70	100	3
EEC	26L6.5- EVS-408	Research Ethics	T	2	2	0	0	2	15	35	50	2

Scheme of Semester-IV when a student opts for Dissertation Work or Project Work

4	DEC-3 (Anyone)	26L6.5-EVS-403	Environment, Energy and Safety Audit	T	4	4	0	0	4	30	70	100	3
		26L6.5- EVS-410	Nanoscience Environment and Life	T	4	4	0	0	4	30	70	100	3
	DEC-4 (Anyone)	26L6.5- EVS-404	Nano for Sustainable Energy	T	4	4	0	0	4	30	70	100	3
		26L6.5- EVS-411	*Environmental Occupational Hazards	T	4	4	0	0	4	30	70	100	3
	DEC-5 (Anyone)	26L6.5- EVS-405	Environmental Nanotechnology	T	4	4	0	0	4	30	70	100	3
		26L6.5- EVS-412	*Environmental Quality Monitoring & Analysis	T	4	4	0	0	4	30	70	100	3
	EEC	26L6.5- EVS-408	Research Ethics	T	2	2	0	0	2	15	35	50	2
	Dissertation / Project Work	26L6.5- EVS-409	Dissertation	D	12	0	0	0	12	100	200	300	—

Note:

- *Students can opt up to 40% of total elective courses (up to 3 any courses available at that time) mentioned in the Scheme (relevant to Environmental Science with four credit) available on SWAYAM/NPTEL/MOOCs Portal, or other online portal recognized by the UGC and the University.
- A student will be awarded with **Master Degree in the Subject** after successful completion of 2 year PG Programme by earning 108 Credits.

OR

A student will be awarded with **Master Degree in the Subject** after successful completion of 1 year PG Programme by earning 52 Credits, in the

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case of lateral entry after 4 year UG Programme with Honours/ Honours with Research/ one year PG Diploma in the Subject

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Part A - Introduction			
Name of Subject	M.Sc. Environmental Sciences		
Semester	1		
Nature of Course	Theory (Lecture + Tutorial)		
Nomenclature of the Course	Ecology and Natural Resources		
Course Code	26L6.0-EVS-101		
Course Type	CC-1		
Course Level	400-499		
Pre-requisite for the course (if any)	Basic knowledge of Biology, Environmental Science and Earth Science at undergraduate level		
Course Learning Outcomes (CLOs ₁) After completing this course, the learner will be able to:	CLO ₁	Explain the fundamental principles of ecology, ecological factors, ecosystem structure and natural resources.	
	CLO ₂	Analyze ecological interactions, population and community dynamics, ecological succession, ecosystem functioning and resource degradation.	
	CLO ₃	Evaluate biodiversity conservation, natural resource utilization and integrated resource management for sustainable development.	
	CLO ₄	Apply ecological principles and sustainable management strategies for conservation and effective utilization of forest, land, water, mineral and energy resources.	
	Theory	Practical	Total
Credits	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Duration (in Hours)	3		
Part B- Contents of the Course			
<u>Instructions for Paper- Setter:</u> The paper setter shall prepare 9 questions selecting two questions from each unit with consideration given to the Course Learning Outcomes. Among these, question number 1 will be compulsory, comprising 7 short answer type questions carrying two marks each (total 14 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt five questions: the compulsory question no. 1 and 1 question from the each of the four units.			
Unit	Topics	CLO/s Attempt	Contact Hours
I	Ecology: -Definition, subdivisions, and scope, basic concepts of ecology, Autecology and Synecology, biological levels of organization-genes to the biosphere, Interaction of ecological factors - Light, temperature, precipitation, humidity. Atmospheric gases, wind, and fire, topographic and edaphic factors, adaptation, Ecological concepts of species.	CLO 1	15
II	Population and community ecology: - Population characteristics, population interaction, prey-predator relations, competition, exploitation, mutualism, parasitism, allelopathy, Population growth, and regulation. Community structure and organization, ecological succession - types and mechanism.	CLO 2	15

	Ecosystem stability and regulation, biogeochemical cycles- cycling of water and nutrients, Structure of some typical ecosystems - forest, desert, grassland, pond, marine, wetland, estuaries, crop land.		
III	Introduction to Natural Resource Basics: Concept of resource, classification of natural resources, Factors influencing resource availability, distribution, and uses, Interrelationships among different types of natural resources ecological, social and economic dimensions of resource management. Natural resources and development. Biodiversity conservation and management.	CLO 3	15
IV	Traditional ecological knowledge in conservation and sustainable management of forests, water and biodiversity. Forest resources: Forest vegetation, status, distribution, contribution as a resource, Use, over-exploitation, deforestation. Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. Food, Water, Marine, Land, Mineral resources, and management. Integrated resource management strategies.	CLO 4	15
	Total Contact hours		60
Evaluation Methods			
Internal Assessment: 30 Marks		End Term Examination: 70 Marks	
• Class Participation:	5	Written Examination: 70	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		
Part C-Learning Resources			
Recommended Books/Journals/ e-resources/ Learning Management Systems (LMS):			
1. Agarwal, K. C. (2001). <i>Environmental Biology</i> . Nidhi Publications.			
2. Cunningham, W. P., Cunningham, M. A., & Saigo, B. W. (2021). <i>Environmental Science: A Global Concern</i> (15th ed.). McGraw-Hill.			
3. Gotelli, N. J. (2008). <i>A Primer of Ecology</i> (4th ed.). Sinauer Associates.			
4. Mishra, H. N. (2014). <i>Managing Natural Resources: Focus on Land and Water</i> . PHI Learning.			
5. Primack, R. B. (2010). <i>Essentials of Conservation Biology</i> (5th ed.). Sinauer Associates.			
6. Rogers, P. P., Jalal, K. F., & Boyd, J. A. (2008). <i>An Introduction to Sustainable Development</i> . Earthscan.			
7. Stiling, P. (2015). <i>Ecology: Global Insights and Investigations</i> (2nd ed.). McGraw-Hill.			
8. Townsend, C. R., Begon, M., & Harper, J. L. (2018). <i>Essentials of Ecology</i> (5th ed.). Wiley-Blackwell.			
9. Odum, E. P., & Barrett, G. W. (2005). <i>Fundamentals of Ecology</i> (5th ed.). Cengage Learning.			
10. Heywood, V. H., & Watson, R. T. (1995). <i>Global Biodiversity Assessment</i> . Cambridge University Press.			
11. Ministry of Environment, Forest and Climate Change (MoEFCC). Government of India.			
12. SWAYAM MOOCs, NPTEL Environmental Science Courses and National Digital Library of India (NDLI).			

**Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs)
& Program Specific Outcomes (PSOs)**

CLOs	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁
CLO ₁	3	1	-	2	-	1	-	2	-	-	-
CLO ₂	2	2	1	3	1	2	1	3	-	-	-
CLO ₃	3	2	1	3	1	2	1	2	2	2	1
CLO ₄	2	2	2	3	2	2	2	2	2	3	2

Content Mapping with NEP thrust areas

Field	Hours devoted
Employability	8
Entrepreneurship	3
Skill Enhancement	8
Communication Development	2
Indian Knowledge System	2
Environmental Awareness/SDGs	15
Current Issues and Social Awareness	10
Gender issues	1
Public policies	6
Any Other (Field-based Learning & Sustainability)	5

Part A - Introduction			
Name of Subject	M.Sc. Environmental Sciences		
Semester	I		
Nature of Course	Theory (Lecture + Tutorial)		
Nomenclature of the Course	Environmental Pollution, Health & Safety		
Course Code	26L6.0-EVS-102		
Course Type	CC-2		
Course Level	400-499		
Pre-requisite for the course (if any)	Basic knowledge of Environmental Science, Chemistry, Biology and Environmental Studies at undergraduate level.		
Course Learning Outcomes (CLOs ₁) After completing this course, the learner will be able to:	CLO ₁	Explain the sources, characteristics, transport and impacts of environmental pollutants on ecosystems and human health.	
	CLO ₂	Analyze various forms of air, water, soil, marine, noise and radioactive pollution, their associated health risks, and applicable environmental standards and legislation.	
	CLO ₃	Evaluate pollution pathways, epidemiological concerns, and pollution control strategies using scientific principles and environmental regulations.	
	CLO ₄	Apply modern pollution monitoring technologies and innovative pollution prevention and mitigation approaches for sustainable environmental management.	
	Theory	Practical	Total
Credits	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Duration (in Hours)	3		
Part B- Contents of the Course			
<u>Instructions for Paper- Setter:</u>			
The paper setter shall prepare 9 questions selecting two questions from each unit with consideration given to the Course Learning Outcomes. Among these, question number 1 will be compulsory, comprising 7 short answer type questions carrying two marks each (total 14 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt five questions: the compulsory question no. 1 and 1 question from the each of the four units.			
Unit	Topics	CLO/s Attempt	Contact Hours
I	Chemistry of environmental pollutants: -Definition and classification of pollutants, solubility and transfer of pollutants in different mediums, Biotransformation and bioaccumulation, Environmental policy resolution, legislation, public policy strategies in pollution control. Radioactivity: Radioactive decay and half-life of pollutants, Organometallic compounds, Soil pollution: Cause, effect and control strategies for soil	CLO1	15

	pollution, Toxic chemicals in the environment, Mode of entry of toxic substances.		
II	Air Pollution: Sources, types, health impacts on human health and control measures, Carcinogens in air, Air Quality Index, Ambient Air Quality Standards; Indoor air pollution: sources and effects on human health, Air (Prevention & control of pollution) Act 1981 as amended by amendment 1987 & rule 1982. Noise pollution: sources, impacts, and control measures; Radioactive Pollution: Sources, impacts, and control measures	CLO2	15
III	Water Pollution: Sources and impact of water contaminants on human health; Eutrophication; Waterborne diseases; Water quality parameters and standards, Water (prevention & control of pollution) Act, 1974 as amended by amendment 1978 & rules 1975. Marine pollution: Sources, impacts, and control; Oil spill and its effects; Coral Bleaching and Reef Degradation; Coastal Zone Management; Thermal pollution and its effects. Epidemiological issues: Goiter, Fluorosis, Arsenic poisoning.	CLO3	15
IV	Traditional Indian environmental practices for pollution prevention, including community-based sanitation, water conservation, and eco-friendly waste management. Advanced strategies to control pollution, Pollution Mitigation with Innovation, pollution control, and detection technology, Introduction to on-the-spot pollution monitoring devices for water, soil, and air.	CLO4	15
	Total Contact hours		60

Evaluation Methods

Internal Assessment: 30 Marks		End Term Examination: 70 Marks
• Class Participation:	5	Written Examination: 70
• Seminar/presentation/assignment/quiz/class test etc.:	10	
• Mid-Term Exam:	15	

Part C-Learning Resources

Recommended Books/Journals/ e-resources/ Learning Management Systems (LMS):

- Goel, P. K. (2016). *Water Pollution: Causes, Effects and Control* (3rd ed.). New Age International Publishers.
- Gurjar, B. R., Molina, L. T., & Ojha, C. S. P. (Eds.). (2010). *Air Pollution: Health and Environmental Impacts*. CRC Press.
- Landrigan, P. J. (2017). Air pollution and health. *The Lancet Public Health*, 2(1), e4–e5.
- Park, K. (2023). *Park's Textbook of Preventive and Social Medicine* (27th ed.). Banarsidas Bhanot.
- Pepper, I. L., Gerba, C. P., & Brusseau, M. L. (2021). *Environmental and Pollution Science* (4th ed.). Academic Press.
- Purohit, S. S., & Ranjan, R. (2003). *Ecology, Environment and Pollution*. Agrobios.
- Vesilind, P. A., Peirce, J. J., & Weiner, R. F. (2013). *Environmental Pollution and Control* (5th ed.). Butterworth-Heinemann.
- Wang, L. K., Pereira, N. C., & Hung, Y. T. (Eds.). (2005). *Advanced Air and Noise Pollution Control*. Humana Press.
- Rao, C. S. (2018). *Environmental Pollution Control Engineering*. New Age International.
- Ministry of Environment, Forest and Climate Change (MoEFCC), Government of India.

11. CPCB. National Ambient Air Quality Standards and Pollution Control Guidelines.
12. SWAYAM, NPTEL, National Digital Library of India (NDLI), and CPCB e-learning resources.

**Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs)
& Program Specific Outcomes (PSOs)**

CLOs	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁
CLO ₁	3	1	-	2	-	1	1	2	-	1	-
CLO ₂	3	2	1	3	1	2	2	3	-	2	1
CLO ₃	2	3	2	3	1	3	2	3	1	2	2
CLO ₄	2	2	2	3	2	2	3	2	2	3	2

Content Mapping with NEP thrust areas

Field	Hours devoted
Employability	10
Entrepreneurship	2
Skill Enhancement	8
Communication Development	2
Indian Knowledge System	2
Environmental Awareness/SDGs	12
Current Issues and Social Awareness	12
Gender issues	1
Public policies	8
Any Other(Innovation in Pollution Monitoring & Management)	3

Part A - Introduction			
Name of Subject	M.Sc. Environmental Sciences		
Semester	I		
Nature of Course	Theory (Lecture + Tutorial)		
Nomenclature of the Course	Fundamentals of Data Analytics		
Course Code	26L6.0-EVS-103		
Course Type	CC-3		
Course Level	400-499		
Pre-requisite for the course (if any)	Basic knowledge of Mathematics, Statistics, Environmental Science and Computer Applications at undergraduate level.		
Course Learning Outcomes (CLOs ₁) After completing this course, the learner will be able to:	CLO1	Explain the principles of descriptive statistics, probability theory, probability distributions and mathematical expectation for environmental data analysis.	
	CLO2	Apply correlation, regression techniques and inferential statistical methods to analyze environmental datasets and develop statistical models.	
	CLO3	Evaluate experimental data using hypothesis testing, parametric and non-parametric statistical methods for scientific research.	
	CLO4	Utilize analytical software and data visualization tools including MS Excel, SPSS, Tableau, R and Python for environmental data analysis and decision-making.	
	Theory	Practical	Total
Credits	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Duration (in Hours)	3		
Part B- Contents of the Course			
Instructions for Paper- Setter: The paper setter shall prepare 9 questions selecting two questions from each unit with consideration given to the Course Learning Outcomes. Among these, question number 1 will be compulsory, comprising 7 short answer type questions carrying two marks each (total 14 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt five questions: the compulsory question no. 1 and 1 question from the each of the four units.			
Unit	Topics	CLO/ s Attempt	Contact Hours
I	Data Analytics: Introduction, types, characteristics, and advantages of data analytics. Descriptive statistical techniques: Central tendency, Dispersion, Skewness, and kurtosis. Correlation and Regression: Simple, Partial, and Multiple.	CLO1	15
II	Probability Theory: Concept and Approaches, Application of additive and multiplication Laws, Bay's Theorem, Mathematical Expectations. Probability distribution: binomial, poisson, normal. Intertial statistics: sampling parameter	CLO2	15

	and statistic, sampling and non-sampling errors, sampling distribution of the mean, proportion and difference of means, central limit theorem.		
III	Hypothesis testing, parametric test: t-test and analysis of variance, one-way classification, two-way classification. Chi-square and its application.	CLO 3	15
IV	Non-parametric test: the run test of randomness: a test of two-matched samples: wilcoxon test, signed-rank-sum test: a test involving two independent samples: the Mann- Whitney U test: test for k-related samples: the Kruskalwallis h test, Friedmann test. Overview of analytic tools: excel as an analytical tool, SPSS, data visualizationin tableau, elementary idea and use of R programming and python in analytics	CLO 4	15
	Total Contact hours		60
Evaluation Methods			
Internal Assessment: 30 Marks		End Term Examination: 70 Marks	
• Class Participation:	5	Written Examination: 70	
• Seminar/presentation/assignment/quiz/ class test etc.:	10		
• Mid-Term Exam:	15		
Part C-Learning Resources			
Recommended Books/Journals/ e-resources/ Learning Management Systems (LMS):			
1. Arora, P. N., & Malhan, P. K. (2019). <i>Biostatistics</i> . Himalaya Publishing House.			
2. Quinn, G. P., & Keough, M. J. (2002). <i>Experimental Design and Data Analysis for Biologists</i> . Cambridge University Press.			
3. Pagano, M., & Gauvreau, K. (2018). <i>Principles of Biostatistics</i> (2nd ed.). CRC Press.			
4. Zolman, J. F. (2014). <i>Biostatistics: Experimental Design and Statistical Inference</i> . Oxford University Press.			
5. Motulsky, H. (2022). <i>Intuitive Biostatistics</i> (4th ed.). Oxford University Press.			
6. Sokal, R. R., & Rohlf, F. J. (2012). <i>Introduction to Biostatistics</i> . Dover Publications.			
7. Le, C. T. (2003). <i>Introductory Biostatistics</i> . John Wiley & Sons.			
8. Daniel, W. W., & Cross, C. L. (2018). <i>Biostatistics: A Foundation for Analysis in the Health Sciences</i> (11th ed.). Wiley.			
9. Montgomery, D. C. (2020). <i>Design and Analysis of Experiments</i> (10th ed.). Wiley.			
10. • James, G., Witten, D., Hastie, T., & Tibshirani, R. (2021). <i>An Introduction to Statistical Learning</i> (2nd ed.). Springer.			
E-resources/ Learning Management Systems			
11. National Programme on Technology Enhanced Learning (NPTEL). (2024). <i>Statistics, Data Analytics and Machine Learning Courses</i> . https://nptel.ac.in			
12. SWAYAM. (2024). <i>Online courses in statistics, data science and analytics</i> . https://swayam.gov.in			
13. National Digital Library of India. (2024). <i>Digital learning resources on statistics and data science</i> . https://ndli.iitkgp.ac.in			
14. R Foundation for Statistical Computing. (2024). <i>The R Project for Statistical Computing</i> . https://www.r-project.org			
15. Python Software Foundation. (2024). <i>Python Documentation</i> . https://www.python.org			
16. IBM. (2024). <i>SPSS Documentation and Learning Resources</i> . https://www.ibm.com/spss			
17. Coursera. (2024). <i>Data Analytics and Applied Statistics Courses</i> . https://www.coursera.org			

**Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs)
& Program Specific Outcomes (PSOs)**

CLOs	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁
CLO ₁	3	2	-	2	-	1	2	2	-	-	-
CLO ₂	3	3	1	3	1	2	3	3	1	-	1
CLO ₃	2	3	2	3	1	3	2	3	1	1	2
CLO ₄	2	2	2	3	2	2	3	2	3	1	2

Content Mapping with NEP thrust areas

Field	Hours devoted
Employability	10
Entrepreneurship	3
Skill Enhancement	12
Communication Development	2
Indian Knowledge System	2
Environmental Awareness/SDGs	6
Current Issues and Social Awareness	5
Gender issues	0
Public policies	2
Any Other (Digital Literacy, Data Visualization & Research Analytics)	10

Part A - Introduction			
Name of Subject		M.Sc. Environmental Sciences	
Semester		I	
Nature of Course		Theory (Lecture + Tutorial)	
Nomenclature of the Course		Atmosphere And Global Climate Change	
Course Code		26L6.0-EVS-104	
Course Type		CC-4	
Course Level		400-499	
Pre-requisite for the course (if any)		Basic knowledge of Environmental Science, Earth Science, Geography and Atmospheric Science at undergraduate level.	
Course Learning Outcomes (CLOs ₁) After completing this course, the learner will be able to:		CLO1	Explain the structure and functioning of Earth's atmospheric system, climatic processes, atmospheric circulation and interactions among Earth's spheres.
		CLO2	Analyze the causes and consequences of global climate change, greenhouse gas emissions, ozone depletion and climate variability using scientific principles.
		CLO3	Evaluate the environmental, ecological and socio-economic impacts of climate change and propose suitable adaptation and mitigation strategies.
		CLO4	Apply climate change assessment tools, international environmental agreements and carbon management approaches for sustainable climate governance.
	Theory	Practical	Total
Credits	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Duration (in Hours)	3		
Part B- Contents of the Course			
Instructions for Paper- Setter: The paper setter shall prepare 9 questions selecting two questions from each unit with consideration given to the Course Learning Outcomes. Among these, question number 1 will be compulsory, comprising 7 short answer type questions carrying two marks each (total 14 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt five questions: the compulsory question no. 1 and 1 question from the each of the four units.			
Unit	Topics	CLO/s Attempt	Contact Hours
I	Earth Systems: Atmosphere, Hydrosphere, Lithosphere, Biosphere, and their linkage. Earth’s geological history and development and evolution of the atmosphere, Gaia Hypothesis. Atmosphere and climate. Basic atmospheric properties, climatic controls, Climatic classifications and variability. Movement in the atmosphere: global scale, regional scale, local scale.	CLO 1	15

