

V136

**Syllabus:**

**M.Sc. (Environmental Science)**

**[MSc (EVS)]**

**{2021 Pattern}**

2021

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# SYLLABUS FOR M.Sc.(ENVIRONMENTAL SCIENCE) {2021 PATTERN}

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## Programme Objective and Scope

This programme is designed to achieve following objectives and scope.

**Objectives:** After successful completion of this programme, students will be able to

1. Explain core concepts related to environment science, ecology, environmental policies and legislation, issues in environmental science, advances in environmental science, biostatistics, computer applications and sustainability.
2. Identify and analyse environmental and social issues.
3. Develop skills, tools and strategies to combat environmental problems.
4. Discuss core concepts and methods from ecological and physical sciences and their application in environmental problem-solving.
5. Appreciate key concepts from economic, political, and social analysis as they pertain to the design and evaluation of environmental policies and institutions.
6. Demonstrate proficiency in quantitative methods, qualitative analysis, critical thinking, and written and oral communication needed to conduct high-level work as interdisciplinary scholars and/or practitioners.

**Scope of the Environmental Science programmes:** After successful completion of this programme, students may get opportunities in various fields/sectors to work as

- Career opportunities in both private and government sector/ in India and abroad
- Job opportunities in allied sectors[Engineering, Social sciences, Political sciences, Humanities, Photography etc.]
- Educate about the environment
- Inculcation of research attitude
- Inculcation of entrepreneurship
- Develop understanding of complex relationships between humans and nature
- Create awareness about various environmental problems
- Perceive higher education and research in the same field

## Mode of Education

This Programme will be offered in Open and Distance Learning (ODL) Mode as defined in “UGC Open and Distance Learning Programmes and Online Programmes Regulations, 2020” published in the gazette notification by dated 4<sup>th</sup> Sept 2020 by the UGC as specified below.

*“Open and Distance Learning Mode means a mode of providing flexible learning opportunities by overcoming separation of teacher and learner using a variety of media, including print, electronic, online and occasional interactive face-to-face meetings with the learners or Learner Support Services to deliver teaching-learning experiences, including practical or work experiences”*

## Mode of Examination

Continuous Assessment is conducted at recognized learner support centres/ study centres and End Examination for all type of courses is conducted at recognized Exam Centres of the University under supervision.

## Basic Information

1. **Mode of Education:** Open and Distance Learning (ODL) Mode
2. **Minimum Programme Duration:** 2 years/ 4 semesters after Candidates with B.Sc./ B.Sc.(Agri)/B.E./B.Tech./B. Pharm. Degree or Equivalent pass
3. **Learner Support Centers/ Study Centers:** University approved/ recognized Senior Science Colleges/ Institutes
4. **Medium of Instruction:** English
5. **Attendance:** Minimum 80% attendance for all type of courses.
6. **Minimum Programme Duration:** 2 years after Graduation
7. **Teaching-Learning:** 18 working weeks per semester
8. **Total Teaching-Learning Support:** 1200 Hours in each semester
9. **Total Courses:** 16 courses (subjects) at Semesters 01-04
10. **Total Credits:** 64 Credits. As per UGC norms 1 Credit means 30 hours of study efforts required to gain learning of particular content of each credit.
11. **Semester Credits:** 16 Credits in each semester (12 credits for Theory and 04 credits for Practical/ Project Activity).
12. **Total Courses and Credit Points:**

Semester	Theory	Practical	Credits
01	3	1	16
02	3	1	16
03	3	1	16
04	3	1	16
<b>Total credits</b>			<b>64</b>

13. **Passing:** Minimum 40% or better marks
14. **Credit Transfer:** Credit transfer will be granted in the following courses  
**Course 5: Environmental Sustainability and**  
**Course 13: Sustainable Management of Biodiversity**  
 to those students who has successfully completed and produced the certificate of completion of MOOC offered on the course “Environmental Sustainability” **only** from SWAYAM Platform
15. **Continuous Assessment:** Continuous Assessment conducted for Continuous evaluation during teaching-learning for 20% Weightage
16. **End Exam:** End Examination conducted for Summative evaluation of the student for 80% Weightage
17. **Degree Certification:** Aggregate performance and Class in the programme reported on the basis of performance (including credit transfer) **only** semesters 03 and 04
18. **Curriculum Design:** Student centric curriculum is designed to enable professional ability, employability and skill enhancement.

**19. Approval/Equivalence Status:** UGC Approved. UGC-DEB Approval is available on UGC Website

### Eligibility and Fees

Admission Eligibility	Certification Eligibility	Fees and Deposit / Year	
Candidates with B.Sc./ B.Sc.(Agri)/B.E./B.Tech./B. Pharm. Degree or Equivalent pass	Min 40% or better marks, in all Theory type of courses, with total 64 credits at Semesters 01 to 04	UF is payable for “2 Semesters in an academic year” to the university at the time of online admission	
		Description	INR ₹
		University Fee (UF)	6,100
		Study Center/ Learner Support Center Fee (LSCF)	12,000
		<b>Total ≈</b>	<b>18,100</b>
<b>Refundable LD</b> (Payable only when student choose to avail Library Facility at the SC)	1,500		

### Programme Structure

<b>M.Sc. (Environmental Science){2021Pattern}</b>				
Course Sem.	4 CR, T	4 CR, T	4 CR, T	4 CR, P
Sem. 01 16 CR	EVS011 Environmental Science and Environmental Biology	EVS012 Environmental Education, Polices and Legislation	EVS013 Natural Resources and Their Conservation	EVS014 Lab Activities on EVS011, EVS012, EVS013
Sem. 02 16 CR	EVS021 Environmental Sustainability (MOOC)	EVS022 Environmental Chemistry	EVS023 Environmental Geosciences & Computer Applications	EVS024 Lab Activities on EVS022, EVS023
Sem. 03 16 CR	EVS031 Environmental Monitoring and Energy Studies	EVS032 Instrumentation and Lab Techniques	EVS033 Environmental Microbiology and Toxicology	EVS034 Lab Activities on EVS031, EVS032, EVS033
Sem. 04 16 CR	EVS041 Sustainable Management of Biodiversity (MOOC)	EVS042 Statistical Approaches and Modelling in Environmental Sciences	EVS043 Environmental issues and Human health	EVS044 Project-Work

#### # Note:

We have used syllabus of the MOOCs offered in Swayam Platform for the following two courses.

1. EVS021: Environmental Sustainability (MOOC)
2. EVS041: Sustainable Management of Biodiversity (MOOC)

These Courses are offered on Swayam Platform. Those who will complete these courses on Swayam Platform, for them Credit Transfer will be given in the corresponding courses EVS021 and EVS041 offered in V136: MSc EVS and V135: Diploma in EVS

## Teaching-Learning Scheme:

Description	<b>Total 12 (Twelve) Theory Courses in Programme</b> <b>Total 4 (Four) Practical Courses in Programme</b>
Face-to-face Counselling Sessions for interaction, problem solving and conduction of practical activities at Study Centre	<b>12 hrs each of 01 clock hour duration for each Theory Course of 4 Credits, Study Hours – 60</b>
	<b>12 hrs each of 02 clock hour duration for each Practical/ Activity Course of 4 Credits, Study Hours– 120</b>
Delivery of Information	(1) <b>06</b> eBooks in SLM format: <b>30</b> Hours/ for each (2) <b>18 - 22</b> Video lecture : <b>10</b> Hours already developed by the University for AEC111, SEC511
Self-Study, Learning Evaluation and Feedback	(1) Solving Problems, Self-Tests, SAQs and Exploring more Details on Text-Book: <b>30</b> Hours
Total Study Hours	(12 x 60 = <b>720</b> Hours + 4 x 120 = <b>480</b> Hours) = 1200 Hours

## Semesters and Courses

SN	Code	Name	CA	EE	TM	Type	CR	Grade Point
<b>Semester 01</b>								
01	EVS011	Environmental Science and Environmental Biology	20	80	100	T	4	4
02	EVS012	Environmental Education, Policies and Legislation	20	80	100	T	4	4
03	EVS013	Natural Resources and Their Conservation	20	80	100	T	4	4
04	EVS014	Lab Activities on EVS011, EVS012, EVS013	20	80	100	P	4	4
<b>Semester 02</b>								
05	EVS021	Environmental Sustainability	20	80	100	T	4	4
06	EVS022	Environmental Chemistry	20	80	100	T	4	4
07	EVS023	Environmental Geosciences & Computer Applications	20	80	100	T	4	4
08	EVS024	Lab Activities on EVS022, EVS023	20	80	100	P	4	4
<b>Semester 03</b>								
09	EVS031	Environmental Monitoring and Energy Studies	20	80	100	T	4	4
10	EVS032	Instrumentation and Lab Techniques	20	80	100	T	4	4
11	EVS033	Environmental Microbiology and Toxicology	20	80	100	T	4	4
12	EVS034	Lab Activities on EVS031, EVS032, EVS033	20	80	100	P	4	4
<b>Semester 04</b>								
13	EVS041	Sustainable Management of Biodiversity	20	80	100	T	4	4
14	EVS042	Statistical Approaches and Modelling in Environmental Sciences	20	80	100	T	4	4
15	EVS043	Environmental issues and Human health	20	80	100	T	4	4
16	EVS044	Project-Work	20	80	100	PW	4	4

## Grading system

1. “Absolute Grading”: the marks are converted to grades based on pre-determined class intervals.
2. “Letter Grade”: It is an index of the performance of students in a said programme. Grades are denoted by letters O, A+, A, B+, B, C, and F.

Letter Grade	Grade Point	Class
O	10	Outstanding
A+	9	Excellent
A	8	Very Good
B+	7	Good
B	6	Above Average
C	5	Average
P	4	Pass
F	0	Fail
Ab	0	Absent

3. “Grade Point”: It is a numerical weight allotted to each letter grade on a 10-point scale. Grade Points shall be “0 (Zero)” for Letter Grade “Ab” and “F”. The marks scored by the examinee shall be converted into grade points by dividing the marks scored in the aggregate and dividing the resulting number by maximum marks, multiplying the result by ten, retaining the integer part (ignore the fractional part). Thus if a person has secured 56 marks out of 100 marks in aggregate for a course, we get  $(56/100) \times 10$  which is 5.6. Ignoring the fraction, we get 5 as the grade point.

1. “Credit Point”: It is the product of grade point and number of credits for a course.
2. “Semester Grade Point Average (SGPA)”: It is a measure of performance of work done in a semester. It is a ratio of total credit points secured by a student in various courses registered in a semester and the total course credit stake during that semester. It shall be expressed up to two decimal places.
3. “Cumulative Grade Point Average (CGPA)”: It is a measure of overall cumulative performance of a student over all semesters. The CGPA is the ratio of total credit points secured by a student in various courses in all semesters and the sum of the total credits of all courses in all these semesters. It is expressed up to two decimal places.
4. “Transcript Grade Card or Certificate”: Based on the grades earned, a grade certificate shall be issued to all the registered students after every semester. The grade certificate will display the course details (code, title, number of credits, grades secured) along with SGPA of that semester and CGPA earned till that semester.

## Evaluation Pattern

Separate and independent passing @40% in EE and (CAT+EE) shall be essential for Theory and Practical component of each course. “CA, EE and Total marks” shall be separately reported for each course in the transcript or mark-statement.

