



**SCHOOL OF SCIENCES**  
(FORMERLY, SCHOOL OF ARCHITECTURE, SCIENCE AND TECHNOLOGY)  
**YASHWANTRAO CHAVAN MAHARASHTRA OPEN UNIVERSITY**



**Syllabus:**

**V152: M.Sc. (Environmental Science)**

**{2023 Pattern}**

**(Semester 01 to 04)**

(Incorporating  
NEP2020  
Recommendations,  
PG Credit and  
Curriculum  
Framework GR dated  
16-05-2023)

With effect from Academic  
Year 2023-24, vide G.R.  
No. NEP-2022/CR No.  
09/VISHI-3/शिकाना, dated  
16 May, 2023.

**2023**

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**NEP2020: Programme Structure with Syllabus of all Courses at Semester 01 to 04 was finalized in PAC meeting held on 24 July 2023.**

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Finalized on 28 Aug 2023, Revised on 25 Nov 2023 for Evaluation Pattern

# SYLLABUS FOR M.Sc.(ENVIRONMENTAL SCIENCE) {2023 PATTERN}

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## About the Programme

**PROGRAMME CODE: V152**

**PROGRAMME NAME: M. SC. (ENVIRONMENTAL SCIENCE)**

This M.Sc. programme is uniquely designed to impart essential knowledge in all major areas of EVS. This programme offers an exciting opportunity for specialization in EVS to model and solve different real-life problems. The course contents of total 04 semesters are a carefully selected blend of theory, practical and field project/ research project which prepare students for specialist professional employment, research in academia, and various industries for broader applications. Learner centric curriculum is designed in adherence to the principles of National Education Policy (NEP 2020) to acquire knowledge and skills with valuable experiences through hands-on activities, projects and internships.

## Programme Objective, Programme Outcomes and Scope

This programme is designed to achieve following objectives, outcomes and scope.

**Objectives:** The objectives of this course are

1. **Develop Advanced Knowledge:** The primary objective of the postgraduate program in Environmental Studies is to provide students with advanced knowledge and a deeper understanding of various aspects of environmental science, ecology, sustainability, and environmental management.
2. **Interdisciplinary Perspective:** The program aims to foster an interdisciplinary perspective, enabling students to integrate knowledge from various disciplines, including biology, chemistry, geology, economics, and social sciences, to address complex environmental issues.
3. **Critical Thinking and Research Skills:** The program seeks to cultivate critical thinking and research skills in students, encouraging them to analyze environmental problems, conduct empirical research, and apply data-driven approaches to find sustainable solutions.
4. **Environmental Policy and Governance:** Students will gain insights into environmental policy frameworks, laws, and governance mechanisms to evaluate the effectiveness of environmental regulations and contribute to policy formulation.
5. **Sustainable Development:** The program aims to equip students with the tools to promote sustainable development, considering the social, economic, and ecological dimensions of environmental challenges.
6. **Environmental Awareness and Ethics:** Enhance environmental awareness and ethical values among students, emphasizing their responsibility as future environmental professionals to protect and preserve the natural world.

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

1. **Advanced Knowledge:** Graduates will demonstrate a deep understanding of key environmental concepts, principles, and theories relevant to the field of environmental studies.
2. **Problem-Solving Skills:** Graduates will be capable of applying scientific and analytical approaches to identify and address complex environmental issues effectively.
3. **Interdisciplinary Integration:** Graduates will be able to integrate knowledge from different disciplines to comprehend and resolve environmental problems with a comprehensive approach.
4. **Research Proficiency:** Graduates will be skilled in conducting independent research, designing experiments, collecting and analyzing data, and interpreting research findings related to environmental studies.
5. **Policy Analysis:** Graduates will be able to analyze environmental policies, assess their impact on environmental sustainability, and contribute to the formulation of evidence-based policies.
6. **Sustainable Solutions:** Graduates will demonstrate the ability to develop and propose sustainable solutions for environmental challenges, taking into account social, economic, and environmental factors.
7. **Communication and Advocacy:** Graduates will possess effective communication skills to convey scientific information and advocate for environmental protection and sustainable practices.
8. **Environmental Leadership:** Graduates will be prepared to take on leadership roles in environmental organizations, governmental agencies, research institutions, and industries related to environmental conservation and sustainability.

**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 4th 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

- Mode of Education:** ODL Mode.
- 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
- Maximum Programme Duration:** 4 years from the date of admission to the PG programme, also referred as Valid Registration Period
- Learner Support Centers (LSC):** University approved/recognized Senior Science Colleges/ Institutes offering PG Environmental Science programme
- Medium of Instruction:** English
- Attendance:** Minimum 80% attendance for all type of courses.
- Profile of Prospective Students:** In-Service Science Teachers from Schools/ Junior College and Equivalent pass students
- Teaching-Learning:** Total 12 + 3 = 15 working weeks in each semester, where 3-weeks' time duration in each semester for clearing face-to-face counseling session's backlog (if any).
- Total Teaching-Learning Support:** Total 2640 Hours including Self-Study during all 4 semesters. 660 Hours (including Self-Study) **during** each semester.
- Total Courses:** Total 23 courses (subjects) distributed over Semesters 01 to 04.
- Total Credits:** 88 Credits [As per UGC norms 1 Credit means 30 hours of study efforts required to gain learning of particular content of each credit].
- Total Courses and Credit Distribution Scheme:**

Sem	Mandatory Courses (DSC)			Elective Courses (DSE) (4 Credits)	Other Courses (4 Credits)/ (6 Credits)	Total Courses (Credits)
	Theory		Practical (4 Credits)			
	4 Credits	2 Credits				
1	2	1	1	1	1 – Research Methodology (4 Credits)	<b>6</b> (22 Credits)
2	2	1	1	1	Any one - OJT/ Field Projects (4 Credits)	<b>6</b> (22 Credits)
3	2	1	1	1	1- Research Project (4 Credits)	<b>6</b> (22 Credits)
4	2	-	1	1	1- Research Project (6 Credits)	<b>5</b> (22 Credits)
Total	8 x 4 = 32 (38 Credits)	3 x 2 = 06	4 x 4 = (16 Credits)	4 x 4 = (16 Credits)	3 x 4 + 1 x 6 = (18 Credits)	<b>23</b> (88 Credits)

- Multiple Entry and Multiple Exit:** The multiple entry and multiple exit features

open up new opportunities for learners, even if they have stopped or discontinued their study in the middle for a variety of reasons. This feature provides entry options in order to promote flexible learning within the valid registration period (04 years from the date of admission to the PG programme). Learners only have the choice to leave the program at the end of even semester 02, and they have the option to reenter at the start of odd semester 03. Only one exit option and reentry is permissible for MSc programme during stipulated time period.

14. **Exit Option- PG Diploma Certificate:** The learner who passes all registered courses of first year (two semesters) of the programme successfully in the examinations and obtains required credits (44 Credits), shall be awarded with **Post Graduate Diploma PGD 10-EVS** if learner shall opt for exit. The aggregate performance (SGPA of Semester 01 and Semester 02) and Class in the programme shall be reported on the basis of performance.
15. **PG Degree Certificate:** After successful completion of all courses (semesters 01 to 04) at two year of the programme and obtaining required credits (88 Credits), learner shall be awarded with **Post Graduate Degree**. The aggregate performance (CGPA of Semester 01 to Semester 04) and Class in the programme shall be reported on the basis of performance.
16. **Approval/Equivalence Status:** UGC and DEB recognized and approved [AY 2023 and onwards] with UGC/DEB letter F.No. 1-2/2021 (DEB-I), Dated: 02.08.2021, available at [https://www.ugc.ac.in/pdfnews/4204139\\_HEI-Recognition-list-02-08-2021.pdf](https://www.ugc.ac.in/pdfnews/4204139_HEI-Recognition-list-02-08-2021.pdf)

### Eligibility and Fees

Admission Eligibility	Certification Eligibility	Fees per Year Annual Admission Form Amount (AAFA) is payable to university <b>along with</b> admission form at the start of <b>each</b> year.					
Candidates with B.Sc./ B.Sc. (Agri) / B.E. / B.Tech. / B. Pharm. Degree or Equivalent pass	<p><b>V152:</b> Min <b>40%</b> or better marks in total <b>23</b> courses (subjects) of total <b>88</b> credits at Semesters <b>01 to 04</b>.</p> <p>CGPA: Aggregate performance and Class in the programme shall be reported on the basis of semesters 01 to 04.</p> <p>For exit option <b>PGD 10-EVS:</b> Min <b>40%</b> or better marks in total <b>12</b> courses (subjects) of total <b>44</b> credits at Semesters <b>01 to 02</b>.</p>	<b>Description</b>	<b>INR ₹</b>				
			<b>1<sup>st</sup> Year</b>	<b>2<sup>nd</sup> Year</b>			
		<b>Mandatory Fees</b>	<b>608</b>	<b>858</b>			
		<b>Tuition Fee</b>	<b>USF</b>	<b>6,100</b>	<b>6,100</b>		
			<b>LSCF</b>	<b>12,000</b>	<b>12,000</b>		
		<b>End Exam Fees</b>	<b>1,640</b>	<b>1,750</b>			
<b>AAFA</b>	<b>20,348</b>	<b>20,708</b>					

## Programme Structure

### V152: M.Sc (Environmental Science) {2023 Pattern} as per NEP 2020

Year (2 Yr. PG)	Level	Sem.	Major				RM	OJT/FP	RP	Cum. Cr.				
			Mandatory	CR	Elective	CR								
I	6.0	I	EVS501: Environmental Science and Environmental Biology (T)	4	EVS506: Environmental Education, Policies & Legislation (T)	4	RES505: Research Methodology (T) 4 CR	-	-	22				
			EVS502: Natural Resources and Their Conservation (T)	4	OR EVS507: Management of Water Resources (T)									
			EVS503: Biodiversity and Conservation (T)	2	OR									
			EVS504: Lab Activities on EVS501, EVS502 & EVS503 (P)	4	EVS508: Open Elective (T)									
		II	EVS509: Environmental Chemistry (T)	4	EVS515: Environmental Sustainability (T)	4					-	EVS513:OJT (4 CR)  OR EVS514:FP (4 CR)	-	22
			EVS510: Environmental Geosciences & Computer Applications (T)	4	OR EVS516: Solid & Hazardous Waste Management (T)									
			EVS511: Herbal Wealth (T)	2	OR									
			EVS512: Lab Activities on EVS509 & EVS510 (P)	4	EVS517: Open Elective (T)									
<b>Cum. Cr. For 1 Year PG Diploma</b>			<b>28</b>		<b>8</b>	<b>4</b>	<b>4</b>	<b>-</b>	<b>44</b>					
<b>Exit option: Post Graduate Diploma {PGD 10 –EVS (44 Credits)} after Three Year UG Degree</b>														

Year (2 Yr. PG)	Level	Sem	Major				RM	OJT/ FP	RP	Cum. Cr.
			Mandatory	CR	Elective	CR				
II	6.5	III	<b>EVS601:</b> Environmental Monitoring and Energy Studies (T)	4	<b>EVS606:</b> Sustainable management of Biodiversity (T)  <b>OR</b> <b>EVS607:</b> Environmental Management (T)  <b>OR</b> <b>EVS608:</b> Renewable Energy Studies (T)	4	-	-	<b>EVS605:</b> <b>Research Project:</b> <b>(4 CR)</b>	22
			<b>EVS602:</b> Instrumentation & Lab Techniques (T)	4						
			<b>EVS603:</b> Green Chemistry (T)	2						
			<b>EVS604:</b> Lab Activities on EVS601 & EVS602 (P)	4						
		IV	<b>EVS609:</b> Environmental Microbiology and Toxicology (T)	4	<b>EVS613:</b> Statistical Approaches & Modeling in Environmental Sciences (T)  <b>OR</b> <b>EVS614:</b> Disaster Management (T)  <b>OR</b> <b>EVS615:</b> Medicinal plants and their Applications (T)	4	-	-	<b>EVS612:</b> <b>Research Project:</b> <b>(6 CR)</b>	22
			<b>EVS610:</b> Environmental issues & Human Health (T)	4						
<b>EVS611:</b> Lab Activities on EVS609 & EVS610 (P)	4									
<b>Cum. Cr. For 2 Years PG Degree</b>			<b>54</b>	<b>16</b>	<b>4</b>	<b>4</b>	<b>10</b>	<b>88</b>		
<b>2 Years- 4 Semester PG Degree in Environmental Science (88 credits) after Three Year UG Degree</b>										

Abbreviations: Yr.: Year; Sem.: Semester; Cumulative Credits: Cum. Cr. ; T- Theory Course; P- Practical course; TW-Term Work; PW- Project Work

**# Note:**

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

1. EVS515: Environmental Sustainability (MOOC)
2. EVS606: Sustainable Management of Biodiversity (MOOC)



## Semesters and Courses

### Abbreviations of the courses

<b>Mandatory DSC</b>	Discipline Specific Core Course	<b>Elective DSE</b>	Discipline Specific Elective Course
<b>RM</b>	Research Methodology	<b>OJT</b>	On Job Training: Internship/ Apprenticeship
<b>FP</b>	Field projects	<b>RP</b>	Research Project
<b>OE</b>	Open Elective (May be taken from MOOC or may be chosen from other domain of learning to get exposure to interdisciplinary domain) [OE will be offered in phase manner]		

<b>S N</b>	<b>Course Category</b>	<b>Code</b>	<b>Course Name</b>	<b>CA</b>	<b>EE</b>	<b>TM</b>	<b>Type</b>	<b>CR</b>	<b>Min %</b>
<b>[Level 6.0] Semester 01 : 22 Credits</b>									
01	Mandatory(DSC)	EVS501	Environmental Science and Environmental Biology	30	70	100	T	4	40%
02	Mandatory(DSC)	EVS502	Natural Resources and Their Conservation	30	70	100	T	4	40%
03	Mandatory(DSC)	EVS503	Biodiversity and Conservation	15	35	50	T	2	40%
04	Mandatory(DSC)	EVS504	Lab Activities on EVS501, EVS502 & EVS503	50	50	100	P	4	40%
05	RM	RES505	Research Methodology	30	70	100	T	4	40%
<b>Elective (DSE) Courses (Select Any One)</b>									
06	Elective (DSE)	EVS506	Environmental Education, Policies & Legislation	30	70	100	T	4	40%
07	Elective (DSE)	EVS507	Management of Water Resources	30	70	100	T	4	40%
<b>[Level 6.0] Semester 02 : 22 Credits</b>									
08	Mandatory(DSC)	EVS509	Environmental Chemistry	30	70	100	T	4	40%
09	Mandatory(DSC)	EVS510	Environmental Geosciences & Computer Applications	30	70	100	T	4	40%
10	Mandatory(DSC)	EVS511	Herbal Wealth	15	35	50	T	2	40%
11	Mandatory(DSC)	EVS512	Lab Activities on EVS509 & EVS510	50	50	100	P	4	40%
12	OJT	EVS513	Any one OJT or FP	50	50	100	TW	4	40%
	FP	EVS514							
<b>Elective (DSE) Courses (Select Any One)</b>									
13	Elective (DSE)	EVS515	Environmental Sustainability	30	70	100	T	4	40%
14	Elective (DSE)	EVS516	Solid & Hazardous Waste Management	30	70	100	T	4	40%
<b>Exit option: PG Diploma {PGD 10 – EVS (44 Credits)} after Three Year UG Degree</b>									

<b>[Level 6.5] Semester 03 : 22Credits</b>									
15	Mandatory(DSC)	EVS601	Environmental Monitoring and Energy Studies	30	70	100	T	4	40%
16	Mandatory(DSC)	EVS602	Instrumentation & Lab Techniques	30	70	100	T	4	40%
17	Mandatory(DSC)	EVS603	Green Chemistry	15	35	50	T	2	40%
18	Mandatory(DSC)	EVS604	Lab Activities on EVS601 & EVS602	50	50	100	P	4	40%
19	RP	EVS605	Research Project	50	50	100	PW	4	40%
<b>Elective (DSE) Courses (Select Any One)</b>									
20	Elective (DSE)	EVS606	Sustainable management of Biodiversity	30	70	100	T	4	40%
21	Elective (DSE)	EVS607	Environmental Management	30	70	100	T	4	40%
22	Elective (DSE)	EVS608	Renewable Energy Studies	30	70	100	T	4	40%
<b>[Level 6.5] Semester 04 : 22 Credits</b>									
23	Mandatory(DSC)	EVS609	Environmental Microbiology and Toxicology	30	70	100	T	4	40%
24	Mandatory(DSC)	EVS610	Environmental issues & Human Health	30	70	100	T	4	40%
25	Mandatory(DSC)	EVS611	Lab Activities on EVS609 & EVS610	30	70	100	P	4	40%
26	RP	EVS612	Research Project	75	75	150	PW	6	40%
<b>Elective (DSE) Courses (Select Any One)</b>									
27	Elective (DSE)	EVS613	Statistical Approaches & Modeling in Environmental Sciences	30	70	100	T	4	40%
28	Elective (DSE)	EVS614	Disaster Management	30	70	100	T	4	40%
29	Elective (DSE)	EVS615	Medicinal plants and their Applications	30	70	100	T	4	40%
<b>2 Years- 4 Semesters PG Degree in Environmental Science (88 credits) after Three Year UG Degree</b>									

## 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, P and F.
3. **“Grade Point”**: It is a numerical weight allotted to each letter grade on a 10-point scale. Grade Point shall be “o (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.