II	Oceans: General circulation patterns. Air-Sea interaction. Global Energy balance: Source, transfer, distribution. Energy balance of the atmosphere. Wind, stability and turbulence; Monsoons; El-Nino, Southern Oscillations, cyclones. Natural climate changes: Records of climate change (glacial cycles, ocean sediments, corals, tree rings).	CLO2	15
III	Human Impacts on climate: (i) Causes and consequences of Global warming:Greenhouse effect; Global and regional trends in greenhouse gas emissions; Sea level rise; the role of oceans and forests as carbon sinks(ii) Ozone depletion – Stratospheric Ozone Shield, Ozone hole, Montreal protocol Global climate change: Greenhouse effect, greenhouse gases-sources, trends, radiative forcing, warming potential of gases.	CLO 3	15
IV	Impacts of Climate change: Effects on organisms including humans; effects on ecosystem and productivity; species distribution ranges; spread of diseases; UV effects Climate change and Policy: Montreal Protocol; Kyoto Protocol; Carbon trading; clean development mechanisms. Indigenous water conservation, afforestation and sustainable land management practices supporting climate resilience and carbon sequestration. Role of traditional environmental ethics in promoting climate-resilient and sustainable lifestyles.	CLO 4	15
Total Contact hours			60
Evaluation Methods			
Internal Assessment: 30 Marks		End Term Examination: 70 Marks	
•Class Participation:	5	Written Examination: 70	
•Seminar/presentation/assignment/quiz/ class test etc.:	10		
•Mid-Term Exam:	15		
Part C-Learning Resources			
Recommended Books/Journals/ e-resources/ Learning Management Systems (LMS):			
1. Barry, R. G., & Chorley, R. J. (2010). <i>Atmosphere, Weather and Climate</i> (9th ed.). Routledge.			
2. Critchfield, H. J. (2002). <i>General Climatology</i> . Prentice Hall of India.			
3. Firor, J., & Jacobsen, J. E. (2002). <i>The Crowded Greenhouse: Population, Climate Change, and Creating a Sustainable World</i> . Yale University Press.			
4. Glantz, M. H. (2003). <i>Climate Affairs: A Primer</i> . Island Press.			
5. Harvey, D. (2000). <i>Climate and Global Climate Change</i> . Prentice Hall.			
6. Kump, L. R., Kasting, J. F., & Crane, R. G. (2010). <i>The Earth System</i> (3rd ed.). Pearson.			
7. IPCC. (2023). <i>Climate Change 2023: Synthesis Report</i> . Intergovernmental Panel on Climate Change.			
8. Lutgens, F. K., Tarbuck, E. J., & Tasa, D. (2022). <i>The Atmosphere: An Introduction to Meteorology</i> (14th ed.). Pearson.			
9. Ahrens, C. D., & Henson, R. (2019). <i>Meteorology Today</i> (13th ed.). Cengage Learning.			
10. Singh, S. (2018). <i>Climatology</i> . Prayag Pustak Bhawan.			
E-Resources / Learning Management Systems (APA Style)			

11. Intergovernmental Panel on Climate Change (IPCC). (2023). *Assessment reports and climate science resources*. <https://www.ipcc.ch>
12. Ministry of Environment, Forest and Climate Change. (2024). *Climate change programmes and policies*. <https://moef.gov.in>
13. India Meteorological Department. (2024). *Weather and climate services*. <https://mausam.imd.gov.in>
14. National Programme on Technology Enhanced Learning (NPTEL). (2024). *Atmospheric science and climate change courses*. <https://nptel.ac.in>
15. SWAYAM. (2024). *Online courses on climate change and environmental sciences*. <https://swayam.gov.in>
16. National Digital Library of India. (2024). *Digital resources in environmental sciences*. <https://ndl.iitkgp.ac.in>
17. United Nations Framework Convention on Climate Change (UNFCCC). (2024). *Climate agreements and policy documents*. <https://unfccc.int>
18. National Aeronautics and Space Administration (NASA). (2024). *Global Climate Change*. <https://climate.nasa.gov>
19. National Oceanic and Atmospheric Administration (NOAA). (2024). *Climate and weather resources*. <https://www.noaa.gov>
20. United Nations Environment Programme (UNEP). (2024). *Climate and environmental reports*. <https://www.unep.org>

Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs) & Program Specific Outcomes (PSOs)

CLOs	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁
CLO ₁	3	1	-	2	-	1	1	2	-	-	-
CLO ₂	3	2	1	3	1	2	2	3	1	1	1
CLO ₃	3	2	2	3	1	2	2	3	2	2	2
CLO ₄	2	2	2	3	2	2	2	2	2	3	3

Content Mapping with NEP thrust areas

Field	Hours devoted
Employability	8
Entrepreneurship	2
Skill Enhancement	8
Communication Development	2
Indian Knowledge System	3
Environmental Awareness/SDGs	15
Current Issues and Social Awareness	10
Gender issues	1
Public policies	8
Any Other(Climate Governance & Carbon Management)	3

Part A – Introduction			
Name of the Programme	M.Sc. Environmental Sciences		
Semester	I		
Nature of Course/Course Composition	Practical		
Nomenclature of the Course	Practicum–I (Ecology & Natural Resources, Environmental Pollution, Health & Safety)		
Course Code	26L6.0-EVS-105		
Course Type	PP-1 (Practicum-I)		
Course Level	400–499		
Pre-requisite for the course (if any)	Basic laboratory skills and knowledge of ecology, environmental pollution and environmental chemistry		
Course Learning Outcomes (CLOs) After completing this course, the learner will be able to:	CLO ₁	Perform ecological field investigations and analyze vegetation and ecosystem characteristics using standard ecological techniques.	
	CLO ₂	Apply standard laboratory methods for the analysis of soil and water quality parameters following prescribed protocols.	
	CLO ₃	Assess environmental pollution through the estimation of important physicochemical parameters and interpret the results for environmental monitoring.	
	CLO ₄	Demonstrate scientific laboratory practices, field survey techniques, data recording, report writing and safe handling of analytical instruments	
	Theory	Practical	Total
Credits	0	4	4
Teaching hours per week	0	8	8
Internal Assessment Marks	0	30	30
End Term Exam Marks	0	70	70
Max. Marks	0	100	100
Examination Duration (in Hours)	0	03	

Part B- Contents of the Course

Instructions for Examiner:

Write-up and execution of the practical will be conducted as per the nature of the practical by the external examiner, with consideration given to the Course Learning Outcomes.

Unit	Topics	CLO/s Attempt	Contact Hours
Unit-I (Ecology & Natural Resources)	1. Determination of minimum quadrat size for studying vegetation in a grassland. 2. Study of plant community by quadrat method by determining frequency, density and abundance of different plant species. 3. Study and identification of biotic and abiotic components of pond and forest ecosystems.	CLO 1	30
Unit-II (Ecology & Natural Resources)	1. Soil analysis: Particle size composition and density. 2. Field visit to a nearby hydroelectric power plant and submission of field report. 3. Estimation of organic carbon content in the given solid waste sample.	CLO 2	30
Unit-III (Environmental Pollution, Health & Safety)	1. Determination of harmful radiation level of mobile phones. 2. Estimation of pH, Total Dissolved Solids (TDS) and Electrical Conductivity (EC) of water samples.	CLO 3	30

Safety)	3. Study of physical characteristics of water: Colour, Odour, Turbidity and Temperature.		
Unit-IV (Environmental Pollution, Health & Safety)	1. Determination of Dissolved Oxygen (DO) by Winkler's method. 2. Estimation of Chemical Oxygen Demand (COD) of industrial effluent samples. 3. Estimation of Biological Oxygen Demand (BOD) of wastewater samples.	CLO 4	30
Note: Addition or deletion in the list of experiments may be made by the Department from time to time depending upon the availability of laboratory facilities and resources.			
Total Contact Hours			120
Evaluation Methods			
Internal Assessment:30	MM-30	End Term Examination: 70	MM- 70
Class Participation:	5	Lab record	10
Seminar/Demonstration/Viva-voce/Lab records etc.:	10	Viva-Voce	20
Mid-Term Exam:	15	Write-up and execution of the practical	40
Part C-Learning Resources			
Recommended Books/Journals/ e-resources/ Learning Management Systems (LMS):			
1. American Public Health Association (APHA). (2023). <i>Standard Methods for the Examination of Water and Wastewater</i> (24th ed.). APHA. 2. Metcalf & Eddy, Inc. (2014). <i>Wastewater Engineering: Treatment and Resource Recovery</i> (5th ed.). McGraw-Hill Education. 3. Bureau of Indian Standards. (2012). <i>Indian Standard: Drinking Water Specification (IS 10500:2012)</i>. BIS, New Delhi. 4. Birdie, G. S., & Birdie, J. S. (2017). <i>Water Supply and Sanitary Engineering</i>. Dhanpat Rai Publications. 5. Trivedy, R. K., & Goel, P. K. (2019). <i>Chemical and Biological Methods for Water Pollution Studies</i>. Environmental Publications. 6. Jackson, M. L. (2005). <i>Soil Chemical Analysis</i>. Prentice Hall of India. 7. Mishra, D. D. (2010). <i>Fundamental Concepts in Environmental Studies</i>. S. Chand Publishing. 8. Sharma, P. D. (2020). <i>Ecology and Environment</i> (14th ed.). Rastogi Publications.			
E-Resources / Learning Management Systems (APA Style)			
9. Central Pollution Control Board. (2024). <i>Laboratory methods and environmental monitoring protocols</i>. https://cpcb.nic.in 10. Ministry of Environment, Forest and Climate Change. (2024). <i>Environmental monitoring manuals and laboratory guidelines</i>. https://moef.gov.in 11. Bureau of Indian Standards. (2024). <i>Indian Standards for Drinking Water Quality</i>. https://www.bis.gov.in 12. National Programme on Technology Enhanced Learning (NPTEL). (2024). <i>Environmental engineering and laboratory techniques</i>. https://nptel.ac.in 13. SWAYAM. (2024). <i>Environmental laboratory and analytical techniques</i>. https://swayam.gov.in 14. National Digital Library of India. (2024). <i>Environmental science laboratory resources</i>. https://ndl.iitkgp.ac.in 15. American Public Health Association. (2024). <i>Standard methods resources</i>. https://www.apha.org 16. World Health Organization. (2024). <i>Water quality and environmental health resources</i>. https://www.who.int			

**Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs)
& Program Specific Outcomes (PSOs)**

CLOs	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁
CLO ₁	2	2	1	2	2	3	2	2	1	1	1
CLO ₂	2	2	1	3	1	3	2	2	1	2	1
CLO ₃	2	3	2	3	1	3	3	3	1	2	2
CLO ₄	2	2	3	2	3	2	2	2	2	3	2

Content Mapping with NEP thrust areas

Field	Hours devoted
Employability	12
Entrepreneurship	2
Skill Enhancement	24
Communication Development	14
Indian Knowledge System	0
Environmental Awareness/SDGs	16
Current Issues and Social Awareness	14
Gender issues	0
Public policies	12
Any Other(Laboratory Competency, Field Techniques & Scientific Report Writing)	16

Part A – Introduction			
Name of the Programme	M.Sc. Environmental Sciences		
Semester	I		
Nature of Course/Course Composition	Practical		
Nomenclature of the Course	Practicum–II (Fundamentals of Data Analytics, Atmosphere and Global Climate Change)		
Course Code	26L6.0-EVS-106		
Course Type	PP-1I (Practicum-II)		
Course Level	400–499		
Pre-requisite for the course (if any)	Basic knowledge of statistics, environmental science, atmospheric science and laboratory analytical techniques.		
Course Learning Outcomes (CLOs) After completing this course, the learner will be able to:	CLO1	Apply descriptive and inferential statistical techniques for organizing, analyzing and interpreting environmental data.	
	CLO2	Perform statistical analyses using appropriate analytical tools and interpret experimental data for environmental research.	
	CLO3	Conduct laboratory experiments related to environmental quality assessment and pollutant removal using standard analytical methods.	
	CLO4	Demonstrate laboratory competency, scientific report writing and interpretation of environmental and climate-related analytical results.	
	Theory	Practical	Total
Credits	0	4	4
Teaching hours per week	0	8	8
Internal Assessment Marks	0	30	30
End Term Exam Marks	0	70	70
Max. Marks	0	100	100
Examination Duration (in Hours)	0	03	
Part B- Contents of the Course			
<u>Instructions for Examiner:</u> Write-up and execution of the practical will be conducted as per the nature of the practical by the external examiner, with consideration given to the Course Learning Outcomes.			
Unit	Topics	CLO/s Attempt	Contact Hours
Unit-I (Fundamentals of Data Analytics)	1. Descriptive statistics: Systematic tabular summarization of data. 2. Measures of central tendency. 3. Measures of dispersion using calculators.	CLO 1	30
Unit-II (Fundamentals of Data Analytics)	1. Tests of significance (Mean, Standard Deviation, Proportion, Chi-square goodness of fit and test of independence). 2. Analysis of Variance (One-way and Two-way ANOVA).	CLO 2	30
Unit-III (Atmosphere and Global Climate Change)	1. Estimation of heavy metals using spectrophotometer. 2. Synthesis of low-cost adsorbent using waste material. 3. Removal of heavy metals from wastewater by adsorption methods.	CLO 3	30
Unit-IV (Atmosphere and Global Climate Change)	1. Removal of dye from textile industry effluent by adsorption methods.	CLO 4	30

Change)	2. Study of physical and chemical characteristics of industrial effluent contaminated soil. 3. Assessment of drinking water quality of a selected area and interpretation of results.		
Total Contact Hours			120
Evaluation Methods			
Internal Assessment:30	MM-30	End Term Examination: 70	MM- 70
Class Participation:	5	Lab record	10
Seminar/Demonstration/Viva-voce/Lab records etc.:	10	Viva-Voce	20
Mid-Term Exam:	15	Write-up and execution of the practical	40
Part C-Learning Resources			
Recommended Books/Journals/ e-resources/ Learning Management Systems (LMS):			
1. Arora, P. N., & Malhan, P. K. (2019). <i>Biostatistics</i>. Himalaya Publishing House. 2. Quinn, G. P., & Keough, M. J. (2002). <i>Experimental Design and Data Analysis for Biologists</i>. Cambridge University Press. 3. Pagano, M., & Gauvreau, K. (2018). <i>Principles of Biostatistics</i> (2nd ed.). CRC Press. 4. Zolman, J. F. (2014). <i>Biostatistics: Experimental Design and Statistical Inference</i>. Oxford University Press. 5. Daniel, W. W., & Cross, C. L. (2018). <i>Biostatistics: A Foundation for Analysis in the Health Sciences</i> (11th ed.). Wiley. 6. APHA. (2023). <i>Standard Methods for the Examination of Water and Wastewater</i> (24th ed.). American Public Health Association. 7. Harris, D. C. (2020). <i>Quantitative Chemical Analysis</i> (10th ed.). W. H. Freeman. 8. Skoog, D. A., Holler, F. J., & Crouch, S. R. (2018). <i>Principles of Instrumental Analysis</i> (7th ed.). Cengage Learning.			
E-Resources / Learning Management Systems (APA Style)			
9. National Programme on Technology Enhanced Learning (NPTEL). (2024). <i>Statistics, Environmental Analysis and Climate Science Courses</i>. https://nptel.ac.in 10. SWAYAM. (2024). <i>Environmental Science and Data Analytics Courses</i>. https://swayam.gov.in 11. National Digital Library of India. (2024). <i>Digital learning resources in environmental sciences</i>. https://ndl.iitkgp.ac.in 12. Central Pollution Control Board. (2024). <i>Laboratory methods and environmental monitoring guidelines</i>. https://cpcb.nic.in 13. Ministry of Environment, Forest and Climate Change. (2024). <i>Environmental monitoring and climate change resources</i>. https://moef.gov.in 14. Intergovernmental Panel on Climate Change. (2023). <i>Assessment Reports</i>. https://www.ipcc.ch 15. India Meteorological Department. (2024). <i>Climate and meteorological datasets</i>. https://mausam.imd.gov.in 16. R Foundation for Statistical Computing. (2024). <i>The R Project for Statistical Computing</i>. https://www.r-project.org			

**Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs)
& Program Specific Outcomes (PSOs)**

CLOs	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁
CLO ₁	2	2	1	2	1	2	2	2	1	-	-
CLO ₂	2	3	2	3	1	3	3	3	1	-	1
CLO ₃	2	3	1	3	2	3	3	3	1	2	2
CLO ₄	2	2	3	2	3	2	2	2	2	3	2

Content Mapping with NEP thrust areas

Field	Hours devoted
Employability	12
Entrepreneurship	2
Skill Enhancement	24
Communication Development	14
Indian Knowledge System	0
Environmental Awareness/SDGs	16
Current Issues and Social Awareness	14
Gender issues	0
Public policies	12
Any Other(Research Methodology, Laboratory Skills & Data Interpretation)	16

Part A - Introduction			
Name of Subject	M.Sc. Environmental Sciences		
Semester	I		
Nature of Course	Tutorial		
Nomenclature of the Course	Seminar		
Course Code	26L6.0-EVS-107		
Course Type	SEMINAR		
Course Level	400-499		
Pre-requisite for the course (if any)	-		
Course Learning Outcomes (CLOs) After completing this course, the learner will be able to:	CLO ₁	Select, review, and critically analyze relevant review or original research articles from reputed national and international journals to develop comprehensive understanding of the selected topic.	
	CLO ₂	Prepare and deliver an effective PowerPoint seminar presentation demonstrating scientific communication, depth of subject knowledge, analytical thinking, and ability to respond to questions confidently.	
	Theory	Tutorial	Total
Credits	0	2	0
Teaching Hours per week	0	2	0
Internal Assessment Marks	0	50	50
End Term Exam Marks	0	0	0
Max. Marks	50	0	50
Examination Duration (in Hours)	30 minutes per student		
Part B- Contents of the Course			
Guideline (as per university’s guidelines):			
The students are required to present a seminar the theme/ topic allotted/given to him/her from the Review articles/original research articles published in International/Reputed National journals in his/her area of interest. The topic will be selected by the student in consultation with the teacher allotted to him/her by the department. An Internal committee of teachers headed by the Chairperson of the Department will evaluate the seminar presented by the students. The evaluation (Internal evaluation only) will be based on the presentation (30 min.) of student, depths of subject knowledge and answer to questions.			