1. **Only 1 attempt** for EE for **each** course shall be allowed in **each** semester. **Maximum 2 attempts**, for CAT for **each** course, shall be allowed in **each** semester.
2. Only best of past performances shall be reported in transcript or mark statement.
3. **Total student evaluation for**
  - a. **Each** semester shall be for **400** marks.
  - b. **Each** regular PG degree shall be for **1600** marks.
  - c. **Each** year shall be for **800** marks

SN	Type of Course	Continuous Assessment	End Examination
1	Theory (T)	“Continuous Assessment (CA)” of total <b>20</b> 4SAQs, each of 5 marks, 1 SAQ on each CR in a <b>Single attempt only</b>	“End Examination (EE)” of total <b>80</b> Marks and <b>16</b> “Short Answer Questions (SAQs)” each of <b>05</b> marks ( <b>4 out of 5 SAQs one each Credit</b> ), during <b>150</b> Minutes
2	Practical (P)	Student is required to submit “Activity Report” of total 20 Marks and total 4 Activities, each of 5 Marks on each CR in a <b>Single Attempt only</b>	External and internal examiners shall assess each student based on for total 80 Marks:  Conduct of One Randomly Selected Practical Activity – 20 Marks  Viva-Voice - 20 Marks  Journal (Workbook) - 20 Marks and  Report of Practical Activity - 20 Marks  <b>Duration:</b> 240 minutes

**Evaluation Pattern Of Practical Type Courses of 4 CR**

SN	Description	Internal Examiner	External Examiner	Total Marks
<b>Duration of End Exam: 240 minutes(4hrs)    Batch size: ≈ 15 students</b>				
a	Actual Conduct of 1 randomly selected practical activity	8 Marks	12 Marks	20
b	Viva-Voice	6 Marks	14 Marks	20
c	Workbook	8 Marks	12 Marks	20
d	Report of Practical Activity with Diagram, synoptic Answers, Graph/Observation and Conclusion	8 Marks	12 Marks	20
<b>Total</b>		<b>30 Marks</b>	<b>50 Marks</b>	<b>80 Marks</b>

**Evaluation Pattern Of Project Type Courses of 4 CR**

Description	Internal Examiner	External Examiner	Total Marks
<b>Duration of End Exam: 240 minutes(4hrs)    Batch size: ≈ 08 students</b>			
Project Proposal and Review of Literature	-	20 Marks	20
Project Results and Report	20 Marks	20 Marks	40
Presentation	6 Marks	6 Marks	12
Viva-Voce	4 Marks	4 Marks	8

## Successful Completion of Course or Programme

1. "Successful Completion of the Course" means - either course is exempted or student gets minimum specified or better grade, either in end examination of that course or by credit transfer. A student obtaining grade "F" shall be considered failed and will be required to reappear in the examination. The student obtained minimum "P" (Pass) letter grade required for successful completion of the each course.
2. "Successful Completion of the Programme" means – all courses at all semesters are successfully completed either in end examination of that course or by credit transfer and the student obtained "P" (Pass) letter grade for all courses at all semesters along with minimum specified SGPA and CGPA.

## Semester 01

### EVS011

#### COURSE INFORMATION

Sem.	Code	Course Name	CR	CST	ST	CA	EE	TM	Type
01	EVS011	Environmental Science and Biology	4	08	120	20	80	100	T

#### PRESUMED KNOWLEDGE AND LEARNING OBJECTIVES

Presumed Knowledge	Learning Objectives
<p>For successful completion of this course, student should have successfully completed:</p> <ul style="list-style-type: none"> <li>Candidates with B.Sc./ B.Sc.(Agri)/B.E./B.Tech./B. Pharm. Degree or Equivalent pass</li> </ul>	<p>After successful completion of this course, student should be able to</p> <ul style="list-style-type: none"> <li>Explain scope of environmental science and ecology</li> <li>Explain Biology</li> <li>Analyze importance of environmental science and allied areas</li> </ul>

#### UNITS AND DETAILED SYLLABUS

UN	Detailed Syllabus of the Unit	CR
1-1	<b>Background and scope of environmental science:</b> Introduction to Environmental Science as a multi-disciplinary subject, Definition, principles-nature, background and scope of environmental science, necessity, understanding of environment and measurements.	CR 01
1-2	Use of technology, media and people in environmental science, decision making and applications of Environmental science.	
1-3	Human impact on environment and its consequences, hunting and gathering, agriculture societies, industrial societies, impact of cultural change on environment.	
1-4	Population explosion, degradation of natural resources, pollution of air, water and soil, urbanization, industrialization, food security, public health, energy crises.	
2-1	<b>Definition of Ecology and sub divisions:</b> Definition of Ecology and subdivisions, Ecology relation to other sciences, levels of organization hierarchy, Case and other ecological models, Population ecology-Population structure, characteristics and processes, population pyramids, 'J' and 'S' shaped growth curves and limits.	CR 02
2-2	<b>Community Ecology:</b> Organism to organism relationship population dynamics (balances and functions)	
2-3	<b>Biomes:</b> Types of biomes, climatic factors influencing biomes, biotic elements. Concept of carrying capacity.	

2-4	The concept of tragedy of commons, human population, food, water and energy security, present status of environment.	
3-1	<b>Principal and Scope of Biology:</b> Fundamental Concepts and Principles; structure and function, food chain and food web.	<b>CR 03</b>
3-2	<b>Classification of ecosystem:</b> Fresh water, marine, estuarine and terrestrial ecosystems. Primary and secondary production – definition, measurement of productivity in terrestrial and aquatic pathways in ecosystem.	
3-3	Basic laws of energy flow; energy flow models in ecosystem	
3-4	<b>Succession:</b> Primary succession, secondary succession and ecological climax, impacts of development of ecosystem, population, predator and prey relationship.	
4-1	<b>Forest ecology:</b> Definition and Characteristics, forest influence on climatic regulations, flood and soil erosion control and wild habitat protection, maintaining hydrology, nutrient cycling and moisture conservation.	<b>CR 04</b>
4-2	<b>Effect of fire on forest ecosystem</b> – soil, moisture, nutrient content, micro and macro fauna.	
4-3	<b>Marine environment:</b> Biota in different types of zones, its diversity-plankton, nekton, benthos, their adaptations and productivity.	
4-4	Indian marine territory, Coastal Regulatory Zone	

#### LEARNING RESOURCE DETAILS

LR Code	Title Author	Edition Year	ISBN Publisher
01. Text-Books	1. An Introduction to Ecology and Environmental Science - Prabu 2. Ecology and Biology-Saha 3. Aquatic Ecosystems – Findlay 4. Fundamental Ecology – Odum 5. Elements of Environmental Science – PK Gaur 6. Biology - Mike Calver, Alan Lymbery, Jennifer McComb and Mike Bamford 7. Biology - Arvind Kumar		
02. Reference-Books:			
03. CD / DVD:			
04. Web Links:			
OER:	<a href="https://openstax.org/">https://openstax.org/</a> <a href="https://www.merlot.org/">https://www.merlot.org/</a>		

## EVS012

### COURSE INFORMATION

Sem	Code	Course Name	CR	CST	ST	CA	EE	TM	Type
01	EVS012	Environmental Education, Polices and Legislation	4	08	120	20	80	100	T

### PRESUMED KNOWLEDGE AND LEARNING OBJECTIVES

Presumed Knowledge	Learning Objectives
<p>For successful completion of this course, student should have successfully completed:</p> <ul style="list-style-type: none"> <li>Candidates with B.Sc./B.Sc.(Agri)/B.E./B.Tech./B. Pharm. Degree or Equivalent pass.</li> </ul>	<p>After successful completion of this course, student should be able to</p> <ul style="list-style-type: none"> <li>State various policies and acts regarding protection of the environment</li> </ul>

### UNITS AND DETAILED SYLLABUS

UN	Detailed Syllabus of the Unit	CR
1-1	<b>Environmental Education:</b> Definition and background of environmental education, need and objectives of environmental education.	<b>CR 01</b>
1-2	Status of environmental education in new education policy - Role of various institutions (Govt. and Non Govt.).	
1-3	<b>Environmental Policy:</b> Government policies in the protection and development of environment- environmental considerations in economic planning and development in India. NCEP and district environmental committee.	
1-4	<b>State of India's Environment( with respect to)-</b> Land, Forest, Atmosphere ,Hydrosphere, Dams, Environmental Health, Habitat, People and Environment ,Renewable and Non-renewable resources	
2-1	<b>Emerging environmental concerns in India: List</b> of various environmental concerns in India, Case study of silent environmental concerns in India - case study of silent valley, Sardarsarovar dam, TehriGarwal dam. Pollution trading, Carbon credits, Carbon trading, etc. Kyoto protocol :an Indian perspective	<b>CR 02</b>
2-2	<b>Awareness of Society with respect to global terminology as:</b> Carbon footprints ,Ecological footprints,Happy Planet Index,Ecosystemvaluation,Earth overshoot Day	
2-3	<b>Environmental Awareness:</b> Stockholm conference (UNCHE), World commission on Environment and Development (WCED)	
2-4	"Our Common Future" Rio de Janerio- Conference (UNCED).	
3-1	<b>Global Environment Conservation Strategy -1:</b> United Nations environmental Programme(UNEP). World Wide Fund for Nature (WWF)	<b>CR 03</b>

3-2	<b>Global Environment Conservation Strategy - 2:</b> International Union for conservation of Nature and Natural Resources. (IUCN)	
3-3	International Environmental Law [ILE],Tbilisi Declaration (1977)	
3-4	<b>Environmental Conventions and Agreements:</b> Stockholm Conference on Human Environment 1972, Montreal Protocol, 1987, Conference of Parties (COPs), Basel Convention (1989, 1992), Ramsar Convention on Wetlands (1971), Earth Summit at Rio de Janeiro, 1992, Agenda-21, Global Environmental Facility (GEF), Convention on Biodiversity (1992), UNFCCC, Kyoto Protocol, 1997, Clean Development Mechanism (CDM), Earth Summit at Johannesburg, 2002, RIO+20, UN Summit on Millennium Development Goals, 2000, Copenhagen Summit, 2009. IPCC, UNEP, IGBP.	
4-1	<b>Environmental Acts-1:</b> The wild life (protection) Act, 1972. The Water (Pollution and Control of Pollution) Act, 1974. Forest (Conservation) Act, 1980. The Air (Prevention and Control of Pollution) Act, 1981	<b>CR 04</b>
4-2	The environment (protection) Act, 1986. Public Liability Insurance At,1991	
4-3	<b>Environmental Acts-2:</b> Industrial wastes and Law, Sec. 12 of Factories Act, (1948) and rules framed there under. Noise pollution and Law, Sec.119and120of the Motor Vehicles Act (1989) and rules framed there under.	
4-4	The National Green Tribunal Act, 2010, The Hazardous Waste Management Regulations, etc. <b>Note:</b> Any amendment to the act impinged time to time is to be covered.	