Marks Obtained out of 100	Grade Point	Semester GPA / Programme CGPA Semester/ Programme	% of Marks	Alpha-Sign / Letter Grade Result
90 – 100	10	9.00 – 10.00	90.0 - 100	O (Outstanding)
80 – 89.99	9	8.00 - < 9.00	80.0 - < 90.0	A+ (Excellent)
70 – 79.99	8	7.00 - < 8.00	70.0 - < 80.0	A (Very Good)
60 – 69.99	7	6.00 - < 7.00	60.0 - < 70.0	B+ (Good)
55 – 59.99	6	5.50 - < 6.00	55.0 - < 60.0	B (Above Average)
50 – 54.99	5	5.00 - < 5.50	50.0 - < 55.0	C (Average)
40 – 49.99	4	4.00 - < 5.00	40.0 - < 50.0	<b>P (Pass)</b>
0 – 39.99	0	Below 4.00	<b>Below 40</b>	<b>F (Fail)</b>
		<b>Ab (Absent)</b>	-	<b>Absent</b>

4. **“Credit Point”**: It is the product of grade point and number of credits for a course.
5. **“Semester Grade Point Average (SGPA)”**: It is a measure of performance of work done in a semester. It is the ratio of sum of the product of the number of credits with the grade points scored by a student in all courses taken by a student and the sum of number of credits of all the courses undergone by a student:

$$SGPA (S_i) = \frac{\sum C_i G_i}{\sum C_i}$$

It shall be expressed up to two decimal places.

6. **“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 the semesters. The CGPA is also calculated in the same manner taking into account all the courses undergone by a student over all the semesters of a programme.

$$CGPA = \frac{\sum C_i S_i}{\sum C_i}$$

Where,  $S_i$  is the SGPA of the  $i^{\text{th}}$  semester &  $C_i$  is the total number of credits in that semester. It shall be expressed up to two decimal places.

7. **“Transcript or 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, grade secured) along with SGPA of that semester and CGPA **earned till that semester**.

8. **“Evaluation Pattern”**: As per NEP2020, the ‘Evaluation Pattern’ of the Post graduate Programme consists of the following components:

Course Type	Number of Credits	Continuous Assessment (CA)	End Examination (EE)	Total Marks ‘TM’ = (CA+EE)	Minimum Passing %
Theory(T)	4	30	70	100	minimum 40% in CA, EE and (CA + EE) shall be essential for each course to pass
Theory (T)	2	15	35	50	
Practical (P)	4	50	50	100	
OJT/Field Project (FP)	4	50	50	100	
Research Project (RP)	4	50	50	100	
Research Project(RP)	6	75	75	150	

## EVALUATION PATTERN

[CA and EE Evaluation Pattern as per the Minutes of the Meeting of the NEP Cell Dated 21.11.2023]

SN	Type of Course	Continuous Assessment (CA)	End Examination (EE)
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SN	Type of Course	Continuous Assessment (CA)	End Examination (EE)
1	Theory (T)  4 Credit 100 Marks  CA: 30% EE: 70%	<p>Each student is required to attempt <b>total 02</b> (Two) “Continuous Assessments (CAs)” for <b>each</b> course of <b>each</b> Semester, as per the following details:</p> <ol style="list-style-type: none"> <li> <b>CA01:</b> ‘Continuous Assessment 01 (CA01)’ on <b>Credit 01 to Credit 04</b> of <b>each</b> course, consists of               <ul style="list-style-type: none"> <li>2 (Two) ‘Short Answer Questions (SAQs)’, each carrying <b>05</b> Marks, on Credit 01 and Credit 02</li> </ul> <p style="text-align: center;"><b>and</b></p> <li>1 (One) ‘Long Answer Question (LAQ)’ of 10 Marks, on Credit 03 and Credit 04. LAQ may consist of sub-questions.</li> </li></ol> <p><b>CA01:</b> On Credit 01 to Credit 04, of Marks = <math>(5 \times 2 + 10) = \mathbf{20}</math> Marks</p> <ol style="list-style-type: none"> <li> <b>CA02:</b> ‘Continuous Assessment 02 (CA02)’ on <b>Credit 01 to Credit 04</b> of <b>each</b> course, consists of               <ul style="list-style-type: none"> <li>A test containing total <b>10</b> (Ten) ‘Objective Type Questions,’ <b>05 (Five)</b> on <b>Credit 01 and Credit 02</b>, and <b>05 (Five)</b> on <b>Credit 03 and Credit 04</b>. Each ‘Objective Type Question’ of 1 Mark.</li> </ul> <p><b>CA02:</b> On Credit 01 to Credit 04, of Marks = <b>10</b> Marks</p> </li> <li>Maximum number of attempts for <b>CA</b>, during <b>each</b> semester : <b>Single</b> attempt only</li> <li><b>Total Marks: 30</b> Marks</li> </ol>	<ol style="list-style-type: none"> <li>Student is required to answer <b>05 ‘VSAQs’ out of 06 ‘VSAQs’</b>, each carrying <b>03</b> Marks, on <b>Credit 01 to 04</b>, for total <b>15</b> Marks. <b>One VSAQ will be on each Credit.</b></li> <li>Student is required to answer <b>05 ‘SAQs’ out of 06 ‘SAQs’</b>, each carrying <b>05</b> Marks, on <b>Credit 01 to 04</b>, for total <b>25</b> Marks. <b>One SAQ will be on each Credit.</b></li> <li>Student is required to answer <b>01 ‘LAQ’ out of 2 LAQs</b>, of <b>10</b> Marks on <b>Credit 01 and Credit 02</b>, for total <b>10</b> Marks. <b>LAQ may consist of sub-questions.</b></li> <li>Student is required to answer <b>01 ‘LAQ’ out of 2 LAQs</b>, of <b>10</b> Marks on <b>Credit 03 and Credit 04</b>, for total <b>10</b> Marks. <b>LAQ may consist of sub-questions.</b></li> <li>Student is required to answer <b>01 ‘LAQ’ out of 2 LAQs</b>, of <b>10</b> Marks on <b>Credit 01 to Credit 04</b>, for total <b>10</b> Marks. <b>LAQ may consist of sub-questions.</b></li> <li>Number of attempts: <b>Till Valid Registration Period (VRP) only</b></li> <li><b>Marks: 70</b> Marks</li> <li><b>Duration: 150</b> minutes</li> </ol>

SN	Type of Course	Continuous Assessment (CA)		End Examination (EE)	
		SN	Description	Evaluation of End Examination(EE)	Marks
		1	Question Types	Very Short Answer Question (VSAQ) on each Credit Short Answer Question (SAQ) on each Credit On each Credit, either Single Long Answer Question (LAQ) <b>or</b> LAQ contains sub-questions (a), (b) and so on.	03 Marks 05 Marks 10 Marks
		2	Grand Total Marks	Total <b>five</b> Questions in EE Question paper based on: Credit 01 to 04 : 05 VSAQs out of 06 VSAQs (15 Marks) Credit 01 to 04 : 05 SAQs out of 06 SAQs (25 Marks) Credit 01 to 02 : 01 LAQ out of 02 LAQs (10 Marks) Credit 03 to 04 : 01 LAQ out of 02 LAQs (10 Marks) Credit 01 to 04 : 01 LAQ out of 02 LAQs (10 Marks) <b>LAQ may contains sub-questions</b>	70 Marks
2	Theory (T) <b>2 Credit</b> 50 Marks CA: 30% EE: 70%	Each student is required to attempt <b>total 01</b> (One) “Continuous Assessment (CA)” for <b>each</b> course of <b>each</b> Semester, as per the following details: 1. <b>CA01</b> : 1 (One) ‘Continuous Assessment 01 (CA01)’ on <b>Credit 01</b> and <b>Credit 02</b> of <b>each</b> course, consists of <ul style="list-style-type: none"> <li>• 1 (One) ‘Short Answer Question (SAQ)’ of 5 Marks</li> <li><b>and</b></li> <li>• 1 (One) ‘Long Answer Question (LAQ)’ of 10 Marks, LAQ may consist of sub-questions.</li> </ul> <b>CA01</b> : On <b>Credit 01</b> and <b>Credit 02</b> , of Marks = (5 + 10) = <b>15 Marks</b> 2. Maximum number of attempts for <b>CA</b> , during <b>each</b> semester: <b>Single</b> attempt only 3. <b>Total Marks: 15</b> Marks		1. Student is required to answer <b>05 ‘VSAQs’ out of 06 ‘VSAQs’</b> , each carrying <b>03</b> Marks, on <b>Credit 01 to 02</b> , for total <b>15 Marks. One VSAQ will be on each Credit.</b> 2. Student is required to answer <b>02 ‘SAQs’ out of 03 ‘SAQs’</b> , each carrying <b>05</b> Marks, on <b>Credit 01 to 02</b> , for total <b>10 Marks. One SAQ will be on each Credit.</b> 3. Student is required to answer <b>01 ‘LAQ’ out of 2 LAQs</b> , of <b>10</b> Marks on <b>Credit 01</b> and <b>Credit 02</b> , for total <b>10 Marks. LAQ may consist of sub-questions.</b> 4. Number of attempts: <b>Till Valid Registration Period (VRP) only</b> 5. <b>Marks: 35</b> Marks 6. <b>Duration: 75</b> minutes	

SN	Type of Course	Continuous Assessment (CA)		End Examination (EE)	
		SN	Description	Evaluation of End Examination (EE)	Marks
		1	Question Types	Very Short Answer Question (VSAQ) on each Credit	03 Marks
				Short Answer Question (SAQ) on each Credit	05 Marks
				On each Credit, either Single Long Answer Question (LAQ) <b>or</b> LAQ contains sub-questions (a), (b) and so on.	10 Marks
		2	Grand Total Marks	Total <b>three</b> Questions in EE Question paper based on: Credit 01 to 02 : 05 VSAQs out of 06 VSAQs (15 Marks) Credit 01 to 02 : 02 SAQs out of 03 SAQs (10 Marks) Credit 01 to 02 : 01 LAQ out of 02 LAQs (10 Marks) <b>LAQ may contains sub-questions</b>	35 Marks

SN	Type of Course	Continuous Assessment (CA)	End Examination (EE)												
3	Practical (P) 4 Credit 100 Marks CA: 50% EE: 50%	<ol style="list-style-type: none"> <li>Student is required to submit "Activity Report in Work-Book Format" for <b>each</b> Credit in the prescribed format.</li> <li>Maximum number of attempts for <b>each</b> CA, during <b>each</b> semester : <b>Single</b> attempt only</li> <li><b>Marks: 50</b> Marks</li> <li>Grading criteria: <table border="1"> <tr> <td>Lab Punctuality, Preparedness &amp; Ethics</td> <td>Irregular in lab. Copies the experiment from others <b>(0 Points)</b></td> <td>Consistently regular but unable to explain the concepts <b>(06 Points)</b></td> <td>Punctuality in lab. Follows the procedure and responds to questions asked <b>(10 Points)</b></td> </tr> <tr> <td>Activity Report and Performance  (Experiment No, Date, Objectives, Apparatus with specification, Observations, Graphs, software used if any)</td> <td>Poor Documentation and copied the experiment from others. Couldn't perform the Activity /poor observation made <b>(04 Points)</b></td> <td>Average Documentation : Report is in format but some of the formatting guidelines are missed. Performed the Activity but observations made with some mistakes <b>(12 Points)</b></td> <td>Good Documentation: Lab activity writing is in proper format with all references, Grammar. Performed the Activity on time observations made with no mistakes <b>(20 Points)</b></td> </tr> <tr> <td>Results and Conclusion</td> <td>Unable to achieve the desired results but makes attempts to relate data to theory. Poor concluding statements <b>(08 Points)</b></td> <td>Average graphical and tabulated representation with misinterpret physical significance of theory. Achieve the desired results and but insufficient conclusion statement. <b>(14 Points)</b></td> <td>Analyses and interpret observed data carefully with good graphical and tabulated representation using appropriate theory/evidence. Achieve the results and reach to appropriate Conclusion <b>(20 Points)</b></td> </tr> </table> </li> </ol>	Lab Punctuality, Preparedness & Ethics	Irregular in lab. Copies the experiment from others <b>(0 Points)</b>	Consistently regular but unable to explain the concepts <b>(06 Points)</b>	Punctuality in lab. Follows the procedure and responds to questions asked <b>(10 Points)</b>	Activity Report and Performance  (Experiment No, Date, Objectives, Apparatus with specification, Observations, Graphs, software used if any)	Poor Documentation and copied the experiment from others. Couldn't perform the Activity /poor observation made <b>(04 Points)</b>	Average Documentation : Report is in format but some of the formatting guidelines are missed. Performed the Activity but observations made with some mistakes <b>(12 Points)</b>	Good Documentation: Lab activity writing is in proper format with all references, Grammar. Performed the Activity on time observations made with no mistakes <b>(20 Points)</b>	Results and Conclusion	Unable to achieve the desired results but makes attempts to relate data to theory. Poor concluding statements <b>(08 Points)</b>	Average graphical and tabulated representation with misinterpret physical significance of theory. Achieve the desired results and but insufficient conclusion statement. <b>(14 Points)</b>	Analyses and interpret observed data carefully with good graphical and tabulated representation using appropriate theory/evidence. Achieve the results and reach to appropriate Conclusion <b>(20 Points)</b>	<p>External and internal examiners shall assess each student based on:</p> <ol style="list-style-type: none"> <li>Workbook/Activity Report submission by the student (Only by <b>External Examiner</b>) [05 Marks]</li> <li>Practical Activity performed by the student [12 Marks]</li> <li>Result and Conclusion of the Practical Activity [13 Marks]</li> <li>Viva-Voce on Practical Activities [20 Marks]</li> <li>Number of attempts: <b>Till Valid Registration Period (VRP) only</b></li> <li><b>Marks: 50</b> Marks</li> <li><b>Duration: 180</b> minutes</li> </ol>
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<b>SN</b>	<b>Type of Course</b>	<b>Continuous Assessment (CA)</b>	<b>End Examination (EE)</b>		
			<b>Evaluation of Practical End Examination</b>		
		SN	Description	Internal Examiner	External Examiner
		1	Workbook/Activity Report	-	05 Marks
		2	Actual Conduct of one randomly selected Practical Activity	02 Marks	10 Marks
		3	Diagram, Synoptic Answers, Graph/Observation and Conclusion	03 Marks	10 Marks
		4	Viva-Voce/Oral	05 Marks	15 Marks
		5	Total	10 Marks	40 Marks

SN	Type of Course	Continuous Assessment (CA)	End Examination (EE)																					
4	Field Project (TW) 4 Credit 100 Marks CA: 50% EE: 50%	<p>Students need to complete one month Field Project (Total Study hours <b>120 hrs</b> including Activity Report). After completion of the field project, learners shall submit a report to the LSC - Programme Coordinator (PC) and Mentor/Guide.</p> <ol style="list-style-type: none"> <li>Maximum number of attempts for <b>each</b> CA, during <b>each</b> semester: <b>Single</b> attempt only</li> <li>Duration: 1 Month or 4 Weeks duration               <ol style="list-style-type: none"> <li>After end examination of semester 02 and before beginning of semester 03 <b>or</b></li> <li>Any one month during semester 02 duration</li> </ol> </li> <li><b>Marks: 50</b> Marks</li> <li>Grading Criteria for Evaluation of FP (<b>only by Mentor/Guide</b>):</li> </ol> <table border="1"> <thead> <tr> <th>SN</th> <th>Description</th> <th>Marks</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>Key Definitions of Problem area and analysis of preliminary data</td> <td>15</td> </tr> <tr> <td>2</td> <td>Work related to formats, Correspondence, Interactions and liaising etc</td> <td>05</td> </tr> <tr> <td>3</td> <td>Field work and data collection</td> <td>15</td> </tr> <tr> <td>4</td> <td>Analysis and Report</td> <td>10</td> </tr> <tr> <td>5</td> <td>Feedback to community</td> <td>05</td> </tr> <tr> <td colspan="2">Total</td> <td>50</td> </tr> </tbody> </table>	SN	Description	Marks	1	Key Definitions of Problem area and analysis of preliminary data	15	2	Work related to formats, Correspondence, Interactions and liaising etc	05	3	Field work and data collection	15	4	Analysis and Report	10	5	Feedback to community	05	Total		50	<ol style="list-style-type: none"> <li><b>External</b> and Internal examiners (Internal examiner - <b>Programme Coordinator (PC) / Supervisor of LSC</b>) shall assess each student based on:           <ol style="list-style-type: none"> <li>Activity Report submission by the student (Only by <b>External Examiner</b>) [10 Marks]</li> <li>Viva-Voce on Activity Report [40 Marks]</li> </ol> </li> <li>Number of attempts: <b>Till Valid Registration Period (VRP) only</b></li> <li><b>Marks: 50</b> Marks</li> <li><b>Duration: 180</b> minutes</li> </ol>
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	1	Workbook/Report submission	-	10 Marks																				
	2	Viva-Voce /Oral	10 Marks	30 Marks																				
	3	Total	10 Marks	40 Marks																				