Part A - Introduction			
Name of Subject	M.Sc. Environmental Sciences		
Semester	II		
Nature of Course	Theory (Lecture + Tutorial)		
Nomenclature of the Course	Industrial Water & Wastewater Treatment		
Course Code	26L6.0-EVS-201		
Course Type	CC-5		
Course Level	400-499		
Pre-requisite for the course (if any)	Basic knowledge of Environmental Chemistry, Water Pollution and Environmental Engineering.		
Course Learning Outcomes (CLOs ₁) After completing this course, the learner will be able to:	CLO ₁	Explain the sources, characteristics, standards and environmental impacts of industrial wastewater generated from various industries.	
	CLO ₂	Evaluate physical, chemical, biological and advanced treatment technologies used for industrial wastewater treatment and resource recovery.	
	CLO ₃	Design and recommend suitable industrial wastewater treatment systems, reuse strategies and pollution prevention measures under Indian conditions.	
	CLO ₄	Adopt the methods for the reduction, recycling, and reuse of industrial wastewater. Assess sustainable wastewater management approaches	
	Theory	Practical	Total
Credits	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Duration (in Hours)	3		
Part B- Contents of the Course			
<u>Instructions for Paper- Setter:</u> The paper setter shall prepare 9 questions selecting two questions from each unit with consideration given to the Course Learning Outcomes. Among these, question number 1 will be compulsory, comprising 7 short answer type questions carrying two marks each (total 14 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt five questions: the compulsory question no. 1 and 1 question from the each of the four units.			
Unit	Topics	CLO/s Attempt	Contact Hours
I	Industrial waste water treatment: - Types of industrial wastewater pollutants, Industrial wastewater characterization, Classification of industries into green, orange and red, Standards of disposal for industrial wastes, MINAS, Industrial Estate planning. CETP: Requirement and objectives of CETP, General steps for the treatment of industrial wastewater: equalization, neutralization, sedimentation, oil separation, flotation, coagulation), Biological oxidation - removal of organics (sorption, stripping, biodegradation).	CLO ₁	15
II	Waste water treatment-I: physicochemical methods, Nutrient removal – nitrification, denitrification, Biological phosphate removal (BPR); Fundamentals	CLO ₂	15

	of Membrane processes; Types and classification of membranes; Advanced oxidation process and its application for wastewater treatment: Photocatalysis, ozonation.		
III	Waste water Treatment-II: High-Rate Technologies for industrial wastewater Treatment: Bioreactors for wastewater treatment - Membrane bioreactors (MBR), Moving Bed Biological Reactors (MBBR), Anaerobic Baffled Reactor (ABR), Energy recovery from wastewater, Natural systems for the management of Industrial wastewater, Constructed Wetland; Duckweed ponds, Reed Bed system, Waste stabilization ponds, Others: Sludge management, Zero liquid discharge concept in Industries.	CLO ₃	15
IV	Sustainable water management principles described in ancient Indian texts and their relevance to modern Integrated Water Resources Management (IWRM) and circular water economy. Wastewater reuse and resource recovery- Waste/emission generation sources, Waste characteristics, Effluent Treatment, reuse and recovery of resources from (1)Textile Industries (2) Distilleries (3) Sugar (4) Paper and Pulp mills (5) Tanneries (6) Food Processing industries (7) Fertilizer Industry.	CLO ₄	15
	Total Contact hours		60
Evaluation Methods			
Internal Assessment: 30 Marks		End Term Examination: 70 Marks	
• Class Participation:	5	Written Examination: 70	
• Seminar/presentation/assignment/quiz/ class test etc.:	10		
• Mid-Term Exam:	15		
Part C-Learning Resources			
Recommended Books/Journals/ e-resources/ Learning Management Systems (LMS):			
1. American Public Health Association. (2012). <i>Standard Methods for the Examination of Water and Wastewater</i> (22nd ed.). APHA.			
2. Crittenden, J. C., Trussell, R. R., Hand, D. W., Howe, K. J., & Tchobanoglous, G. (2012). <i>Water Treatment: Principles and Design</i> (3rd ed.). Wiley.			
3. Judd, S. (2011). <i>The MBR Book: Principles and Applications of Membrane Bioreactors for Water and Wastewater Treatment</i> (2nd ed.). Elsevier.			
4. Metcalf & Eddy. (2014). <i>Wastewater Engineering: Treatment and Resource Recovery</i> (5th ed.). McGraw-Hill.			
5. Okafor, N. (2011). <i>Environmental Microbiology of Aquatic and Waste Systems</i> . Springer.			
6. Parsons, S. (Ed.). (2004). <i>Advanced Oxidation Processes for Water and Wastewater Treatment</i> . IWA Publishing.			
7. Quevauviller, P. (2006). <i>Analytical Methods for Drinking Water</i> . Wiley.			
8. Eckenfelder, W. W. (1989). <i>Industrial Water Pollution Control</i> (2nd ed.). McGraw-Hill.			
9. Nathanson, J. A. (2003). <i>Basic Environmental Technology</i> (4th ed.). Prentice Hall of India.			
10. Kapoor, K., & Danino, M. (Eds.). (2019). <i>Indian Knowledge Systems</i> (Vol. I). Indian			
11. Institute of Advanced Study.			
12. Nene, Y. L. (2012). <i>Glimpses of the Agricultural Heritage of India</i> . Asian Agri-History			
13. Foundation.			
14. Agarwal, A., & Narain, S. (1997). <i>Dying Wisdom: Rise, Fall and Potential of India's</i>			

**Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs)
& Program Specific Outcomes (PSOs)**

CLOs	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁	PSO ₁	PSO ₂
CLO ₁	3	2	1	2	-	2	1	2	1	1	-	1	1
CLO ₂	3	3	1	3	2	3	3	3	2	1	2	3	2
CLO ₃	3	3	2	3	2	3	3	3	2	2	3	3	3
CLO ₄	2	2	2	3	2	2	2	3	3	3	2	2	3

Content Mapping with NEP thrust areas

Field	Hours devoted
Employability	12
Entrepreneurship	4
Skill Enhancement	10
Communication Development	4
Indian Knowledge System	4
Environmental Awareness/SDGs	12
Current Issues and Social Awareness	6
Gender issues	-
Public policies	4
Any Other(Experiential/Field-based Learning)	4

Part A - Introduction			
Name of Subject	M.Sc. Environmental Sciences		
Semester	II		
Nature of Course	Theory (Lecture + Tutorial)		
Nomenclature of the Course	Tools and Techniques		
Course Code	26L6.0-EVS-202		
Course Type	Core Course (CC-6)		
Course Level	400-499		
Pre-requisite for the course (if any)	Basic knowledge of Environmental Science, Chemistry, Biology and Laboratory Techniques.		
Course Learning Outcomes (CLOs ₁) After completing this course, the learner will be able to:	CLO ₁	Explain the principles and applications of major environmental analytical tools and techniques used for environmental monitoring and analysis.	
	CLO ₂	Operate analytical instruments based on spectroscopic, chromatographic, and molecular techniques and optimize their use for environmental analysis.	
	CLO ₃	Apply molecular and analytical techniques for the identification of microorganisms and for the analysis and measurement of environmental pollutants.	
	CLO ₄	Select and apply appropriate spectroscopic, chromatographic, and molecular techniques for environmental research, monitoring, and analysis of biotic and abiotic samples.	
	Theory	Practical	Total
Credits	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Duration (in Hours)	3		
Part B- Contents of the Course			
<u>Instructions for Paper- Setter:</u>			
The paper setter shall prepare 9 questions selecting two questions from each unit with consideration given to the Course Learning Outcomes. Among these, question number 1 will be compulsory, comprising 7 short answer type questions carrying two marks each (total 14 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt five questions: the compulsory question no. 1 and 1 question from the each of the four units.			
Unit	Topics	CLO/s Attempt	Contact Hours
I	Principles and application of Spectrophotometry (UV-Visible spectrophotometry), Atomic absorption spectrophotometry, Microscopy-Phase contrast, Light, and Fluorescence microscopes, Scanning and Transmission Electron Microscopes, Flame photometry, Titrimetry, Gravimetry, Colorimetry	CLO ₁	15
II	Chromatographic techniques (Paper chromatography, thin layer chromatography, Ion exchange chromatography, Column chromatography), Gas-liquid chromatography, and High-pressure liquid chromatography.	CLO ₂	15
III	X-ray diffraction, X-ray fluorescence, Autoradiography, Ultracentrifugation, Cytophotometry and Flow cytometry.	CLO ₃	15

IV	Electrophoresis, Agarose Gel Electrophoresis (AGE) & Polyacrylamide Gel Electrophoresis (PAGE), Methods for measuring nucleic acid and protein interactions, DNA fingerprinting Molecular markers RFLP, AFLP, RAPD, Sequencing of proteins and Nucleic Acids, Southern, Northern, Western Blotting Techniques, Polymerase Chain Reaction (PCR). Principles and techniques of Nucleic Acid hybridization and Cot curves.	CLO ₄	15
	Total Contact hours		60
Evaluation Methods			
Internal Assessment: 30 Marks		End Term Examination: 70 Marks	
• Class Participation:	5	Written Examination: 70	
• Seminar/presentation/assignment/quiz/ class test etc.:	10		
• Mid-Term Exam:	15		
Part C-Learning Resources			
Recommended Books/Journals/ e-resources/ Learning Management Systems (LMS):			
1.Skoog, D. A., Holler, F. J., & Crouch, S. R. (2018). Principles of Instrumental Analysis (7th ed.). Cengage Learning.			
2. Willard, H. H., Merritt, L. L., Dean, J. A., & Settle, F. A. (1988). Instrumental Methods of Analysis (7th ed.). CBS Publishers & Distributors.			
3.Christian, G. D., Dasgupta, P. K., & Schug, K. A. (2014). Analytical Chemistry (7th ed.). John Wiley & Sons.			
4.Rouessac, F., & Rouessac, A. (2013). Chemical Analysis: Modern Instrumentation Methods and Techniques (2nd ed.). John Wiley & Sons.			
5.Manahan, S. E. (2017). Environmental Chemistry (10th ed.). CRC Press.			
6.Sawyer, C. N., McCarty, P. L., & Parkin, G. F. (2003). Chemistry for Environmental Engineering and Science (5th ed.). McGraw-Hill.			
7.Keith, L. H. (1996). Principles of Environmental Sampling (2nd ed.). CRC Press.			
8.APHA, AWWA & WEF. (2023). Standard Methods for the Examination of Water and Wastewater (24th ed.). American Public Health Association, Washington, D.C.			
9.Patnaik, P. (2004). Dean's Analytical Chemistry Handbook (2nd ed.). McGraw-Hill.			

Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs) & Program Specific Outcomes (PSOs)

CLOs	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁	PSO ₁	PSO ₂
CLO ₁	3	2	-	2	-	2	3	2	-	-	-	3	2
CLO ₂	3	3	-	3	2	3	3	2	-	-	2		3
CLO ₃	2	3	2	3	2	3	3	3	2	-	2		3
CLO ₄	2	2	2	3	2	2	2	3	3	3	2		2

Content Mapping with NEP thrust areas

Field	Hours devoted
Employability	12
Entrepreneurship	5
Skill Enhancement	16
Communication Development	5

Indian Knowledge System	-
Environmental Awareness/SDGs	10
Current Issues and Social Awareness	5
Gender issues	1
Public policies	3
Any Other	-

Part A - Introduction			
Name of Subject	M.Sc. Environmental Sciences		
Semester	II		
Nature of Course	Theory (Lecture + Tutorial)		
Nomenclature of the Course	Environmental Microbiology and Biotechnology		
Course Code	26L6.0-EVS-203		
Course Type	Core Course (CC-7)		
Course Level	400-499		
Pre-requisite for the course (if any)	Basic knowledge of Microbiology, Biotechnology and Environmental Science.		
Course Learning Outcomes (CLOs ₁) After completing this course, the learner will be able to:	CLO ₁	Explain the principles of environmental microbiology and biotechnology and their applications in microbial production, biodiversity conservation and environmental sustainability.	
	CLO ₂	Apply biotechnological tools for environmental monitoring, contaminant detection, biodegradation and microbial detoxification.	
	CLO ₃	Evaluate bioremediation and phytoremediation approaches for restoring contaminated ecosystems.	
	CLO ₄	Assess biodegradable products, biosafety, bioethics and the role of Indian Knowledge Systems in sustainable environmental biotechnology.	
	Theory	Practical	Total
Credits	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Duration (in Hours)	3		
Part B- Contents of the Course			
<u>Instructions for Paper- Setter:</u> The paper setter shall prepare 9 questions selecting two questions from each unit with consideration given to the Course Learning Outcomes. Among these, question number 1 will be compulsory, comprising 7 short answer type questions carrying two marks each (total 14 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt five questions: the compulsory question no. 1 and 1 question from the each of the four units.			
Unit	Topics	CLO/s Attempt	Contact Hours
I	Environmental Microbiology and Biotechnology: Environmental microbiology and biotechnology; fermentative technologies; microbial enzymes; batch and continuous culture of microbes for commercial use; role of biotechnology in conservation of species; cryopreservation; tissue culture; gene banks.	CLO ₁	15
II	Environmental Monitoring and Biodegradation: Biosensors in detection of environmental contaminants (BOD, methane, ammonia); biomarkers of pollution; Bio indicators; recalcitrant nature of xenobiotics; microbial metal resistance and detoxification; biodegradation of halogenated hydrocarbons, polycyclic aromatic hydrocarbons (PAHs) and pesticides.	CLO ₂	15
III	Bioremediation and Phytoremediation: Environmental applications of bioremediation; types of bioremediation;	CLO ₃	15

	oil spill bioremediation; limitations of bioremediation; bioleaching; phytoremediation of xenobiotics and heavy metals; algal remediation and recent advances in phytotechnology.		
IV	Traditional Indian microbial technologies including Panchagavya, Jeevamrit and Beejamrit. Biodegradable and Eco-friendly Products: Biofuel, biodiesel, bioethanol, biohydrogen, biofertilizers, biopesticides and biopolymers. Bioethics in Environmental Biotechnology: Genetically engineered microbes, GM crops and biosafety	CLO ₄	15
	Total Contact hours		60
Evaluation Methods			
Internal Assessment: 30 Marks		End Term Examination: 70 Marks	
• Class Participation:	5	Written Examination: 70	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		
Part C-Learning Resources			
Recommended Books/Journals/ e-resources/ Learning Management Systems (LMS):			
• Bhattacharyya, B. C., & Banerjee, R. (2007). <i>Environmental Biotechnology</i>. Oxford University Press. • Bitton, G. (2013). <i>Wastewater Microbiology</i>. John Wiley & Sons. • Lynch, J. M., & Wiseman, A. (2011). <i>Environmental Biomonitoring: The Biotechnology–Ecotoxicology Interface</i>. Cambridge University Press. • Rittmann, B. E., & McCarty, P. L. (2020). <i>Environmental Biotechnology: Principles and Applications</i>. Tata McGraw-Hill. • Scragg, A. H. (2016). <i>Environmental Biotechnology</i>. Oxford University Press. • Thakur, I. S. (2011). <i>Environmental Biotechnology: Basic Concepts and Applications</i>. IK International Publishing. • Nene, Y. L. (2012). <i>Indian Agricultural Heritage</i>. Asian Agri-History Foundation. • Sadhale, N. (Trans.). (1996). <i>Surapala's Vrikshayurveda</i>. Asian Agri-History Foundation. • AICTE. (2023). <i>Introduction to Indian Knowledge Systems: Concepts and Applications</i>. AICTE, Ministry of Education.			

**Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs)
& Program Specific Outcomes (PSOs)**

CLOs	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁	PSO ₁	PSO ₂
CLO ₁	3	2	-	2	-	2	3	2	-	-	-	3	2
CLO ₂	3	3	-	3	2	3	3	2	-	-	2	3	3
CLO ₃	2	3	2	3	2	3	3	3	2	-	2	2	3
CLO ₄	2	2	2	3	2	2	2	3	3	3	2	3	2

Content Mapping with NEP thrust areas

Field	Hours devoted
Employability	12
Entrepreneurship	5
Skill Enhancement	16
Communication Development	5
Indian Knowledge System	3
Environmental Awareness/SDGs	10
Current Issues and Social Awareness	5
Gender issues	1
Public policies	3
Any Other	-

Part A - Introduction			
Name of Subject	M.Sc. Environmental Sciences		
Semester	II		
Nature of Course	Theory (Lecture + Tutorial)		
Nomenclature of the Course	Solid & Hazardous Waste Management		
Course Code	26L6.0-EVS-204		
Course Type	Core Course (CC-8)		
Course Level	400-499		
Pre-requisite for the course (if any)	Graduate in Sciences		
Course Learning Outcomes (CLOs ₁) After completing this course, the learner will be able to:	CLO ₁	Explain the sources, generation, classification, characterization and handling of solid and hazardous wastes.	
	CLO ₂	Evaluate waste minimization technologies and solid waste management plans for sustainable waste management.	
	CLO ₃	Apply biomedical, hazardous, radioactive, plastic and e-waste management rules for safe treatment and disposal.	
	CLO ₄	Assess sustainable solid waste management technologies and resource recovery approaches, including the relevance of Indian Knowledge Systems in promoting circular economy and environmental sustainability.	
	Theory	Practical	Total
Credits	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Duration (in Hours)	3		
Part B- Contents of the Course			
<u>Instructions for Paper- Setter:</u> The paper setter shall prepare 9 questions selecting two questions from each unit with consideration given to the Course Learning Outcomes. Among these, question number 1 will be compulsory, comprising 7 short answer type questions carrying two marks each (total 14 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt five questions: the compulsory question no. 1 and 1 question from the each of the four units.			
Unit	Topics	CLO/s Attempt	Contact Hours
I	Sources, Generation, Classification & Composition of Solid Wastes. Generation rates; factors affecting generation rates; onsite handling, storage and processing of solid wastes; necessary equipment.	CLO1	15
II	Solid Waste Management Plan; waste minimization technologies; Hazardous Waste Management; sources & classification; physicochemical properties; hazardous waste control and treatment.	CLO2	15
III	Biomedical Waste Management Rules, 2016; Hazardous Waste Management & Handling Rules, 2016 (Amendments); Radioactive Waste: definition, sources, classification, collection, segregation, treatment and disposal; Rules regarding solid waste, biomedical	CLO3	15

	waste, plastic waste and e-waste.		
IV	IKS Integration: Indigenous Indian waste recycling and organic resource management practices; traditional composting methods (NADEP composting, Farm Yard Manure), Panchagavya-based organic waste utilization, village-level circular resource management, and traditional practices supporting sustainable waste management and environmental conservation Solid Waste Management Methods: sanitary landfilling, recycling, composting, vermicomposting, incineration, energy recovery from organic waste, fly ash generation & utilization, rules regarding fly ash.	CLO4	15
	Total Contact hours		60
Evaluation Methods			
Internal Assessment: 30 Marks		End Term Examination: 70 Marks	
• Class Participation:	5	Written Examination: 70	
• Seminar/presentation/assignment/quiz/ class test etc.:	10		
• Mid-Term Exam:	15		
Part C-Learning Resources			
Recommended Books/Journals/ e-resources/ Learning Management Systems (LMS):			
1. Agarwal, S. K. (2005). Green Management. APH Publishing Corporation. 2. Agarwal, S. K. (2005). Wealth from Waste. APH Publishing Corporation. 3. Bhatia, S. C. (2013). Solid and Hazardous Waste Management (2nd ed.). Atlantic Publishers & Distributors. 4. Tchobanoglous, G., & Kreith, F. (2002). Handbook of Solid Waste Management (2nd ed.). McGraw-Hill. 5. Tchobanoglous, G., Theisen, H., & Vigil, S. A. (1993). Integrated Solid Waste Management: Engineering Principles and Management Issues. McGraw-Hill. 6. Vesilind, P. A., Worrell, W., & Reinhart, D. (2017). Solid Waste Engineering (3rd ed.). Cengage Learning. 7. Khan, M. K. (2004). Hospital Waste Management: Principles and Guidelines. Kanishka Publishers. 8. Central Pollution Control Board. (2024). Solid Waste Management Manual. Government of India. 9. Nene, Y. L. (2012). Indian Agricultural Heritage. Asian Agri-History Foundation. 10. Sadhale, N. (Trans.). (1996). Surapala's Vrikshayurveda. Asian Agri-History Foundation.			
E-Resources			
• SWAYAM (https://swayam.gov.in) • NPTEL (https://nptel.ac.in) • CPCB (https://cpcb.nic.in) • Ministry of Environment, Forest and Climate Change (https://moef.gov.in) • TERI Knowledge Resource Centre (https://www.teriin.org)			

Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs) & Program Specific Outcomes (PSOs)

CLOs	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁		PSO ₂
CLO ₁	3	3	2	2	2	2	2	1	1	1	1		2
CLO ₂	2	3	3	2	3	2	2	2	2	1	1		3
CLO ₃	2	2	3	3	2	3	2	2	2	1	1	3	3

CLO ₄	2	2	2	3	3	2	3	2	3	2	2	3	3
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Content Mapping with NEP thrust areas

Field	Hours devoted
Employability	10
Entrepreneurship	4
Skill Enhancement	12
Communication Development	2
Indian Knowledge System	4
Environmental Awareness/SDGs	12
Current Issues and Social Awareness	6
Gender issues	0
Public policies	6
Any Other (Case studies , field visit)	4

Part A – Introduction			
Name of the Programme	M.Sc. Environmental Sciences		
Semester	II		
Nature of Course/Course Composition	Practical		
Nomenclature of the Course	Practicum–III		
Course Code	26L6.0-EVS-205		
Course Type	PP-3 (Practicum)		
Course Level	400–499		
Pre-requisite for the course (if any)	Basic knowledge of Industrial Water & Wastewater Treatment and Environmental Analytical Techniques.		
Course Learning Outcomes (CLOs) After completing this course, the learner will be able to:	CLO ₁	Perform physicochemical and biological analyses of industrial water and wastewater samples using standard laboratory procedures.	
	CLO ₂	Operate common environmental analytical instruments and apply appropriate techniques for water and wastewater quality assessment.	
	CLO ₃	Interpret analytical data and evaluate the efficiency of wastewater treatment processes in accordance with environmental standards.	
	CLO ₄	Demonstrate laboratory safety, scientific reporting, teamwork, and ethical laboratory practices during environmental investigations.	
	Theory	Practical	Total
Credits	0	4	4
Teaching hours per week	0	8	8
Internal Assessment Marks	0	30	30
End Term Exam Marks	0	70	70
Max. Marks	0	100	100
Examination Duration (in Hours)		03	03
Part B- Contents of the Course			
Instructions for Examiner: Write-up and execution of the practical will be conducted as per the nature of the practical by the external examiner, with consideration given to the Course Learning Outcomes.			
Unit	Topics	CLO/s Attempt	Contact Hours
Unit-I	Sampling and preservation of industrial water and wastewater; determination of pH, EC, TDS, TSS, turbidity, alkalinity, hardness and chlorides.	CLO1	30
Unit-II	Determination of DO, BOD, COD, nitrate, phosphate, sulphate, oil & grease; physicochemical analysis of wastewater.	CLO2	30
Unit-III	Heavy metal estimation using UV-Visible Spectrophotometer/AAS (where available); jar test; adsorption studies; membrane filtration techniques.	CLO3	30
Unit-IV	Characterization of industrial effluent; performance evaluation of wastewater treatment units; industrial/ETP visit and report writing; interpretation of analytical data and laboratory safety.	CLO4	30
Note: Addition and deletion in the list of experiments may be made from time to time by the department depending on the availability of resources			
Total Contact Hours			120
Evaluation Methods			

Internal Assessment:30	MM-30	End Term Examination: 70	MM- 70
Class Participation:	5	Lab record	10
Seminar/Demonstration/Viva-voce/Lab records etc.:	10	Viva-Voce	20
Mid-Term Exam:	15	Write-up and execution of the practical	40

Part C-Learning Resources

Recommended Books/Journals/ e-resources/ Learning Management Systems (LMS):

1. American Public Health Association (APHA), American Water Works Association (AWWA), & Water Environment Federation (WEF). (2023). *Standard methods for the examination of water and wastewater* (24th ed.). APHA Press.
2. Metcalf & Eddy, Inc. (2014). *Wastewater engineering: Treatment and resource recovery* (5th ed.). McGraw-Hill Education.
3. Sawyer, C. N., McCarty, P. L., & Parkin, G. F. (2003). *Chemistry for environmental engineering and science* (5th ed.). McGraw-Hill.
4. Spellman, F. R. (2023). *Handbook of water and wastewater treatment plant operations* (4th ed.). CRC Press.
5. Tchobanoglous, G., Stensel, H. D., Tsuchihashi, R., & Burton, F. L. (2014). *Wastewater engineering: Treatment and resource recovery* (5th ed.). McGraw-Hill Education.
6. Central Pollution Control Board. (2017). *Laboratory analytical techniques for environmental monitoring*. Ministry of Environment, Forest and Climate Change, Government of India.
7. National Environmental Engineering Research Institute (NEERI). (2020). *Manual on water and wastewater analysis*. CSIR-NEERI.
8. Bureau of Indian Standards. (2012, with latest amendments). *Indian Standard drinking water—Specification (IS 10500:2012)*. BIS.

Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs) & Program Specific Outcomes (PSOs)

CLOs	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁	PSO ₁	PSO ₂
CLO ₁	3	2	1	2	1	3	2	2	1	1	1	2	3
CLO ₂	2	3	2	2	2	3	3	2	1	1	1	2	3
CLO ₃	2	3	2	3	2	2	2	3	2	2	2	2	3
CLO ₄	1	1	3	2	3	2	2	2	3	3	2	1	2

Content Mapping with NEP thrust areas

Field	Hours devoted
Employability	24
Entrepreneurship	8
Skill Enhancement	36
Communication Development	8
Indian Knowledge System	2
Environmental Awareness/SDGs	18
Current Issues and Social Awareness	12
Gender issues	2
Public policies	6
Any Other (Laboratory Safety, Ethics & Professional Practices)	4

Part A – Introduction			
Name of the Programme	M.Sc. Environmental Sciences		
Semester	II		
Nature of Course/Course Composition	Practical		
Nomenclature of the Course	Practicum–IV		
Course Code	26L6.0-EVS-206		
Course Type	PP-4 (Practicum)		
Course Level	400–499		
Pre-requisite for the course (if any)	Basic knowledge of Environmental Microbiology, Biotechnology, Solid Waste Management and laboratory practices.		
Course Learning Outcomes (CLOs) After completing this course, the learner will be able to:	CLO ₁	Perform microbiological techniques for isolation, identification, culturing and enumeration of environmental microorganisms.	
	CLO ₂	Apply molecular and analytical techniques for environmental monitoring and microbial characterization.	
	CLO ₃	Characterize solid waste and conduct composting/vermicomposting experiments for sustainable waste management.	
	CLO ₄	Evaluate solid waste handling, segregation, treatment and disposal practices through field investigations and prepare technical reports.	
	Theory	Practical	Total
Credits	0	4	4
Teaching hours per week	0	8	8
Internal Assessment Marks	0	30	30
End Term Exam Marks	0	70	70
Max. Marks	0	100	100
Examination Duration (in Hours)		03	03
Part B- Contents of the Course			
Instructions for Examiner:			
Write-up and execution of the practical will be conducted as per the nature of the practical by the external examiner, with consideration given to the Course Learning Outcomes.			
Unit	Topics	CLO/s Attempt	Contact Hours
Unit-I	Isolation, culture, staining, microscopy, MPN test, preparation of media, bacterial growth studies and microbial identification.	CLO1	30
Unit-II	Enumeration of wastewater microorganisms, sterilization techniques, laboratory equipment, PCR principles and environmental molecular diagnostics.	CLO2	30
Unit-III	Determination of physical and chemical characteristics of solid waste, survey of waste handling, segregation and storage, composting/vermicomposting experiments.	CLO3	30
Unit-IV	Study of solid waste collection, transportation, treatment and disposal methods, group activity, landfill/Waste-to-Energy plant field visit and technical report preparation.	CLO4	30
Note: Addition and deletion in the list of experiments may be made from time to time by the department depending on the availability of resources			
Total Contact Hours			120

Evaluation Methods			
Internal Assessment:30	MM-30	End Term Examination: 70	MM- 70
Class Participation:	5	Lab record	10
Seminar/Demonstration/Viva-voce/Lab records etc.:	10	Viva-Voce	20
Mid-Term Exam:	15	Write-up and execution of the practical	40
Part C-Learning Resources			
Recommended Books/Journals/ e-resources/ Learning Management Systems (LMS):			
1. Bitton, G. (2020). <i>Wastewater Microbiology</i> (5th ed.). John Wiley & Sons. 2. Rittmann, B. E., & McCarty, P. L. (2020). <i>Environmental Biotechnology: Principles and Applications</i>. McGraw-Hill Education. 3. Scragg, A. H. (2019). <i>Environmental Biotechnology</i> (3rd ed.). Oxford University Press. 4. Thakur, I. S. (2018). <i>Environmental Biotechnology: Basic Concepts and Applications</i> (2nd ed.). I.K. International Publishing House. 5. Tchobanoglous, G., & Kreith, F. (2022). <i>Handbook of Solid Waste Management</i> (3rd ed.). McGraw-Hill. 6. Central Pollution Control Board. (2024). <i>Solid Waste Management Rules, 2016 (as amended) and Technical Guidelines</i>. Ministry of Environment, Forest and Climate Change, Government of India. 7. Central Pollution Control Board. (2024). <i>Biomedical Waste Management Rules and Hazardous Waste Management Guidelines</i>. Government of India. 8. National Environmental Engineering Research Institute. (2022). <i>Manual on Municipal Solid Waste Management</i>. CSIR–NEERI. 9. National Programme on Technology Enhanced Learning (NPTEL). (2025). <i>Environmental Biotechnology</i> (Online Course). https://nptel.ac.in 10. Ministry of Environment, Forest and Climate Change. (2025). <i>Environmental Rules, Notifications and Guidelines</i>. https://moefcc.gov.in			

Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs) & Program Specific Outcomes (PSOs)

CLOs	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁	PSO ₁	PSO ₂
CLO ₁	3	1	2	2	2	3	3	2	1	1	1	3	2
CLO ₂	3	2	2	2	2	3	3	2	2	1	1	3	3
CLO ₃	2	2	3	3	3	2	2	3	2	2	2	2	3
CLO ₄	2	3	2	2	3	2	2	3	3	3	2	2	2

Content Mapping with NEP thrust areas

Field	Hours devoted
Employability	24
Entrepreneurship	8
Skill Enhancement	28
Communication Development	16
Indian Knowledge System	-
Environmental Awareness/SDGs	18
Current Issues and Social Awareness	12
Gender issues	2
Public policies	6
Any Other (Laboratory Safety, Ethics & Professional Practices)	4

Part A - Introduction			
Name of Programme	M.Sc. Environmental Sciences		
Semester	II		
Nature of Course/Course Composition	Theory (Lecture + Tutorial)		
Nomenclature of the Course	Constitutional, Human and Moral Values and IPR		
Course Code	26L6.0-CHM-201		
Course Type	CHM		
Course Level	400-499		
Pre-requisite for the course (if any)	NA		
Course Learning Outcomes (CLOs) After completing this course, the learner will be able to:	CLO ₁	Explain the historical background of the Indian Constitution, constitutional values, fundamental rights and duties, directive principles of state policy, humanistic values, constitutional morality, and their role in nation building and social harmony.	
	CLO ₂	Describe moral and professional ethics, gender sensitization, social justice, intellectual property rights, plagiarism policy, and ethical responsibilities in higher education and professional life.	
	Theory	Practical	Total
Credits	2	0	2
Teaching Hours per week	2	0	2
Internal Assessment Marks	15	0	15
End Term Exam Marks	35	0	35
Max. Marks	50	0	50
Examination Duration (in Hours)	02	0	
Part B- Contents of the Course			
<u>Instructions for Paper- Setter:</u> The paper setter shall prepare 5 questions selecting two questions from each of the two units with consideration given to the Course Learning Outcomes. Among these, question number 1 will be compulsory question comprising 07 short answer type questions carrying one mark each (total 07 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt three questions: the compulsory question no. 1 and 1 question from the each of the two units.			
Unit	Topics	CLO Attempt	Contact Hours
I	Constitutional Values Historical Perspective of Indian Constitution; Basic Values enshrined in the Preamble of the Indian Constitution; Concept of Constitutional Morality; Patriotic Values and Ingredients Nation Building; Fundamental Rights and Duties ; Directive Principles of the State Policy. Humanistic Values: Humanism, Human Virtues and Civic Sense; Social Responsibilities of Human Beings; Ethical ways to deal with human aspirations; Harmony with society and nature; Idea of International Peace and Brotherhood (Vasudhaiv Kutumbkam).	CLO 1	15
II	Moral Values and Professional Conduct Understanding Morality and Moral Values; Moral Education and Character Building; Ethics of Relations: Personal, Social and Professional; Introduction to Gender Sensitization; Affirmative approach towards Weaker Sections (SCs, STs, OBCs, EWS& DAs); Ethical Conduct in Higher Education Institutions; Professional Ethics. Intellectual Property Rights:	CLO 2	15

	Meaning, Origins and Nature of Intellectual Property Rights (IPRs); Different Kinds of IPRs – Copyright, Patent, Trademark, Trade Secret/Dress, Design, Traditional Knowledge; Infringement and Offences of IPRs – Remedies and Penalties; Basics of Plagiarism policy of UGC.		
Total Contact hours			30
Evaluation Methods			
Internal Assessment: 15 Marks		End Term Examination: 35 Marks	
• Class Participation:	5	Written Examination: 35	
• Seminar/presentation/assignment/quiz/ class test etc.:	5		
• Mid-Term Exam:	5		
Part C-Learning Resources			
Recommended Books/Journals/ e-resources/ Learning Management Systems (LMS):			
1. Basu, D. D. (2024). <i>Introduction to the Constitution of India</i> (Latest ed.). LexisNexis Butterworths. 2. Government of India. (2023). <i>The Constitution of India</i> (as amended up to the Constitution (106th Amendment) Act, 2023). Ministry of Law and Justice. 3. Jain, M. P. (2023). <i>Indian constitutional law</i> (9th ed.). LexisNexis. 4. Laxmikanth, M. (2025). <i>Indian polity</i> (7th ed.). McGraw Hill Education. 5. Naagarazan, R. S. (2022). <i>A textbook on professional ethics and human values</i> (3rd ed.). New Age International Publishers. 6. Narayanan, P. (2025). <i>Intellectual property law</i> (Latest ed.). Eastern Law House. 7. Subramanian, R. (2025). <i>Professional ethics</i> (3rd ed.). Oxford University Press. 8. Cengage Learning India. (2023). <i>Constitution of India, professional ethics and human rights</i>. Cengage Learning India. 9. University Grants Commission. (2025). <i>UGC regulations on promotion of academic integrity and prevention of plagiarism in higher educational institutions</i>. University Grants Commission. 10. World Intellectual Property Organization. (2024). <i>Introduction to intellectual property</i>. WIPO Academy.			
e-resources:			
• UGC – Academic Integrity & Plagiarism Regulations • Ministry of Law & Justice – Constitution of India • WIPO Academy (Free IPR Courses) • IP India – Office of the Controller General of Patents, Designs & Trade Marks • NPTEL: Constitutional Law and Public Administration in India (IIT Madras) • NPTEL: Intellectual Property Rights and Competition Law (IIT Kharagpur) • NPTEL: Introduction to Intellectual Property • National Digital Library of India (NDLI) • e-PG Pathshala (UGC-MoE) • SWAYAM MOOCs			

Note: Syllabus of this paper will be provided by academic branch of the university.

Part A - Introduction			
Name of Subject	M.Sc. Environmental Sciences		
Semester	III		
Nature of Course	Theory (Lecture + Tutorial)		
Nomenclature of the Course	Application of Remote Sensing and Geographic Information System		
Course Code	26L6.5-EVS-301		
Course Type	Core Course (CC-9)		
Course Level	500-599		
Pre-requisite for the course (if any)	Graduate in Sciences		
Course Learning Outcomes (CLOs ₁) After completing this course, the learner will be able to:	CLO ₁	Explain the principles of Remote Sensing, electromagnetic radiation, sensor systems, and satellite data acquisition for environmental applications.	
	CLO ₂	Analyze aerial photographs, remotely sensed data, photogrammetric concepts, and GIS data models for spatial information management.	
	CLO ₃	Apply digital image processing and geospatial techniques for environmental monitoring, natural resource assessment, and disaster management.	
	CLO ₄	Evaluate the applications of GIS, GPS, and geospatial technologies for sustainable environmental planning by integrating Indian Knowledge Systems (IKS) related to traditional resource mapping and indigenous environmental management practices.	
	Theory	Practical	Total
Credits	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Duration (in Hours)	3		
Part B- Contents of the Course			
<u>Instructions for Paper- Setter:</u>			
The paper setter shall prepare 9 questions selecting two questions from each unit with consideration given to the Course Learning Outcomes. Among these, question number 1 will be compulsory, comprising 7 short answer type questions carrying two marks each (total 14 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt five questions: the compulsory question no. 1 and 1 question from the each of the four units.			
Unit	Topics	CLO/s Attempt	Contact Hours
I	Fundamentals of Remote Sensing: Definition, principles, scope and applications of Remote Sensing; Electromagnetic radiation and spectrum; Atmospheric windows; Spectral reflectance; Platforms and sensors; Data acquisition systems; Types of scanning systems; Characteristics of sensors; Salient features of LANDSAT, SPOT and Indian Remote Sensing (IRS) satellites.	CLO1	15
II	Aerial Photography and GIS Fundamentals: Aerial photography—vantage point, cameras, filters and types of films; Elements of visual image	CLO2	15

	interpretation; Multispectral and Microwave Remote Sensing; Introduction to Photogrammetry, stereoscopic vision and projection systems; GIS software; Hierarchical, Network and Relational data models.		
III	Digital Image Processing and Environmental Applications: Digital image and image structure; Image restoration and enhancement; Image classification; Applications of Remote Sensing in forestry, ecology, environment, land use, agriculture, soils, geology and disaster management.	CLO3	15
IV	Traditional Indian knowledge of land resource mapping, watershed management, indigenous landscape planning and community-based natural resource management Geographic Information System and Environmental Management: GIS technology and its applications in Environmental Sciences; GIS hardware and software requirements; Conceptual models of spatial and non-spatial information; Global Positioning System (GPS).	CLO4	15
	Total Contact hours		60
Evaluation Methods			
Internal Assessment: 30 Marks		End Term Examination: 70 Marks	
• Class Participation:		5	Written Examination: 70
• Seminar/presentation/assignment/quiz/ class test etc.:		10	
• Mid-Term Exam:		15	
Part C-Learning Resources			
Recommended Books/Journals/ e-resources/ Learning Management Systems (LMS):			
1. Campbell, J. B., & Wynne, R. H. (2011). <i>Introduction to remote sensing</i> (5th ed.). Guilford Press.			
2. Jensen, J. R. (2015). <i>Introductory digital image processing: A remote sensing perspective</i> (4th ed.). Pearson.			
3. Lillesand, T. M., Kiefer, R. W., & Chipman, J. W. (2015). <i>Remote sensing and image interpretation</i> (7th ed.). Wiley.			
4. Richards, J. A. (2013). <i>Remote sensing digital image analysis: An introduction</i> (5th ed.). Springer.			
5. Sabins, F. F., Jr. (1997). <i>Remote sensing: Principles and interpretation</i> (3rd ed.). W. H. Freeman.			
6. Lo, C. P., & Yeung, A. K. W. (2007). <i>Concepts and techniques of geographic information systems</i> (2nd ed.). Prentice Hall.			
7. Chang, K.-T. (2018). <i>Introduction to geographic information systems</i> (9th ed.). McGraw-Hill Education.			
8. Longley, P. A., Goodchild, M. F., Maguire, D. J., & Rhind, D. W. (2015). <i>Geographic information science and systems</i> (4th ed.). Wiley.			
9. Jensen, J. R. (2014). <i>Remote sensing of the environment: An earth resource perspective</i> (2nd ed.). Pearson.			
10. ISRO. <i>Indian Remote Sensing Satellite (IRS) programme and Earth observation resources</i> . Indian Space Research Organisation.			
11. USGS. <i>Landsat Missions and EarthExplorer</i> . United States Geological Survey.			
12. NASA Earthdata. <i>Earth observation and remote sensing data resources</i> . NASA.			