#### LEARNING RESOURCE DETAILS

LR Code	Title Author	Edition Year	ISBN Publisher
01. Text-Books	1. Environmental Dilemmas and Policy Design-Pellikaan 2. Environmental Economics and Natural Resource Management -MuralidharMajhi 3. Environmental Management-Thakur 4. Environmental Studies and Ethics- Gouri Suresh 5. Environmental Impact Assessment - R.R. Barthwal 6. Global Environmental Policies-RavinderDhanai 7. Environmental Law and Pollution Control - P.N.Prasad 8. Environmental Impact Assessment: A Guide to Best Professional Practices- Charles H. Eccleston 9. Environmental Impact Assessment - Larry W. Canter		
02. Reference-Books:			
03. CD / DVD:			
04. Web Links:			
OER	<a href="https://openstax.org/">https://openstax.org/</a> <a href="https://www.merlot.org/">https://www.merlot.org/</a>		

## EVS013

### COURSE INFORMATION

Sem	Code	Course Name	CR	CST	ST	CA	EE	TM	Type
01	EVS013	Natural Resources and Their Conservation	4	08	120	20	80	100	T

#### PRESUMED KNOWLEDGE AND LEARNING OBJECTIVES

Presumed Knowledge	Learning Objectives
<p>For successful completion of this course, student should have successfully completed:</p> <ul style="list-style-type: none"><li>Candidates with B.Sc./B.Sc.(Agri)/B.E./B.Tech./B. Pharm. Degree or Equivalent pass</li></ul>	<p>After successful completion of this course, student should be able to –</p> <ul style="list-style-type: none"><li>Identify various natural resources</li><li>Apply knowledge for conservation of various natural resources</li><li>Critically evaluate current events and public information related to natural resources as being scientifically-based or opinion-based and contribute to the knowledge base of information.</li><li>Write in a style appropriate for technical or informative publications for various audiences related to natural resources.</li></ul>

#### UNITS AND DETAILED SYLLABUS

UN	Detailed Syllabus of the Unit	CR
1-1 1-1	Definition of resources, biotic and abiotic resources, uses and values of a resource, major abiotic resources- minerals, fossil fuels, water, soil air etc.	CR 01
1-2	Biotic resources-wild plants, forests, grasslands, plankton, domesticated plants, plantations, agriculture, horticulture etc., animals, fisheries, domesticated animals, use of captive and cultured animals.	
1-3	Natural resource -conservation and Natural resource Accounting [NRA]: Principles, Classification, concepts and approaches of natural resource conservation. Natural resources of India. Resources and reserves. Mineral and population. Oceans as new areas for exploration of mineral resources.	
1-4	Concept of resource conservation and its importance, economic aspects of resource conservation, planning for the conservation of resources, NRA for soil, water, air .Bio-diversity resource, Environmental Action Plan (EAP)	
2-1	Conservation of Wetlands, Watersheds, Ground water, Surface water: Definition and classification of wetlands, wetland functions and values, present status of wetlands in India, conservation of wetlands. Definition, characters and functions of watersheds, watershed	

	conservation.	
2-2	Groundwater as resource, conservation of ground and surface water in quality and quantity, the water crisis present and future, methods of water conservation.	CR 02
2-3	Land use, land cover and soil conservation: Definition of land as a natural resource, concept, scope and classification of land use, history of land use practices, land use practices in mountains, river basins, coast etc. urban and rural land use in India, types of land covers and their role in conserving soils.	
2-4	Soil conservation: Definition, causes of soil degradation and their effects, methods of soil conservation and practices.	
3-1	Forest resources, plantations, social forestry: Forest as resource in the past and present, causes of deforestation, forest conservation, silviculture, energy plantation, social forestry, forests and local people, joint forest management programme (JFM).	CR 03
3-2	Impact of growing population on resource use, Human population growth and increasing demand for resources, factors affecting human population distribution, population and degradation of resource, changing life styles and technology, equity, justice and common resources future scenario.	
3-3	Wildlife management and conservation: Definition of wildlife, wildlife as a resource in the past and present, need for wildlife conservation, in situ and ex- situ conservation, protected areas, national parks, sanctuaries.	
3-4	Wilderness areas, wildlife management, concept of sustainable use of wildlife, Indian ethos of Wildlife conservation.	
4-1	Mineral resources: Sources, distribution, consumption, conservation of mineral resources. Impact of mining activities on environment, mining laws, National Mineral Policy.	CR 04
4-2	Fossil fuels: Definition, Types, Formation and Uses of Fossil Fuels, Advantages and Disadvantages of Fossil Fuels, Conservation of fossil fuels.	
4-3	Atmosphere as a natural resource: Introduction, Atmospheric circulation and energy balance, Meteorology, atmospheric stability and chemistry, Global warming and climate change.	
4-4	Sustainable natural resources management and development: Industrialization and its impacts, growth vs. inclusive growth, societal impacts, types of farming systems, globalization, urbanization and privatization, sustainability of modern developments: dams and displacement, mining, high impact agriculture	

**LEARNING RESOURCE DETAILS**

<b>LR Code</b>	<b>Title Author</b>	<b>Edition Year</b>	<b>ISBN Publisher</b>
01. Text-Books	1. Natural Resources - Christian Lannerberth 2. Environmental Science - Santra 3. A Text book of Environmental Science - Prabhat Patnaik 4. A Textbook of Environmental Sciences- Purohit 5. Natural Resources: Exploration and Development - Satish Tiwari 6. Natural resources - S. B. Ghosh 7. Target 3 Billion: Innovative Solutions towards Sustainable Development - APJ Abdul Kalam and Srijan Pal Singh 8. Sustainable Development (Encyclopaedia of Sustainable Development) - P. C. Sinha 9. Urban Environmental Management - Shahab Fazal		
02. Reference-Books:			
03. CD / DVD:			
04. Web Links:			

## EVS014

### Lab Activities on EVS011, EVS012, EVS013

#### PROGRAMME INFORMATION

SN	Description	Details
1	University	Yashwantrao Chavan Maharashtra Open University Nashik - 422 222, Maharashtra, India Website: <a href="http://ycmou.digitaluniversity.ac/">http://ycmou.digitaluniversity.ac/</a>
2	School	School of Architecture, Science and Technology
3	Discipline	Science
4	Level	PG
5	Course Used in	M.Sc. in Environmental Science

#### COURSE INFORMATION

Sem	Code	Course Name	CR	CST	ST	CA	EE	TM	Type
01	EVS014	Lab Activities on EVS011, EVS012, EVS013	4	60	120	20	80	100	P

#### PRESUMED KNOWLEDGE AND LEARNING OBJECTIVES

Presumed Knowledge	Learning Objectives
For successful completion of this course, student should have successfully completed: <ul style="list-style-type: none"><li>Candidates with B.Sc./B.Sc.(Agri)/B.E./B.Tech./B. Pharm. Degree or Equivalent pass</li></ul>	After successful completion of this course, student should be able to <ul style="list-style-type: none"><li>Perform various lab activities and test the results</li></ul>

#### UNITS AND DETAILED SYLLABUS

Sn	Detailed syllabus of the Unit	Credits
1	Practical's based on: Course 1 - Environmental science and ecology. 1) Study of ecological pyramids (at least four) 2) Study of food chain – Any one example of fresh water, marine water and terrestrial food chain. 3) Estimation of Biomass of a given area. 4) Study of pond ecosystem 5) Mounting / Quantitative estimation of planktonic forms. 6) Study of plant community by list quadrat method.	CR01
2	Practical's based on: Course 2 - Environmental Education, Policies and Legislation 7. Legal Case citation (one per student) 8. Reports on various study tours/academic visits. 9. Preparation/drafting of EIA Report (Chemical Industry, Fertilizer Industry, hydropower station). 10. Report on Eco-tourism.	CR02
3	Practical's based on : Course 3- Natural resources and their conservation 11) Determination of SAR (sodium absorption ratio) of soil 12) Study of land degradation. 13) Study of texture of soil. 14) Estimation of elements {all major and minor} from soil sample 15) Measurement of intensity of solar radiations by Lux meter 16) Determination of the pH of given soil sample	CR03
4	1. Visit to water treatment plant (WTP) and Industrial effluent treatment plant (ETP) 2. Design a waste water disposal plant	CR04

## LEARNING RESOURCE DETAILS

LR Code	Title Author	Edition Year	ISBN Publisher
<b>Text-Books</b>			
EVS011	1. Biology - Mike Calver, Alan Lymbery, Jennifer McComb and Mike Bamford 2. Biology - Arvind Kumar 3. An Introduction to Ecology and Environmental Science - Prabu 4. Ecology and Biology-Saha		
EVS012	1. Standard methods for examination of water and waste water, American Public Health Association. 2. A comprehensive laboratory manual for Environmental Sciences and Engineering By P.R. Sreemahadevan Pillai. New Age International Publishers. 3. Chemical and biological methods for water pollution studies By R.K. Trivedi 4. Handbook of water and waste water analysis By S.K. Maiti. 5. Soil and air analysis by S.K. Maiti.		
EVS013	1. Natural Resources - Christian Lannerberth 2. Environmental Science - Santra 3. A Text book of Environmental Science - Prabhat Patnaik		

## Semester 02

### EVS021

#### COURSE INFORMATION

Sem	Code	Course Name	CR	CST	ST	CA	EE	TM	Type
02	EVS021	Environmental Sustainability [MOOC]	4	08	120	20	80	100	T

#### PRESUMED KNOWLEDGE AND LEARNING OBJECTIVES

Presumed Knowledge	Learning Objectives
For successful completion of this course, student should have successfully completed: <ul style="list-style-type: none"><li>Candidates with B.Sc./B.Sc.(Agri)/B.E./B.Tech./B. Pharm. Degree or Equivalent pass</li></ul>	After successful completion of this course, student should be able to <ul style="list-style-type: none"><li>Explain need of sustainable living</li></ul>

#### UNITS AND DETAILED SYLLABUS

UN	Detailed Syllabus of the Unit	CR
1-1	Introduction to environment and society Factors affecting environment and society-1 Factors affecting environment and society-2	CR 01
1-2	Our Common Future Introduction to Terms of Significance -1 Introduction to Terms of Significance -2	
1-3	Trade & Environment- Concepts, issues and recent developments- part 1 Trade & Environment- Concepts, issues and recent developments- part 2	
1-4	Legal Edifice of Environmental Protection Environmental Impact Assessment Norms and their application in India, The Wild Life Protection Act, 1972	
2-1	The Case of Western Ghats- The Gadgil Report The Kasturirangan Report	

2-2	The Forest Conservation Act, 1980 The Water Act The Air –Prevention & Control of Pollution Act, 1981	CR 02
2-3	Seminal Cases in Environmental Protection, The Environment Protection Act, 1986, Environmental Friendly Technologies- Concept and Need, A Consumer Behaviour perspective to Environmental Sustainability	
2-4	Managing our environment for sustainability- Solar Energy part1 Managing our environment for sustainability, Solar Energy part 2 Managing our environment for sustainability, Wind Energy Managing our environment for sustainability- Geothermal, Hydro and Tidal Energy Sustainable Development and Environment friendly practices	
3-1	Waste Management for Sustainable Development Environment Friendly practices and the use of Environment Friendly products	CR 03
3-2	Live Examples of Environment Friendly Technologies-1 Live Examples of Environment Friendly Technologies-2 Case Studies on environment and society-1 Case Studies on environment and society-2	
3-3	Changing Interactions Environmental Education- An Introduction	
3-4	Sensitivity towards environment and environmental issues-1 Sensitivity towards environment and environmental issues-2 Awareness through knowledge- part 1 Awareness through knowledge- part 2	
4-1	Attitude towards protection of the Environment Critical thinking, utilization of skills and reflective solutions	CR 04

4-2	Local strategies and innovations in Environmental Protection- Part 1 Local strategies and innovations in Environmental Protection- Part 2
4-3	Active Participation in the resolution of Environmental Challenges-part 1 Active Participation in the resolution of Environmental Challenges-part 2
4-4	Motivational Sustainability Environmental Sustainability – the conclusion

#### LEARNING RESOURCE DETAILS

LR Code	Title Author	Edition Year	ISBN Publisher
01. Text-Books			
02. Reference-Books:			
03. CD / DVD:			
04. Web Links:	<a href="https://swayam.gov.in/nd2_nou20_ag12/preview">https://swayam.gov.in/nd2_nou20_ag12/preview</a>		