SN	Type of Course	Continuous Assessment (CA)	End Examination (EE)																																							
5	OJT or Internship (TW)  4 Credit 100 Marks  CA: 50% EE: 50%	<p>1. Students need to complete one month On Job Training (OJT) or Internship (Total Study hours <b>120 hrs</b> including Internship Report) in any Industry/Organization/Institute/ R&amp;D Division /Any Micro/Small/Medium/enterprise/Govt/N GO/PSU/Online Internship related to major course.</p> <p>2. Maximum number of attempts for <b>each</b> CA, during <b>each</b> semester: <b>Single</b> attempt only</p> <p>3. <b>Marks: 50</b> Marks</p> <p>4. Duration: 1 Month or 4 Weeks – i) After end examination of semester 02 and before beginning of semester 03. <b>or</b> ii) Any one month during semester 02 duration</p> <p>5. Grading Criteria for Evaluation of OJT (or Intern) <b>only by Mentor where the Internship is proposed to be imparted:</b></p> <table border="1"> <thead> <tr> <th>S N</th> <th>Parameters</th> <th>Marks Out of</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>Behaviors, Shows interest in assigned work, Willingness to learn</td> <td>10</td> </tr> <tr> <td>2</td> <td>Accepts responsibility, Cooperates with co-workers and supervisors, Demonstrates organizational skills</td> <td>10</td> </tr> <tr> <td>3</td> <td>Uses time, knowledge and expertise effectively, Analyzes problems effectively</td> <td>10</td> </tr> <tr> <td>4</td> <td>Demonstrates creativity/ originality / any innovative contribution, Professional ethics and accountability</td> <td>10</td> </tr> <tr> <td>5</td> <td>Writes effectively, Produces high quality work/Skill Proficiency</td> <td>10</td> </tr> <tr> <td colspan="2">Total</td> <td>50</td> </tr> </tbody> </table> <p><b>Document as Evidence:</b> Activity report along with Certificate or Declaration, duly issued and signed by the concerned authority [<b>To be assessed during EE</b>] should be submitted during End Examination to the parent Learner support Centre (LSC).</p>	S N	Parameters	Marks Out of	1	Behaviors, Shows interest in assigned work, Willingness to learn	10	2	Accepts responsibility, Cooperates with co-workers and supervisors, Demonstrates organizational skills	10	3	Uses time, knowledge and expertise effectively, Analyzes problems effectively	10	4	Demonstrates creativity/ originality / any innovative contribution, Professional ethics and accountability	10	5	Writes effectively, Produces high quality work/Skill Proficiency	10	Total		50	<p>At the end of <b>second</b> semester, <b>Programme Coordinator (PC)/ Supervisor of LSC and 1 (one) External Examiner</b> will complete 'End Exam (EE)' for <b>all</b> allotted students as follows:</p> <ol style="list-style-type: none"> <li>Duration of EE: After Theory EE of second Semester</li> <li>Programme Coordinator (PC)/ <b>Supervisor of LSC and External Expert</b> will have 20% and 80% weightage respectively in EE.</li> <li>Number of attempts: <b>Till Valid Registration Period (VRP) only</b></li> <li><b>Marks</b> for EE: <b>50</b> Marks</li> </ol> <table border="1"> <thead> <tr> <th>Parameter</th> <th>PC /Supervisor of LSC</th> <th>External Expert</th> </tr> </thead> <tbody> <tr> <td>Professional Attitude</td> <td>-</td> <td>05 Marks</td> </tr> <tr> <td>Maintenance of Daily Diary</td> <td>-</td> <td>10 Marks</td> </tr> <tr> <td>Internship Report</td> <td>05 Marks</td> <td>10 Marks</td> </tr> <tr> <td>Viva/Oral</td> <td>05 Marks</td> <td>15 Marks</td> </tr> <tr> <td><b>Total</b></td> <td>10 Marks</td> <td>40 Marks</td> </tr> </tbody> </table>	Parameter	PC /Supervisor of LSC	External Expert	Professional Attitude	-	05 Marks	Maintenance of Daily Diary	-	10 Marks	Internship Report	05 Marks	10 Marks	Viva/Oral	05 Marks	15 Marks	<b>Total</b>	10 Marks	40 Marks
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SN	Type of Course	Continuous Assessment (CA)	End Examination (EE)																				
6	Project Work (PW)  RP-I <b>4 Credit</b> 100 Marks  CA: 50% EE: 50%	<ol style="list-style-type: none"> <li>Student is required to submit "Activity Report" based on Grading Criteria of the course in the prescribed format.</li> <li>Maximum number of attempts for <b>each</b> CA, during <b>each</b> semester: <b>Single</b> attempt only</li> <li><b>Marks: 50</b> Marks</li> <li>Grading Criteria: <table border="1"> <thead> <tr> <th>SN</th> <th>Desc</th> <th>Marks</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>Seminar*</td> <td>25</td> </tr> <tr> <td>2</td> <td>Research Proposal</td> <td>25</td> </tr> </tbody> </table> </li> </ol> <p>*To be conducted in Online/Offline mode at LSC.</p>	SN	Desc	Marks	1	Seminar*	25	2	Research Proposal	25	<ol style="list-style-type: none"> <li><b>External</b> and internal examiners shall assess each student based on: <ol style="list-style-type: none"> <li>Project Report submission by the student (Only by <b>External Examiner</b>) [10 Marks]</li> <li>Project Presentation by the student [20 Marks]</li> <li>Viva-Voce on Project Report [20 Marks]</li> </ol> </li> <li>Number of attempts: <b>Till Valid Registration Period (VRP) only</b></li> <li><b>Marks: 50</b> Marks</li> <li><b>Duration: 180</b> minutes</li> </ol>											
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SN	Description	Internal Examiner	External Examiner																				
1	Project Report	-	10 Marks																				
2	Project Presentation	05 Marks	15 Marks																				
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7	Project Work (PW)  RP-II <b>6 Credit</b> 150 Marks  CA: 50% EE: 50%	<ol style="list-style-type: none"> <li>Student is required to submit "Activity Report" based on Grading Criteria of the course in the prescribed format.</li> <li>Maximum number of attempts for <b>each</b> CA, during <b>each</b> semester: <b>Single</b> attempt only</li> <li><b>Marks: 75</b> Marks</li> <li>Grading Criteria: <table border="1"> <thead> <tr> <th>SN</th> <th>Desc</th> <th>Marks</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>Seminar*</td> <td>30</td> </tr> <tr> <td>2</td> <td>Research Paper Presentation**</td> <td>30</td> </tr> <tr> <td>3</td> <td>Project Report</td> <td>15</td> </tr> </tbody> </table> </li> </ol> <p>*To be conducted in Online/Off line mode at LSC. ** Journals/Conferences/ at LSC, in Online/Offline mode [This activity shall be organized by respective LSC in Online/Offline mode in case student didn't get an opportunity for presentation at Journals/Conferences]</p>	SN	Desc	Marks	1	Seminar*	30	2	Research Paper Presentation**	30	3	Project Report	15	<ol style="list-style-type: none"> <li><b>External</b> and internal examiners shall assess each student based on: <ol style="list-style-type: none"> <li>Project Report submission by the student (Only by <b>External Examiner</b>) [20 Marks]</li> <li>Project Presentation by the student [25 Marks]</li> <li>Viva-Voce on Project Report [30 Marks]</li> </ol> </li> <li>Number of attempts: <b>Till Valid Registration Period (VRP) only</b></li> <li><b>Marks: 75</b> Marks</li> <li><b>Duration: 180</b> minutes</li> </ol>								
SN	Desc	Marks																					
1	Seminar*	30																					
2	Research Paper Presentation**	30																					
3	Project Report	15																					

SN	Type of Course	Continuous Assessment (CA)		End Examination (EE)	
		SN	Evaluation of Project Work End Examination		
			Description	Internal Examiner	External Examiner
		1	Project Report	-	20 Marks
		2	Project Presentation	05 Marks	20 Marks
		3	Viva-Voce /Oral	10 Marks	20 Marks
			Total	15 Marks	60 Marks

- Separate and independent passing @ 40% in CA, EE and (CA+EE) shall be essential for each course - Theory, Practical, OJT/FP and RP.** “CA, EE and Total marks” shall be separately reported for each course in the transcript or mark-statement. The minimum and maximum marks for “CA, EE and Total Marks” are shown in the table below. If student does not score a minimum of 40% marks in CA or in EE of a course then the result of such a course will be reported as FAIL.

Course Type	Number of Credits	Continuous Assessment (CA)		End Examination(EE)		Total Marks ‘TM’ = (CA +EE)	
		Min	Max	Min	Max	Min	Max
Theory	2	6	15	14	35	20	50
	4	12	30	28	70	40	100
Practical/ OJT/FP/RP	4	20	50	20	50	40	100
	6	30	75	30	75	60	150

- In each semester, **only 1 attempt**, for CA for each course and for EE for each course shall be allowed. Only **during valid registration period (VRP)**, students are allowed to appear for CA and EE for each course against the payment of the specified ‘Examination Fee’ for each attempt, for each course where he/she is admitted by the university. The ‘CA and/or EE’ attempts are counted for each examination option offered by the university to the student, irrespective of whether student actually chooses to appear in end exam or not.
- If a student does not successfully complete the continuous assessment (CA) or pass the End Examination of Practical/Term work/OJT/Field Project/Research Project courses, they may complete these requirements with the next semester at the respective Learning Support Center (LSC) **only** during the valid registration period (VRP).
- Duration for Practical/Term work/OJT/Field Project/Research Project type of Courses:** 180 Minutes for a batch of typically 15 ± 3 students
- Only best of past performance shall be reported in transcript or mark statement.**
- Total student evaluation for**
  - Each** semester shall be for **550** marks
  - Each** year shall be for **1100** marks
  - Each** regular PG degree shall be for **2200** marks

7. **Reporting Semesters** for certification:

- Min 40% or better marks in total 23 courses (subjects) of total 88 credit points at Semesters 01-04.

## 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 each course.
2. "Successful Completion of the Programme" means – all courses at all semesters are successfully completed and the student obtained "P" (Pass) letter grade for all courses at all semesters along with minimum specified SGPA and CGPA.

## Semester 01

### EVS501: ENVIRONMENTAL SCIENCE AND BIOLOGY

#### Programme Information

SN	Description	Details
1	University	Yashwantrao Chavan Maharashtra Open University Nasik - 422 222, Maharashtra, India Website: <a href="http://www.ycmou.ac.in">http://www.ycmou.ac.in</a>
2	School	School of Sciences
3	Discipline	Science
4	Level	PG
5	Course Used in	V152: M.Sc.(Environmental Science) {2023 Pattern}& V136: M.Sc.(Environmental Science) {2021 Pattern}

#### Course Information

Sem	Major	Code	Course Name	CR	CST	ST	CA	EE	TM	Type
01	DSC	EVS501	Environmental Science & Biology	4	12	120	30	70	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>The objectives of this course are–</p> <ul style="list-style-type: none"> <li>Explore the scientific methods and tools used in environmental research and biology.</li> <li>Investigate the impact of human activities on ecosystems and biodiversity.</li> <li>Recognize the importance of sustainable practices and conservation efforts.</li> <li>Analyze the ethical, social, and economic dimensions of environmental issues.</li> <li>Enhance scientific literacy and the ability to interpret and communicate scientific information.</li> </ul>

#### Units

UN	Name of the Unit	CSs	Questions
01-01	Background And Scope Of Environmental Science	<b>CR 01</b> <b>MLs</b> <b>01-20</b>	As per evaluation pattern, on <b>Each Credit</b> , Student is required to answer
01-02	Use Of Technology In Environmental Science		
01-03	Human Impact On Environment And its Consequences		
01-04	Population Explosion	<b>CR 02</b> <b>MLs</b> <b>21-40</b>	<ul style="list-style-type: none"> <li>Very Short Answer Question (VSAQ), of 03 marks</li> <li>Short Answer Question (SAQ), of 05 marks</li> <li>Long Answer Question (LAQ) of 10 Marks</li> </ul> (LAQ may contain sub-questions (a), (b) and so
02-01	Ecology and sub divisions		
02-02	Community Ecology		
02-03	Biomes		
02-04	Tragedy of commons	<b>CR 03</b> <b>MLs</b> <b>41-60</b>	
03-01	Principle and Scope of Biology		
03-02	Classification of ecosystem		
03-03	Basic laws of energy flow		
03-04	Succession		

04-01	Forest Ecology	<b>CR 04</b> <b>MLs</b> <b>61-80</b>	on.)
04-02	Effect of fire on Forest Ecosystem		
04-03	Marine Environment		
04-04	Indian Marine Territory [Exclusive Economic Zone]		

## 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.	<b>CR 01</b>
1-2	<b>Use Of Technology In Environmental Science:</b> Use of technology, media and people in environmental science, decision making and applications of Environmental science.	
1-3	<b>Human Impact On Environment And its Consequences:</b> Human impact on environment and its consequences, hunting and gathering, agriculture societies, industrial societies, impact of cultural change on environment.	
1-4	<b>Population Explosion:</b> Population explosion, degradation of natural resources ,pollution of -air, water and soil, urbanization ,industrialization, food security, public health, energy crises.	
2-1	<b>Ecology and sub divisions:</b> Definition of Ecology and subdivisions, Ecology relation to other sciences, levels of organization hierarchy, Cake and other ecological models, Population ecology-Population structure, characteristics and processes, population pyramids, 'J' and 'S' shaped growth curves and limits.	<b>CR 02</b>
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	<b>Tragedy of commons:</b> 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	<b>Basic laws of energy flow:</b> 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	<b>Indian Marine Territory:</b> Indian marine territory, Coastal Regulatory Zone	

### Learning resource details

LR Code	Title Author	Edition Year	ISBN Publisher
<b>Course Website Link for (1) Mobile and Online Lectures, (2) Discussion Forum for online interaction and (3) Self-Test for each CR Block, Continuous Assessment Test and End Examination</b>			
<b>Text-Books</b>			
EVS501	Environmental Science & Biology – Mrs. Chandrashila Gaikwad & Mrs. Shweta More	2021	978-9392982071 YCMOU, Nashik
<b>Reference-Books:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS501:RB1	Environmental Science: A Global Concern – William P. Cunningham & Mary Ann Cunningham	14 <sup>th</sup> edition 2017	McGraw-Hill Education
EVS501:RB2	Environmental Science: Systems and Solutions – Michael L. McKinney, Robert M. Schoch, and Logan Yonavjak	6 <sup>th</sup> Edition, 2017	978-013401127 Jones & Bartlett Learning
EVS501:RB3	Introduction to Environmental Science: Earth and Man – William P. Cunningham and Mary Ann	15 <sup>th</sup> Edition, 2019	978-1260153125 McGraw-Hill Education
EVS501:RB4	Living in the Environment – G. Tyler Miller and Scott Spoolman	19 <sup>th</sup> Edition, 2016	978-1337094153 Cengage Learning.
EVS501:RB5	Biology – Sylvia S. Mader and Michael Windelspecht	12 <sup>th</sup> Edition, 2015	978-1260494718 McGraw-Hill Education
EVS501:RB6	Essential Cell Biology – Bruce Alberts, Dennis Bray, Karen Hopkin, Alexander D. Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter	6 <sup>th</sup> Edition, 2014	978-0393679296 Garland Science.
EVS501:RB7	Campbell Biology – Lisa A. Urry, Michael L. Cain, Steven A. Wasserman, Peter V. Minorsky, Jane B. Reece	12 <sup>th</sup> Edition, 2020	978-0136573795 Pearson
<b>CD / DVD:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS501:CD1			
<b>Web Links:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS501:WL1			
<b>OER:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS501:OER1	<a href="https://openstax.org/">https://openstax.org/</a>		

## Course Outcomes

After successful completion of this course, student should be able to –

- Applying scientific principles and methods to investigate and analyze environmental issues.
- Evaluating the impact of human activities on ecosystems, biodiversity, and natural resources.
- Generating creative solutions to address environmental challenges and promote sustainability.
- Engaging in ethical decision-making processes related to environmental and biological issues.
- Conducting fieldwork and laboratory experiments to collect and analyze environmental data.