13. Copernicus Data Space Ecosystem. *Sentinel satellite data and Earth observation resources*.
14. QGIS Development Team. *QGIS Geographic Information System: User Guide and Training Manual*. Open-source GIS platform.
15. ESRI. *ArcGIS Pro documentation and learning resources*. Geographic information system and spatial analysis resources.

LMS / E-learning: SWAYAM, NPTEL, ISRO-IIRS e-learning resources, NASA Earthdata, USGS EarthExplorer, Copernicus Data Space Ecosystem, QGIS training resources.

Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs) & Program Specific Outcomes (PSOs)

CLOs	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁	PSO ₁	PSO ₂
CLO1	3	2	1	2	—	2	3	3	2	1	1	2	1
CLO2	3	3	2	3	2	3	3	3	2	1	2	2	1
CLO3	3	3	2	3	2	3	3	3	2	2	3	3	2
CLO4	3	3	3	3	3	3	3	3	3	3			

Content Mapping with NEP thrust areas

Field	Hours devoted
Employability	6
Entrepreneurship	3
Skill Enhancement	15
Communication Development	4
Indian Knowledge System	6
Environmental Awareness/SDGs	10
Current Issues and Social Awareness	5
Gender issues	2
Public policies	5
Any Other(Digital & Geospatial Literacy)	4

Part A - Introduction			
Name of Subject	M.Sc. Environmental Sciences		
Semester	III		
Nature of Course	Theory (Lecture + Tutorial)		
Nomenclature of the Course	Environmental Toxicology		
Course Code	26L6.5-EVS-302		
Course Type	Core Course (CC-10)		
Course Level	500-599		
Pre-requisite for the course (if any)	Graduate in Sciences		
Course Learning Outcomes (CLOs ₁) After completing this course, the learner will be able to:	CLO ₁	Explain major toxic chemicals and pollutants in air and water, including pesticides and toxic metals, and their effects on human health and the environment.	
	CLO ₂	Analyze the routes of entry, biotransformation of xenobiotics, and mechanisms and testing approaches associated with environmental carcinogenicity.	
	CLO ₃	Evaluate the environmental and health effects of insecticides, MIC, major, trace and rare earth elements, including their mobility and imbalance in environmental systems.	
	CLO ₄	Assess biogeochemical and epidemiological factors associated with environmental health problems, including goiter, fluorosis, arsenic poisoning and diseases related to human land-use practices.	
	Theory	Practical	Total
Credits	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Duration (in Hours)	3		
Part B- Contents of the Course			
<u>Instructions for Paper- Setter:</u> The paper setter shall prepare 9 questions selecting two questions from each unit with consideration given to the Course Learning Outcomes. Among these, question number 1 will be compulsory, comprising 7 short answer type questions carrying two marks each (total 14 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt five questions: the compulsory question no. 1 and 1 question from the each of the four units.			
Unit	Topics	CLO/s Attempt	Contact Hours
I	Toxic chemicals in the environment - air, water & their effects, Pesticides in water, Biochemical aspects of arsenic, cadmium, lead mercury, carbon monoxide, ozone and PAN pesticide.	CLO1	15
II	Mode of entry of toxic substance, Process of biotransformation of xenobiotics, Carcinogens in air, chemical carcinogenicity, mechanism of	CLO2	15

	carcinogenicity, Environmental carcinogenicity testing.		
III	Insecticides, MIC effects, Concept of major, trace and Rare Earth Element (REE)- possible effects of imbalance of some trace elements and human health, classification of trace elements, Mobility of trace elements.	CLO3	15
IV	Biogeochemical factors in environmental health, Epidemiological issues goiter, fluorosis, arsenic poisoning, Diseases induced by human use of land.	CLO4	15
	Total Contact hours		60
Evaluation Methods			
Internal Assessment: 30 Marks		End Term Examination: 70 Marks	
• Class Participation:	5	Written Examination: 70	
• Seminar/presentation/assignment/quiz/ class test etc.:	10		
• Mid-Term Exam:	15		
Part C-Learning Resources			
Recommended Books/Journals/ e-resources/ Learning Management Systems (LMS):			
1. Calow, P. (Ed.). (1998). <i>Handbook of environmental risk assessment and management</i> . Blackwell Science.			
2. Hayes, A. W. (Ed.). (2014). <i>Principles and methods of toxicology</i> (6th ed.). CRC Press.			
3. Klaassen, C. D. (Ed.). (2019). <i>Casarett & Doull's toxicology: The basic science of poisons</i> (9th ed.). McGraw-Hill.			
4. Hodgson, E. (2010). <i>A textbook of modern toxicology</i> (4th ed.). Wiley.			
5. Manahan, S. E. (2017). <i>Environmental chemistry</i> (10th ed.). CRC Press.			
6. Walker, C. H. (2009). <i>Organic pollutants: An ecotoxicological perspective</i> (2nd ed.). CRC Press.			
7. Newman, M. C. (2015). <i>Fundamentals of ecotoxicology: The science of pollution</i> (4th ed.). CRC Press.			
8. Landis, W. G., & Yu, M.-H. (2004). <i>Introduction to environmental toxicology: Molecular substructures to ecological landscapes</i> (3rd ed.). CRC Press.			
9. Wright, D. A., & Welbourn, P. (2002). <i>Environmental toxicology</i> . Cambridge University Press.			
10. U.S. Environmental Protection Agency. <i>Ecotoxicology and environmental risk assessment resources</i> .			
11. World Health Organization. <i>Chemical safety and environmental health resources</i> .			
12. Central Pollution Control Board. <i>Environmental monitoring and pollution-related resources</i> .			

Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs) & Program Specific Outcomes (PSOs)

CLOs	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁		PSO ₂
CLO ₁	3	2	1	3	1	2	2	3	2	2	1		3
CLO ₂	3	3	2	3	1	3	3	3	2	2	2		3
CLO ₃	3	3	2	3	2	3	3	3	2	2	2	3	3
CLO ₄	3	3	3	3	3	3	2	3	3	3	2	3	3

Content Mapping with NEP thrust areas

Field	Hours devoted
Employability	5
Entrepreneurship	5
Skill Enhancement	12
Communication Development	4
Indian Knowledge System	4
Environmental Awareness/SDGs	12
Current Issues and Social Awareness	7
Gender issues	2
Public policies	5
Any Other (Health & Toxicological Awareness)	4

Part A - Introduction			
Name of Subject	M.Sc. Environmental Sciences		
Semester	III		
Nature of Course	Theory (Lecture + Tutorial)		
Nomenclature of the Course	Environmental Hazards and Disasters Management		
Course Code	26L6.5-EVS-303		
Course Type	DEC-1		
Course Level	500-599		
Pre-requisite for the course (if any)	Graduate in Sciences		
Course Learning Outcomes (CLOs ₁) After completing this course, the learner will be able to:	CLO ₁	Explain the concepts, classification, causes and spatial distribution of environmental hazards, disasters, risk, vulnerability and exposure.	
	CLO ₂	Analyze natural, geological, hydrological and atmospheric hazards, including their causes, consequences and relationship with climatic variability and change.	
	CLO ₃	Evaluate biophysical and technological hazards, including epidemics, wildfires, industrial disasters and hazard modelling approaches.	
	CLO ₄	Apply risk assessment, vulnerability analysis, preparedness, adaptation, land-use planning and disaster-management policies for reducing environmental disaster impacts.	
	Theory	Practical	Total
Credits	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Duration (in Hours)	3		
Part B- Contents of the Course			
<u>Instructions for Paper- Setter:</u> The paper setter shall prepare 9 questions selecting two questions from each unit with consideration given to the Course Learning Outcomes. Among these, question number 1 will be compulsory, comprising 7 short answer type questions carrying two marks each (total 14 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt five questions: the compulsory question no. 1 and 1 question from the each of the four units.			
Unit	Topics	CLO/s Attempt	Contact Hours
I	Concept of hazard, disaster, risk, vulnerability, exposure, and response. The distinction between natural hazards and anthropogenic environmental disturbances, Hybrid hazards Environmental Hazards: Classification, Causes, and Distribution.	CLO1	15
II	Natural Hazards & Geological Hazards: Mass movement, Earthquakes, Volcanoes, Tsunamis, Floods, Droughts and famines- Causes, consequences.Hydrological Hazards: Cyclones, Hurricanes.Atmospheric/Climatic Hazards: Extreme	CLO2	15

	weather events, Global Climatic change.		
III	Man-made Hazards: Biophysical Hazard epidemics, wildfires. Technological Hazards: Nature and significance. Lessons from Bhopal and Chernobyl disasters. Modeling of Hazards: Hill slopes and landslides.	CLO3	15
IV	Disasters and Hazard Management: Human and ecological impacts; Risk assessment and vulnerability analysis; National preparedness and adaptation strategies; Hazards policies and agencies; Land use classification.	CLO4	15
	Total Contact hours		60
Evaluation Methods			
Internal Assessment: 30 Marks		End Term Examination: 70 Marks	
• Class Participation:	5	Written Examination: 70	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		
Part C-Learning Resources			
Recommended Books/Journals/ e-resources/ Learning Management Systems (LMS):			
1. Bell. F.G, E & FN Spon, (2003) Geological Hazards: Their Assessment, Avoidance, and Mitigation, Taylor & Francis.			
2. Burton. I, Kates. R.W and White. G.F, (1993) Environment as Hazard Guilford Press.			
3. Casale. R and Margottini. C. (Ed.), Springer, (2004) Natural Disasters and Sustainable Development			
4. Henry J.G. and Heinke, G.W. (2004) Environmental Science and Engineering, Pearson Education, Delhi, India.			
5. Hewitt.K., (1997) Regions of risk, Longman Press.32			
6. Keller. Edward A, (1996) Introduction to Environmental Geology, Prentice-Hall, Upper Saddle River, New Jersey.			
7. Smith Keith, (2001) Environmental Hazards: Assessing Risk and Reducing Disaster, Routledge.			

Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs) & Program Specific Outcomes (PSOs)

CLOs	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁	PSO ₁	PSO ₂
CLO ₁	3	2	2	3	1	2	2	3	2	2	1	2	2
CLO ₂	3	3	2	3	2	3	2	3	3	2	2		2
CLO ₃	3	3	2	3	2	3	3	3	2	3	2		3
CLO ₄	3	3	3	3	3	3	3	3	3	3	3		2

Content Mapping with NEP thrust areas

Field	Hours devoted
Employability	5
Entrepreneurship	2
Skill Enhancement	12
Communication Development	4

Indian Knowledge System	4
Environmental Awareness/SDGs	10
Current Issues and Social Awareness	7
Gender issues	2
Public policies	5
Any Other(Disaster Risk Reduction & Resilience)	9

Part A - Introduction			
Name of Subject	M.Sc. Environmental Sciences		
Semester	III		
Nature of Course	Theory (Lecture + Tutorial)		
Nomenclature of the Course	Environmental Resources Economics		
Course Code	26L6.5-EVS-304		
Course Type	DEC-2		
Course Level	500-599		
Pre-requisite for the course (if any)	Graduate in Sciences		
Course Learning Outcomes (CLOs ₁) After completing this course, the learner will be able to:	CLO ₁	Explain the concepts, scope and evolution of environmental economics and its relationship with natural resources, environmental quality and economic growth.	
	CLO ₂	Analyze environmental valuation, social costs and benefits, collective-choice problems, common-pool resources and ecological-economic approaches to resource management.	
	CLO ₃	Apply environmental accounting, market analysis and cost-benefit approaches to evaluate environmental projects, resource-use decisions and stakeholder benefits.	
	CLO ₄	Evaluate the economic value of ecosystem services and formulate sustainable approaches for natural-resource management considering national and international environmental institutions.	
	Theory	Practical	Total
Credits	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Duration (in Hours)	3		
Part B- Contents of the Course			
<u>Instructions for Paper- Setter:</u> The paper setter shall prepare 9 questions selecting two questions from each unit with consideration given to the Course Learning Outcomes. Among these, question number 1 will be compulsory, comprising 7 short answer type questions carrying two marks each (total 14 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt five questions: the compulsory question no. 1 and 1 question from the each of the four units.			
Unit	Topics	CLO/s Attempt	Contact Hours
I	Definition and scope of environmental economics. Concept of economic value, the relevance of environmental economics, relationship with natural resources, environment, and economic growth. The Evolution and growth of environmental economics.	CLO1	15
II	Basic concept and theories, Collective Choices and applications: Social benefits, costs, and welfare function. Concept of CPR, open access. Hardin’s Thesis of ‘The Tragedy of Common’. Environmental valuation, valuation of non-market benefits, ecological economics-methodology.	CLO2	15

III	Environmental Accounting: Genesis of environmental accounting. Market, demand, supply, and prices. Cost/benefit analysis, methods of costing, cost criteria, evaluating alternative projects, operational vs. total costs, determining benefiting vs. comprehensive stakeholders.	CLO3	15
IV	Ecosystems services –Direct and indirect economic benefit from – forest ecosystems, mountain ecosystems, mineral and water resources, ecotourism Role of national and international organizations in the promotion of sustainable natural resource use and management.	CLO4	15
	Total Contact hours		60
Evaluation Methods			
Internal Assessment: 30 Marks		End Term Examination: 70 Marks	
• Class Participation:	5	Written Examination: 70	
• Seminar/presentation/assignment/quiz/ class test etc.:	10		
• Mid-Term Exam:	15		
Part C-Learning Resources			
Recommended Books/Journals/ e-resources/ Learning Management Systems (LMS):			
1. Field, B. C., & Field, M. K. (2017). <i>Environmental economics: An introduction</i> (7th ed.). McGraw-Hill Education.			
2. Harris, J. M., & Roach, B. (2018). <i>Environmental and natural resource economics: A contemporary approach</i> (4th ed.). Routledge.			
3. Singh, K., & Shishodia, A. (2007). <i>Environmental economics: Theory and applications</i> . Sage Publications.			
4. Perman, R., Ma, Y., Common, M., Maddison, D., & McGilvray, J. (2011). <i>Natural resource and environmental economics</i> (4th ed.). Pearson.			
5. Hanley, N., Shogren, J. F., & White, B. (2019). <i>Environmental economics in theory and practice</i> (2nd ed.). Palgrave Macmillan.			
6. Tietenberg, T., & Lewis, L. (2018). <i>Environmental and natural resource economics</i> (11th ed.). Routledge.			
7. Heal, G. (2000). <i>Nature and the marketplace: Capturing the value of ecosystem services</i> . Island Press.			
8. Barbier, E. B. (2011). <i>Capitalizing on nature: Ecosystems as natural assets</i> . Cambridge University Press.			
9. Costanza, R., et al. (1997). The value of the world's ecosystem services and natural capital. <i>Nature</i> , 387, 253–260.			
E-resources/LMS:			
SWAYAM, NPTEL, UNEP, World Bank Environmental Economics resources, OECD Environment resources and UN SDG resources.			

Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs) & Program Specific Outcomes (PSOs)

CLOs	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁		PSO ₂
CLO ₁	3	2	2	3	1	1	1	3	2	2	1	3	1
CLO ₂	3	3	2	3	2	2	2	3	2	3	2		2
CLO ₃	3	3	2	3	2	3	3	3	2	3	3		2
CLO ₄	3	3	3	3	3	2	2	3	3	3	3		2

Content Mapping with NEP thrust areas

Field	Hours devoted
Employability	5
Entrepreneurship	3
Skill Enhancement	12
Communication Development	4
Indian Knowledge System	5
Environmental Awareness/SDGs	10
Current Issues and Social Awareness	6
Gender issues	2
Public policies	6
Any Other(Sustainable Resource Economics & Valuation)	7

Part A - Introduction			
Name of Subject	M.Sc. Environmental Sciences		
Semester	III		
Nature of Course	Theory (Lecture + Tutorial)		
Nomenclature of the Course	Bioinformatics		
Course Code	26L6.5-EVS-305		
Course Type	DEC-2		
Course Level	500-599		
Pre-requisite for the course (if any)	Graduate in Sciences		
Course Learning Outcomes (CLOs ₁) After completing this course, the learner will be able to:	CLO ₁	Explain computer architecture, programming concepts, algorithms, databases and networking fundamentals relevant to bioinformatics.	
	CLO ₂	Apply PERL programming concepts, including variables, arrays, operators, input/output, regular expressions, pattern matching and subroutines, to basic bioinformatics applications.	
	CLO ₃	Analyze biological sequence databases and apply sequence-comparison methods, scoring matrices and computational approaches for protein and nucleic-acid sequence analysis.	
	CLO ₄	Apply database-searching, sequence-alignment, phylogenetic, pattern-recognition, profile-HMM and homology-modelling approaches for computational analysis of biological sequences.	
	Theory	Practical	Total
Credits	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Duration (in Hours)	3		
Part B- Contents of the Course			
<u>Instructions for Paper- Setter:</u> The paper setter shall prepare 9 questions selecting two questions from each unit with consideration given to the Course Learning Outcomes. Among these, question number 1 will be compulsory, comprising 7 short answer type questions carrying two marks each (total 14 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt five questions: the compulsory question no. 1 and 1 question from the each of the four units.			
Unit	Topics	CLO/s Attempt	Contact Hours
I	Computers: An overview of computers, architecture; generations, Concept of programming, Algorithms; Languages and packages: Introduction to MS Office, MS Access, introduction to JAVA, C, and SQL (structured query language). Introduction to Database; Introduction to computer networking; topology; networking protocol (FTP; TCP/IP), Colour, Sound and Graphics	CLO1	15
II	Introduction to PERL: Scalar variables, strings and numbers, Assignment statements, Arrays, Hashes, Operators, Input/output, Standard Input, Conditional and logical operators, Input from file named in	CLO2	15

	command line, loops, Regular expression, Pattern matching, Subroutines. Applications of PERL in Bioinformatics		
III	Biological Sequence Databases: Overview of various primary and secondary databases that deal with protein and nucleic acid sequences. Databases to be covered in detail are GeneBank, EMBL, DDBJ, Swiss Prot, PIR, and MIPS for primary sequences. Databases like TIGR, Hovergen, TAIR, PlasmoDB. Preliminary ideas of query and analysis of sequence information. Sequence Comparison Methods: Method for the comparison of two sequences viz., Dot matrix plots, NeedlemanWusch&SmithWaterman algorithms. Analysis of computational complexities, relative merits and demerits of each method. Theory of scoring matrices and their use for sequence comparison.	CLO3	15
IV	Database Search Algorithms: Methods for searching sequence databases like FASTA and BLAST algorithms. Statistical analysis and evaluation of BLAST results. CLUSTAL-W and Phylogenetic analysis. Secondary and tertiary structure prediction tools. The use of pattern databases like PROSITE and PRINTS. Concept of position specific weight matrices and their use in sequence analysis. Theory of profiles and their use with special reference to PSIBLAST. Concept of HMMS, the Forward backward and the Viterbi algorithm. Use of profile HMM for protein family classification. Homology modeling.	CLO4	15
	Total Contact hours		60
Evaluation Methods			
Internal Assessment: 30 Marks		End Term Examination: 70 Marks	
•Class Participation:	5	Written Examination: 70	
•Seminar/presentation/assignment/quiz/class test etc.:	10		
•Mid-Term Exam:	15		
Part C-Learning Resources			
Recommended Books/Journals/ e-resources/ Learning Management Systems (LMS):			
1. Mount, D. W. (2004). <i>Bioinformatics: Sequence and genome analysis</i> (2nd ed.). Cold Spring Harbor Laboratory Press.			
2. Lesk, A. M. (2019). <i>Introduction to bioinformatics</i> (5th ed.). Oxford University Press.			
3. Baxevanis, A. D., & Ouellette, B. F. F. (Eds.). (2005). <i>Bioinformatics: A practical guide to the analysis of genes and proteins</i> (3rd ed.). Wiley.			
4. Durbin, R., Eddy, S. R., Krogh, A., & Mitchison, G. (1998). <i>Biological sequence analysis: Probabilistic models of proteins and nucleic acids</i> . Cambridge University Press.			
5. Pevsner, J. (2015). <i>Bioinformatics and functional genomics</i> (3rd ed.). Wiley-Blackwell.			
6. Gibas, C., & Jambeck, P. (2001). <i>Developing bioinformatics computer skills</i> . O'Reilly.			
7. Claverie, J.-M., & Notredame, C. (2007). <i>Bioinformatics for dummies</i> (2nd ed.). Wiley.			