## EVS022

### COURSE INFORMATION

Sem	Code	Course Name	CR	CST	ST	CA	EE	TM	Type

02	EVS022	Environmental Chemistry	4	08	120	20	80	100	T
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**PRESUMED KNOWLEDGE AND LEARNING OBJECTIVES**

Presumed Knowledge	Learning Objectives
<p>For successful completion of this course, student should have successfully completed:</p> <ul style="list-style-type: none"> <li>Candidates with B.Sc./ B.Sc.(Agri)/B.E./B.Tech./B. Pharm. Degree or Equivalent pass</li> </ul>	<p>After successful completion of this course, student should be able to</p> <ul style="list-style-type: none"> <li>To develop an understanding of chemicals and their effects on the environment.</li> <li>To learn basic chemical content in context.</li> <li>To design and carry out field research.</li> <li>To understand how business and government policies toward chemicals in the environment effect the planet.</li> </ul>

**UNITS AND DETAILED SYLLABUS**

UN	Detailed Syllabus of the Unit	CR
1-1	<b>Fundamentals of Environmental Chemistry:</b> Stoichiometry, Gibbs energy, chemical potential, chemical equilibria, acid-base reactions, solubility product, solubility of gases in water, the carbonate system, unsaturated and saturated hydrocarbons, radio nuclides.	CR 01
1-2	<b>Soil Chemistry:</b> Inorganic and organic components of soil, chemical properties of soil-saline. Acidic and alkaline soils, micro and macro nutrients of soil, nitrogen, phosphorus and Potassium Pathways in the soil.	
1-3	<b>Chemical composition of Air and Water:</b> Classification of elements, chemical speciation, ions and radicals in the atmosphere. Chemical processes for formation of inorganic and organic particulate matters. Thermo chemical and photochemical reactions in the atmosphere. Toxic chemicals in the environment.	
1-4	<b>Properties of water, water pollutants -</b> Sources & types, heavy metals, metalloids, types of reactions in various water bodies including marine environment.	
		CR 02
2-1	<b>Radioactivity, it's Types, Sources and Hazards:</b> Definition, sources, types, Alpha Particle ( $\alpha$ ), Beta Particle ( $\beta$ ), Gamma Radiation ( $\gamma$ ), Positron Emission ( $\beta^+$ decay) and Electron Capture, Nuclear Fission Laws of radioactivity, Uses of Radioactivity, Advantages and Disadvantages of Radioactivity.	
2-2	Laws of radioactivity, Uses of Radioactivity, Advantages and Disadvantages of Radioactivity.	
2-3	Biological effects of radiation exposure	
2-4	Protection against occupational exposure, principles of radiation protection and the international framework	
3-1	<b>Water treatment and environmental chemistry</b> 1-Sanitary survey of source, protection of sources, methods of intakes, Unit operation in water treatment; intakes aeration, Coagulation, flocculation.	CR 03

3-2	<b>Water treatment and environmental chemistry 2-</b> Filtration Sedimentation, Disinfection, softening and, Manganese removal, fluoride and DE fluoridation removal, Taste and odor, Storage, Corrosion and corrosion control, Distribution of treated water.	
3-3	<b>Tertiary treatment and Advanced waste water treatments:</b> Total dissolved solids, ion exchange, reverse osmosis dialysis, membrane, filters, carbon adsorption, phosphorus removal, nitrogen removal	
3-4	<b>Classical Methods:</b> Basic concepts and techniques, titrimetric analysis - Primary standards acid base titration, oxidation - reduction methods, eudiometry. Electro- analytical Methods: Basic electronic and instrumentation, conductometry, potentiometers Glass-electrode, pH-Ion selective electrode, Voltammetry- Polarography and Dropping Mercury Electrode.	
4-1	<b>Toxic chemicals:</b> Pesticides, their classification and effects.	<b>CR 04</b>
4-2	<b>Biochemical aspects</b> of heavy metals (Hg, Cd, Pb, Cr) and metalloids (As, Se). CO, O <sub>3</sub> , PAN, VOC and POP.	
4-3	Contaminants and their natural pathways of degradation and their abatement	
4-4	Carcinogens in the air	

#### LEARNING RESOURCE DETAILS

LR Code	Title Author	Edition Year	ISBN Publisher
01. Text-Books	1. A Text book of Environmental Science - Prabhat Patnaik 2. A Textbook of Environmental Sciences - Purohit 3. Elements of Environmental Chemistry – J. Hussain 4. Environmental Instrumentation and Analysis Handbook – R.D. Down and J.H. Lehr 5. Environmental Analysis and Instrumentation - N. Rajvaidya and D. K. Markande 6. Environmental Monitoring and Analysis - Dr. Aradhana Salpekar		
02. Reference-Books:			
03. CD / DVD:			
04. Web Links:			

## EVS023

### COURSE INFORMATION

Sem	Code	Course Name	CR	CST	ST	CA	EE	TM	Type
02	EVS023	Environmental geosciences and Computer Applications	4	08	120	20	80	100	T

### PRESUMED KNOWLEDGE AND LEARNING OBJECTIVES

Presumed Knowledge	Learning Objectives
<p>For successful completion of this course, student should have successfully completed:</p> <ul style="list-style-type: none"><li>Candidates with B.Sc./ B.Sc.(Agri)/B.E./B.Tech./B. Pharm. Degree or Equivalent pass.</li></ul>	<p>After successful completion of this course, student should be able to</p> <ul style="list-style-type: none"><li>describe the scientific method as applied in the earth sciences; and</li><li>explain the hydrologic cycle and theory of plate tectonics as related to natural hazards and earth resources; and</li><li>describe common earth materials and their relationship to environmental hazards; and</li><li>explain how earth processes create hazards to life and property; and</li><li>describe the occurrence and formation of earth resources and significant environmental effects caused by their extraction, processing, and use; and</li><li>describe the major sources of water, soil, and sediment pollution and methods for their management; and</li><li>explain the causes and effects of global climate change.</li></ul>

### UNITS AND DETAILED SYLLABUS

UN	Detailed Syllabus of the Unit	CR
1-1	<b>Principles:</b> Scope and necessity, origin of the earth, earth systems and its interaction – lithosphere, atmosphere, hydrosphere and biosphere,	<b>CR 01</b>
1-2	<b>Interior of the Earth, earth's materials</b> – minerals and their definition. Distribution and abundance of elements in the earth's crust.	
1-3	<b>The earth systems and biosphere:</b> Structure and composition of lithosphere, hydrosphere, atmosphere and biosphere. Geographical classification and zones of Environment. Energy budget of the earth	
1-4	<b>Elements:</b> Concepts of major, trace and REE. Classification of trace elements, mobility of trace elements and geochemical cycles.	

2-1	<b>Biochemical factors</b> in environmental health. Human use, trace elements and health. Possible effects of imbalance of some trace elements. Diseases induced by human use of land.	<b>CR 02</b>
2-2	<b>The Ocean Environment</b> - will focus on the physical dynamics of the ocean basins themselves, the mechanisms that induce changes into this environment and the mechanics behind surface and subsurface wave action.	
2-3	Coastal processes, erosion, and controls	
2-4	Volcanoes: types, hazards, and prediction	
3-1	<b>Climate:</b> General relationship between landscapes, biomes and climate. Climate of India. Indian Monsoon, El Niño, droughts, Tropical cyclones and westerly disturbances. Earthquake and Tsunamis, Volcanoes, Landslides	<b>CR 03</b>
3-2	<b>Remote Sensing in Environmental Monitoring:</b> Principles of remote sensing, its applications in Environmental Monitoring.	
3-3	<b>Concept of remote sensing.</b> EMR & its interaction with matter, aerial photography types, camera, elements of photo interpretation (Aerial photography image recognition),	
3-4	<b>Geographical Information System (GIS):</b> Concept of GIS, types of geographical data, data structure, vector and raster data, their advantages and disadvantages, Input, verification, storage and output of geographical data. Importance of geographical information system in environmental studies	
4-1	<b>Information and communication technology in Environmental Science:</b> National Management Information System (NMIS), Environmental Information System (ENVIS), Use of common computer application software in biology: word processing, spreadsheets, graphics and data base	<b>CR 04</b>
4-2	<b>Introduction to web browsing</b> software and search engines with special reference to online environmental resources.	
4-3	<b>Computer applications in environmental modelling:</b> Computer-based modelling: Linear, regression, validation and forecasting	
4-4	<b>Computer-based modelling</b> for population and population studies	

#### LEARNING RESOURCE DETAILS

LR Code	Title Author	Edition Year	ISBN Publisher
01. Text-Books	1. A TB of Geology-S.Rao 2. Environmental Science -Santra 3. A Text book of Environmental Science -Prabhat Patnaik		

	<p>4. A Textbook of Environmental Sciences-Purohit</p> <p>1. Biostatistics: A Guide to Design, Analysis and Discovery, 2nd Edition</p> <p>2. Environmental Statistics (Handbook of Statistics) - Ganapati P. Patil and C. Radhakrishna Rao</p> <p>3. Environmental Statistics - Books LLC</p> <p>4. Scientific Writing: A Reader and Writer's Guide - Lebrun, Jean-Luc</p> <p>5. Scientific Writing - Hall Marian Rose</p> <p>6. From Research to Manuscript: A Guide to Scientific Writing- Michael J. Katz</p> <p>7. Computing Research for Sustainability - Committee on Computing Research for Environmental and Societal Sustainability, Computer Science and Telecommunications Board, Division on Engineering and Physical Sciences and National Research Council</p> <p>8. Statistics for Environmental Science and Management- Manjunatha</p>		
02. Reference-Books:			
03. CD / DVD:			
04. Web Links:			

## EVS024

### Lab Activities on EVS022, EVS023

#### COURSE INFORMATION

Sem	Code	Course Name	CR	CST	ST	CA	EE	TM	Type
02	EVS024	Lab Activities on EVS022, EVS023	4	60	120	20	80	100	P

#### PRESUMED KNOWLEDGE AND LEARNING OBJECTIVES

Presumed Knowledge	Learning Objectives
For successful completion of this course, student should have successfully completed: <ul style="list-style-type: none"><li>Candidates with B.Sc./B.Sc.(Agri)/B.E./B.Tech./B. Pharm. Degree or Equivalent pass</li></ul>	After successful completion of this course, student should be able to <ul style="list-style-type: none"><li>Perform various lab activities and test the results</li></ul>

#### UNITS AND DETAILED SYLLABUS

SN	Detailed syllabus of the Unit	Credits
1	Practical's based on: Course 6 – Environmental Chemistry 1. Analysis of Soil and Water: Physical properties, chemical properties, nutrients, bacterial parameters. 2. Conductivity of soil 3. Analysis of Total hardness of water. 4. Estimation of halides in water samples.	CR01
2	5. Estimation of sulphates in water samples. 6. Estimation of carbon di-oxide in water samples. 7. Estimation of non-respirable dust in air using dust sampler 8. Estimation of respirable dust in air using dust sampler	CR02
3	Practical's based on : Course 7- Environmental Geosciences & Computer Applications 1. Studies of models of various rock types. 2. Study of geological maps. 3. BOD and COD. 4. Study of various ground water sources and its quality. 5. Wind rose. 6. Study of various meteorological parameters and climate.	CR03
4	7. Student Tests. 8. Correlation and regression. 9. Sample manuscript writing. 11. Study and use of various computer applications/models for environmental use.	CR04