## EVS502: NATURAL RESOURCES AND THEIR CONSERVATION

### Programme Information

SN	Description	Details
1	University	Yashwantrao Chavan Maharashtra Open University Nasik - 422 222, Maharashtra, India Website: <a href="http://www.ycmou.ac.in">http://www.ycmou.ac.in</a>
2	School	School of Sciences
3	Discipline	Science
4	Level	PG
5	Course Used in	V152: M.Sc.(Environmental Science) {2023 Pattern}& V136: M.Sc.(Environmental Science) {2021 Pattern}

### Course Information

Sem	Major	Code	Course Name	CR	CST	ST	CA	EE	TM	Type
01	DSC	EVS502	Natural Resources and Their Conservation	4	12	120	30	70	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>The objectives of this course are–</p> <ul style="list-style-type: none"> <li>Recognizing the various types of natural resources and their characteristics.</li> <li>Exploring the economic, social, and environmental values and benefits associated with conserving natural resources.</li> <li>Analyzing the interdependencies between natural resources, ecosystems, and human well-being.</li> <li>Developing critical thinking and problem-solving skills to address challenges related to natural resource conservation</li> </ul>

### Units

UN	Name of the Unit	CSs	Questions
01-01	Resources: Biotic and Abiotic Resources	<b>CR 01</b> <b>MLs</b> <b>01-20</b>	As per evaluation pattern, on <b>Each Credit</b> , Student is required to answer
01-02	Biotic resources		
01-03	Natural resource		
01-04	Resource conservation and its importance		
02-01	Wetland And Conservation of Wetland	<b>CR 02</b> <b>MLs</b> <b>21-40</b>	<ul style="list-style-type: none"> <li>Very Short Answer Question (VSAQ), of 03 marks</li> <li>Short Answer Question (SAQ), of 05 marks</li> <li>Long Answer Question (LAQ) of 10 Marks</li> </ul> (LAQ may contain sub-questions (a), (b) and so on.)
02-02	Ground Water As A Resource		
02-03	Uses of Land		
02-04	Soil conservation		
03-01	Forest Resources, Plantation, Social Forestry	<b>CR 03</b> <b>MLs</b> <b>41-60</b>	
03-02	Impact Of Growing Population On Resource Use		
03-03	Wildlife management and conservation		
03-04	Sustainable Wildlife Management		
04-01	Mineral resources	<b>CR 04</b> <b>MLs</b> <b>61-80</b>	
04-02	Fossil fuels		
04-03	Atmosphere as a natural resource		
04-04	Sustainable natural resources management and development		

## Detailed Syllabus

UN	Detailed Syllabus of the Unit	CR
1-1	<b>Resources: Biotic and Abiotic Resources:</b> Definition of resources, biotic and abiotic resources, uses and values of a resource, major abiotic resources- minerals, fossil fuels, water, soil air etc.	<b>CR 01</b>
1-2	<b>Biotic resources:</b> wild plants, forests, grasslands, plankton, domesticated plants, plantations, agriculture, horticulture etc., animals, fisheries, domesticated animals, use of captive and cultured animals.	
1-3	<b>Natural resource</b> -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	<b>Resource conservation and its importance:</b> 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	<b>Wetland And Conservation of Wetland:</b> 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.	<b>CR 02</b>
2-2	<b>Ground Water As A Resource:</b> Groundwater as resource, conservation of ground and surface water in quality and quantity, the water crisis present and future, methods of water conservation.	
2-3	<b>Uses of Land:</b> 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	<b>Soil conservation:</b> Definition, causes of soil degradation and their effects, methods of soil conservation and practices.	
3-1	<b>Forest Resources, Plantation, Social Forestry:</b> 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).	<b>CR 03</b>
3-2	<b>Impact Of Growing Population On Resource Use:</b> 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	<b>Wildlife management and conservation:</b> 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	<b>Sustainable Wildlife Management:</b> Wilderness areas, wildlife management, concept of sustainable use of wildlife, Indian ethos of Wildlife conservation.	

4-1	<b>Mineral resources:</b> Sources, distribution, consumption, conservation of mineral resources. Impact of mining activities on environment, mining laws, National Mineral Policy.	<b>CR 04</b>
4-2	<b>Fossil fuels:</b> Definition, Types, Formation and Uses of Fossil Fuels, Advantages and Disadvantages of Fossil Fuels, Conservation of fossil fuels.	
4-3	<b>Atmosphere as a natural resource:</b> Introduction, Atmospheric circulation and energy balance, Meteorology, atmospheric stability and chemistry, Global warming and climate change.	
4-4	<b>Sustainable natural resources management and development:</b> 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

LR Code	Title Author	Edition Year	ISBN Publisher
<b>Course Website Link for (1) Mobile and Online Lectures, (2) Discussion Forum for online interaction and (3) Self-Test for each CR Block, Continuous Assessment Test and End Examination</b>			
<b>Text-Books</b>			
EVS502-T01	Natural Resources and Their Conservation – Mr. Ashutosh Nirbhavane & Mr. Amol Pund	2021	978-9392982095 YCMOU, Nashik
<b>Reference-Books:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS502:RB1	Natural Resource Conservation: Management for a Sustainable Future – Daniel D. Chiras	11th Edition, 2020	978-1337569612 Cengage Learning
EVS502:RB2	Renewable and Efficient Electric Power Systems" – Gilbert M. Masters	2nd Edition, 2013	978-1118633292 Wiley
EVS502:RB3	Natural Resources: Ecology, Economics, and Policy – Dan Binkley and Jerry Melillo	3rd Edition, 2018	978-1605357455 Sinauer Associates
EVS502:RB4	Conservation Science: Balancing the Needs of People and Nature – Peter Kareiva, Michelle Marvier, and Brian Silliman	1st Edition, 2011	978-1464107804 Roberts & Company Publishers
EVS502:RB5	Principles of Conservation Biology – Martha J. Groom, Gary K. Meffe, and C. Ronald Carroll	4th Edition, 2019	978-1605357974 Sinauer Associates, Inc
EVS502:RB6	Sustaining Life: How Human Health Depends on Biodiversity – Eric Chivian, Aaron Bernstein, and the Center for Health and the Global Environment	1st Edition, 2008	978-0195175097 Oxford University Press
EVS502:RB7	Conservation Biology: Foundations, Concepts, Applications" – Fred Van Dyke, John B. Schnase, and Peter M. Kareiva	2nd Edition, 2018	978-1108428438 Cambridge University Press

<b>CD / DVD:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS502:CD1			
<b>Web Links:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS502:WL1			
<b>OER:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS502:OER1	<a href="https://openstax.org/">https://openstax.org/</a>		
EVS502:OER2	<a href="https://www.merlot.org/">https://www.merlot.org/</a>		

<b>Course Outcomes</b>
<p>After successful completion of this course, student should be able to –</p> <ul style="list-style-type: none"> <li>• Students will be able to propose and evaluate conservation strategies and practices to mitigate the impacts on natural resources.</li> <li>• Students will understand the economic, social, and environmental values associated with the conservation of natural resources.</li> <li>• Students will be able to analyze case studies and assess the interdependencies between natural resources, ecosystems, and human well-being.</li> <li>• Students will be able to apply critical thinking skills to evaluate and propose solutions for challenges related to natural resource conservation.</li> </ul>

## EVS503: BIODIVERSITY AND CONSERVATION

### Programme Information

SN	Description	Details
1	University	Yashwantrao Chavan Maharashtra Open University Nasik - 422 222, Maharashtra, India Website: <a href="http://www.ycmou.ac.in">http://www.ycmou.ac.in</a>
2	School	School of Sciences
3	Discipline	Science
4	Level	PG
5	Course Used in	V152: M.Sc.(Environmental Science) {2023 Pattern}& V143: M.Sc.(Zoology) {2022 Pattern}

### Course Information

Sem	Major	Code	Course Name	CR	CST	ST	CA	EE	TM	Type
01	DSC	EVS503	Biodiversity and Conservation	2	06	60	15	35	50	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>The objectives of this course are–</p> <ul style="list-style-type: none"> <li>Advancing the understanding of biodiversity science</li> <li>Developing advanced research skills.</li> <li>Exploring the role of genetics in biodiversity conservation.</li> <li>Evaluating conservation strategies and policies.</li> <li>Enhancing interdisciplinary perspectives</li> </ul>

### Units

UN	Name of the Unit	CSs	Questions
01-01	Causes for Depletion of Wildlife With Special Reference to India	<b>CR 01</b> <b>MLs</b> <b>01-20</b>	As per evaluation pattern, on <b>Each Credit</b> , Student is required to answer <ul style="list-style-type: none"> <li>Very Short Answer Question (VSAQ), of 03 marks</li> <li>Short Answer Question (SAQ), of 05 marks</li> <li>Long Answer Question (LAQ) of 10 Marks (LAQ may contain sub-questions (a), (b) and so on.)</li> </ul>
01-02	Special conservation projects in India		
01-03	Climate and Climate Change		
01-04	Environmental Stress		
02-01	Conservation Planning of Biodiversity and Climate Change	<b>CR 02</b> <b>MLs</b> <b>21-40</b>	
02-02	Global Biological Impacts of Climate Change		
02-03	Threats to biodiversity		
02-04	Conservation challenges in the Twenty first century		

### Detailed Syllabus

UN	Detailed Syllabus of the Unit	CR
1-1	<b>Causes for Depletion of Wildlife With Special Reference to India:</b> Causes for depletion of wildlife with special reference to India. Study of Threatened, Endangered, Endemic, Extinct fauna of India vertebrate -Invertebrates	<b>CR</b>
1-2	<b>Special conservation projects in India</b> -Project Tiger, Project Gir Lion, Project	



	hangul, musk deer project, Manipur Deer project, Project Elephant, Crocodile Breeding Project, Great Indian Bustard project.	<b>01</b>
1-3	<b>Climate and Climate Change:</b> Concept and current status of climatic change, Nature of Climate Change Observed and Projected Changes in Climate, Climate Change Policy of India.	
1-4	<b>Environmental Stress:</b> Environmental Stresses and their management, global climatic pattern, global warming, atmospheric ozone, acid and nitrogen deposition, coping with climatic variations	
2-1	<b>Conservation Planning of Biodiversity and Climate Change:</b> Identification and prioritization of ecologically sensitive area (ESA). Coarse filter and fine filter approaches of biodiversity conservation.	<b>CR 02</b>
2-2	<b>Global Biological Impacts of Climate Change:</b> Predicted Biological impacts, Observed Biological impacts on Species and Ecosystems; Climate Change and Gender Equality; Projected Impacts on Traditional and Indigenous species	
2-3	<b>Threats to biodiversity:</b> Biodiversity losses: past and present, Natural and Human induced threats and vulnerability of species to extinctions.	
2-4	<b>Conservation challenges in the Twenty first century:</b> Urbanization; Creating knowledge society, Conflict management and decision making, Management of introduced species.	

### Learning resource details

LR Code	Title Author	Edition Year	ISBN Publisher
<b>Course Website Link for (1) Mobile and Online Lectures, (2) Discussion Forum for online interaction and (3) Self-Test for each CR Block, Continuous Assessment Test and End Examination</b>			
<b>Text-Books</b>			
EVS503-T01	Biodiversity and Conservation – Dr. Anil Kurhe	2022	978-9395855334 YCMOU, Nashik
<b>Reference-Books:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS503:RB1	Biodiversity: An Introduction – Kevin J. Gaston and John I. Spicer	3rd Edition, 2017	978-1118945288 Wiley-Blackwell
EVS503:RB2	Conservation Biology: Foundations, Concepts, Applications – Fred Van Dyke, John B. Schnase, and Peter M. Kareiva	2nd Edition, 2018	978-1108428438 Cambridge University Press
EVS503:RB3	Biodiversity Conservation: A Handbook of Techniques – Nick Garbutt	1st Edition, 2007	978-0198530367 Oxford University Press
EVS503:RB4	Biodiversity and Conservation – Michael J. Jeffries and Julian D. Radford	1st Edition, 2010	978-0415435198 Routledge
EVS503:RB5	Principles of Conservation Biology – Martha J. Groom, Gary K. Meffe, and C. Ronald Carroll	4th Edition, 2019	978-1605357974 Sinauer Associates, Inc
EVS503:RB6	Biodiversity and Conservation of the Yucatán	1st Edition,	978-3319094560 Springer



	Peninsula – Gerald Alexander Islebe and Eduardo J. Naranjo Piñera	2015	
EVS503:RB7	Introduction to Conservation Genetics – Richard Frankham, Jonathan D. Ballou, and David A. Briscoe	2nd Edition, 2010	978-0521702713 Cambridge University Press
<b>CD / DVD:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS503:CD1			
<b>Web Links:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS503:WL1			
<b>OER:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS503:OER1	<a href="https://openstax.org/">https://openstax.org/</a>		
EVS503:OER2	<a href="https://www.merlot.org/">https://www.merlot.org/</a>		

## Course Outcomes

After successful completion of this course, student should be able to –

- Demonstrate an advanced understanding of biodiversity science, including the factors influencing biodiversity patterns and processes, the role of species interactions, and the impact of human activities on biodiversity.
- Proficient in conducting independent research in biodiversity and conservation, including designing and implementing field studies, analyzing data using advanced statistical methods, and communicating research findings effectively.
- Critically evaluate the genetic aspects of biodiversity conservation, including assessing genetic diversity, understanding population dynamics, and utilizing genetic information in conservation planning.
- Critically analyze and evaluate conservation strategies and policies, considering their ecological, socio-economic, and ethical implications, and propose evidence-based recommendations for effective conservation.
- Integrate knowledge and perspectives from various disciplines to develop interdisciplinary approaches to biodiversity conservation. They will collaborate effectively with professionals from diverse backgrounds to address complex conservation issues.

## EVS504: LAB ACTIVITIES ON EVS501, EVS502 and EVS503

### Programme Information

SN	Description	Details
1	University	Yashwantrao Chavan Maharashtra Open University Nasik - 422 222, Maharashtra, India Website: <a href="http://www.ycmou.ac.in">http://www.ycmou.ac.in</a>
2	School	School of Sciences
3	Discipline	Science
4	Level	PG
5	Course Used in	V152: M.Sc.(Environmental Science) {2023 Pattern}& V136: M.Sc.(Environmental Science) {2021 Pattern}

### Course Information

Sem	Major	Code	Course Name	CR	CST	ST	CA	EE	TM	Type
01	DSC	EVS504	Lab Activities on EVS501, EVS502 & EVS503	4	12	120	50	50	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>	The objectives of this course are– <ul style="list-style-type: none"> <li>Analyze the ethical, social, and economic dimensions of environmental issues.</li> <li>Enhance scientific literacy and the ability to interpret and communicate scientific information.</li> <li>Analyze the interdependencies between natural resources, ecosystems, and human well-being.</li> <li>Develop critical thinking and problem-solving skills to address challenges related to natural resource conservation</li> </ul>

### Detailed Syllabus

UN	Detailed Syllabus of the Unit	CR
<b>EVS501: Environmental Science &amp; Biology</b>		
1-1	Study of ecological pyramids (at least four)	<b>CR 01</b>
1-2	Study of food chain – Any one example of fresh water, marine water and terrestrial food chain.	
1-3	Estimation of Biomass of a given area.	
1-4	Study of pond ecosystem	
1-5	Mounting / Quantitative estimation of planktonic forms	
1-6	Study of plant community by list quadrat method.	
<b>EVS502: Natural Resources &amp; Their Conservation</b>		
2-1	Determination of SAR (sodium absorption ratio) of soil	<b>CR 02</b>
2-2	Study of land degradation.	
2-3	Study of texture of soil.	
2-4	Estimation of elements{all major and minor} from soil sample	
2-5	Measurement of intensity of solar radiations by Lux meter	
2-6	Determination of the pH of given soil sample	

EVS503: Biodiversity & Conservation		
3-1	Identification and classification of Honey Bee species.	<b>CR 03</b>
3-2	Study of morphology and identification of fishes.	
3-3	Water Analysis: Estimation of total hardness, salinity, chloride, calcium, magnesium, phosphate.	
3-4	Estimation of Primary productivity of water bodies.	
3-5	Study of the traditional knowledge of biodiversity conservation of any local communities	
3-6	Study of bacterial succession in Milk.	
Case Study/ Report Writing		
4-1	Case Study of water treatment plant (WTP) and Industrial effluent treatment plant (ETP).	<b>CR 04</b>
4-2	Design a waste water disposal plant	
4-3	Legal Case citation (one per student)	
4-4	Reports on various study tours/academic visits	
4-5	Preparation/drafting of EIA Report (Chemical Industry, Fertilizer Industry, hydropower station).	
4-6	Report on Eco-tourism	