8. Attwood, T. K., & Parry-Smith, D. J. (2001). *Introduction to bioinformatics*. Pearson Education.
9. National Center for Biotechnology Information (NCBI). *GenBank, BLAST and sequence-analysis resources*.
10. European Bioinformatics Institute (EMBL-EBI). *Bioinformatics databases and analysis tools*.
11. UniProt Consortium. *UniProt protein sequence and functional information resources*.
12. SWISS-MODEL. *Protein structure homology-modelling resources*.
13. Protein Information Resource (PIR). *Protein sequence and annotation resources*.

LMS/E-learning:

SWAYAM, NPTEL and EMBL-EBI training resources.

Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs) & Program Specific Outcomes (PSOs)

CLOs	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁	PSO ₁	PSO ₂
CLO ₁	3	2	1	2	2	2	2	3	1	2	1	3	1
CLO ₂	3	2	2	3	2	2	3	3	1	2	2	2	1
CLO ₃	3	3	2	3	2	3	3	3	2	3	2	3	2
CLO ₄	3	3	3	3	3	3	3	3	3	3	3	3	2

Content Mapping with NEP thrust areas

Field	Hours devoted
Employability	8
Entrepreneurship	3
Skill Enhancement	18
Communication Development	4
Indian Knowledge System	3
Environmental Awareness/SDGs	5
Current Issues and Social Awareness	5
Gender issues	2
Public policies	3
Any Other	9

Part A – Introduction			
Name of the Programme	M.Sc. Environmental Sciences		
Semester	III		
Nature of Course/Course Composition	Practical		
Nomenclature of the Course	Practicum–V(301&302)		
Course Code	26L6.5-EVS-307		
Course Type	PP-V (Practicum-V)		
Course Level	500–599		
Pre-requisite for the course (if any)	Basic knowledge of environmental science and Laboratory analytical techniques.		
Course Learning Outcomes (CLOs) After completing this course, the learner will be able to:	CLO ₁	Apply fundamental principles of remote sensing and aerial photo interpretation to interpret aerial photographs and satellite imagery, understand map scale, measure distances, and perform stereoscopic interpretation using appropriate techniques and tools.	
	CLO ₂	Develop and analyses raster and vector spatial data using GIS software, including data creation and management, geo-referencing, map preparation, layer visualization, basic spatial analysis, styling, and attribute-data handling.	
	CLO ₃	Apply fundamental concepts of environmental toxicology to assess the toxic impacts of industrial activities on water and soil, compare contaminated and drinking-water quality, and determine/interpret the LD ₅₀ of selected chemicals.	
	CLO ₄	Perform and interpret basic environmental chemical analyses of water and soil using spectrophotometric and flame-photometric techniques for determination of fluoride, nitrate, phosphate, major cations, and cation exchange capacity of soil.	
	Theory	Practical	Total
Credits	0	4	4
Teaching hours per week	0	8	8
Internal Assessment Marks	0	30	30
End Term Exam Marks	0	70	70
Max. Marks	0	100	100
Examination Duration (in Hours)	0	03	
Part B- Contents of the Course			
Instructions for Examiner: Write-up and execution of the practical will be conducted as per the nature of the practical by the external examiner, with consideration given to the Course Learning Outcomes.			
Unit	Topics	CLO/s Attempt	Contact Hours
Unit-I	- Visual interpretation of aerial photographs and satellite images. - Understanding map scale and measurement of distance on maps and images. - Aerial photograph stereo interpretation using a pocket stereoscope. - Observation and interpretation of satellite imagery using Zoom Earth.	CLO1	30

Unit-II	○ Displaying and exploring raster and vector layers using GIS software. ○ Creating and managing vector data using GIS software. ○ Preparation of a map of a particular area using GIS software. ○ Geo-referencing of aerial imagery using the image-to-image method. ○ Basic vector and raster styling and analysis using GIS software. ○ Working with attribute data using GIS software.	CLO2	30
Unit-III	○ Assessment of the toxic impact of industrial activities on water and soil quality, with reference to textile/automobile industries. ○ Comparative assessment of drinking water and toxic/industrial-contaminated water quality. ○ Calculation/estimation of LD₅₀ of selected chemicals and interpretation of their toxicity.	CLO3	30
Unit-IV	○ Determination of fluoride concentration in water samples by the spectrophotometric method. ○ Estimation of nitrate concentration in water samples by the spectrophotometric method. ○ Estimation of phosphate concentration in water samples by the spectrophotometric method. ○ Determination of Na, K, Ca and Mg in water/soil samples using a flame photometer. ○ Determination of cation exchange capacity (CEC) of soil.	CLO4	30

Note: Addition and deletion in the list of experiments may be made from time to time by the department depending on the availability of resources

Total Contact Hours	120
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Evaluation Methods

Internal Assessment:30	MM-30	End Term Examination: 70	MM- 70
Class Participation:	5	Lab record	10
Seminar/Demonstration/Viva-voce/Lab records etc.:	10	Viva-Voce	20
Mid-Term Exam:	15	Write-up and execution of the practical	40

Part C-Learning Resources

Recommended Books/Journals/ e-resources/ Learning Management Systems (LMS):

Instructions

- Kaushik, A. & Kaushik, C.P. **Perspectives in Environmental Studies**. New Age International.
- Joseph, G. & Jeganathan, C. **Fundamentals of Remote Sensing**. Universities Press.
- Lillesand, T.M., Kiefer, R.W. & Chipman, J.W. **Remote Sensing and Image Interpretation**. Wiley.
- Chang, K.-T. **Introduction to Geographic Information Systems**. McGraw-Hill.
- De, A.K. **Environmental Chemistry**. New Age International.
- Manahan, S.E. **Environmental Chemistry**. CRC Press.
- □ Hodgson, E. **A Textbook of Modern Toxicology**. Wiley.

Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs) & Program Specific Outcomes (PSOs)

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PSO1	PSO2
CLO1	3	2	3	3	2	1	2	1	1	1	2	3	2
CLO2	3	3	3	3	3	2	2	1	2	2	2	3	3
CLO3	3	3	3	3	2	3	3	2	2	2	3	3	3
CLO4	3	3	3	3	3	3	3	2	2	2	3	3	3

Content Mapping with NEP thrust areas

Field	Hours Devoted
Employability	20
Entrepreneurship	8
Skill Enhancement	40
Communication Development	5
Indian Knowledge System	3
Environmental Awareness/SDGs	18
Current Issues and Social Awareness	10
Gender Issues	2
Public Policies	6
Any Other	8

Part A – Introduction			
Name of the Programme	M.Sc. Environmental Sciences		
Semester	III		
Nature of Course/Course Composition	Practical		
Nomenclature of the Course	Practicum–VI(303&304/305/306)		
Course Code	26L6.5-EVS-308		
Course Type	PP-VI (Practicum-VI)		
Course Level	500–599		
Pre-requisite for the course (if any)	Basic knowledge of environmental science and Laboratory analytical techniques.		
Course Learning Outcomes (CLOs) After completing this course, the learner will be able to:	CLO ₁	Apply practical techniques to identify, assess and spatially represent natural, renewable and non-renewable energy resources, determine calorific value and interpret hazard zonation maps.	
	CLO ₂	Identify major geological and biological resources, analyse resource-economic case studies and apply appropriate approaches for forest carbon assessment and sustainable resource management.	
	CLO ₃	Apply bioinformatics tools and databases to retrieve and analyse nucleotide and protein sequences, perform sequence similarity searches, predict protein structures, conduct multiple sequence alignment and construct phylogenetic relationships.	
	CLO ₄	Apply computational and programming approaches in molecular biology for primer design and genomic, transcriptomic and proteomic analysis, including basic PERL programming for DNA/RNA sequence manipulation and phylogenetic analysis.	
	Theory	Practical	Total
Credits	0	4	4
Teaching hours per week	0	8	8
Internal Assessment Marks	0	30	30
End Term Exam Marks	0	70	70
Max. Marks	0	100	100
Examination Duration (in Hours)	0	03	
Part B- Contents of the Course			
<u>Instructions for Examiner:</u> Write-up and execution of the practical will be conducted as per the nature of the practical by the external examiner, with consideration given to the Course Learning Outcomes.			
Unit	Topics	CLO/s Attempt	Contact Hours
Unit-I	- Determination of calorific value of the given plant material. Locating and interpreting hazard zonation maps. - Locating major renewable energy resources on the map of India. - Locating major non-renewable energy resources on the map of India. - Identifying and locating major renewable and non-renewable resources on the world map.	CLO1	30
Unit-II	Identification of igneous, sedimentary and metamorphic rocks and their characteristic features.	CLO2	30

	○ Case studies related to resource economics: • Payment for ecosystem services • Mineral mining • Sustainable fisheries • Forest certification ○ Assessment of forest carbon, including above-ground and below-ground carbon.		
Unit-III	○ Retrieval of nucleotide sequences from the NCBI database. ○ Retrieval of protein sequences from protein databases. Sequence similarity analysis using BLAST/pBLAST/nrBLAST. ○ Prediction of protein secondary structures. ○ Multiple sequence alignment using ClustalW. Phylogenetic analysis.	CLO3	30
Unit-IV	○ Primer design using computational tools. ○ Computational modelling and analysis of genomic, transcriptomic and proteomic data. ○ Application of PERL programming for: - Storing DNA sequences - DNA-to-RNA transcription - Counting nucleotides - Phylogenetic tree construction	CLO4	30

Note: Addition and deletion in the list of experiments may be made from time to time by the department depending on the availability of resources

Total Contact Hours			120
Evaluation Methods			
Internal Assessment:30	MM-30	End Term Examination: 70	MM- 70
Class Participation:	5	Lab record	10
Seminar/Demonstration/Viva-voce/Lab records etc.:	10	Viva-Voce	20
Mid-Term Exam:	15	Write-up and execution of the practical	40

Part C-Learning Resources

Recommended Books/Journals/ e-resources/ Learning Management Systems (LMS):

Instructions

- Odum, E.P. & Barrett, G.W. **Fundamentals of Ecology**. Cengage Learning.
- Cunningham, W.P. & Cunningham, M.A. **Principles of Environmental Science**. McGraw-Hill.
- Smith, T.M. & Smith, R.L. **Elements of Ecology**. Pearson.
- Mount, D.W. **Bioinformatics: Sequence and Genome Analysis**. Cold Spring Harbor Laboratory Press.
- Baxevanis, A.D. & Ouellette, B.F.F. **Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins**. Wiley.
- Lesk, A.M. **Introduction to Bioinformatics**. Oxford University Press.
- Pevsner, J. **Bioinformatics and Functional Genomics**. Wiley-Blackwell.
- Durbin, R. et al. **Biological Sequence Analysis**. Cambridge University Press.

**Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs)
& Program Specific Outcomes (PSOs)**

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PSO1	PSO2
CLO1	3	3	3	3	2	2	3	2	2	1	3	3	2
CLO2	3	3	3	3	2	3	3	2	2	2	3	3	3
CLO3	3	3	3	3	3	2	2	2	3	3	2	2	3
CLO4	3	3	3	3	3	3	2	2	3	3	2	2	3

Content Mapping with NEP thrust areas

Field	Hours Devoted
Employability	20
Entrepreneurship	10
Skill Enhancement	40
Communication Development	5
Indian Knowledge System	3
Environmental Awareness/SDGs	18
Current Issues and Social Awareness	8
Gender Issues	2
Public Policies	6
Any Other	8

OEC			
Part A - Introduction			
Name of Programme	M.Sc. Environmental Sciences		
Semester	III		
Nature of Course/Course Composition	Theory (Lecture + Tutorial)		
Nomenclature of the Course	Hydrology and Water Resources		
Course Code	26L6.5-EVS-309		
Course Type	OEC		
Course Level	500–599		
Pre-requisite for the course (if any)	NA		
Course Learning Outcomes (CLOs) After completing this course, the learner will be able to:	CLO ₁	Develop understanding about different components of the hydrological cycle and Enable the students to estimate runoff, infiltration, evaporation, ground water flow.	
	CLO ₂	Understand the concept of Darcy's Law, geological formation of aquifers and Students will be able to learn various environmental influences on water resources and water resource conservation and management practices.	
	Theory	Practical	Total
Credits	2	0	2
Teaching Hours per week	2	0	2
Internal Assessment Marks	15	0	15
End Term Exam Marks	35	0	35
Max. Marks	50	0	50
Examination Duration (in Hours)	02	0	
Part B- Contents of the Course			
<u>Instructions for Paper- Setter:</u>			
The paper setter shall prepare 5 questions selecting two questions from each of the two units with consideration given to the Course Learning Outcomes. Among these, question number 1 will be compulsory question comprising 07 short answer type questions carrying one mark each (total 07 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt three questions: the compulsory question no. 1 and 1 question from the each of the two units.			
Unit	Topics	CLO Attempt	Contact Hours
I	Introduction: The hydrologic cycle; Structure and properties of water, Inventory of Earth's water, quality and quantity. Limits of cations and anions in portable water including fluoride and arsenic, phosphate, nitrate and heavy metals. Hydrogeology of India. Surface water resources: precipitation, infiltration, water balance, Evapo-transpiration and runoff. Groundwater resources: rock properties affecting ground water, vertical distribution of ground water, zone of saturation. Darcy's law: permeability, transmissivity and storage coefficient. Geologic formations as aquifers, type of aquifers.	CLO1	15
II	Environmental Influences on water resources: surface and groundwater resources of arid and semiarid regions, Snowmelt	CLO2	15

hydrology from glaciers, fluctuations due to urbanization, Evapotranspiration and tides. Recent development in surface and groundwater resources monitoring and assessing processes. Water logging and soil salinity.			
Water resource management: Flood and flood plain management; Water-shed management, water harvesting and artificial recharge to ground water; water pollution and water treatment. Environmental issues: River linking debate. Dams and their impacts.			
Total Contact hours			30
Evaluation Methods			
Internal Assessment: 15 Marks		End Term Examination: 35 Marks	
• Class Participation:	5	Written Examination: 35	
• Seminar/presentation/assignment/quiz/ class test etc.:	5		
• Mid-Term Exam:	5		
Part C-Learning Resources			
Recommended Books/Journals/ e-resources/ Learning Management Systems (LMS):			
1. Andrew D. Ward and Stanley Trimble, 2004, 2 nd Ed., Environmental Hydrology, Lewis Publishers.			
2. Karanth, K.R.C., 1988, Ground Water: Exploration, Assessment and Development. Tata-McgrawHill, New Delhi.			
3. Mahajan, G., 1989, Evaluation and Development of Groundwater. Ashish Publishing House, NewDelhi.			
4. Rao, K.L., 1982, India’s water wealth. Orient Longman, Delhi.			
5. Subramaniam V., 2002, Text Book of Environmental Science, Narosa Publishing House, Delhi.			
6. Timothy, Davie, 2003, Fundamentals of Hydrology. Rowledge, Taylor and Francis Group,U.K.			
7. Todd, D.K., 2004, Groundwater Hydrology, John Wiley & Sons Inc.			
8 Vijay P. Singh, 1995, Environmental Hydrology. Kluwer Academic Publications, The Netherlands.			
9 Wright. R.T and Nebel. B.J., 2002, Environmental Science: toward a sustainable future, Prentice Hall India Ltd, 8th Edition			

Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs) & Program Specific Outcomes (PSOs)

CLOs	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁		PSO ₂
CLO ₁	3	2	1	3	1	2	2	3	1	-	1		2
CLO ₂	3	2	2	3	2	2	2	3	2	2	3	3	3

Content Mapping with NEP thrust areas

Field	Hours devoted
Employability	5
Entrepreneurship	2
Skill Enhancement	6

Communication Development	2
Indian Knowledge System	1
Environmental Awareness/SDGs	5
Current Issues and Social Awareness	3
Gender issues	0
Public policies	3
Any Other	3

Part A – Introduction			
Programme	M. Sc. Environmental Sciences		
Semester	IV		
Nature of Course	Theory (Lecture + Tutorial)		
Nomenclature of the Course	Environmental Impact Assessment		
Course Code	24L6.5-EVS-401		
Course Type	CC-11		
Course Level	500-599		
Pre-requisite for the course (if any)	Graduation in Sciences		
Course Learning Outcomes (CLOs ₁) After completing this course, the learner will be able to:	CLO ₁	Explain the principles, objectives, development and regulatory framework of EIA.	
	CLO ₂	Apply EIA methodologies, environmental monitoring, GIS and impact assessment techniques.	
	CLO ₃	Explain EMS, ISO 14000 and LCA for sustainable environmental management.	
	CLO ₄	Analyse public participation, SIA, SEA and environmental risks using standard assessment approaches.	
	Theory	Practical	Total
Credits	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Duration (in Hours)	3		
Part B- Contents of the Course			
<u>Instructions for Paper- Setter:</u> The paper setter shall prepare 9 questions selecting two questions from each unit with consideration given to the Course Learning Outcomes. Among these, question number 1 will be compulsory, comprising 7 short answer type questions carrying two marks each (total 14 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt five questions: the compulsory question no. 1 and 1 question from the each of the four units.			
Unit	Topics	CLO/s Attempt	Contact Hours
I	Introduction to environmental impact analysis, Objectives, and development of EIA. Benefits of EIA, Indian directions of EIA. Rapid and comprehensive EIA. EIA guidelines and amendments.	1	15
II	EIA Methodology & monitoring: Outline of EIA process, Screening, Scoping, Purpose of scoping, impact implications, Protocol for Baseline studies, and monitoring using standard matrices of air, soil, and water; checklist, matrices, Overlays and Geographical Information System (Sampling &	2	15

	analysis), Impact analysis and Predictions, Environmental Impact Statement [EIS]; Public hearing as part of EIA; EIA report.		
III	Environmental Management and ISO Certification: Environmental Management Systems (EMS), ISO 14000 (EMS).Components of Environmental Management System- Objectives, Policies, Implementation and Review. Life Cycle Analysis – LCA	3	15
IV	Public Participation, Social impact assessment, and monitoring. Strategic Environmental Assessment and monitoring (SEA),Risk analysis – definition of risk, Environmental risk monitoring and analysis-hazard identification, dose-response assessment, exposure assessment, and monitoring, Risk characterization.	4	15
	Total Contact hours		60
Evaluation Methods			
Internal Assessment: 30 Marks		End Term Examination: 70 Marks	
• Class Participation:	5	Written Examination: 70	
• Seminar/presentation/assignment/quiz/ class test etc.:	10		
• Mid-Term Exam:	15		
Part C-Learning Resources			
1. Aggarwal S.K (1996), Industrial Environment – Assessment and strategy APH Pub. Corp.			
2. Anjaneyulu, Y. and Manickam, V. (2002), Environmental Impact Assessment Methodologies. B.S.			
3. Publications.			
4. Boland, R.G.A. (1993), Environmental Management Training. Sterling Publishers Pvt. Ltd. New Delhi.			
5. Canter, L. (1996), Environmental Impact Assessment.2 nd Edition. McGraw-hill Book Company, New York.			
6. Cutter, S. L. (1999), Environmental Risks and Hazards, Prentice Hall of India, New Delhi.			
7. Glasson, J. (2011), Introduction to Environmental Impact Assessment, 4 edition Routledge.			
8. Kulkarni, V. and Ramachandra, T. V. (2006), Environmental Management, Capitol Pub. Co., New Delhi.			
9. Manahan, S.E. (2000), Environmental Chemistry. Seventh Edition. Lewis Publishers, New York.			
10. Morris, P. and Therivel R. (2001), Methods of Environmental Impact Assessment., 2 nd Edition, Spon Press London.			

Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs) & Program Specific Outcomes (PSOs)

CLOs	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO10	PLO11	PSO 1	PSO 2
CLO1	3	2	–	–	2	–	3	3	2	1	2	3	2
CLO2	2	3	3	3	3	3	2	3	3	2	3	3	3
CLO3	3	2	1	2	3	2	3	3	2	2	3	3	3
CLO4	3	3	2	3	3	2	3	3	3	3	3	3	3

Content Mapping with NEP thrust areas

Field	Hours devoted
Employability	15
Entrepreneurship	8
Skill Enhancement	20
Communication Development	10
Indian Knowledge System	5
Environmental Awareness/SDGs	15
Current Issues and Social Awareness	12
Gender issues	4
Public policies	10
Any Other	-

Part A – Introduction			
Programme	M. Sc. Environmental Sciences		
Semester	IV		
Nature of Course	Theory (Lecture + Tutorial)		
Nomenclature of the Course	Environmental Laws, Policies & Ethics		
Course Code	24L6.5-EVS-402		
Course Type	CC-12		
Course Level	500-599		
Pre-requisite for the course (if any)	Graduation in Sciences		
Course Learning Outcomes (CLOs ₁) After completing this course, the learner will be able to:	CLO ₁	Explain major environmental policies, international agreements and environmental legislation.	
	CLO ₂	Apply environmental laws, regulations and policy provisions to contemporary environmental issues.	
	CLO ₃	Explain environmental ethics, philosophies, rights and responsibilities towards nature.	
	CLO ₄	Analyse environmental ethics in cultural, social, business and governance contexts.	
	Theory	Practical	Total
Credits	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Duration (in Hours)	3		
Part B- Contents of the Course			
<u>Instructions for Paper- Setter:</u> The paper setter shall prepare 9 questions selecting two questions from each unit with consideration given to the Course Learning Outcomes. Among these, question number 1 will be compulsory, comprising 7 short answer type questions carrying two marks each (total 14 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt five questions: the compulsory question no. 1 and 1 question from the each of the four units.			
Unit	Topics	CLO/s Attempt	Contact Hours
I	Nature of Environmental Policies; Stockholm Conference (1972); Rio Conference (UNCED) (1992); Merits of the Conference (Agenda 21); Need of international agreements and treaties; Johannesburg treaty; GAAT and Environment; CITES. Basel Convention. Environmental policy resolution, legislation, public policy strategies in pollution control. Public liability Insurance Act.1991. Provision of the constitution of India regarding the environment (articles 48 A & 51A). Scheme of labeling of environmentally friendly products (Ecomark).	1	15
II	Wildlife Protection act, 1972 amended 2002. Forest conservation act, 1980. Indian forest act 1927, Motor vehicle act, 1988, The environment (protection) Act, 1986, rules 1986. Concept and need of public interest litigation; Jurisdiction of the National Green Tribunal; Need of CRZ rules for regulating the activities in the coastal zone. Rules regarding solid waste, hazardous	2	15

	material, e-waste, fly ash, Biomedical waste, and Plastic waste.		
III	An Introduction to Environmental Ethics and Philosophy: Ethics in society, Environmental Consequences, Responsibility for Environmental Degradation. Eco Centric Theories of Nature: Deep ecology and animal rights theories, environmental rights, environmental racism.	3	15
IV	Cross-cultural views on Nature: The relationship between humans, nature, and adaptation. Theoretical frameworks of cultural and social ecology; debates on culture/nature divide. Environment and Business Ethics: Foundations of Environmental Ethics for Business, Corporate Environmental Ethics, Environmental Disclosure, Social and Ethical Issues for Sustainable Development, Business Ethics, and Corporate Environmental Performance. Environmental Ethics and Issues of National and International Governance: changing nature of environmental ethics about international and national paradigms of environmental governance.	4	15
	Total Contact hours		60

Evaluation Methods

Internal Assessment: 30 Marks		End Term Examination: 70 Marks
• Class Participation:	5	Written Examination: 70
• Seminar/presentation/assignment/quiz/class test etc.:	10	
• Mid-Term Exam:	15	

Part C-Learning Resources

- Aggarwal Anil & Narain Sunita, (1991), Global warming in an unequal world: A case of Environmental colonialism, Centre for Science & Environment.
- Anti-Pollution Acts (3) and Commentaries published theorem.
- Constitution of India [Referred articles from Part-III, Part-IV, and Part-IV-A].
- Cooper, D.E. & Palmer. J.A., (Ed.), 1992, The Environment in question: Ethics & Global Issues, London, Routledge.
- Declaration of: The Stockholm Conference, Rio, Rio+5, and Rio+10.
- Des Jardius, J.R., 2001, Environmental Ethics: An invitation to Environmental Philosophy (3 Rd Ed.), Wadsworth Publ., Belmont, California.
- Divan S. and Rosencrantz A. (2002), Environmental law and policy in India: cases, materials, and statutes, Oxford University Press
- Diwaa. P. (2002), Environmental administration & law, 2nd edition, Deep & Deep Publications.
- Grim. John. A., 2001, Indigenous Traditions and Ecology (Ed.), Harvard University Press. Lesourd, J.B., and Schilizzi, S.G. M., 2001, The Environment in Corporate Management: New Directions and Economic Insights, Edward Elgar, UK.
- Holmes, G., Singh B.R., and Theodore, L, Environmental management and technology
- Jain, S. and Jain V., Environmental Laws in India, The Lawyers home, Indore.
- James C., Werksman H., and Roderick P. (2006) Improving compliance with International Environmental Law, Earth Scan London.
- Leela Krishnan, P. (2016), EnvironmentallawinIndia, 4th edition LexisNexis;
- Saxena, K.D. (1993), Environmental planning, policies & programs in India, Shipra Publications.
- Philosophy, Ecology, Economics (3rdEd.), Wadsworth Publishing, California.

**Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs)
& Program Specific Outcomes (PSOs)**

CLOs	PL O1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO1 0	PLO1 1	PSO 1	PSO 2
CLO1	3	2	–	1	2	1	3	3	2	1	2	3	2
CLO2	2	3	2	2	3	2	3	3	2	2	3	3	3
CLO3	3	2	–	1	2	–	2	3	2	2	2	2	2
CLO4	3	3	1	2	3	1	3	3	3	3	3	3	3

Content Mapping with NEP thrust areas

Field	Hours devoted
Employability	12
Entrepreneurship	6
Skill Enhancement	12
Communication Development	8
Indian Knowledge System	6
Environmental Awareness/SDGs	15
Current Issues and Social Awareness	12
Gender issues	4
Public policies	10
Any Other	0

Part A – Introduction			
Programme	M. Sc. Environmental Sciences		
Semester	IV		
Nature of Course	Theory (Lecture + Tutorial)		
Nomenclature of the Course	Environment, Energy and Safety Audit		
Course Code	24L6.5-EVS-403		
Course Type	DEC-3		
Course Level	500-599		
Pre-requisite for the course (if any)	Graduation in Sciences		
Course Learning Outcomes (CLOs ₁) After completing this course, the learner will be able to:	CLO ₁	Explain environmental auditing, EMS, ISO 14001 and environmental performance indicators.	
	CLO ₂	Apply energy auditing, energy management and conservation techniques for efficiency improvement.	
	CLO ₃	Assess industrial safety, occupational hazards and risks using safety audit and HIRA techniques.	
	CLO ₄	Prepare audit reports and corrective action plans considering legal requirements and sustainability.	
	Theory	Practical	Total
Credits	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Duration (in Hours)	3		
Part B- Contents of the Course			
<u>Instructions for Paper- Setter:</u> The paper setter shall prepare 9 questions selecting two questions from each unit with consideration given to the Course Learning Outcomes. Among these, question number 1 will be compulsory, comprising 7 short answer type questions carrying two marks each (total 14 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt five questions: the compulsory question no. 1 and 1 question from the each of the four units.			
Unit	Topics	CLO/s Attempt	Contact Hours
I	Environmental Audit – Concepts and Framework: Environmental audit: definition, objectives, scope, and types; Environmental management systems (EMS); Environmental audit process: planning, pre-audit activities, on-site audit, post-audit activities; Audit protocols and checklists; ISO 14001: principles and implementation; Environmental performance indicators	CLO1	15
II	Energy Audit and Management: Energy resources and energy consumption patterns; Energy audit: definition, need, scope, and classification (preliminary and detailed); Energy balance and energy flow diagrams; Energy conservation measures and efficiency improvement; Energy management systems; Role of Bureau of Energy Efficiency (BEE) and energy policies in India.	CLO2	15

III	Safety Audit and Risk Assessment: Industrial safety: concepts and importance; Safety audit: objectives, scope, and methodology; Occupational health hazards: physical, chemical, biological, and ergonomic; Hazard identification and risk assessment (HIRA); Accident analysis, safety inspections, and emergency preparedness; Personal protective equipment (PPE) and safety management practices.	CLO3	15
IV	Legal Framework, Reporting, and Case Studies: Environmental and safety legislations relevant to audits in India; Factory Act, Environmental Protection Act, and occupational safety regulations; Audit reporting: format, findings, non-compliance, and corrective action plans; Role of audits in sustainable development and corporate social responsibility (CSR); Case studies on environmental, energy, and safety audits in industries	CLO4	15
	Total Contact hours		60
Evaluation Methods			
Internal Assessment: 30 Marks		End Term Examination: 70 Marks	
• Class Participation:	5	Written Examination: 70	
• Seminar/presentation/assignment/quiz/ class test etc.:	10		
• Mid-Term Exam:	15		
Part C-Learning Resources			
1. Canter, L. W. Environmental Impact Assessment. McGraw-Hill. 2. Goel, P. K. Environmental Management and Auditing. New Age International. 3. Worrell, E., & Galitsky, C. Energy Efficiency Improvement and Cost Saving Opportunities. 4. Raghavan, K. V. Safety Engineering and Management. 5. ISO 14001: Environmental Management Systems – Requirements and Guidelines. 6. Bureau of Energy Efficiency (BEE) Manuals and Guidelines.			

Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs) & Program Specific Outcomes (PSOs)

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PSO1	PSO2
CLO1	3	3	2	2	3	3	3	3	2	2	3	3	3
CLO2	3	3	3	3	3	3	2	3	2	2	3	3	3
CLO3	3	3	3	2	3	2	3	2	2	3	3	3	2
CLO4	2	3	2	3	3	2	3	3	3	3	3	3	3

Content Mapping with NEP thrust areas

Field	Hours devoted
Employability	15
Entrepreneurship	8
Skill Enhancement	20
Communication Development	8
Indian Knowledge System	4
Environmental Awareness/SDGs	15
Current Issues and Social Awareness	10
Gender issues	4
Public policies	10

Part A – Introduction			
Programme	M. Sc. Environmental Sciences		
Semester	IV		
Nature of Course	Theory (Lecture + Tutorial)		
Nomenclature of the Course	Nanomaterials for Sustainable Energy		
Course Code	24L6.5-EVS-404		
Course Type	DEC-4		
Course Level	500-599		
Pre-requisite for the course (if any)	Graduation in Sciences		
Course Learning Outcomes (CLOs ₁) After completing this course, the learner will be able to:	CLO ₁	Explain nanotechnology applications in energy conversion and sustainable energy systems.	
	CLO ₂	Apply nanomaterials in energy storage, fuel cells, batteries and energy-efficient technologies.	
	CLO ₃	Explain nanomaterials and devices used in solar energy conversion and clean energy generation.	
	CLO ₄	Analyse nanotechnology-based hydrogen production and storage technologies.	
	Theory	Practical	Total
Credits	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Duration (in Hours)	3		
Part B- Contents of the Course			
<u>Instructions for Paper- Setter:</u>			
The paper setter shall prepare 9 questions selecting two questions from each unit with consideration given to the Course Learning Outcomes. Among these, question number 1 will be compulsory, comprising 7 short answer type questions carrying two marks each (total 14 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt five questions: the compulsory question no. 1 and 1 question from the each of the four units.			
Unit	Topics	CLO/s Attempt	Contact Hours
I	Introduction Nanotechnology for sustainable energy-Energy conversion process, indirect and direct energy conversion-Materials for light emitting diodes, batteries, catalytic reactors, capacitors fuel cells.	CLO1	15
II	Nanomaterials in Energy Storage Nanomaterials for fuel cells, carbon material for energy storage, hydrogen storage in carbon nanotubes, use of nanoscale catalysts to save energy and increase the productivity in industry, Recharge able batteries based on nanomaterials.	CLO2	15
III	Nanomaterials for solarower: Solar energy materials, Solar energy devices, silicon solar technology for clean energy.	CLO3	15
IV	Hydrogen Energy Hydrogen Production Methods: from fossil fuels, electrolysis, thermal decomposition, photochemical, photo catalytic, hybrid; Hydrogen storage methods: metal hydrides, metallic alloy hydrides, carbon nano- tubes etc.	CLO4	15

	Total Contact hours	60
Evaluation Methods		
Internal Assessment: 30 Marks		End Term Examination: 70 Marks
• Class Participation:	5	Written Examination: 70
• Seminar/presentation/assignment/quiz/ class test etc.:	10	
• Mid-Term Exam:	15	
Part C-Learning Resources		
1. Ben G Streetman,Solid’s state electronic device, Prentice Hall of India Pvt Ltd., New Delhi(1995). 2. H J Moller,Semi conductor for solar cells, Artech House Inc,MA,USA,(1993). 3. Hoogers, Fuel cell technology handbook. CRC Press,(2003). 4. J.T widell and T. Weir, Renewable Energy Resources, E & F N Spon Ltd, London,(1986). 5. Linden, Handbook of Batteries and fuel cells, McGraw Hill,(1984). 6. M.A. Kettani, Direct energy conversion, Addison Wesley Reading,(1970). 7. Martin A Green, Solar cells: Operating principles, technology and system applications, Prentice HallInc, Engle wood Cliffs, NJ, USA,(1981). 8. Vielstich, Handbook of fuel cells: Fuel cell technology and applications, Wiley, CRC Press,(2003).		

Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs) & Program Specific Outcomes (PSOs)

CLOs	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO10	PLO11	PSO 1	PSO 2
CLO 1	3	3	2	2	3	3	2	3	1	2	3	3	3
CLO 2	3	3	3	3	3	3	2	3	2	2	3	3	3
CLO 3	3	3	2	3	3	3	2	3	2	2	3	3	3
CLO 4	3	3	3	3	3	3	3	3	2	2	3	3	3

Content Mapping with NEP thrust areas

Field	Hours devoted
Employability	15
Entrepreneurship	8
Skill Enhancement	20
Communication Development	8
Indian Knowledge System	4
Environmental Awareness/SDGs	15
Current Issues and Social Awareness	10
Gender issues	4
Public policies	10

Part A – Introduction			
Programme	M. Sc. Environmental Sciences		
Semester	IV		
Nature of Course	Theory (Lecture + Tutorial)		
Nomenclature of the Course	Environmental Nanotechnology		
Course Code	24L6.5-EVS-405		
Course Type	DEC-4		
Course Level	500-599		
Pre-requisite for the course (if any)	Graduation in Sciences		
Course Learning Outcomes (CLOs ₁) After completing this course, the learner will be able to:	CLO ₁	Explain nanomaterial-based technologies for environmental remediation and water treatment.	
	CLO ₂	Assess the environmental fate, toxicity, exposure and risks of nanomaterials.	
	CLO ₃	Evaluate the environmental and health impacts of nanomaterials through case studies.	
	CLO ₄	Apply analytical techniques for detecting and assessing nanomaterials in the environment.	
	Theory	Practical	Total
Credits	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Duration (in Hours)	3		
Part B- Contents of the Course			
<u>Instructions for Paper- Setter:</u> The paper setter shall prepare 9 questions selecting two questions from each unit with consideration given to the Course Learning Outcomes. Among these, question number 1 will be compulsory, comprising 7 short answer type questions carrying two marks each (total 14 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt five questions: the compulsory question no. 1 and 1 question from the each of the four units.			
Unit	Topics	CLO/s Attempt	Contact Hours
I	Environmental applications of nanomaterials: Mechanism for remediation of aqueous contaminants, photocatalyst; membranes incorporating nanomaterials, transport processes in membrane technology; Nanomaterial- as adsorbents for water and wastewater treatment–adsorption at metal oxide surfaces, hybrid adsorbents.	CLO1	15
II	Impacts of nanomaterials - Exposure and risk assessment, Dose-response, mechanisms of toxicity; eco toxicological impacts of nanomaterials. Relationships between key properties of nanomaterials and their environmental fate, transport, transformation, bio-distribution.	CLO2	15
III	Environment Related Case Studies on Nanomaterials :like use in daily life, Screening of nanomaterials for understanding potential effects to human health and the environment.	CLO3	15
IV	Analytical methodologies for studying impact of	CLO4	15

	nanomaterials in environment – Atomic absorption spectrometry, inductively coupled plasma spectrometry, chromatography, thermal methods.	
	Total Contact hours	60
Evaluation Methods		
Internal Assessment: 30 Marks		End Term Examination: 70 Marks
• Class Participation:	5	Written Examination: 70
• Seminar/presentation/assignment/quiz/ class test etc.:	10	
• Mid-Term Exam:	15	
Part C-Learning Resources		
1. Wiesner, M. R., and Bottero, J. Y. (Ed.) “Environmental Nanotechnology: Applications and Impacts of Nanomaterials” McGraw- Hill, New York.2007. 2. Diallo, M., Duncan, J., Savage, N., Street, A., and Sustich, R. (Eds). “Nanotechnology Applications for Clean Water” William Andrew. 2008. 3. Lead J., and Smith, E. “Environmental and Human Health Impacts of Nanotechnology” John Wiley & Sons. 2009. 4. Skoog, D. A., Holler, F. J., and Crouch S. R. “Instrumental Analysis” Glenage Learning India PrivateLimited, New Delhi. 2007. 5. Masters, G. M. and Ela, W. P. “Introduction to Environmental Engineering and Science”, Prentice Hall 2007.		

Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs) & Program Specific Outcomes (PSOs)

CLOs	PL O1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO1 0	PLO1 1	PSO 1	PSO 2
CLO1	3	3	3	2	3	3	2	3	1	2	3	3	3
CLO2	3	3	3	3	3	2	3	3	2	2	3	3	3
CLO3	3	3	2	3	3	2	3	3	3	3	3	3	3
CLO4	3	3	3	3	3	3	2	2	2	2	3	3	3

Content Mapping with NEP thrust areas

Field	Hours devoted
Employability	15
Entrepreneurship	8
Skill Enhancement	20
Communication Development	8
Indian Knowledge System	4
Environmental Awareness/SDGs	15
Current Issues and Social Awareness	10
Gender issues	4
Public policies	10

Part A – Introduction			
Name of the Programme	M.Sc. Environmental Sciences		
Semester	IV		
Nature of Course/Course Composition	Practical(401&402)		
Nomenclature of the Course	Practicum–VII		
Course Code	26L6.5-EVS-406		
Course Type	PP-VII (Practicum-VII)		
Course Level	500–599		
Pre-requisite for the course (if any)	Basic knowledge of environmental science and Laboratory analytical techniques.		
Course Learning Outcomes (CLOs) After completing this course, the learner will be able to:	CLO ₁	Apply appropriate EIA screening, impact identification and impact assessment techniques to identify, evaluate and classify potential environmental impacts of developmental projects.	
	CLO ₂	Analyse baseline environmental data and spatial information using field/secondary data and GIS tools, and develop appropriate environmental management and monitoring measures for proposed projects.	
	CLO ₃	Apply major Indian environmental laws, policies and regulatory mechanisms to assess environmental compliance and evaluate legal requirements related to pollution control and environmental protection.	
	CLO ₄	Analyse environmental governance mechanisms, environmental clearance procedures and environmental jurisprudence, including landmark judgments, the Polluter Pays Principle and the roles of major environmental regulatory institutions.	
	Theory	Practical	Total
Credits	0	4	4
Teaching hours per week	0	8	8
Internal Assessment Marks	0	30	30
End Term Exam Marks	0	70	70
Max. Marks	0	100	100
Examination Duration (in Hours)	0	03	
Part B- Contents of the Course			
Instructions for Examiner:			
Write-up and execution of the practical will be conducted as per the nature of the practical by the external examiner, with consideration given to the Course Learning Outcomes.			
Unit	Topics	CLO/s Attempt	Contact Hours
Unit-I	- To identify the likely environmental components affected by a proposed project such as a textile industry, highway, mining project or wastewater treatment plant. - To prepare a matrix showing project activities against environmental components and assign impact magnitude and importance. - To score identified impacts based on importance, magnitude, permanence, reversibility and cumulative effects and classify impacts into different significance categories. prepare a simplified	CLO1	30

	EIA report		
Unit-II	○ To analyze secondary/field data for air, water, soil and noise quality and prepare a baseline environmental profile of the selected project area. ○ Use QGIS to prepare a map showing features such as settlements, water bodies, roads, agricultural land, forests and other environmentally sensitive areas around a proposed project. ○ prepare an EMP for a selected project, including: • Identified environmental impact • Mitigation measure • Monitoring parameter • Monitoring frequency • Responsible agency/person • Estimated management requirement	CLO2	30
Unit-III	○ Prepare a chronological/legal framework covering major legislation related to water, air, forests, wildlife, biodiversity, environment and waste management. ○ Examine a real environmental pollution case and identify the relevant provisions, regulatory authorities, environmental standards and possible legal actions. ○ Analyze an industrial water-pollution case and identify the role of CPCB/SPCB, consent mechanisms, monitoring requirements and regulatory provisions.	CLO3	30
Unit-IV	○ Analyze an urban or industrial air-pollution case and prepare a regulatory compliance assessment. ○ Select a proposed project and prepare a simplified flowchart covering screening → scoping → public consultation → appraisal → environmental clearance → compliance monitoring, as applicable. ○ Case Study Analysis: a) Landmark judgments related to environmental protection b) Polluter Pays Principle ○ Role of Institutions- Study of functions of CPCB, SPCB, NGT, and MoEF&CC	CLO4	30

Note: Addition and deletion in the list of experiments may be made from time to time by the department depending on the availability of resources

Total Contact Hours			120
Evaluation Methods			
Internal Assessment:30	MM-30	End Term Examination: 70	MM- 70
Class Participation:	5	Lab record	10
Seminar/Demonstration/Viva-voce/Lab records etc.:	10	Viva-Voce	20
Mid-Term Exam:	15	Write-up and execution of the practical	40
Part C-Learning Resources			
Recommended Books/Journals/ e-resources/ Learning Management Systems (LMS):			
Instructions			
• Glasson, J., Therivel, R. & Chadwick, A. Introduction to Environmental Impact Assessment. Routledge. • Canter, L.W. Environmental Impact Assessment. McGraw-Hill. • Petts, J. Handbook of Environmental Impact Assessment. Blackwell.			

- Wood, C. **Environmental Impact Assessment: A Comparative Review**. Pearson.
- Divan, S. & Rosencranz, A. **Environmental Law and Policy in India**. Oxford University Press.
- Leelakrishnan, P. **Environmental Law in India**. LexisNexis.
- Shastri, S.C. **Environmental Law**. Eastern Book Company.
- Kaushik, A. & Kaushik, C.P. **Perspectives in Environmental Studies**. New Age International.

**Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs)
& Program Specific Outcomes (PSOs)**

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PSO1	PSO2
CLO1	3	3	3	3	3	2	3	2	2	2	3	3	3
CLO2	3	3	3	3	3	2	3	2	2	2	3	3	3
CLO3	3	3	3	3	2	3	3	3	2	2	3	3	3
CLO4	3	3	3	3	2	3	3	3	3	3	3	3	3

Content Mapping with NEP thrust areas

Field	Hours Devoted
Employability	18
Entrepreneurship	6
Skill Enhancement	38
Communication Development	6
Indian Knowledge System	3
Environmental Awareness/SDGs	20
Current Issues and Social Awareness	10
Gender Issues	2
Public Policies	10
Any Other	7

Part A – Introduction			
Name of the Programme	M.Sc. Environmental Sciences		
Semester	IV		
Nature of Course/Course Composition	Practical(403/410)and (404/405)		
Nomenclature of the Course	Practicum–VIII		
Course Code	26L6.5-EVS-407		
Course Type	PP-VIII (Practicum-VIII)		
Course Level	500–599		
Pre-requisite for the course (if any)	Basic knowledge of environmental science and Laboratory analytical techniques.		
Course Learning Outcomes (CLOs) After completing this course, the learner will be able to:	CLO ₁	Apply appropriate environmental, energy, water and waste auditing techniques to assess resource consumption, environmental performance, waste generation and potential improvement measures in institutional, laboratory or industrial settings.	
	CLO ₂	Apply nanoscience and nanotechnology approaches to sustainable energy applications through preparation and evaluation of nanomaterials, photocatalytic systems, photovoltaic applications and nanomaterial-based electrochemical/energy-storage systems.	
	CLO ₃	Apply environmental nanotechnology for pollution control and remediation by preparing nanomaterials/nanoabsorbents, conducting pollutant-removal experiments, evaluating adsorption efficiency and comparing conventional and nanotechnology-based treatment approaches.	
	CLO ₄	Evaluate the interaction of nanomaterials with biological and environmental systems through antimicrobial, phytotoxicity and microbial studies, and assess their environmental risks and sustainability using life-cycle and risk-assessment approaches.	
	Theory	Practical	Total
Credits	0	4	4
Teaching hours per week	0	8	8
Internal Assessment Marks	0	30	30
End Term Exam Marks	0	70	70
Max. Marks	0	100	100
Examination Duration (in Hours)	0	03	
Part B- Contents of the Course			
Instructions for Examiner: Write-up and execution of the practical will be conducted as per the nature of the practical by the external examiner, with consideration given to the Course Learning Outcomes.			
Unit	Topics	CLO/s Attempt	Contact Hours
Unit-I	- Preparation of an Environmental Audit Checklist for a selected institution, laboratory, industry or campus. - Conducting a Preliminary Environmental Audit of a selected area/building based on water, energy, waste, air, noise and resource-use parameters.	CLO1	30

	○ Energy Audit of a Building/Laboratory by recording electricity-consuming equipment, operating hours and estimating energy consumption. ○ Preparation of a Waste Audit by identification, quantification and classification of solid, hazardous, biomedical and e-waste generated in a selected facility. ○ Preparation of a Water Audit by estimating water consumption, major sources of use, wastage and potential water-saving measures.		
Unit-II	○ Preparation of Nanomaterials for Energy Applications using a Simple Synthesis Method such as chemical precipitation or sol-gel method. ○ Synthesis and Characterization of Metal/Metal-Oxide Nanoparticles for potential photocatalytic or energy applications. ○ Comparative Study of Photocatalytic Activity of a Nanomaterial under light irradiation using degradation of a model dye. ○ Study of the Effect of Nanomaterials on Solar-Cell/Photovoltaic Performance using available laboratory or demonstration-scale photovoltaic systems. ○ Preparation and Testing of a Nanomaterial-Based Electrode/Electrode Modification for an energy-storage or electrochemical application. ○ Comparative Analysis of Conventional and Nanomaterial-Based Energy Technologies using efficiency, energy consumption and environmental indicators.	CLO2	30
Unit-III	○ Synthesis of Nanoparticles and nanomaterials for environmental applications using a suitable laboratory method. ○ Preparation of Nanoadsorbent Adsorbent for Removal of Pollutants from Water. Batch Adsorption Study for Removal of a Selected Pollutant Using Nanomaterials/Nanocomposites. ○ Determination of Adsorption Efficiency and Removal Percentage using appropriate analytical measurements. ○ Comparison of Conventional and Nanomaterial-Based Water Treatment Methods in terms of efficiency, cost and environmental sustainability.	CLO3	30
Unit-IV	○ Study of the Antimicrobial Activity of Nanoparticles against selected microorganisms using an appropriate laboratory method. ○ Assessment of the Effect of Nanoparticles on Seed Germination and Plant Growth as a simple nanotoxicity experiment. Study of Phytotoxicity of Selected Nanomaterials using germination percentage, root length and shoot length. ○ Study of the Effect of Nanoparticles on Microbial Growth using appropriate growth/inhibition measurements ○ Life-Cycle Assessment of a Selected Nanomaterial/Nanotechnology Application from synthesis to disposal. ○ Preparation of a Risk Assessment Matrix for Nanomaterials covering exposure, environmental pathways, toxicity and mitigation measures.	CLO4	30
Note: Addition and deletion in the list of experiments may be made from time to time by the department depending on the availability of resources			

Total Contact Hours			120
Evaluation Methods			
Internal Assessment:30	MM-30	End Term Examination: 70	MM- 70
Class Participation:	5	Lab record	10
Seminar/Demonstration/Viva-voce/Lab records etc.:	10	Viva-Voce	20
Mid-Term Exam:	15	Write-up and execution of the practical	40
Part C-Learning Resources			
Recommended Books/Journals/ e-resources/ Learning Management Systems (LMS):			
Instructions			
• Environmental Auditing • Wood, C. <i>Environmental Impact Assessment: A Comparative Review</i>. Pearson. • Harrison, L. <i>Environmental, Health and Safety Audits</i>. CRC Press. • Energy and Sustainable Development • Boyle, G. <i>Renewable Energy: Power for a Sustainable Future</i>. Oxford University Press. • Twidell, J. & Weir, T. <i>Renewable Energy Resources</i>. Routledge. • Nanotechnology • Rao, C.N.R., Müller, A. & Cheetham, A.K. <i>The Chemistry of Nanomaterials</i>. Wiley-VCH. • Poole, C.P. & Owens, F.J. <i>Introduction to Nanotechnology</i>. Wiley. • Cao, G. & Wang, Y. <i>Nanostructures and Nanomaterials: Synthesis and Properties</i>. World Scientific. • Environmental Nanotechnology • Wiesner, M.R. & Bottero, J.-Y. <i>Environmental Nanotechnology: Applications and Impacts of Nanomaterials</i>. McGraw-Hill. • Karn, B., Kuiken, T. & Otto, M. <i>Nanotechnology and In Situ Remediation</i>. Environmental Science & Technology literature. • Nanotoxicology • Warheit, D.B. <i>Nanoparticles: Health and Safety Issues</i>. CRC Press. • Fadeel, B. et al. <i>Nanotoxicology: Principles and Applications</i>. Springer.			

**Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs)
& Program Specific Outcomes (PSOs)**

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PSO1	PSO2
CLO1	3	3	3	3	3	3	3	2	2	2	3	3	3
CLO2	3	3	3	3	3	2	3	2	2	2	3	3	3
CLO3	3	3	3	3	3	3	3	2	2	2	3	3	3
CLO4	3	3	3	3	3	3	3	3	2	3	3	3	3

Content Mapping with NEP thrust areas

Field	Hours Devoted
Employability	18
Entrepreneurship	8
Skill Enhancement	42
Communication Development	5
Indian Knowledge System	3
Environmental Awareness/SDGs	20
Current Issues and Social Awareness	8
Gender Issues	2
Public Policies	5
Any Other	9

Part A - Introduction			
Name of Programme	M.Sc. Environmental Sciences		
Semester	IV		
Nature of Course/Course Composition	Theory (Lecture + Tutorial)		
Nomenclature of the Course	Research Ethics		
Course Code	26L6.5-EVS-408		
Course Type	EEC		
Course Level	500-599		
Pre-requisite for the course (if any)	NA		
Course Learning Outcomes (CLOs)	CLO ₁		
After completing this course, the learner will be able to:	CLO ₂		
	Theory	Practical	Total
Credits	2	0	2
Teaching Hours per week	2	0	2
Internal Assessment Marks	15	0	15
End Term Exam Marks	35	0	35
Max. Marks	50	0	50
Examination Duration (in Hours)	02	0	
Part B- Contents of the Course			
<u>Instructions for Paper- Setter:</u> The paper setter shall prepare 5 questions selecting two questions from each of the two units with consideration given to the Course Learning Outcomes. Among these, question number 1 will be compulsory question comprising 07 short answer type questions carrying one mark each (total 07 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt three questions: the compulsory question no. 1 and 1 question from the each of the two units.			
Unit	Topics		CLO Attempt
I			CLO 1
II			CLO2
Total Contact hours			30
Evaluation Methods			
Internal Assessment: 15 Marks		End Term Examination: 35 Marks	
• Class Participation:	5	Written Examination: 35	
• Seminar/presentation/assignment/quiz/ class test etc.:	5		
• Mid-Term Exam:	5		
Part C-Learning Resources			
Recommended Books/Journals/ e-resources/ Learning Management Systems (LMS):			

Note: Syllabus of this paper will be provided by academic branch of the university.

Part A – Introduction	
Name of the Programme	M.Sc. Environmental Sciences
Semester	IV
Nature of Course	Dissertation/Project Work
Name of the Course	Dissertation
Course Code	26L6.5-EVS-409
Course Type	Dissertation/Project Work
Pre-requisite for the course (if any)	500-599
Course Outcomes (COs) After completing this course, the learner will be able to:	CLOS1 CO ₂ CO ₃ CO ₄
	Total
Credits	12
Max. Marks	300 (Report of dissertation- 200 marks + Open Viva Voce- 100)
Part B – Guidelines for the Dissertation Work/Project Work	
As Per PG Ordinance	
Tentative format of Dissertation/Project Work • General Introduction to the Study and Theoretical Framework • Review of Literature • Research Gap • Statement of the problem • Significance of the Study • Formulation of Research Questions /Issues • Research objectives • Hypotheses • Data source (Primary/Secondary) • Methodology • Analysis of Data • Discussion of the Results • Major findings, Summary, Recommendations (if any) and Conclusion • Bibliography /References &Webliography • Appendices	

Note: As per PG Ordinance

Part A - Introduction			
Name of Subject	M.Sc. Environmental Sciences		
Semester	IV		
Nature of Course	Theory (Lecture + Tutorial)		
Nomenclature of the Course	Nanoscience, Environment, and Life		
Course Code	26L6.5-EVS-410		
Course Type	DEC-3		
Course Level	500-599		
Pre-requisite for the course (if any)	NA		
Course Learning Outcomes (CLOs ₁) After completing this course, the learner will be able to:	CLO ₁	Explain the applications of nanotechnology in environmental protection, waste reduction, energy efficiency, water treatment and remediation, and evaluate the environmental fate and behaviour of nanomaterials.	
	CLO ₂	Analyze the health impacts, safety concerns and toxicological effects of nanoparticles, including their transport and interactions in soil, sediments and biological systems.	
	CLO ₃	Evaluate the role of nanotechnology in waste management and wastewater treatment and interpret relationships between nanomaterial properties, environmental fate, transport, transformation, bio-distribution and toxicity.	
	CLO ₄	Examine the ethical and societal implications of nanoscience, including the precautionary principle, social justice, human values, public participation and responsible technological development.	
	Theory	Practical	Total
Credits	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Duration (in Hours)	3		
Part B- Contents of the Course			
<u>Instructions for Paper- Setter:</u> The paper setter shall prepare 9 questions selecting two questions from each unit with consideration given to the Course Learning Outcomes. Among these, question number 1 will be compulsory, comprising 7 short answer type questions carrying two marks each (total 14 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt five questions: the compulsory question no. 1 and 1 question from the each of the four units.			
Unit	Topics	CLO/s Attempt	Contact Hours
I	Application of Nanotechnology: Nanotechnology for waste reduction and improved energy efficiency; nanotechnology-based water treatment strategies; nanoporous polymers and their applications in food packaging, nanomedicine, nanobiology and environmental remediation.	CLO1	15
II	Environmental Pollution by Nanoparticles: Health impacts, safety and toxicological effects; transport of nanomaterials in soil and sediments; physical and chemical	CLO2	15

	properties of nanomaterials influencing their behaviour in the environment and biological systems.		
III	Environment-Related Case Studies on Nanomaterials: Screening of nanomaterials for understanding potential effects on human health and the environment; relationships between key properties of nanomaterials and their environmental fate, transport, transformation, bio-distribution and toxicity; selected environmental applications and case studies.	CLO3	15
IV	Ethical and Societal Implications: Public interface of science, technology and human values; origins of the precautionary principle; citizen as a moral agent; principle of social justice; utilitarian priorities; role of foresighting in responsible nanoscience and technology.	CLO4	15
	Total Contact hours		60
Evaluation Methods			
Internal Assessment: 30 Marks		End Term Examination: 70 Marks	
• Class Participation:	5	Written Examination: 70	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		
Part C-Learning Resources			
Recommended Books/Journals/ e-resources/ Learning Management Systems (LMS)			
1. Lichtfouse, E., Schwarzbauer, J., & Robert, D. (Eds.). (2012). <i>Environmental chemistry for a sustainable world: Volume 1: Nanotechnology and health risk</i> . Springer.			
2. Kim, J. (Ed.). (2012). <i>Advances in nanotechnology and the environment</i> . CRC Press.			
3. Wiesner, M. R., & Bottero, J.-Y. (Eds.). (2007). <i>Environmental nanotechnology: Applications and impacts of nanomaterials</i> . McGraw-Hill.			
4. Tratnyek, P. G., Johnson, R. L., & others. (Eds.). <i>Environmental applications of nanotechnology</i> . Relevant academic publications on nanomaterials and environmental remediation.			
5. Klaine, S. J., Alvarez, P. J. J., Batley, G. E., Fernandes, T. F., Handy, R. D., Lyon, D. Y., Mahendra, S., McLaughlin, M. J., & Lead, J. R. (2008). Nanomaterials in the environment: Behavior, fate, bioavailability, and effects. <i>Environmental Toxicology and Chemistry</i> , 27(9), 1825–1851.			
6. Handy, R. D., Owen, R., & Valsami-Jones, E. (2008). The ecotoxicology of nanoparticles and nanomaterials: Current status, knowledge gaps, challenges, and future needs. <i>Ecotoxicology</i> , 17, 315–325.			
7. Nel, A., Xia, T., Mädler, L., & Li, N. (2006). Toxic potential of materials at the nanolevel. <i>Science</i> , 311(5761), 622–627.			
8. Colvin, V. L. (2003). The potential environmental impact of engineered nanomaterials. <i>Nature Biotechnology</i> , 21, 1166–1170.			
9. Royal Society & Royal Academy of Engineering. (2004). <i>Nanoscience and nanotechnologies: Opportunities and uncertainties</i> . The Royal Society.			
10. National Programme on Technology Enhanced Learning (NPTEL). Courses and lectures on nanotechnology, environmental nanotechnology and nanomaterials. NPTEL			
11. SWAYAM. Online courses related to nanoscience, nanotechnology, environmental science and sustainability. SWAYAM			
12. • National Digital Library of India. Digital learning resources related to nanoscience, nanotechnology and environmental sciences. National Digital Library of India			

**Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs)
& Program Specific Outcomes (PSOs)**

CLOs	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁	PSO ₁	PSO ₂
CLO ₁	3	3	1	3	1	2	3	3	2	1	1	3	3
CLO ₂	3	3	1	3	2	3	3	3	2	3	1	3	3
CLO ₃	3	3	2	3	2	3	3	3	2	2	3	3	3
CLO ₄	2	2	3	3	2	1	1	3	3	3	2	1	1

Content Mapping with NEP thrust areas

Field	Hours devoted
Employability	10
Entrepreneurship	5
Skill Enhancement	12
Communication Development	4
Indian Knowledge System	3
Environmental Awareness/SDGs	8
Current Issues and Social Awareness	6
Gender issues	1
Public policies	4
Any Other	7