## LEARNING RESOURCE DETAILS

LR Code	Title Author	Edition Year	ISBN Publisher
<b>Text-Books</b>			
EVS022	<b>Environmental Chemistry</b> 1. A Text book of Environmental Science - Prabhat Patnaik 2. A Textbook of Environmental Sciences - Purohit 3. Elements of Environmental Chemistry – J. Hussain		
EVS023	<b>Geosciences-</b> 1. A TB of Geology-S.Rao 2. Environmental Science -Santra 3. A Text book of Environmental Science -Prabhat Patnaik  <b>Computer applications and IT</b> 1. Biostatistics: A Guide to Design, Analysis and Discovery, 2nd Edition 2. Environmental Statistics (Handbook of Statistics) - Ganapati P. Patil and C. Radhakrishna Rao 3. Environmental Statistics - Books LLC		

## Semester 03

### EVS031

#### COURSE INFORMATION

Sem	Code	Course Name	CR	CST	ST	CA	EE	TM	Type
03	EVS031	Environmental monitoring and Energy studies	4	08	120	20	80	100	T

#### PRESUMED KNOWLEDGE AND LEARNING OBJECTIVES

Presumed Knowledge	Learning Objectives
<p>For successful completion of this course, student should have successfully completed:</p> <ul style="list-style-type: none"> <li>Candidates with B.Sc./ B.Sc.(Agri)/B.E./B.Tech./B. Pharm. Degree or Equivalent pass</li> </ul>	<p>After successful completion of this course, student should be able to</p> <ul style="list-style-type: none"> <li>Understand environmental monitoring and energy studies</li> <li>Explain environmental quality aspects and its assessment</li> <li>develop analytical skills including defining a problem, selecting appropriate variables, evaluating the data, as well as they are able to use the appropriate procedures for monitoring various environmental compartments.</li> </ul>

#### UNITS AND DETAILED SYLLABUS

UN	Detailed Syllabus of the Unit	CR
1-1	<b>Environmental Quality Assessment and Monitoring:</b> What is environmental quality? Quality of environment for life on earth and man. Deterioration of environmental quality with reference to anthropogenic impact.	<b>CR 01</b>
1-2	Methods of assessment of environmental quality, short term studies, surveys, rapid assessment continuous short and long term monitoring.	
1-3	<b>Environmental Impact Assessment:</b> Need of EIA, scope and objectives, types of environmental impacts, steps involved in conducting the EIA studies.	
1-4	<b>Environmental Impact Assessment Techniques</b> - Ad-hoc method, checklist method, overlay mapping method, network method, simulation and modeling technique, matrix method, diagram technique, matrix method, and system diagram technique, Merits and Demerits of EIA studies.	
2-1	<b>About Energy:</b> Present status of energy use patterns in India. Population and energy demand, energy use pattern in rural and urban area, impact of growing population on energy use, changing life style and energy use.	<b>CR 02</b>
2-2	Energy profile of oil and natural gas, Indian production and reserves, nuclear option, role of IRDA & MEDA in energy generation.	

2-3	Energy resources and their exploitation: Sun as source of energy - nature of its radiation, Conventional energy sources: coal, oil, and nature gas, non-conventional energy sources: hydroelectric power, tidal, wind, geothermal energy, solar collectors, photovoltaics, solar ponds, nuclear-fission and fusion, magneto-hydrodynamic power (MHD).	
2-4	Energy use pattern in different parts of the world and its impact on the environment. CO2 emission in atmosphere.	
3-1	<b>Bio catalysis and nonconventional energy:</b> Biocatalysts, green chemistry in industries, fuel cell and electric vehicles, solar energy and hydrogen production, energy from alternate sources; Solar photovoltaic technology.	
3-2	<b>Biofuel production (bio-ethanol and biodiesel),</b> Biomass, prevention/minimization of hazardous/toxic products. Agricultural related practices and food processing.	<b>CR 03</b>
3-3	<b>Production of biodegradable materials,</b> concept of green building, and pollution free engineering processes.	
3-4	<b>Energy Use:</b> Relationship among energy, environment and economical level of development. Resources of energy and energy use pattern in different parts of the world. Indian energy scenario and its impact on the environment	
4-1	<b>Energy Conservation and Energy Economics:</b> Energy efficiency at national level, improving energy efficiency, energy analysis, concept of exergy (theoretical treatment), capital recovery factor, levelised annual cost, economic analysis of wind electric generation and thermal power systems.	<b>CR 04</b>
4-2	<b>Solid wastes:</b> Definition, types, sources, characteristics, and impact on environmental health. Waste generation rates. Concepts of waste reduction, recycling and reuse. Collection, segregation and transport of solid wastes. Handling and segregation of wastes at source. Collection and storage of municipal solid wastes.	
4-3	<b>Solid waste processing technologies:</b> Mechanical and thermal volume reduction. Biological and chemical techniques for energy and other resource recovery. Composting, vermin composting and incineration of solid wastes.	
4-4	<b>Disposal in landfills -</b> site selection, design, and operation of sanitary landfills, secure landfills & landfill bioreactors, leachate & landfill gas management, landfill closure & post-closure environmental monitoring and landfill remediation	

#### LEARNING RESOURCE DETAILS

LR Code	Title Author	Edition Year	ISBN Publisher
01. Text-Books	1. Environmental Modeling with GIS and Remote Sensing-Skidmore 2. Dynamic Modeling of Environmental Systems (Modeling Dynamic Systems)-Michael Deaton and James J. Winebrake 3. Geographic Information Systems and		

	<p>Environmental Modeling by Clarke Keith C.,  Parks Bradley O. and Crane Michael P</p> <p>4. Remote Sensing and GIS - Atiqur Rahman</p> <p>5. Basics of Remote Sensing and GIS - Dr. S. Kuma</p> <p>6. Fundamentals of Remote Sensing - George Dr. Joseph</p> <p>7. Datums and Map Projections for Remote Sensing GIS and Surveying - Jonathan C. Iliffe</p> <p>1. Energy Security and Environmental Sustainability - Surya NarainYadav</p> <p>2. Energy and Environment: Technological Challenges for the Future - Y.H. Mori and K. Ohnishi Non-conventional Energy Sources - G.D. Rai</p> <p>3. Energy Explained: v. 1&amp;2: Conventional Energy and Alternative – VikramJanardhan and Bob Fesmire</p> <p>4. Non-Conventional Energy System - S.K. Agarwal</p> <p>5. An Introduction to Environmental Energy Resources - Manjunatha</p>		
02. Reference-Books:			
03. CD / DVD:			
04. Web Links:			

## EVS032

### COURSE INFORMATION

Sem	Code	Course Name	CR	CST	ST	CA	EE	TM	Type
03	EVS032	Instrumentation and lab techniques	4	08	120	20	80	100	T

#### PRESUMED KNOWLEDGE AND LEARNING OBJECTIVES

Presumed Knowledge	Learning Objectives
<p>For successful completion of this course, student should have successfully completed:</p> <ul style="list-style-type: none"> <li>Candidates with B.Sc./ B.Sc.(Agri)/B.E./B.Tech./B. Pharm. Degree or Equivalent pass</li> </ul>	<p>After successful completion of this course, student should be able to</p> <ul style="list-style-type: none"> <li>Develop and practice observational skills</li> <li>Prepare for laboratory work</li> <li>Prepare professional scientific reports</li> <li>Prepare samples and standards for analysis</li> <li>Operate Scientific Instruments</li> <li>Develop team work to divide project duties ensuring efficiency and quality of the final results</li> <li>Design templates using spreadsheets</li> <li>Use electronic forms of communication</li> <li>Critically search the scientific literature for information</li> </ul>

#### UNITS AND DETAILED SYLLABUS

UN	Detailed Syllabus of the Unit	CR
1-1	<b>Instrumentation</b> - Introduction, scope, use, limitations ,safety	<b>CR 01</b>
1-2	<b>Study of machinery, electric motors</b> types and characteristics, other prime covers, pumps, capacity, operation and maintenance of pumping machinery, air compressors preventive maintenance, break-down maintenance, schedules – Factors to be considered in the selection of the equipments.	
1-3	<b>Drilling equipment, pumping equipment</b> for wells. Machinery required for primary and secondary treatment, sewage pumps, sludge pumps, vacuum filtration equipment.	
1-4	<b>Calorimetry and Spectrophotometry:</b> Components and working of spectra photometer, Beer, Lerner's Law.  Flame techniques: Flame photometer and Atomic Absorption Spectrophotometer  Superlative Techniques: Solvent extraction, Ion Exchange Chromatography, Gas chromatography, High pressure Liquid Chromatography, Thin Layer Chromatography, NMR Spectroscopy,Polarography ,UV visible spectrophotometry,ICP emission spectroscopy,infra red spectroscopy	

2-1	<b>Microscopy</b> -Introduction, Fundamentals of optics, Optical microscope and its instrumental details, Variants in the optical microscopes and image formation	<b>CR 02</b>
2-2	Phase contrast,Polarised light, Differential interference contrast, Fluorescence microscopy, Sample preparation and applications	
2-3	Introduction to Scanning electron microscopy, Instrumental details and image formation	
2-4	Various imaging techniques , Sample preparation and Applications	
3-1	<b>Nanotechnology</b> -Introduction,definition,use,scope,limitation	<b>CR 03</b>
3-2	<b>Nanomaterials</b> -Remediation, Nano Membranes, Nano Fibers, Nano Clays Adsorbents, Zeolites, Nano Catalysts, Carbon Nano tubes,	
3-3	<b>Environmental Nano Remediation Technology</b> - Thermal, Physico-Chemical, and Biological Methods	
3-4	<b>Nano Filtration</b> for the Treatment of Wastes, Removal of Organics, Inorganics and Pathogens, Nanotechnology for Water Purification.	
4-1	<b>Laboratory safety</b> - Introduction, Safety training-General lab safety ,emergency management, waste management, chemical safety, biosafety, radiation safety, LASER safety, gas safety, fume hood safety,electrical safety	<b>CR 04</b>
4-2	<b>Personal Protective Equipment [PPE]</b> - Introduction, hazard assessment, eye and face protection, head protection, hand protection, protective clothing, respiratory protection, hearing protection, foot protection	
4-3	<b>Administrative controls</b> - Orientation and controls, Standard operating procedures, safety signs, housekeeping, eating, drinking and applying cosmetics in the lab, working alone, unattended operations, lab security and good lab practices.	
4-4	<b>Response to specific incidents/ accidents</b> - Accidents resulting in personal injury and contamination, fires and explosion, chemical spills, earthquake response, gas leaks or other odors, utility outage, other emergencies	

#### LEARNING RESOURCE DETAILS

LR Code	Title Author	Edition Year	ISBN Publisher
01. Text-Books	Instrumental methods of chemical analysis B. K.Sharma Instrumental methods of analysis Willard,Meritt, Dean and Settle. Handbook of Analytical Instruments Khandpur R.S. Microbiology- A Laboratory Manual(International Students Edition) James G		

	(appuccina&NatalieSherman Addison		
02. Reference- Books:			
03. CD / DVD:			
04. Web Links:			

## EVS033

### COURSE INFORMATION

Sem	Code	Course Name	CR	CST	ST	CA	EE	TM	Type
03	EVS033	Environmental Microbiology and Toxicology	4	08	120	20	80	100	T

### PRESUMED KNOWLEDGE AND LEARNING OBJECTIVES

Presumed Knowledge	Learning Objectives
<p>For successful completion of this course, student should have successfully completed:</p> <ul style="list-style-type: none"> <li>Candidates with B.Sc./ B.Sc.(Agri)/B.E./B.Tech./B. Pharm. Degree or Equivalent pass</li> </ul>	<p>After successful completion of this course, student should be able to-</p> <ul style="list-style-type: none"> <li>to determine the role of microbes</li> <li>learn the basic microbiological principles, the methods in microbial ecology and their theoretical and practical use.</li> <li>recognize the ecological problems and critical evaluation of the human impacts on pollution, climate changes and as well as environmental protection.</li> <li>gain appreciation for the fact that life is dependent on an ongoing series of chemical reactions.</li> <li>analyze toxicological risks versus benefits with the understanding of basic toxicological principles.</li> </ul>