### Learning resource details

LR Code	Title Author	Edition Year	ISBN Publisher
<b>Course Website Link for (1) Mobile and Online Lectures, (2) Discussion Forum for online interaction and (3) Self-Test for each CR Block, Continuous Assessment Test and End Examination</b>			
<b>Text-Books</b>			
EVS504-P01	Lab Activities on EVS501, EVS502 & EVS503 – Mrs. Shweta More	2021	Publication 2494 YCMOU, Nashik
EVS501-T01	Environmental Science & Biology – Mrs. Chandrashila Gaikwad & Mrs. Shweta More	2021	978-9392982071 YCMOU, Nashik
EVS506-T02	Environmental Education, Policies & Legislation – Mrs. Shweta More	2021	978-9392982088 YCMOU, Nashik
EVS502-T03	Natural Resources and Their Conservation – Mr. Ashutosh Nirbhavane & Mr. Amol Pund	2021	978-9392982095 YCMOU, Nashik
EVS503-T04	Biodiversity and Conservation – Dr. Anil Kurhe	2022	978-9395855334 YCMOU, Nashik
<b>Reference-Books:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS504:RB1	Environmental Science: A Global Concern – William P. Cunningham & Mary Ann Cunningham	14 <sup>th</sup> edition 2017	McGraw-Hill Education
EVS504:RB2	Environmental Science: Systems and Solutions – Michael L. McKinney, Robert M. Schoch, and Logan Yonavjak	6 <sup>th</sup> Edition, 2017	978-013401127 Jones & Bartlett Learning

EVS504:RB3	Introduction to Environmental Science: Earth and Man – William P. Cunningham and Mary Ann	15th Edition, 2019	978-1260153125 McGraw-Hill Education
EVS504:RB4	Living in the Environment – G. Tyler Miller and Scott Spoolman	19th Edition, 2016	978-1337094153 Cengage Learning.
EVS504:RB5	Natural Resource Conservation: Management for a Sustainable Future – Daniel D. Chiras	11th Edition, 2020	978-1337569612 Cengage Learning
EVS504:RB6	Renewable and Efficient Electric Power Systems" – Gilbert M. Masters	2nd Edition, 2013	978-1118633292 Wiley
EVS504:RB7	Natural Resources: Ecology, Economics, and Policy – Dan Binkley and Jerry Melillo	3rd Edition, 2018	978-1605357455 Sinauer Associates
EVS504:RB8	Conservation Science: Balancing the Needs of People and Nature – Peter Kareiva, Michelle Marvier, and Brian Silliman	1st Edition, 2011	978-1464107804 Roberts & Company Publishers
<b>CD / DVD:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS504:CD1			
<b>Web Links:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS504:WL1			
<b>OER:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS504:OER1	<a href="https://openstax.org/">https://openstax.org/</a>		
EVS503:OER2	<a href="https://www.merlot.org/">https://www.merlot.org/</a>		

<b>Course Outcomes</b>			
After successful completion of this course, student should be able to –			
<ul style="list-style-type: none"> <li>• Evaluating the impact of human activities on ecosystems, biodiversity, and natural resources.</li> <li>• Generating creative solutions to address environmental challenges and promote sustainability.</li> <li>• Analyze case studies and assess the interdependencies between natural resources, ecosystems, and human well-being.</li> </ul>			

## RES505: RESEARCH METHODOLOGY

### Programme Information

SN	Description	Details
1	University	Yashwantrao Chavan Maharashtra Open University Nasik - 422 222, Maharashtra, India Website: <a href="http://www.ycmou.ac.in">http://www.ycmou.ac.in</a>
2	School	School of Sciences
3	Discipline	Science
4	Level	PG
5	Course Used in	V151: M.Sc.(Mathematics) {2023 Pattern}, V152: M.Sc.(Environmental Science) {2023 Pattern}, V153: M.Sc.(Physics) {2023 Pattern}, V154: M.Sc.(Chemistry) {2023 Pattern}, V155: M.Sc.(Zoolgy) {2023 Pattern}, V156: M.Sc.(Botany) {2023 Pattern}, V141: M.Sc.(Physics) {2022 Pattern}, V142: M.Sc.(Chemistry) {2022 Pattern}, V143: M.Sc.(Zoolgy) {2022 Pattern}, V144: M.Sc.(Botany) {2022 Pattern},

### Course Information

Sem	Other	Code	Course Name	CR	CST	ST	CA	EE	TM	Type
01	RM	RES505	Research Methodology	4	12	120	30	70	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>	The objectives of this course are– <ul style="list-style-type: none"> <li>Familiarizing with various research designs and their appropriate applications.</li> <li>Developing skills in formulating research questions and hypotheses.</li> <li>Learning to analyze and interpret data using appropriate statistical techniques.</li> <li>Enhancing critical thinking and problem-solving skills in the research process.</li> </ul>

### Units

UN	Name of the Unit	CSs	Questions
01-01	Research	<b>CR 01</b> <b>MLs</b> <b>01-20</b>	As per evaluation pattern, on <b>Each Credit</b> , Student is required to answer <ul style="list-style-type: none"> <li>Very Short Answer Question (VSAQ), of 03 marks</li> <li>Short Answer Question (SAQ), of 05 marks</li> <li>Long Answer Question (LAQ) of 10 Marks</li> </ul>
01-02	Methods in research		
01-03	Experimental design		
01-04	Sampling method		
02-01	Data collections	<b>CR 02</b> <b>MLs</b> <b>21-40</b>	
02-02	Representation of data		
02-03	Graphical representation		
02-04	Analysis of data		
03-01	Use of inferential statistical tools in research	<b>CR 03</b> <b>MLs</b>	
03-02	Biostatistical Test		

03-03	Use of ANOVA	41-60	(LAQ may contain sub-questions (a), (b) and so on.)
03-04	Application of correlation of data		
04-01	Literature collection	CR 04 MLs 61-80	
04-02	Intellectual Property Rights		
04-03	Research Databases		
04-04	Research Metrics		

**Important Note:** This course is common across all postgraduate programmes in the ‘School of Sciences’, the content within the Research Methodology course should incorporate illustrations and examples relevant to their respective domains or disciplines.

### Detailed Syllabus

UN	Detailed Syllabus of the Unit	CR
1-1	<b>Research:</b> Basic and applied research, essential steps in research, Research – definition, importance and application.	CR 01
1-2	<b>Methods in research:</b> General methods in research – natural observation, field study, and experimentations.	
1-3	<b>Experimental design</b> – basic principles, hypothesis, one & two group experimental design. Matched pair data analysis, factorial design, randomized block design.	
1-4	<b>Sampling method</b> - Concept of population, random sampling and non random sampling, variables – random, independent and intervening variables.	
2-1	<b>Data collections:</b> methods for primary data- observation, interview, questionnaire methods, and experiments, Methods for secondary data – scientific journals, books, reports, databases.	CR 02
2-2	<b>Representation of data:</b> Tabular representations of quantitative data, frequency table – oneway and two way.	
2-3	<b>Graphical representation:</b> Graphical representation of quantitative data – line graph, histogram, frequency polygon, frequency curve, Ogive, bar diagrams and pie diagrams.	
2-4	<b>Analysis of data</b> – Tools of statistics and software applications.	
3-1	<b>Use of inferential statistical tools in research:</b> Use of different statistical estimations depending on the type of data, hypothesis testing, and test of significance.	CR 03
3-2	<b>Biostatistical Test:</b> Student’s ‘t’ test – applications and importance in research data And Application of Chi-square test for the experimental data	
3-3	<b>Use of ANOVA :</b> (one-way and two-way ANOVA) for the research data analysis.	
3-4	<b>Application of correlation of data:</b> Application of correlation and regression analysis for the data.	
4-1	<b>Literature collection:</b> Need, review process, consulting source material, literature citation; Components of research report – Text, tables, figures, bibliography, Writing of dissertations, project proposals, project reports, research papers.	CR 04
4-2	<b>Intellectual Property Rights:</b> Basics of patent, Types of Patents (patents, copyrights, trademarks, Geographical Indications, Industrial Designs, and	

	traditional knowledge, Patent application process (Searching a patent, Drafting a patent, Filing of patent, Types of patent applications), Patent documents (Specifications and Claims).
4-3	<b>Research Databases:</b> Types of Databases - Indexing Databases and benefits of Indexing, Citation Index Database; Major Citation Indexing Services - Web of Science /Web of Knowledge (WoS/WoK), Scopus/Science Direct, Google Scholar, CiteSeerX, WorldWideScience(WWS), IEEE Xplore, PubMed Central (PMC) Database, Directory of Open Access Journals (DOAJ), Indian Citation Index (ICI) Database, E-Theses Online Service (EThOS), Preprint site arXiv [Refer <b>Chapter 13</b> of <a href="#">Academic Integrity and Research Quality</a> ]
4-4	<b>Research Metrics:</b> Journal Metrics- Impact Factor (IF) or Journal Impact Factor(JIF), List of Impact Factor of Various Journals, Problems of the Impact Factor and the Editorial Ethics, Cite Score, Difference between Cite Score and Impact Factor, Impact Per Publication (IPP); Newly Emerged Indicators - Source Normalised Impact Per Paper (SNIP), Scimago Journal Rank (SJR), Eigenfactor, Article Influence, SCImago Journal; Author level Metrics- H-Index with its Advantages and limitations, G-Index, i10/20 Index; Altmetrics with its Advantages and limitations; Unique ID for Research Contributors/Author . [Refer <b>Chapter 13 and 14</b> of <a href="#">Academic Integrity and Research Quality</a> ]

### Learning resource details

LR Code	Title Author	Edition Year	ISBN Publisher
<b>Course Website Link for (1) Mobile and Online Lectures, (2) Discussion Forum for online interaction and (3) Self-Test for each CR Block, Continuous Assessment Test and End Examination</b>			
<b>Text-Books</b>			
RES505-T01	Research Methodology – Dr. Anant J. Dhembare (Unit 01 to 14 only), Available <a href="#">here</a>	2022	978-9395855624 YCMOU, Nashik
<b>Reference-Books:</b> Explore additional details and reinforce learning, with this optional learning resource!			
RES505:RB1	Research Methods in Environmental Studies: A Social Science Approach – Ismael Vaccaro, Eric Alden Smith, and Shankar Aswani	1st Edition, 2010	978-0813344113 Routledge
RES505:RB2	Environmental Social Science: Human-Environment Interactions and Sustainability – Emilio F. Moran, Edward A. Rosa, and Anantha K. Duraiappah	1st Edition, 2010	978-1402090346 Springer
RES505:RB3	Handbook of Research Methods and Applications in Environmental Studies – Matthias Ruth and Brynhildur Davidsdottir	1st Edition, 2018	978-1785364327 Edward Elgar Publishing
RES505:RB4	Research Methods for Environmental Studies: A Social Science Approach – Mark L. Nichter and Mimi Nichter	1st Edition, 1991	978-0306438297 Springer
RES505- RB5	<a href="#">Academic Integrity and Research Quality</a> (Chapter 13 and 14)	Dec 2021	e-Books , <a href="#">UGC web site</a>
<b>CD / DVD:</b> Explore additional details and reinforce learning, with this optional learning resource!			
RES505:CD1			



<b>Web Links:</b> Explore additional details and reinforce learning, with this optional learning resource!			
RES505-WL1	<a href="#">Academic Integrity and Research Quality</a>	Dec 2021	UGC
RES505-WL2	<a href="#">Guidance Document: Good Academic Research Practices</a>	Sept 2020	UGC
<b>OER:</b> Explore additional details and reinforce learning, with this optional learning resource!			
RES505-OER1			

<b>Course Outcomes</b>
<p>After successful completion of this course, student should be able to –</p> <ul style="list-style-type: none"> <li>• Select and apply appropriate research designs based on the research question or problem.</li> <li>• Formulate clear and relevant research questions or hypotheses.</li> <li>• Analyze and interpret data using appropriate statistical techniques.</li> <li>• Identify and address ethical considerations in research, ensuring the protection of participants and data integrity.</li> <li>• Develop critical thinking skills in evaluating research studies, identifying strengths and weaknesses, and proposing improvements.</li> </ul>



## EVS506: ENVIRONMENTAL EDUCATION, POLICES & LEGISLATION

### Programme Information

SN	Description	Details
1	University	Yashwantrao Chavan Maharashtra Open University Nasik - 422 222, Maharashtra, India Website: <a href="http://www.ycmou.ac.in">http://www.ycmou.ac.in</a>
2	School	School of Sciences
3	Discipline	Science
4	Level	PG
5	Course Used in	V152: M.Sc.(Environmental Science) {2023 Pattern} & V136: M.Sc.(Environmental Science) {2021 Pattern}

### Course Information

Sem	Major	Code	Course Name	CR	CST	ST	CA	EE	TM	Type
01	DSE	EVS506	Environmental Education, Policies & Legislation	4	12	120	30	70	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>	The objectives of this course are – <ul style="list-style-type: none"> <li>Analyzing the role of stakeholders</li> <li>Evaluating the effectiveness of environmental policies.</li> <li>Promoting environmental stewardship and sustainable practices.</li> <li>Building environmental literacy and communication skills.</li> </ul>

### Units

UN	Name of the Unit	CSs	Questions
01-01	Environmental Education	<b>CR 01</b> <b>MLs</b> <b>01-20</b>	As per evaluation pattern, on <b>Each Credit</b> , Student is required to answer  <ul style="list-style-type: none"> <li>Very Short Answer Question (VSAQ), of 03 marks</li> <li>Short Answer Question (SAQ), of 05 marks</li> <li>Long Answer Question (LAQ) of 10 Marks</li> </ul> (LAQ may contain sub-questions (a), (b) and so on.)
01-02	Status of environmental education in new education policy		
01-03	Environmental Policy		
01-04	State of India's Environment		
02-01	Emerging Environmental Concerns in India	<b>CR 02</b> <b>MLs</b> <b>21-40</b>	
02-02	Awareness Of Society With Respect To Global Terminology		
02-03	Environmental Awareness		
02-04	"Our Common Future" Rio de Janerio- Conference-1992		
03-01	Global Environment Conservation Strategy 1	<b>CR 03</b> <b>MLs</b> <b>41-60</b>	
03-02	Global Environment Conservation Strategy 2		
03-03	International Environmental Law [ILE], TBILISI Declaration (1977)		

03-04	Environmental Conventions and Agreements		
04-01	Environmental Acts-1	<b>CR 04 MLs 61-80</b>	
04-02	Environment Protection Act: 1986		
04-03	Environmental Acts-2		
04-04	National Green Tribunal Act 2010		

### 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	<b>Status of environmental education in new education policy :</b> 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, Sardar sarovar dam, Tehri Garwal 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, Ecosystem evaluation, Earth overshoot Day	
2-3	<b>Environmental Awareness:</b> Stockholm conference (UNCHE), World commission on Environment and Development (WCED)	
2-4	<b>Rio de Janerio- Conference:</b> "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	<b>International Environmental Law:</b> 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	<b>The environment (protection) Act:</b> 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	<b>National Green Tribunal Act 2010:</b> 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
<b>Course Website Link for (1) Mobile and Online Lectures, (2) Discussion Forum for online interaction and (3) Self-Test for each CR Block, Continuous Assessment Test and End Examination</b>			
<b>Text-Books</b>			
EVS506-T01	Environmental Education, Policies & Legislation – Mrs. Shweta More	2021	978-9392982088 YCMOU, Nashik
<b>Reference-Books:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS506:RB1	Environmental Education: A Resource Handbook – J. B. Dissanayake	1st Edition, 2015	978-8126917411 Atlantic Publishers and Distributors
EVS506:RB2	Handbook of Environmental Education – Robert B. Stevenson, Michael Brody, Justin Dillon, and Arjen E. J. Wals	1st Edition, 2017	978-1138830735 Routledge
EVS506:RB3	Environmental Education: Principles, Methods, and Applications – John J. Hungerford, Trudi L. Volk, and Robert B. Peyton	6th Edition, 2012	978-0873552400 National Environmental Education & Training Foundation
EVS506:RB4	Environmental Policy and Politics: A Documentary Reader – Michael E. Kraft and Norman J. Vig	10th Edition, 2017	978-1506362123 CQ Press
EVS506:RB5	Environmental Policy: New Directions for the Twenty-First Century – Norman J. Vig and Michael E. Kraft	10th Edition, 2016	978-1483352533 CQ Press
EVS506:RB6	Environmental Politics and Policy – Walter A. Rosenbaum	10th Edition, 2018	978-1506366695 CQ Press

EVS506:RB7	Environmental Law and Policy – James Salzman and Barton H. Thompson Jr	5th Edition, 2017	978-1634609008 Foundation Press
<b>CD / DVD:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS506:CD1			
<b>Web Links:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS506:WL1			
<b>OER:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS506:OER1	<a href="https://openstax.org/">https://openstax.org/</a>		
EVS506:OER2	<a href="https://www.merlot.org/">https://www.merlot.org/</a>		

<b>Course Outcomes</b>
<p>After successful completion of this course, student should be able to –</p> <ul style="list-style-type: none"> <li>• Demonstrate a comprehensive understanding of the principles, theories, and approaches used in environmental education.</li> <li>• Apply environmental education strategies and methodologies to design and implement effective educational programs and initiatives.</li> <li>• Evaluate the impact of environmental education programs on knowledge, attitudes, and behaviors related to environmental conservation and sustainability.</li> <li>• Analyze and interpret environmental policies, legislation, and legal frameworks at the national and international levels.</li> <li>• Assess the effectiveness and impact of environmental policies and legislation in addressing environmental challenges and promoting sustainability.</li> </ul>