### UNITS AND DETAILED SYLLABUS

UN	Detailed Syllabus of the Unit	CR
1-1	<b>Environmental Microbiology:</b> Introduction to Microbiology –Definition, history, scope, limitations	<b>CR 01</b>
1-2	<b>Microbial diversity and Metabolism:</b> Microbial structure, classification according to nutrition, anaerobiosis, chemolithotrophy, photosynthesis and Nitrogen Fixation, Determination of microbial numbers, biomass and activities, Microbial numbers, Direct and viable count procedures, biochemical methods, microbial biomass	
1-2	<b>Microbial activities:</b> Photosynthesis, respiration, heterotrophic potential, specific enzyme assays,	
1-3	<b>Microbial population and community dynamics:</b> Microbial growth in closed and open environments, Methods for enriching, isolating and analyzing microbial communities in laboratory system	
	<b>Effects and measurement of environmental determinants:</b>	

1-4	Temperature, radiation, salinity, moisture activity, redox potential, magnetism, etc. Biological interactions, interactions between microorganisms, interactions of microorganisms with plants and animals, siderophores as iron chelating agents. Concept of bio-surfactants.	
2-1	<b>Bio-indicators:</b> What are bio indicators? Plankton community as indicators of water pollution; use of diversity index in evaluation of water quality.	CR 02
2-2	<b>Determination of microbiological quality</b> of recreational and potable waters, indicator organisms, coliforms and E.coli, fecal streptococci, clostridia, and heterotrophic plate counts etc. lichens as air pollution indicators.	
2-3	<b>Biosensor:</b> What is a biosensor? Components, advantages and limitations, biocatalyst based, ion-affinity based and microorganism based biosensors; Applications of biosensors in environmental monitoring.	
2-4	<b>Bio-transformation, bio-accumulation and bio-magnification:</b> Principles, receptor sites absorption and storage of xenobiotics, types of bio-transformations, toxico-genomics and pharmacogenomics.	
3-1	<b>Toxicology:</b> Definition and scope, acute and chronic toxicity, selective toxicity, does synergism and antagonism. Toxic chemicals in the environment and biochemical aspects of As Cd, Pb, Hg, CO, O <sub>3</sub> , PAN, pesticides.	CR 03
3-2	<b>Environmental Toxicology - 1:</b>  T acute, chronic toxicity, LC 50, LD 50, I NOEL - Concepts and significance, their estimation, Chemical Pharmacological basis of toxicity, Toxic effects at cell, tissue, organ level, Some organ specific toxicity studies -Neurotoxicity, Nephrotoxicity, Hepatotoxicity, Radioactive toxicity	
3-3	<b>Nontoxicity</b> - Mutations, mutagenic agents, mechanism of mutagenesis, Detection of nontoxicity - DNA, GENE, CHROMOSOME LEVEL,	
3-4	<b>CARCINOGENESIS</b> -Relation between mutagenesis and carcinogenesis,  Environmental carcinogens, toxicology-scope, Definition, Evaluation of toxicity-routes of exposure.	

4-1	<b>Environmental Toxicology - 2:</b> Toxic agents in environment pesticides, agrochemicals, industrial chemicals, drugs, food additives, chemical structure - function relationship	<b>CR 04</b>
4-2	<b>Safety regulations</b> , legal control, population monitoring for toxic end points. Influence of ecological factors on the effects of toxicity, concept of green chemistry.	
4-3	<b>Pollution of the ecosphere</b> by industries, global dispersion of toxic substance, dispersion and circulating mechanisms of pollutants.	
4-4	<b>Degradable and non- degradable</b> toxic substances and food chain.	

#### LEARNING RESOURCE DETAILS

LR Code	Title Author	Edition Year	ISBN Publisher
01. Text-Books	Microbiology By; Michael J. Pelezar, Jr; ECS Chan &NR.Krieg. Principles of Microbiology - Ronald M. Atlas, 1. Environmental Microbiology - Ralph Mitchell and Ji-Dong Gu 2. Environmental Microbiology: A Laboratory Manual - Ian L. Pepper and Charles P. Gerba 3. Environmental Microbiology - Alan H. Varnam and Malcolm G. Evans 4. Environmental Microbiology - Annette Bolger 5. Environmental Microbiology - PurnimaSethi and V.S. Kulkarni 6. Environmental Microbiology: Methods and Protocols - Spencer 7. Environmental Microbiology- BanwariLal		
02. Reference-Books:			
03. CD / DVD:			
04. Web Links:			

## EVS034

### Lab Activities on EVS031, EVS032, EVS033

#### COURSE INFORMATION

Sem	Code	Course Name	CR	CST	ST	CA	EE	TM	Type
03	EVS034	Lab Activities on EVS031, EVS032, EVS033	4	60	120	20	80	100	P

#### PRESUMED KNOWLEDGE AND LEARNING OBJECTIVES

Presumed Knowledge	Learning Objectives
For successful completion of this course, student should have successfully completed: <ul style="list-style-type: none"><li>Candidates with B.Sc.(Agri)/B.E./B.Tech./B. Degree or Equivalent pass B.Sc./Pharm.</li></ul>	After successful completion of this course, student should be able to <ul style="list-style-type: none"><li>Perform various lab activities and test the results</li></ul>

#### UNITS AND DETAILED SYLLABUS

Sn	Detailed syllabus of the Unit	Credits
1	Practical's based on: Course 9 – Environmental Monitoring and Energy Studies 1. Interpretation of Aerial photographs and preparing weather report based on it. 2. Determination of relative humidity from the atmosphere. 3. Determination of particulate matter from the industrial area by High Volume Sampler/Settling method. 4. Determination of Salinity of water by volhard's method. 5. Determination of Cation-exchange capacity, moisture content, alkalinity/acidity of soil sample. 6. To prepare the station based wind rose for an area. 7. Determination of Residual Chlorine from drinking water using colorimetric method. 8. Determination of hydrocarbon from fuel gas using Orsat's apparatus.	CR01
2	9. Study of solar cells. 10. Conversion of biomass to alcohol. 11. Case studies on energy efficiency analysis. 12. Study of various agro wastes as substrates for biofuel production. 13. Biological degradation of recalcitrant biomass. 14. Case studies on energy use patterns across the globe.	CR02
3	Practical's based on : Course 10- Instrumentation and Lab Techniques <u>15. Chromatography</u> a. Separation of a mixture of two amino acids by ascending and horizontal paper chromatography b. Separation of a mixture of two sugars by ascending paper chromatography c. Separation of a mixture of o-and p-nitrophenol or o-and p-aminophenol by thin layer chromatography (TLC) <u>16. UV/Visible spectroscopy</u>	CR03

	<p>I. Study the 200-500 nm absorbance spectra of <math>\text{KMnO}_4</math> and <math>\text{K}_2\text{Cr}_2\text{O}_7</math> (in 0.1 M <math>\text{H}_2\text{SO}_4</math>) and determine the <math>\lambda_{\text{max}}</math> values. Calculate the energies of the two transitions in different units (<math>\text{J molecule}^{-1}</math>, <math>\text{kJ mol}^{-1}</math>, <math>\text{cm}^{-1}</math>, <math>\text{eV}</math>).</p> <p>II. Study the pH-dependence of the UV-Vis spectrum (200-500 nm) of <math>\text{K}_2\text{Cr}_2\text{O}_7</math>.</p> <p>III. Record the 200-350 nm UV spectra of the given compounds (acetone, acetaldehyde, 2-propanol, acetic acid) in water. Comment on the effect of structure on the UV spectra of organic compounds.</p> <p><u>17.Colourimetry</u></p> <p>I. Verify Lambert-Beer's law and determine the concentration of <math>\text{CuSO}_4/\text{KMnO}_4/\text{K}_2\text{Cr}_2\text{O}_7</math> in a solution of unknown concentration</p> <p>II. Determine the concentrations of <math>\text{KMnO}_4</math> and <math>\text{K}_2\text{Cr}_2\text{O}_7</math> in a mixture.</p> <p>III. Study the kinetics of iodination of propanone in acidic medium.</p> <p>IV. Determine the amount of iron present in a sample using 1,10-phenanthroline.</p> <p>V. Determine the dissociation constant of an indicator (phenolphthalein).</p> <p>VI. Study the kinetics of interaction of crystal violet/ phenolphthalein with sodium hydroxide.</p> <p>VII. Analysis of the given vibration-rotation spectrum of <math>\text{HCl}(\text{g})</math></p> <p><u>18.Microscopy</u></p> <p>Study of different microscopes</p> <p>Microscopy-</p> <p>Preparation of media for microbial culture, Isolation and culturing of microbes from soil / water samples, Gram Staining.</p>	
4	<p>Practical's based on : Course 11- Environmental Microbiology and Toxicology</p> <p><u>19.Microbiology</u></p> <p>1. Isolation and enumeration of microbes from environmental samples.</p> <p>2. Cultural characteristics of isolated microbes.</p> <p>3. Evaluation of anti-microbial chemical agents.</p> <p>4. Effect of environment on microbes.</p> <p>5. Determination of Bi-phasic growth curve.</p> <p>6. Enrichment of purple non-sulphur bacteria.</p> <p><u>20.Toxicology</u></p> <p>1. Estimation of metals in soil, plants and animal tissue.</p> <p>2. Estimation of reducing sugars in toxic waste.</p> <p>3. Estimation of protein from toxic waste.</p> <p>4. Case studies on environmental effects of pesticides.</p> <p>5. Modeling of pollutant dispersion.</p> <p>6. Toxico-genomic and pharmaco-genomic evaluation of pollutants.</p>	<b>CR04</b>

#### LEARNING RESOURCE DETAILS

LR Code	Title Author	Edition Year	ISBN Publisher
<b>Text-Books</b>			

EVS031	<p><b>Environmental monitoring-</b></p> <ol style="list-style-type: none"> <li>1. Air Environment and Pollution -Purohit</li> <li>2. Environment and Water Pollution cause Effect and Control- Noor</li> <li>3. Environmental Law and Pollution Control -P.N.Prasad</li> </ol> <p><b>Energy studies-</b></p> <ol style="list-style-type: none"> <li>1. Energy and Environment: Technological Challenges for the Future - Y.H. Mori and K. Ohnishi</li> <li>2. Non-conventional Energy Sources - G.D. Rai</li> <li>3. Energy Explained: v. 1&amp;2: Conventional Energy and Alternative –VikramJanardhan and Bob Fesmire</li> <li>4. Non-Conventional Energy System - S.K. Agarwal</li> </ol>		
EVS032	<ul style="list-style-type: none"> <li>•Khosla, B. D.; Garg, V. C. &amp; Gulati, A., Senior Practical Physical Chemistry, R. Chand &amp; Co.: New Delhi (2011).</li> <li>• Garland, C. W.; Nibler, J. W. &amp; Shoemaker, D. P. Experiments in Physical Chemistry 8th Ed.; McGraw-Hill: New York (2003).</li> <li>• Halpern, A. M. &amp; McBane, G. C. Experimental Physical Chemistry 3rd Ed.; W.H. Freeman &amp; Co.: New York (2003).</li> <li>• Mann, F.G. &amp; Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)</li> <li>•Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson (2012)</li> </ul> <ol style="list-style-type: none"> <li>1. Microbiology, Pelzer, M. J. Chan, E.C.S. and Kreig, N. R. McGraw-Hill Publishing Company.</li> </ol>		

	2. Wastewater Microbiology, Bitton, G., John Wiley, NY.		
EVS033	<p>1. Environmental Microbiology - Ralph Mitchell and Ji-Dong Gu</p> <p>2. Environmental Microbiology: A Laboratory Manual - Ian L. Pepper and Charles P. Gerba</p> <p>3. Environmental Microbiology - Alan H. Varnam and Malcolm G. Evans</p> <p><b>Toxicology-</b></p> <p>1. Environmental Toxicology set of 3 volumes- Peter Gomes</p> <p>2. Aquatic Environment and Toxicology-Pawan Kumar Bhart</p> <p>3. Toxicology: Principles and Methods-Second Revised Edition - M A Subramanian</p>		

## Semester 04

### EVS041

#### COURSE INFORMATION

Sem	Code	Course Name	CR	CST	ST	CA	EE	TM	Type
04	EVS041	Sustainable Management of Biodiversity [MOOC]	4	08	120	20	80	100	T

#### PRESUMED KNOWLEDGE AND LEARNING OBJECTIVES

Presumed Knowledge	Learning Objectives
<p>For successful completion of this course, student should have successfully completed:</p> <ul style="list-style-type: none"><li>Candidates with B.Sc./ B.Sc.(Agri)/B.E./B.Tech./B. Pharm. Degree or Equivalent pass</li></ul>	<p>After successful completion of this course, student should be able to</p> <ul style="list-style-type: none"><li>explore the linkages between biodiversity conservation, ecosystem services and climate change</li><li>relate and state various means of conservation, restoration and sustainable utilization of biodiversity which can provide viable solutions to a range of societal challenges and provides an effective tool to bridge the knowledge gap for sustainable management of biodiversity.</li></ul>

#### UNITS AND DETAILED SYLLABUS

UN	Detailed Syllabus of the Unit	CR
1-1	<b>Prelude to biodiversity</b> Basic concept of Biodiversity, Origin of Species, Value of Biodiversity	<b>CR 01</b>
1-2	Ecosystem Services, Biodiversity in India	
1-3	Introduction to Forest Biodiversity, Biodiversity in Tropical Forest , Biodiversity in Subtropical and Temperate Forest	
1-4	Introduction to Wetland Biodiversity, Biodiversity in Wetland Ecosystem,Extinction of Species	
2-1	<b>Genetic resources</b> Plant Genetic Resources, Centres of Origin of Agro biodiversity	<b>CR 02</b>
2-2	Agrobiodiversity, Crop Domestication	
2-3	Animal Genetic Resources, Fish Genetic Resources	

2-4	Germplasm Characterization and Evaluation, Food Security and Agrobiodiversity	
3-1	<b>Drivers of biodiversity loss</b> Direct Drivers of Biodiversity Loss	<b>CR 03</b>
3-2	Biodiversity Hotspots, Threats to Biodiversity Hotspots in India	
3-3	Impact of Climate Change on Biodiversity	
3-4	Invasive Species as a Threat to Biodiversity, Consequences of Biodiversity Loss	
4-1	<b>Biodiversity conservation and sustainable management</b> Conservation Biology, Germplasm Conservation, In situ Conservation of Biodiversity, Ex situ Conservation Methods, Protected Areas	<b>CR 04</b>
4-2	Sustainable Management of Biodiversity- An Ecosystem Approach, Role of Traditional Knowledge in Biodiversity Conservation, Community Based Ecosystem Conservation, Gender and Biodiversity Conservation	
4-3	International Instruments to Conserve Biological Diversity, Convention of Biological Diversity, Millennium Developmental Goals/Sustainable Development Goals and Biodiversity	
4-4	National Instruments to Conserve Biological Diversity, National Biodiversity Act 2002, Governance of Biodiversity in India	

#### LEARNING RESOURCE DETAILS

LR Code	Title Author	Edition Year	ISBN Publisher
01. Text-Books	Primack, R.B., 2002, Essentials of Conservation Biology, 3rd Edn., Sinauer Associates, Sunderland, Ma. USA  Gaston, K J. and J.I. Spicer, 1998, Biodiversity: An Introduction. Blackwell Science, London, UK.  Wilson, Edward O., 1993, Diversity of Life. Harvard University Press, Cambridge, MA.		
02. Reference-Books:			
03. CD / DVD:			
04. Web Links:	<a href="https://swayam.gov.in/nd2_nou20_bt02/preview">HTTPS://SWAYAM.GOV.IN/ND2_NOU20_BT02/PREVIEW</a>		

## EVS042

### COURSE INFORMATION

Sem	Code	Course Name	CR	CST	ST	CA	EE	TM	Type
04	EVS042	Statistical Approaches and Modelling in Environmental Sciences	4	08	120	20	80	100	T

### PRESUMED KNOWLEDGE AND LEARNING OBJECTIVES

Presumed Knowledge	Learning Objectives
For successful completion of this course, student should have successfully completed: <ul style="list-style-type: none"><li>Candidates with B.Sc./B.Sc.(Agri)/B.E./B.Tech./B. Pharm. Degree or Equivalent pass</li></ul>	After successful completion of this course, student should be able to <ul style="list-style-type: none"><li>Apply statistics to solve environmental problems</li><li>develop models based on the mass-balance approach</li><li>predict the impact of the of external waste loading on different environmental matrices</li><li>predict and generate future conditions under various loading scenarios or management/intervention action alternatives</li></ul>

### UNITS AND DETAILED SYLLABUS

UN	Detailed Syllabus of the Unit	CR
1-1	Basics of Statistics: Sampling data, types of data, method of collection and recording	CR 01
1-2	Statistical methods: Measures of central tendencies - mean, median, mode.	
1-3	Dispersion: measures of dispersion range, quartile, deviation, mean deviation and standard deviation, Absolute and relative measures of dispersion, skewness and	
1-4	Probability: Sample space, events, types of events, algebra of events, probability of an event, addition and multiplication of law, conditional probability, random Variable, probability distribution of R.V. mean and Variance of r.v	
2-1	Correlation:- Types of correlation, method of studying correlation, scathes diagram, Karl person's Coefficient of correlation, Spearman's Rank correlation, multiple.	CR 02
2-2	Regression: Uses of regression and properties.	
2-3	Testing of hypothesis: Meaning, Types of hypothesis, level of significance, large sample list of mean, proportions, equality of means.	
2-4	Bioassay- Principle, history, classification, examples	

3-1	Introduction-Environmental modelling: scope and problem definition, goals and objectives, definition; modelling approaches– deterministic, stochastic and the physical approach; applications of environmental models; the model building process	CR 03
3-2	Models in environmental science emphasizing (a) linear models(mathematical principles, time evolution operator, eigenvalues and eigenvectors; Markov chains),	
3-3	(b) chemical transport models including basic principles and numerical methods,	
3-4	(c) inverse modeling (optimal estimation, Kalman filter, adjoint methods).	
4-1	Elementary concepts, laws , theories and processes	CR 04
4-2	The building blocks: extensive and intensive properties, properties relevant to of environmental systems, the material balance approach; the transport processes– advection, diffusion, dispersion, gravitational settling, transport in porous media; the transformation processes–the non-reactive processes, the reactive processes; simulation of transport and transformation processes–introduction, the completely stirred tank reactor, plug flow reactor, mixed flow reactor models; the general material balance models	
4-3	Environmental modelling - applications  Water quality modelling: surface water quality modelling – lakes and impoundments, rivers and streams, estuaries; ground water pollution modelling.	
4-4	Air quality modelling: the box model, the Gaussian plume model  point sources, line sources, area sources; special topics; Gaussian puff model	

**LEARNING RESOURCE DETAILS**

LR Code	Title Author	Edition Year	ISBN Publisher
01. Text-Books	1. Biostatistics: A Guide to Design, Analysis and Discovery, 2nd Edition 2. Environmental Statistics (Handbook of Statistics) - Ganapati P. Patil and C. Radhakrishna Rao 3. Environmental Statistics - Books LLC		

	<p>4. Scientific Writing: A Reader and Writer's Guide - Lebrun, Jean-Luc</p> <p>5. Scientific Writing - Hall Marian Rose</p> <p>6. From Research to Manuscript: A Guide to Scientific Writing- Michael J. Katz</p> <p>7. Computing Research for Sustainability - Committee on Computing Research for Environmental and Societal Sustainability, Computer Science and Telecommunications Board, Division on Engineering and Physical Sciences and National Research Council Statistics for Environmental Science and Management- Manjunatha</p> <p>Environmental Modelling: Finding Simplicity in Complexity, Second Edition Editor(s): John Wainwright Mark Mulligan First published:31 January 2013 ISBN:9780470749111  Online ISBN:9781118351475  </p> <p>10.Introduction to Environmental Modeling William G. Gray, University of North Carolina, Chapel Hill, Genetha A. Gray, Intel Corporation</p>		
02. Reference-Books:			
03. CD / DVD:			
04. Web Links:			

## EVS043

### COURSE INFORMATION

Sem	Code	Course Name	CR	CST	ST	CA	EE	TM	Type
04	EVS043	Environmental issues and Human Health	4	08	120	20	80	100	T

#### PRESUMED KNOWLEDGE AND LEARNING OBJECTIVES

Presumed Knowledge	Learning Objectives
For successful completion of this course, student should have successfully completed: <ul style="list-style-type: none"><li>Candidates with B.Sc./B.Sc.(Agri)/B.E./B.Tech./B. Pharm. Degree or Equivalent pass.</li></ul>	After successful completion of this course, student should be able to <ul style="list-style-type: none"><li>Analyze various environmental issues</li><li>Recognize different diseases due to environmental changes</li></ul>

#### UNITS AND DETAILED SYLLABUS

UN	Detailed Syllabus of the Unit	CR
1-1	Environmental pollution-Air pollution: Definition, sources and classification of air pollutants. Transport and diffusion of pollutants, effect of air pollution on man and climate. Ambient air quality standards and air pollution indices.	CR 01
1-2	Air sampling and monitoring techniques - settle able and suspended particulate matter - dust fall jar and impingement method, high volume air sampler	
1-3	Noise Pollution: Definition, sources and terminology; types of noise; Measurement of noise; Noise indices, noise exposure level and impact on Human beings and climate.	
1-4	Noise control and abatement measures.	
2-1	Aquatic Pollution: Definition, sources and classification of aquatic pollutants. Consequences of pollution on surface, subsurface and mariner water sources.	CR 02
2-2	Soil Pollution – definition, sources and classification of soil pollutants and their impact on soil and plants. Bacteriological sampling and analysis of soil quality	
2-3	Radioactive Pollution: Definition, radioactivity, radionuclides, radiation emissions, sources, radioactive decay and buildup.	
2-4	Biological effects of radiation and ecosystem. Radiation exposure standards, radioactive pollution and pollution control measures. Biological dosimetry.	
3-1	Contemporary and emerging environmental issues of local, regional and global significance I: Linkage between population, development & environment and climate change.	CR 03

3-2	Contemporary and emerging environmental issues of local, regional and global significance II: stratospheric Ozone depletion, water resources, environmental toxicants & human health, biodiversity conservation and environmental episodic events etc.	
3-3	Basic principle of environmental health: Physiological responses of man to relevant stresses in the environment, causes and effects of pollution.	
3-4	Industrial Toxicology - study of environmental dose effect relationships. Evaluation of toxicity and threshold limits. Principles and methods of occupational health. The relationship between occupation, hygiene, safety and disease.	
4-1	Health maintenance: Survey, analysis and recommendations regarding health and safety problems in the working and living environment.	CR 04
4-2	Treatment of variation, with demographic, vital statistics and epidemiological data.	
4-3	Hazard evaluation in polluted environment with specific emphasis on radiological health.	
4-4	Environmental and occupational risk assessment-Introduction, definition, measures of control	