## EVS507: MANAGEMENT OF WATER RESOURCES

### Programme Information

SN	Description	Details
1	University	Yashwantrao Chavan Maharashtra Open University Nasik - 422 222, Maharashtra, India Website: <a href="http://www.ycmou.ac.in">http://www.ycmou.ac.in</a>
2	School	School of Sciences
3	Discipline	Science
4	Level	PG
5	Course Used in	V152: M.Sc.(Environmental Science) {2023 Pattern}

### Course Information

Sem	Major	Code	Course Name	CR	CST	ST	CA	EE	TM	Type
01	DSE	EVS507	Management of Water Resources	4	12	120	30	70	100	T

### Presumed knowledge and learning objectives

Presumed Knowledge	Learning Objectives
<ul style="list-style-type: none"> <li>General introduction of water</li> <li>Basic Understanding of water</li> </ul>	<p>The objectives of this course are–</p> <ul style="list-style-type: none"> <li>Acquire advanced analytical and quantitative skills to assess water resources management</li> <li>Evaluate the environmental, social, and economic aspects of water resource management</li> <li>Explore and analyze modern technologies and innovations used in water resource management</li> <li>Learn techniques for addressing conflicts arising from competing demands for water resources</li> </ul>

### Units

UN	Name of the Unit	CSs	Questions
01-01	Water Resources of India	<b>CR 01</b> <b>MLs</b> <b>01-20</b>	As per evaluation pattern, on <b>Each Credit</b> , Student is required to answer <ul style="list-style-type: none"> <li>Very Short Answer Question (VSAQ), of 03 marks</li> <li>Short Answer Question (SAQ), of 05 marks</li> <li>Long Answer Question (LAQ) of 10 Marks</li> </ul> (LAQ may contain sub-questions (a), (b) and so on.)
01-02	Water Quality and its Management		
01-03	Physical, Chemical and Biological Characteristics of Water		
01-04	Water Pollution-I (Surface and Groundwater Pollution)		
02-01	Water Pollution-II (Marine Pollution)	<b>CR 02</b> <b>MLs</b> <b>21-40</b>	
02-02	Water Pollution-III (Thermal Pollution)		
02-03	Drinking Water Standards		
02-04	Water Related Hazards		
03-01	Water Conservation and Management Strategies	<b>CR 03</b> <b>MLs</b> <b>41-60</b>	
03-02	Rain water harvesting		
03-03	Wetlands Conservation		
03-04	Integrated water resources management-I		
04-01	Integrated Water Resources Management-II (Implementation and Capacity Development)	<b>CR 04</b> <b>MLs</b> <b>61-80</b>	
04-02	Socio-economic aspects of Water		
04-03	Water Governance		
04-04	Challenges in Water Management		

## Detailed Syllabus

UN	Detailed Syllabus of the Unit	CR
1-1	<b>Water Resources of India:</b> Introduction, Precipitation, Surface water resources – Glaciers, Oceans, Estuaries, Rivers, Lakes and Wetlands, Mangroves, Manmade Reservoirs, Groundwater resources	CR 01
1-2	<b>Water Quality and its Management:</b> Definition, Agencies for setting Water Quality Standards, Need for management of water quality, Factors affecting water quality, Steps for Water Quality management	
1-3	<b>Physical, Chemical and Biological Characteristics of Water:</b> Properties of water, Water Quality Characteristics - Physical Characteristics, Chemical Characteristics, Biological Characteristics.	
1-4	<b>Water Pollution-I (Surface and Groundwater Pollution):</b> Surface Water Pollutants, Ground water pollution, Effects of water pollution, Control of water pollution.	
2-1	<b>Water Pollution-II (Marine Pollution):</b> Composition of seawater, Marine pollution, Sources of marine pollution, Effects of Marine pollution, Control of marine pollution, Indian Scenario, International Cooperation	CR 02
2-2	<b>Water Pollution-III (Thermal Pollution):</b> Sources of thermal pollution - Nuclear power plants, Coal-fired power plants, Thermoelectric power plants, Industrial effluents, Sewage, Hydro-electric power, etc. Effects of thermal pollution, Standards for thermal pollution, Control of thermal pollution	
2-3	<b>Drinking Water Standards:</b> History of Drinking Water Standards, Drinking water quality, Standards Setting Process, Virological Examination, Biological Examination	
2-4	<b>Water Related Hazards:</b> Types of water related hazards, Causes of Water Related Hazards, Some Examples of water related hazards in India, Management of water related hazards	
3-1	<b>Water Conservation and Management Strategies:</b> Water management, Watershed management, Desalination, Extended detention wetland, Management policy, Water Management Strategies	CR 03
3-2	<b>Rain water harvesting:</b> Traditional Techniques for Rainwater Harvesting, Modern techniques for Rainwater Harvesting, Estimating the rainwater harvested quantity, Quality of Harvested Water, Types of contaminants of a rainwater harvesting system, Maintenance of Water Quality in Rainwater Harvesting System	
3-3	<b>Wetlands Conservation:</b> Wetland Conservation – General introduction, definitions related to wetlands, Types and Classification of Wetlands, Wetland Ecology (Vegetation, Soils, Flora and Fauna), Wetland Importance and Threats, wetland conservation, Government of India Initiatives to Conserve Wetlands	
3-4	<b>Integrated water resources management-I:</b> Water Cycle and Global Water Resources, Water Use and its Impacts, Integrated water resources management (IWRM), IWRM and the Role in Sustainable Development, Water Policy and IWRM in India	
4-1	<b>Integrated Water Resources Management-II (Implementation and Capacity Development):</b> The potential benefits of IWRM, The IWRM Processes and Planning, IWRM Implementation Process, Water Management at River Basin Scale, River Basins in India, the transboundary indus river basin, Capacity Development, IWRM and Wastewater	CR 04
4-2	<b>Socio-economic aspects of Water:</b> Water as a critical natural resource, Water as a	



	social resource, Water as an Economic resource, Different socio-economic aspects of water, Water and Sustainable development, Water right, Socio-economic Crisis due to Water, Climate Change, Water pricing	
4-3	<b>Water Governance:</b> Water Governance, Dimensions of Water Governance, Water Governance :Global Scenario, Water Governance System in India	
4-4	<b>Challenges in Water Management:</b> Water Resources-at a Glance, Water Management, Challenges in Sustainable Water Management, Solutions and Strategies, Conclusion	

### Learning resource details

LR Code	Title Author	Edition Year	ISBN Publisher
<b>Course Website Link for (1) Mobile and Online Lectures, (2) Discussion Forum for online interaction and (3) Self-Test for each CR Block, Continuous Assessment Test and End Examination</b>			
<b>Text-Books</b>			
<b>Reference-Books:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS507:RB1	Water Resources Systems Engineering – W. A. Hill and J. A. Dracup,	3rd edition, 2000	978-0130824075 John Wiley & Sons.
EVS507:RB2	Water Resources Planning and Management – A. K. Biswas, , ISBN	3rd edition, 2004	978-0471495713 McGraw-Hill
EVS507:RB3	Water Resources Systems Planning and Management – M. C. Chaturvedi	2nd edition, 2005	978-8122413002 Tata McGraw-Hill
EVS507:RB4	Handbook of Water Resources Planning and Management – Larry W. Mays	3rd edition, 2011	978-0071629796 McGraw-Hill
EVS507:RB5	Water Resources Engineering – David A. Maidment	5th edition, 2011	978-0132069998 Pearson
EVS507:RB6	Water Resources Management – James L. W. Quirk and William W.-G. Yeh	3rd edition, 2014	978-1118449515 Elsevier
EVS507:RB7	Integrated Water Resources Management – Asit K. Biswas and Cecilia Tortajada	2nd edition, 2016	978-1119106409 Routledge
<b>CD / DVD:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS507:CD1			
<b>Web Links:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS507:WL1			
<b>OER:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS507:OER1	<a href="https://openstax.org/">https://openstax.org/</a>		
EVS507:OER2	<a href="https://www.merlot.org/">https://www.merlot.org/</a>		

## Course Outcomes

After successful completion of this course, student should be able to –

- Identifying and address complex water management challenges, applying their analytical skills to make informed decisions.
- Equipped to design and implement sustainable water management practices that consider environmental, social, and economic factors.
- Capable of conducting advanced research on water resource-related topics, utilizing appropriate methodologies and data analysis techniques.
- Contributing to the development and evaluation of water policies and governance frameworks at various levels, including regional and national scales.



## Semester 02

### EVS509: ENVIRONMENTAL CHEMISTRY

#### Programme Information

SN	Description	Details
1	University	Yashwantrao Chavan Maharashtra Open University Nasik - 422 222, Maharashtra, India Website: <a href="http://www.ycmou.ac.in">http://www.ycmou.ac.in</a>
2	School	School of Sciences
3	Discipline	Science
4	Level	PG
5	Course Used in	V152: M.Sc.(Environmental Science) {2023 Pattern} & V136: M.Sc.(Environmental Science) {2021 Pattern}

#### Course Information

Sem	Major	Code	Course Name	CR	CST	ST	CA	EE	TM	Type
02	DSC	EVS509	Environmental Chemistry	4	12	120	30	70	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>	The objectives of this course are– <ul style="list-style-type: none"><li>Advancing knowledge of environmental chemistry principles</li><li>Investigating environmental pollutants and their behaviour</li><li>Analyzing environmental monitoring and assessment techniques</li><li>Evaluating environmental remediation strategies</li><li>Examining emerging issues in environmental chemistry</li></ul>

#### Units

UN	Name of the Unit	CSs	Questions
01-01	Fundamentals of Environmental Chemistry	<b>CR 01</b> <b>MLs</b> <b>01-20</b>	As per evaluation pattern, on <b>Each Credit</b> , Student is required to answer
01-02	Soil Chemistry		
01-03	Chemical composition of Air and Water		
01-04	Properties of water, water pollutants		
02-01	Radioactivity, it's Types, Sources and Hazards	<b>CR 02</b> <b>MLs</b> <b>21-40</b>	<ul style="list-style-type: none"><li>Very Short Answer Question (VSAQ), of 03 marks</li><li>Short Answer Question (SAQ), of 05 marks</li><li>Long Answer Question (LAQ) of 10 Marks</li></ul> (LAQ may contain sub-questions (a), (b) and so on.)
02-02	Radioactivity		
02-03	Biological effects		
02-04	Protection against occupational exposure		
03-01	Water treatment and environmental chemistry – 1	<b>CR 03</b> <b>MLs</b> <b>41-60</b>	
03-02	Water treatment and environmental chemistry - 2		
03-03	Tertiary treatment and Advanced waste water treatments		
03-04	Classical Methods		
04-01	Toxic chemicals	<b>CR 04</b> <b>MLs</b> <b>61-80</b>	
04-02	Biochemical aspects		
04-03	Contaminants and their natural pathways of degradation and their abatement		
04-04	Carcinogens in the air		

## 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.	
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.	CR 02
2-2	<b>Radioactivity:</b> Laws of radioactivity, Uses of Radioactivity, Advantages and Disadvantages of Radioactivity.	
2-3	<b>Biological effects:</b> Biological effects of radiation exposure	
2-4	<b>Protection against occupational exposure,</b> principles of radiation protection and the international framework	
3-1	<b>Water treatment and environmental chemistry1-</b> 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.	CR 04
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	<b>Contaminants and their natural pathways of degradation and their abatement</b>	
4-4	<b>Carcinogens in the air</b>	

## Learning resource details

LR Code	Title Author	Edition Year	ISBN Publisher
<b>Course Website Link for (1) Mobile and Online Lectures, (2) Discussion Forum for online interaction and (3) Self-Test for each CR Block, Continuous Assessment Test and End Examination</b>			
<b>Text-Books</b>			
EVS509-To1	Environmental Chemistry – Mrs. Chandrashila Gaikwad	2022	978-9392982590 YCMOU, Nashik
<b>Reference-Books:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS509:RB1	Environmental Chemistry – Stanley E. Manahan	10 <sup>th</sup> ed. (2018)	978-1498776949 CRC Press
EVS509:RB2	Environmental Chemistry: A Global Perspective – Gary W. vanLoon and Stephen J. Duffy	4th edition (2017)	978-0198749979 Oxford University Press
EVS509:RB3	Principles of Environmental Chemistry – James E. Girard	3rd edition (2007)	978-0763739111 Jones & Bartlett Learning
EVS509:RB4	Environmental Chemistry – Colin Baird and Michael Cann	5th edition (2012)	978-1429289059 W.H. Freeman
EVS509:RB5	Chemistry for Environmental Engineering and Science Clair N. Sawyer, Perry L. McCarty, and Gene F. Parkin	5th edition (2002)	978-0072480665 McGraw-Hill Education
EVS509:RB6	Environmental Chemistry: Fundamentals – Jorge G. Ibanez, Stanley E. Manahan, and Nancy E. Manahan	1st edition (1998)	978-1577660203 Waveland Press
EVS509:RB7	Introduction to Environmental Chemistry – Colin Baird and Michael Cann	4th edition (2008)	978-1429201468 W.H. Freeman
<b>CD / DVD:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS509:CD1			
<b>Web Links:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS509:WL1			
<b>OER:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS509:OER1	<a href="https://openstax.org/">https://openstax.org/</a>		
EVS509:OER2	<a href="https://www.merlot.org/">https://www.merlot.org/</a>		

### Course Outcomes

After successful completion of this course, student should be able to –

- Demonstrate a deep understanding of the principles and theories of environmental chemistry and their application to real-world environmental issues.
- Analyze and assess the behavior of environmental pollutants in different environmental compartments, applying concepts of transport, transformation, and fate.
- Possess advanced skills in environmental monitoring and assessment techniques, including sampling, analysis, and data interpretation.
- Evaluate and propose remediation strategies for environmental pollutants, considering their effectiveness, feasibility, and environmental implications.

## EVS510: ENVIRONMENTAL GEOSCIENCES & COMPUTER APPLICATIONS

### Programme Information

SN	Description	Details
1	University	Yashwantrao Chavan Maharashtra Open University Nasik - 422 222, Maharashtra, India Website: <a href="http://www.ycmou.ac.in">http://www.ycmou.ac.in</a>
2	School	School of Sciences
3	Discipline	Science
4	Level	PG
5	Course Used in	V152: M.Sc.(Environmental Science) {2023 Pattern} & V136: M.Sc.(Environmental Science) {2021 Pattern}

### Course Information

Sem	Major	Code	Course Name	CR	CST	ST	CA	EE	TM	Type
02	DSC	EVS510	Environmental Geosciences and Computer Applications	4	12	120	30	70	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>The objectives of this course are–</p> <ul style="list-style-type: none"> <li>Advancing knowledge of environmental geosciences.</li> <li>Exploring the role of computer applications in environmental geosciences.</li> <li>Integrating geospatial and environmental data.</li> <li>Applying computer applications to environmental problem-solving.</li> <li>Exploring emerging technologies and trends.</li> </ul>

### Units

UN	Name of the Unit	CSs	Questions
01-01	Principles	<b>CR 01</b> <b>MLs</b> <b>01-20</b>	As per evaluation pattern, on <b>Each Credit</b> , Student is required to answer
01-02	Interior of the Earth, earth's materials		
01-03	The earth systems and biosphere		
01-04	Elements		
02-01	Biochemical factors	<b>CR 02</b> <b>MLs</b> <b>21-40</b>	<ul style="list-style-type: none"> <li>Very Short Answer Question (VSAQ), of 03 marks</li> <li>Short Answer Question (SAQ), of 05 marks</li> <li>Long Answer Question (LAQ) of 10 Marks</li> </ul> (LAQ may contain sub-questions (a), (b) and so on.)
02-02	The Ocean Environment		
02-03	Coastal processes, erosion, and controls		
02-04	Volcanoes		
03-01	Climate	<b>CR 03</b> <b>MLs</b> <b>41-60</b>	
03-02	Remote Sensing in Environmental Monitoring		
03-03	Concept of remote sensing		
03-04	Geographical Information System		
04-01	Information & Communication Technology in EVS	<b>CR 04</b> <b>MLs</b> <b>61-80</b>	
04-02	Introduction to web browsing		
04-03	Computer applications in environmental modelling		
04-04	Computer-based modelling		

## 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	<b>Coastal processes, erosion, and controls</b>	
2-4	<b>Volcanoes:</b> Types, hazards, and prediction	
3-1	<b>Climate:</b> General relationship between landscapes, biomes and climate. Climate of India. Indian Monsoon, Elnino, 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
<b>Course Website Link for (1) Mobile and Online Lectures, (2) Discussion Forum for online interaction and (3) Self-Test for each CR Block, Continuous Assessment Test and End Examination</b>			
<b>Text-Books</b>			
EVS510-T01	Environmental geosciences and Computer Applications – Dr. G. M. Pondhe	2022	978-9392982644 YCMOU, Nashik
<b>Reference-Books:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS510:RB1	Environmental Geology – Carla W. Montgomery	10th edition, 2016	978-1259686517 McGraw-Hill Education
EVS510:RB2	Introduction to Environmental Geology – Edward A. Keller and Duane E. DeVecchio	5th edition, 2018	978-0134818149 Pearson
EVS510:RB3	Environmental Science – G. Tyler Miller and Scott E. Spoolman	15th edition, 2018	978-1337569613 Cengage Learning
EVS510:RB4	Global Environmental Issues: A Climatological Approach – David D. Kemp	2nd edition, 2014	978-0415529161 Routledge
EVS510:RB5	Environmental and Geotechnical Engineering – Lawrence K. Wang, Norman C. Pereira, and Yung-Tse Hung	2014	978-1439873509 CRC Press
EVS510:RB6	Principles of Environmental Geochemistry – G. Nelson Eby	2nd edition, 2013	978-0122290619 Brooks Cole
EVS510:RB7	The Human Impact on the Natural Environment: Past, Present, and Future – Andrew S. Goudie	7th edition, 2013	978-1118940050 Wiley-Blackwell
<b>CD / DVD:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS510:CD1			
<b>Web Links:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS510:WL1			
<b>OER:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS510:OER1	<a href="https://openstax.org/">https://openstax.org/</a>		
EVS510:OER2	<a href="https://www.merlot.org/">https://www.merlot.org/</a>		

## Course Outcomes

After successful completion of this course, student should be able to –

- Demonstrate an advanced understanding of the principles and concepts of environmental geosciences and their applications to environmental management.
- Proficient in using computer applications, such as GIS, remote sensing, and modeling software, for analyzing and visualizing environmental data and processes.

- Integrate geospatial and environmental data, conducting spatial analysis and modeling to assess environmental patterns and relationships.
- Apply computer applications to solve complex environmental problems and make informed decisions in various environmental domains.
- Demonstrate awareness and understanding of emerging technologies and trends in environmental geosciences and computer applications, and their potential applications to environmental research and management.



## EVS511: HERBAL WEALTH

### Programme Information

SN	Description	Details
1	University	Yashwantrao Chavan Maharashtra Open University Nasik - 422 222, Maharashtra, India Website: <a href="http://www.ycmou.ac.in">http://www.ycmou.ac.in</a>
2	School	School of Sciences
3	Discipline	Science
4	Level	PG
5	Course Used in	V152: M.Sc.(Environmental Science) {2023 Pattern} , V156: M.Sc.(Botany) {2023 Pattern} , V144: M.Sc. (Botany) [2022 Pattern]

### Course Information

Sem	Major	Code	Course Name	CR	CST	ST	CA	EE	TM	Type
02	DSC	EVS511	Herbal Wealth	2	12	120	15	35	50	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>The objectives of this course are–</p> <ul style="list-style-type: none"> <li>Analyze the importance of safety &amp; quality in herbal products</li> <li>Develop research skills to critically evaluate scientific literature, conduct evidence-based research, and interpret findings related to herbal medicine</li> <li>Examine the principles of herbal formulations and their preparation techniques</li> <li>Explore the various applications of herbal medicine in preventive, curative, and promotive healthcare</li> </ul>

### Units

UN	Name of the Unit	CSs	Questions
01-01	Conservation	<b>CR 01</b> <b>MLs</b> <b>01-20</b>	As per evaluation pattern, on <b>Each Credit</b> , Student is required to answer <ul style="list-style-type: none"> <li>Very Short Answer Question (VSAQ), of 03 marks</li> <li>Short Answer Question (SAQ), of 05 marks</li> <li>Long Answer Question (LAQ) of 10 Marks (LAQ may contain sub-questions (a), (b) and so on.)</li> </ul>
01-02	Conservation organizations		
01-03	Cultivation		
01-04	Adaptive planning and management for sustainable harvesting		
02-01	Food flavors and natural colours	<b>CR 02</b> <b>MLs</b> <b>21-40</b>	
02-02	Natural colours		
02-03	Production Technology		
02-04	Plant sweeteners (natural sweeteners)		

### Detailed Syllabus

UN	Detailed Syllabus of the Unit	CR
1-1	<b>Conservation:</b> Biodiversity and concepts of conservation: in-situ and ex-situ,	



	Medicinal Plants Conservation Area (MPCA), Medicinal Plants Development Area, (MPDA); Categories of assessment (seven categories)	<b>CR 01</b>
1-2	<b>Conservation organizations:</b> Red Data book, National and International Conservation organizations and their initiatives. CBD, FAO mandate, Project Tiger.	
1-3	<b>Cultivation:</b> Medicinal plant cultivation in India, Agro climatic zones of Maharashtra and India	
1-4	<b>Adaptive planning and management for sustainable harvesting:</b> Garcinia, Decalepis, Cinnamomun, Vateria, Limonia and Dioscorea; sustainability factor - trade.	
2-1	<b>Food flavors and natural colours</b> – Study of some important plants used as sources and importance of food flavour's; Natural colours – introduction; classification; sources, examples – Juglansregia (walnut), Rubiatantrum and Rubiaperegrine (madder), Lithospermumerythrorhizon (Japanese shikone), Lawsoniainermis (henna), Alkannatinctoria (alkanna), Crocussativus (saffron),	<b>CR 02</b>
2-2	<b>Natural colours:</b> Introduction; classification; sources, examples -Tageteserecta (marigold), Capsicumannum (capsicum), Indigo feratinctoria and Indigoferasuffruticosa(indigo), Curcumalonga (turmeric), Haematoxylon campechianum (logwood) and Monascuspurpurea (monascus, mould)	
2-3	<b>Production technology:</b> Study of highly used medicinal plants - their cultivation, extraction of active principle, and quality control. List of plants: Bacopamonnier, Centellaasiatica, Tinosporacordifolia, Garcinia indica, Eclipta alba, Gymnemasylvestris, Cymbopogoncitratus, Vetiveriazanioides, Piper longum, Phyllanthusamarus, Cassiaangustifolia (Tirunelvellisenna), Morindacitriifolia (Noni), Andrographispaniculata	
2-4	<b>Plant sweeteners (natural sweeteners):</b> Sweeteners - Introduction, sources of sweeteners, groups of sweeteners – nutritive and non-nutritive; examples - Stevia reboudiana, Glycyrrhizaglabra, Citrus aurantiumvaramara, Thaumatooccusdanielli, Dioscoreophyllummcumminii; sucralose	

### Learning resource details

LR Code	Title Author	Edition Year	ISBN Publisher
<b>Course Website Link for (1) Mobile and Online Lectures, (2) Discussion Forum for online interaction and (3) Self-Test for each CR Block, Continuous Assessment Test and End Examination</b>			
<b>Text-Books</b>			
EVS511 –T01	Herbal Wealth – Dr. Deepak Bhaskar Shelke, Dr.Hiralal Bhaskar Sonawane, Dr.Balkrishna Ankush Shinde, Dr.Mahadev Ramkisan Chambhare	2022	978-9395855518 YCMOU, Nashik
<b>Reference-Books:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS511:RB1	The Encyclopedia of Medicinal Plants – Andrew Chevallier	2nd edition, 2016	978-0241229446 DK
EVS511:RB2	The Complete Medicinal Herbal: A Practical Guide to the Healing Properties of Herbs – Penelope Ody	1st edition, 1993	978-1852307589 HarperCollins Publishers

EVS511:RB3	Herbal Medicine: Expanded Commission E Monographs – Mark Blumenthal, Alicia Goldberg, and Josef Brinckmann	1st edition, 2000	978-0965555507, American Botanical Council
EVS511:RB4	The Herbal Medicine-Maker's Handbook: A Home Manual – James Green	1st edition, 2000	978-0895949905, Crossing Press
EVS511:RB5	The Modern Herbal Dispensatory: A Medicine-Making Guide – Thomas Easley and Steven Horne	1st edition, 2016	978-1623170790, North Atlantic Books
EVS511:RB6	Rodale's Basic Herbal with Information on Essential Herbs and Where to Grow Them, How to Harvest, and How to Use Them-Plus, over 200 of the Most Commonly Used Medicinal Herbs – William H. Hylton	1st edition, 2000	978-1579542347, Rodale Books
EVS511:RB7	Herbal Medicine from the Heart of the Earth – Sharol Marie Tilgner	1st edition, 2009	978-1888483147, Wise Acres LLC
<b>CD / DVD:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS511:CD1			
<b>Web Links:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS511:WL1			
<b>OER:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS511:OER1	<a href="https://openstax.org/">https://openstax.org/</a>		
EVS511:OER2	<a href="https://www.merlot.org/">https://www.merlot.org/</a>		

<h3>Course Outcomes</h3> <p>After successful completion of this course, student should be able to –</p> <ul style="list-style-type: none"> <li>• Equipped with advanced knowledge and expertise in herbal medicine, enabling them to make informed decisions and recommendations in various healthcare settings.</li> <li>• Critically evaluate the scientific literature and apply evidence-based approaches to assess the efficacy and safety of herbal interventions.</li> <li>• Designing and conduct research studies related to herbal medicine, contributing to the advancement of knowledge in this field.</li> <li>• Integrating herbal medicine knowledge into broader healthcare contexts, collaborating with other healthcare professionals to enhance patient care.</li> <li>• Grasping of the quality assurance measures and regulatory frameworks related to herbal products and traditional medicine practices.</li> <li>• Advocate for the recognition and incorporation of herbal medicine in healthcare systems and public health initiatives.</li> <li>• Contributing to advancements in herbal medicine research, potentially leading to the development of new herbal products or therapeutic approaches.</li> </ul>
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## EVS512: LAB ACTIVITIES ON EVS509 and EVS510

### Programme Information

SN	Description	Details
1	University	Yashwantrao Chavan Maharashtra Open University Nasik - 422 222, Maharashtra, India Website: <a href="http://www.ycmou.ac.in">http://www.ycmou.ac.in</a>
2	School	School of Sciences
3	Discipline	Science
4	Level	PG
5	Course Used in	V152: M.Sc.(Environmental Science) {2023 Pattern} & V136: M.Sc.(Environmental Science) {2021 Pattern}

### Course Information

Sem	Major	Code	Course Name	CR	CST	ST	CA	EE	TM	Type
02	DSC	EVS512	Lab Activities on EVS509 & EVS510	4	24	120	50	50	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>	The objectives of this course are– <ul style="list-style-type: none"> <li>Advancing knowledge of environmental chemistry principles</li> <li>Investigating environmental pollutants and their behaviour</li> <li>Integrating geospatial and environmental data.</li> <li>Applying computer applications to environmental problem-solving.</li> <li>Exploring emerging technologies and trends.</li> </ul>

### Detailed Syllabus

UN	Detailed Syllabus of the Unit	CR
<b>EVS509: Environmental Chemistry</b>		
1-1	Analysis of Soil and Water: Physical properties, chemical properties, nutrients, bacterial parameters	<b>CR 01</b>
1-2	Conductivity of soil	
1-3	Analysis of Total hardness of water.	
1-4	Estimation of halides in water samples.	
<b>EVS509: Environmental Chemistry</b>		
2-1	Estimation of sulphates in water samples.	<b>CR 02</b>
2-2	Estimation of carbon di-oxide in water samples.	
2-3	Estimation of non-respirable dust in air using dust sampler	
2-4	Estimation of respirable dust in air using dust sampler	
<b>EVS510: Environmental geosciences and Computer Applications</b>		
3-1	Studies of models of various rock types.	<b>CR 03</b>
3-2	Study of geological maps.	
3-3	BOD and COD.	

3-4	Study of various ground water sources and its quality.	
3-5	Wind rose.	
<b>EVS510: Environmental geosciences and Computer Applications</b>		
4-1	Study of various meteorological parameters and climate.	<b>CR 04</b>
4-2	Student Tests.	
4-3	Correlation and regression.	
4-4	Sample manuscript writing.	
4-5	Study and use of various computer applications/models for environmental use.	

### Learning resource details

LR Code	Title Author	Edition Year	ISBN Publisher
<b>Course Website Link for (1) Mobile and Online Lectures, (2) Discussion Forum for online interaction and (3) Self-Test for each CR Block, Continuous Assessment Test and End Examination</b>			
<b>Text-Books</b>			
EVS512	Lab Activities on EVS509 & EVS510 – Dr. Yogeshwar Baste	2022	Publication 2495 YCMOU, Nashik
EVS509	Environmental Chemistry – Mrs. Chandrashila Gaikwad	2022	978-9392982590 YCMOU, Nashik
EVS510	Environmental geosciences and Computer Applications – Dr. G. M. Pondhe	2022	978-9392982644 YCMOU, Nashik
<b>Reference-Books:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS512:RB1	Environmental Chemistry – Stanley E. Manahan	10th edition (2018)	978-1498776949 CRC Press
EVS512:RB2	Environmental Chemistry: A Global Perspective – Gary W. vanLoon and Stephen J. Duffy	4th edition (2017)	978-0198749979 Oxford University Press
EVS512:RB3	Principles of Environmental Chemistry - James E. Girard	3rd edition (2007)	978-0763739111 Jones & Bartlett Learning
EVS512:RB4	Environmental Chemistry – Colin Baird and Michael Cann	5th edition (2012)	978-1429289059 W.H. Freeman
EVS512:RB5	Chemistry for Environmental Engineering and Science – Clair N. Sawyer, Perry L. McCarty, and Gene F. Parkin	5th edition (2002)	978-0072480665 McGraw-Hill Education
EVS512:RB6	Environmental Chemistry: Fundamentals - Jorge G. Ibanez, Stanley E. Manahan, and Nancy E. Manahan	1st edition (1998)	978-1577660203 Waveland Press
EVS512:RB7	Introduction to Environmental Chemistry – Colin Baird and Michael Cann	4th edition (2008)	978-1429201468 W.H. Freeman
EVS512:RB8	Environmental Geology – Carla W. Montgomery	10th edition,	978-1259686517 McGraw-Hill

		2016	Education
EVS512:RB9	Introduction to Environmental Geology – Edward A. Keller and Duane E. DeVecchio	5th edition, 2018	978-0134818149 Pearson
EVS512:RB10	Environmental Science – G. Tyler Miller and Scott E. Spoolman	15th edition, 2018	978-1337569613 Cengage Learning
EVS512:RB11	Global Environmental Issues: A Climatological Approach – David D. Kemp	2nd edition, 2014	978-0415529161 Routledge
EVS512:RB12	Environmental and Geotechnical Engineering – Lawrence K. Wang, Norman C. Pereira, and Yung-Tse Hung	2014	978-1439873509 CRC Press
EVS512:RB13	Principles of Environmental Geochemistry – G. Nelson Eby	2nd edition, 2013	978-0122290619 Brooks Cole
EVS512:RB14	The Human Impact on the Natural Environment: Past, Present, and Future – Andrew S. Goudie	7th edition, 2013	978-1118940050 Wiley-Blackwell
<b>CD / DVD:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS512:CD1			
<b>Web Links:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS512:WL1			
<b>OER:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS512:OER1	<a href="https://openstax.org/">https://openstax.org/</a>		
EVS512:OER2	<a href="https://www.merlot.org/">https://www.merlot.org/</a>		

## Course Outcomes

After successful completion of this course, student should be able to –

- Demonstrate a deep understanding of the principles and theories of environmental chemistry and their application to real-world environmental issues.
- Analyze and assess the behavior of environmental pollutants in different environmental compartments, applying concepts of transport, transformation, and fate.
- Integrate geospatial and environmental data, conducting spatial analysis and modeling to assess environmental patterns and relationships.
- Apply computer applications to solve complex environmental problems and make informed decisions in various environmental domains.
- Demonstrate awareness and understanding of emerging technologies and trends in environmental geosciences and computer applications, and their potential applications to environmental research and management.

## EVS513: ON JOB TRAINING (OJT)

### Programme Information

SN	Description	Details
1	University	Yashwantrao Chavan Maharashtra Open University Nashik - 422 222, Maharashtra, India Website: <a href="http://www.ycmou.ac.in/">http://www.ycmou.ac.in/</a> and <a href="http://ycmou.digitaluniversity.ac/">http://ycmou.digitaluniversity.ac/</a>
2	School	School of Sciences
3	Discipline	Science
4	Level	PG
5	Course Used in	V152: M.Sc.(Environmental Science) {2023 Pattern}

### Course Information

Sem	Other	Code	Course Name	CR	CST	ST	CA	EE	TM	Type
02	OJT	EVS513	On Job Training (OJT)	4	12	120	50	50	100	TW

### 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>	The objectives of this course are– <ul style="list-style-type: none"><li>Gaining actual work practice experience</li><li>Developing specific job-related skills</li><li>Acquiring industry knowledge and familiarity</li><li>Building professional networks and relationships</li><li>Enhancing problem-solving and critical thinking abilities</li></ul>

### Details about On-Job-Training (OJT)/Internships

Internships offer valuable opportunities for postgraduate students to bridge the gap between academia and the professional world, promote research and innovation.