#### LEARNING RESOURCE DETAILS

LR Code	Title Author	Edition Year	ISBN Publisher
01. Text-Books	<input type="checkbox"/> Global Environmental Issues - Ed. Frances Harris and Frances Harris <input type="checkbox"/> Global Environmental Issues - K. Jagamohan Reddy <input type="checkbox"/> Global Environmental and Pollution Issues by Dr. AaradhanaSalpekar and Dr. Kadambari Sharma <input type="checkbox"/> The Global Casino: An Introduction to Environmental Issues, Fourth Edition -Nick Middleton <input type="checkbox"/> Global Environmental Change: The Threat to Human Health <input type="checkbox"/> Occupational Health - G. French		
02. Reference-Books:			
03. CD / DVD:			
04. Web Links:			

**EVS044:**  
**Project-Work**

**COURSE INFORMATION**

SN	Description	Details
1	University	YashwantraoChavan Maharashtra Open University Nashik - 422 222, Maharashtra, India  Website: <a href="http://ycmou.digitaluniversity.ac/">http://ycmou.digitaluniversity.ac/</a>
2	School	School of Architecture, Science and Technology
3	Discipline	Science -
4	Level	PG
5	Course Used in	M.Sc.(EVS)

**COURSE INFORMATION**

Sem	Code	Course Name	CR	CST	ST	CA	EE	TM	Type
04	EVS044	Project-Work	4	08	120	20	80	100	PW

**PRESUMED KNOWLEDGE AND LEARNING OBJECTIVES**

Presumed Knowledge	Learning Objectives
<p>For successful completion of this course, student should have successfully completed:</p> <ul style="list-style-type: none"> <li>Candidates with B.Sc./B.Sc.(Agri)/B.E./B.Tech./B. Pharm. Degree or Equivalent pass Knowledge of all above subjects</li> <li>Practical knowledge</li> <li>Research attitude</li> </ul>	<p>After successful completion of this course, student should be able to</p> <ul style="list-style-type: none"> <li>perform experiments independently</li> <li>search the literature</li> <li>construct and present the project work</li> </ul>

**DETAILED ACTIVITIES**

UN	Details of Activities
1	Selection of the Project and Project Guide
2	Preparation of Project Execution Plan : Time and Resource Allocation
3	Guidance by the Project Guide, for the self-study of relevant course topics and concepts by the student.
4	Self-study of relevant course topics and concepts by the student.
5	Preparation of Project Specifications by the student: For (1) User Inputs (2) Outputs for User

	(3) Environmental constraints (4) Other Inputs (5) Other Outputs (6) Other important processes
6	Guidance and approval by Project Guide for Project Specifications: For (1) User Inputs (2) Outputs for User (3) Environmental constraints (4) Other Inputs (5) Other Outputs (6) Other important processes
7	Design, Development, Testing and Troubleshooting of <b>First</b> Prototype–1
8	Design, Development, Testing and Troubleshooting of <b>First</b> Prototype–2
9	Design, Development, Testing and Troubleshooting of First Prototype–3
10	Design, Development, Testing and Troubleshooting of First Prototype–4
11	Design, Development, Testing and Troubleshooting of First Prototype–5
12	Comparison of First Prototype Performance with Set Project Specifications and Preparation of list showing (1) Problems (2) Improvements Needed (3) External Enclosure Details. The Project Guide should guide the student about this task.
13	Design, Development, Testing and Troubleshooting of Final Prototype–1
14	Design, Development, Testing and Troubleshooting of Final Prototype–2
15	Design, Development, Testing and Troubleshooting of Final Prototype–3
16	Design, Development, Testing and Troubleshooting of Final Prototype–4
17	Design, Development, Testing and Troubleshooting of Final Prototype–5
18	Preparation of Project Report and all research documentation like Schematic Drawings, Testing reports, Complete Bill of Material, User Instructions, Artwork and Films, List of Problems encountered etc.–1
19	Preparation of Project Report and all research documentation like Schematic Drawings, Testing reports, Complete Bill of Material, User Instructions, Artwork and Films, List of Problems encountered etc.–1
20	Preparation of Project Report and all documentation like Schematic Drawings, Testing reports, Complete Bill of Material, User Instructions, Artwork and Films, List of Problems encountered etc. and Final submission of the Project Report.

#### DETAILED SYLLABUS

UN	Detailed Syllabus of the Unit
1	The “Project Work” course envisages to expose the students to actual work environment, work practices during the implementation of a project. The aim is to imbibe in students the principle that working is learning. Learning and working are two sides of the same coin and thus, work experience enhances the learning.

2	<b>The Project Work must involve practical research work related to your selected discipline</b>
3	Students are expected to work on “Project Work” for about 6 hours per week (About 2 hour’s self-study at residence and 4 hours in counselling session at study centre), for <b>minimum 20 days</b> in a semester. <b>Thus only those projects, demanding such study efforts on all those activities, listed in above, should be selected.</b>
4	Students have to finance expenditure on “Project Work” by own. Hence students should select those projects, which involve minimum expenditure.
5	The original design requirements <b>are not essential</b> , although highly encouraged. Hence, normally, projects should not be repeated. The same project undertaken in recent past, by past students, should be avoided. But it is most important that, students must put his independent study efforts on the project. Thus, student should gain practical project execution knowledge about making some useful product, after he goes through all projects completion steps listed above.
6	A single student will normally do a project. The university also encourages large Joint projects, requiring the participation of a small team of students. <b>However, in such cases, clear delegation of work and responsibilities, among the students, must be clearly stated in the “Project Report”. Maximum number of students, in a team for joint project, should not exceed 5.</b>
7	The student invests his energy, time and resources in a project. The project therefore should, if possible, have important bearing on some practical aspect. This will help student to justify his efforts on project.
8	Employed Students are allowed to complete “Project Work” in the industry where he is employed or his place of choice. Such a student has to identify a resource person in industry, who can take responsibility of guiding him in project work. Such person should be eligible to work as “ProjectGuide”.
9	Study center should assist unemployed students, in locating sponsored “Projects” from local industries. Students are encouraged to locate sponsored projects from the local industries. <b>But, in case, a student is unable to locate such project, he is also allowed to complete “Project Work” at his study center.</b>
10	Each “Project Guide” may be assigned <b>maximum 5</b> students.
11	<b>Suggested Scheme of Chapters in Project Report:</b>  <b>Chapter 1: Introduction:</b> Background of the project, Need for the project, Brief idea of the project  <b>Chapter 2: System Overview and Design:</b> Present the overview of the complete system. Use Block Diagrams. Specify design parameters for the system. Specify interfacing problems (if any) visualized beforehand, and how to eliminate these. <b>Chapter 3: Module Design:</b> Discuss individual parts (sub-part) in details, clearly indicating the scientific principles involved and design of each sub-circuit used in a project.

	<p><b>Chapter 4: Testing and Troubleshooting:</b> Discuss how the sub-parts were tested, how the complete system was tested and how measurements were made. Include observations.</p> <p><b>Chapter 5: Results and Conclusions:</b> Analyze the observations made in previous chapter. Discuss why the specifications were not met or the reasons for the failure, if any. Discussed the problems and difficulties encountered and how they were / can be eliminated. Discuss any extension work or modifications, which you want to suggest.</p> <p><b>Chapter 6: References:</b> List the books, magazines and data manuals used.</p>
12	<p><b>Submission Process:</b> Student should prepare 2 copies of the Project Report. At the beginning, the respective Project Guide must approve both copies positively before the end examination of S27044: Project Work. Then respective Study Center Coordinator approves both copies of the Project Report. Student should submit one of these approved copies to the study center. The student should retain remaining one of these approved copies. Study center should preserve their copy of, all project reports, till the end examination of S27044: Project Work. <b>Even student must bring his own copy during this end examination.</b></p>
13	<p><b>Project Report Format:</b></p> <ol style="list-style-type: none"> <li>The project report should be printed on <b>only right side</b> of A4 size (210 mm ´ 297 mm) paper. There is <b>no minimum or maximum page number limit</b> for the “Project Report”, but report of minimum 15–20 page is expected. University recommends only flexible binding for the “Project Report”. But, if student wishes, he may also use spiralbinding.</li> <li>Margins should be as follows:- <ul style="list-style-type: none"> <li>Left Margin : 40mm</li> <li>Right Margin : 20mm</li> <li>Top Margin : 20mm</li> <li>Bottom Margin : 27mm</li> </ul> </li> <li>Header should not be used. Footer, containing page number at the center should only be used, with footer margin of 25mm.</li> <li>Text should be printed in font size of 12 points and at interline distance of 18 points. (That is 1.5 line spacing). Normally, figures should be embedded in the text, where there first reference occurs. But if necessary, figures may be grouped on separate pages. Figure should be numbered as ‘<b>Fig C.F</b>’, where ‘<b>C</b>’ is chapter number and ‘<b>F</b>’ is figure number. Figure number ‘<b>F</b>’ is reset back to 1 for each new chapter.</li> </ol> <p><b>Page Sequence:</b> (1) Cover page as per <b>specimen 1</b> (2) Certificate page as per <b>specimen 2</b> (3) Acknowledgement page for the help offered by individuals and institution (4) Content page as per <b>specimen 3</b>. Following suggested scheme of chapters in project report then follows these first 4pages.</p>
14	<p><b>Specimen of Pages</b></p>

<p><b>Specimen 1</b></p> <p><b>Project Title- M.Sc. in Environmental Science</b></p> <p><b>Submitted by</b></p> <p><b>Name of Student-</b></p> <p><b>Name of Project Guide-</b></p> <p><b>Name of the Study Center–</b></p> <p>Yashwantrao Chavan Maharashtra Open University 20... - ...</p> <p><b>Specimen 3 Contents</b></p> <p><b>1. Introduction</b></p> <p>1.1 Background</p> <p>1.2 Need for Work</p> <p>1.3 Brief Idea</p> <p><b>2. System Overview and Design</b></p> <p>2.1 Operation</p> <p>2.2 Design Parameters</p> <p>2.3 System Design</p> <p><b>3. Module Design</b></p> <p>3.1 Module1</p> <p>3.2 Module2</p> <p>3.3 Module 3</p> <p>4. Testing and Troubleshooting</p> <p>4.1 Module1</p> <p>4.2 Module1</p>	<p><b>Specimen 2 Certificate</b></p> <p>This is to certify that</p> <p>Mr/Ms.....</p> <p>.....(PRN..... )</p> <p>has successfully completed a project titled ". ....."</p> <p>in partial fulfilment for the requirement of</p> <p><b>Master of Science in Environmental Science</b></p> <table border="1" style="width: 100%;"> <tr> <td colspan="2">Signature with Date</td> </tr> <tr> <td>Project Guide</td> <td>SC Coordinator</td> </tr> <tr> <td>Internal Examiner</td> <td>External Examiner</td> </tr> </table>	Signature with Date		Project Guide	SC Coordinator	Internal Examiner	External Examiner
Signature with Date							
Project Guide	SC Coordinator						
Internal Examiner	External Examiner						

4.3	Module1
5.	Results and Conclusions
5.1	Further Modifications
5.2	Summary
6.	Reference

**LEARNING RESOURCE DETAILS**

LR Code	Title Author	Edition Year	ISBN Publisher
<b>Text-Books</b>			