By engaging in hands-on experiences and collaborating with experts, students can develop practical skills, expand their network, and gain insights into potential career paths.

### Guidelines: [In process]

#### A. General:

- 1) It is mandatory for a student to successfully complete the OJT (Internship) for the award of the PG Diploma / PG Degree. This internship could be the research internship or any normal industry, Organization/Institute, Start-up/ ATAL Innovation/Incubation centers, Micro/Small/Medium/Enterprise, Govt/NGO/PSU/, Online/offline academic activities at School/Regional Centers/ University Head Quarters, Online Internship related to major courses.
- 2) In case of working students if his/her job nature is related to major courses or in allied domain then he/she will be permitted for the internship at workplace provided; a declaration by an employer is submitted directly to the LSC head and School. Both, declaration by an employer and the training completion certificate will be attached along with Internship report.
- 3) Internship is of four credits with a period of 4 weeks and carries a weightage of 50-50% in 'Continuous Assessment (CA)' and 'End examination (EE)'. The internship time period does not extend beyond end examination of OJT.

- Total Study efforts (including Self-Study) in Hours: Total 120 Hours
  - On-Job-Training/Internship (@during 22working days) in a month: minimum 110Hours
  - Preparation of Internship Report: 10 Hours
  - Duration– i) After end examination of semester 02 and before beginning of semester 03 or ii) Any one month within semester 02 of the programme
- 4) At the end of the internship, each student is required to provide a printed copy of their consolidated diary/journal and internship report for the evaluation of internship. The report must express exactly what was learned and accomplished during the internship.
- 5) The Intern will be assessed by
- a) Continuous Assessment (CA) - Mentor of the Industry/NGO/organization/Institute etc where student is selected for Internship
  - b) End Examination (EE) - LSC Supervisor/PC and External Examiner.

### **B. Monitoring and Evaluation:**

**Monitoring:** During internship period as part of ‘Continuous assessment (CA)’, the mentor should evaluate the interns using the following points and should issue a recommendation letter that whether Intern/student meets the expectations of the internship or not:

1	Behaviors, Shows interest in assigned work, Willingness to learn
2	Accepts responsibility, Cooperates with co-workers and supervisors, Demonstrates organizational skills
3	Uses time, knowledge and expertise effectively, Analyzes problems effectively
4	Demonstrates creativity/ originality / any innovative contribution, Professional ethics and accountability
5	Writes effectively, Produces high quality work/Skill Proficiency

**Evaluation:** At internship, the intern will be evaluated in the end examination (EE), by duly constituted expert committee of internal and external, on the following suggestive aspects:

- Professional Attitude
- Maintenance of Daily Diary
- Internship Report
- Viva voce/Oral

<b>Reference-Link:</b> Explore additional details!	
EVS513–RB1	UGC Internship Guidelines <a href="https://www.ugc.gov.in/pdfnews/1887287_Rsearch-Internship-Guidelines-120522.pdf">https://www.ugc.gov.in/pdfnews/1887287_Rsearch-Internship-Guidelines-120522.pdf</a>
EVS513–RB2	AICTE Internship Portal, <a href="https://internship.aicte-india.org/">https://internship.aicte-india.org/</a>
EVS513–RB3	NITI Aayog Internship Scheme <a href="https://www.niti.gov.in/internship">https://www.niti.gov.in/internship</a>



## Course Outcomes

After successful completion of this course, student should be able to –

- Students will demonstrate proficiency in applying theoretical knowledge and academic concepts to real-world professional situations.
- Students will possess job-specific skills that are relevant to their chosen field of study, enabling them to perform tasks and responsibilities effectively and efficiently.
- Students will acquire a comprehensive understanding of industry practices, trends, and challenges, contributing to their overall knowledge and expertise in the field.
- Students will establish professional networks and relationships, expanding their professional connections and opportunities for future collaborations and career advancement.
- Students will develop problem-solving and critical thinking abilities, demonstrating the ability to analyze complex situations, make informed decisions, and propose effective solutions.
- Students will demonstrate professionalism, adaptability, and effective communication skills in a professional work environment.



## EVS514: FIELD PROJECT (FP)

### Programme Information

SN	Description	Details
1	University	Yashwantrao Chavan Maharashtra Open University Nashik - 422 222, Maharashtra, India Website: <a href="http://www.ycmou.ac.in/">http://www.ycmou.ac.in/</a> and <a href="http://ycmou.digitaluniversity.ac/">http://ycmou.digitaluniversity.ac/</a>
2	School	School of Sciences
3	Discipline	Science
4	Level	PG
5	Course Used in	V152: M.Sc.(Environmental Science) {2023 Pattern}

### Course Information

Sem	Other	Code	Course Name	CR	CST	ST	CA	EE	TM	Type
02	FP	EVS514	Field Project (FP)	4	12	120	50	50	100	TW

### 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>	The objectives of this course are– <ul style="list-style-type: none"><li>Apply theoretical knowledge in real-world settings</li><li>Develop research and investigative skills</li><li>Conduct independent research</li><li>Collaborate and communicate effectively</li><li>Develop problem-solving and critical thinking abilities</li></ul>

### Details about Field Project (FP) [In process]

#### Domains

Maharashtra is a diverse state with various ecosystems, environmental challenges, and research opportunities. Choose a domain that aligns with your interests, the expertise of your faculty, and the resources available in your region. Field projects offer an opportunity to apply theoretical knowledge to real-world situations and contribute to addressing environmental challenges in the region. Some potential domains of field work for Environmental Science students are listed as follows. Learner may find this helpful while choosing topic of the field work, but not limited to -

- Urban Air Quality Monitoring and Analysis:** Conduct air quality assessments in urban areas of Maharashtra to measure pollutants, identify sources of pollution, and recommend mitigation strategies.
- Wetland Ecosystem Assessment:** Study the health of wetland ecosystems like mangroves, marshes, and lakes, analyzing water quality, biodiversity, and the impact of human activities.
- Biodiversity Inventory and Conservation:** Identify and document plant and animal species in specific regions or protected areas to contribute to biodiversity conservation efforts.

- **River Water Quality and Pollution Source Identification:** Evaluate the water quality of rivers, including pollution sources and their impacts on aquatic ecosystems and human health.
- **Climate Change Vulnerability and Adaptation:** Assess how communities in different parts of Maharashtra are vulnerable to climate change and develop strategies for adaptation.
- **Solid Waste Management Strategies:** Investigate solid waste generation, disposal practices, and recycling initiatives in urban and rural areas, and propose sustainable waste management solutions.
- **Sustainable Agriculture and Soil Health:** Study agricultural practices, soil quality, and the adoption of sustainable farming techniques to enhance productivity while minimizing environmental impacts.
- **Renewable Energy Feasibility Study:** Assess the feasibility of implementing renewable energy projects (solar, wind, etc.) in specific locations, considering technical, economic, and environmental factors.
- **Eco-Tourism Impact Assessment:** Analyze the impacts of tourism on ecologically sensitive areas, suggesting ways to promote sustainable tourism while preserving natural resources.
- **Indigenous Knowledge and Conservation:** Collaborate with local indigenous communities to document their traditional ecological knowledge and explore its potential role in conservation.
- **Green Infrastructure and Urban Resilience:** Evaluate the effectiveness of green infrastructure (parks, green roofs, etc.) in enhancing urban resilience to environmental challenges.
- **Water Harvesting and Management:** Study traditional and modern water harvesting techniques in rural areas, assessing their effectiveness in enhancing water availability.
- **E-Waste Management and Recycling:** Examine the challenges and opportunities of managing electronic waste, including recycling technologies and awareness campaigns.
- **Noise Pollution Assessment:** Measure and analyze noise pollution levels in urban and industrial areas, considering its effects on human health and well-being.
- **Land Use Change Analysis:** Use remote sensing and GIS to monitor and analyze land use changes over time, studying their environmental impacts.
- **Conservation of Endangered Species:** Focus on the conservation efforts of specific endangered species, like the Great Indian Bustard or the Indian Pangolin.
- **Water Pollution and Aquatic Life:** Investigate the impact of water pollution on aquatic organisms, studying their health and behavior in polluted environments.

- **Environmental Education and Outreach:** Develop educational materials or workshops to raise awareness about local environmental issues and promote sustainable practices.
- **Community Engagement in Green Belt Development:** Study the involvement of local communities in the planning, establishment, and maintenance of green belts. Analyze the impact of community engagement on the success and sustainability of green belt projects.
- **Green Belt Connectivity and Corridors:** Investigate the importance of establishing ecological connectivity through green belts. Study the potential for creating wildlife corridors and greenways to enhance biodiversity movement.

Guidelines: [\[In process\]](#)

#### **Topic Selection and Proposal:**

- Choose a well-defined and feasible topic that aligns with your interests, available resources, and the expertise of your mentors.
- Develop a clear and comprehensive project proposal that outlines the research objectives, significance, methodology, and expected outcomes.

#### **Research Planning:**

- Define your research question and objectives precisely. Identify the scope of your study, study area within Maharashtra, and the timeline for fieldwork.
- Conduct a thorough literature review to understand the existing knowledge and identify gaps in the chosen area of study.

#### **Methodology:**

- Determine the appropriate research methods and techniques based on your research objectives. These might include field surveys, sample collection, laboratory analysis, interviews, or experiments.
- Detail the step-by-step procedures you will follow during fieldwork, ensuring they are well-structured and repeatable.

#### **Ethics and Permissions:**

- If your research involves human subjects, ensure you obtain necessary ethical approvals from your academic institution.
- If conducting research/field work in protected areas or involving sensitive species, obtain required permits or approvals from relevant authorities.

**Data Collection:**

- Collect data systematically and accurately according to your defined methodology. Maintain organized records of observations, samples, measurements, and any other relevant information.

**Data Analysis:**

- Organize and manage your collected data in a format suitable for analysis.
- Apply appropriate statistical or analytical techniques to interpret your data and draw meaningful conclusions.

**Results and Interpretation:**

- Present your findings using tables, graphs, charts, and descriptive text.
- Interpret your results in the context of your research question and compare them with existing literature.

**Discussion and Conclusion:**

- Discuss the implications of your findings, considering how they contribute to the existing knowledge in your field and address the research gaps you identified.
- Reflect on any limitations of your study and suggest potential avenues for further research.

**Reporting and Documentation:**

- Create a well-structured report that includes an introduction, objectives, methods, results, discussion, and conclusion sections.
- Include proper citations for references to literature.
- Visual aids such as photographs, maps, and diagrams can enhance the clarity of your report.

**Presentation and Communication:**

- Present your findings to your academic institution, peers, and mentors through a seminar, presentation, or poster session.
- Practice clear and concise communication to effectively convey your research process and outcomes.

**Time Management:**

- Plan your fieldwork, data collection, and analysis schedule to ensure efficient use of time and resources.

**Mentorship and Feedback:**

- Collaborate closely with mentors or advisors who can provide guidance, feedback, and support throughout the project.

### Flexibility and Adaptability:

- Be prepared to adjust your plans if you encounter unexpected challenges during fieldwork or analysis.

### Learning resource details

LR Code	Title Author	Edition Year	ISBN Publisher
<b>Course Website Link for (1) Mobile and Online Lectures, (2) Discussion Forum for online interaction and (3) Self-Test for each CR Block, Continuous Assessment Test and End Examination</b>			
<b>Text-Books</b>			
EVS502-T01	Natural Resources and Their Conservation – Mr. Ashutosh Nirbhavane & Mr. Amol Pund	2021	978-9392982095 YCMOU, Nashik
EVS503-T02	Biodiversity and Conservation – Dr. Anil Kurhe	2022	978-9395855334 YCMOU, Nashik
EVS515-T03	Environmental Sustainability – Mr. Kailas Ahire	2021	978-9392982101 YCMOU, Nashik
EVS606-T04	Sustainable Management of Biodiversity – Dr. Jagruti Chavan	2022	978-9395855716 YCMOU, Nashik
<b>Reference-Books:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS514:RB2	Biodiversity: An Introduction – Kevin J. Gaston and John I. Spicer	3rd edition, 2018	978-1119580201, Wiley-Blackwell
EVS514:RB3	Principles of Conservation Biology – Martha J. Groom, Gary K. Meffe, and C. Ronald Carroll	4th edition, 2014	978-0878935970, Sinauer Associate
EVS514:RB4	Sustaining Life: How Human Health Depends on Biodiversity – Eric Chivian and Aaron Bernstein	1st edition, 2008	978-0195175097, Oxford University Press
EVS514:RB5	Conservation Biology: Foundations, Concepts, Applications – Fred Van Dyke	2nd edition, 2008	978-1405107375, Springer
<b>CD / DVD:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS514:CD1			
<b>Web Links:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS514:WL1	<a href="https://sdgs.un.org/goals">https://sdgs.un.org/goals</a>		
EVS514:WL2	<a href="https://cpcb.nic.in/standards/">https://cpcb.nic.in/standards/</a>		
EVS514:WL3	<a href="http://www.ipcc.org">www.ipcc.org</a> ; <a href="https://www.ipcc.ch/report/sixth-assessment-report-cycle/">https://www.ipcc.ch/report/sixth-assessment-report-cycle/</a>		
<b>OER:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS514:OER1	<a href="https://openstax.org/">https://openstax.org/</a>		
EVS514:OER2	<a href="https://www.merlot.org/">https://www.merlot.org/</a>		

## Course Outcomes

After successful completion of this course, student should be able to –

- Students will demonstrate the ability to apply theoretical knowledge and concepts to real-world situations, effectively bridging the gap between academia and practical applications.
- Students will develop advanced research and investigative skills, including the ability to design and execute research projects, collect and analyze data, and draw well-founded conclusions.
- Students will conduct independent research, demonstrating the ability to formulate research questions, design appropriate methodologies, and independently execute fieldwork or data collection.
- Students will exhibit effective collaboration and communication skills, demonstrating the ability to work collaboratively with others, engage in professional dialogue, and effectively communicate their research findings to diverse audiences.
- Students will showcase advanced problem-solving and critical thinking abilities, demonstrating the capacity to identify and address challenges encountered during fieldwork, analyze complex data, and propose innovative solutions.
- Students will demonstrate a thorough understanding of ethical considerations, field safety protocols, and best practices in their chosen field of study.

## EVS515: ENVIRONMENTAL SUSTAINABILITY

### Programme Information

SN	Description	Details
1	University	Yashwantrao Chavan Maharashtra Open University Nasik - 422 222, Maharashtra, India Website: <a href="http://www.ycmou.ac.in">http://www.ycmou.ac.in</a>
2	School	School of Sciences
3	Discipline	Science
4	Level	PG
5	Course Used in	V152: M.Sc.(Environmental Science) {2023 Pattern} & V136: M.Sc.(Environmental Science) {2021 Pattern}

### Course Information

Sem	Major	Code	Course Name	CR	CST	ST	CA	EE	TM	Type
02	DSE	EVS515	Environmental Sustainability	4	12	120	30	70	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>	The objectives of this course are– <ul style="list-style-type: none"> <li>Advancing research skills in environmental sustainability.</li> <li>Evaluating sustainability challenges and opportunities</li> <li>Analyzing policy frameworks and governance structures</li> <li>Developing sustainable management strategies</li> <li>Deepening understanding of environmental sustainability</li> </ul>

### Units

UN	Name of the Unit	CSs	Questions
01-01	Introduction to environment and society	<b>CR 01</b> <b>MLs</b> <b>01-20</b>	As per evaluation pattern, on <b>Each Credit</b> , Student is required to answer
01-02	Introduction to Terms of Significance		
01-03	Trade & Environment		
01-04	Protection Acts		
02-01	The Case of Western Ghats	<b>CR 02</b> <b>MLs</b> <b>21-40</b>	<ul style="list-style-type: none"> <li>Very Short Answer Question (VSAQ), of 03 marks</li> <li>Short Answer Question (SAQ), of 05 marks</li> <li>Long Answer Question (LAQ) of 10 Marks</li> </ul>
02-02	The Forest Conservation Act		
02-03	Seminal Cases in Environmental Protection		
02-04	Managing our environment for sustainability		
03-01	Waste Management for Sustainable Development	<b>CR 03</b> <b>MLs</b> <b>41-60</b>	(LAQ may contain sub-questions (a), (b) and so on.)
03-02	Environment Friendly Technologies		
03-03	Changing Interactions Environmental Education		
03-04	Sensitivity towards environment		
04-01	Attitude towards protection of the Environment	<b>CR 04</b> <b>MLs</b> <b>61-80</b>	(LAQ may contain sub-questions (a), (b) and so on.)
04-02	Local strategies and innovations in Environmental Protection		
04-03	Active Participation in the resolution of Environmental Challenges		
04-04	Motivational Sustainability		



## Detailed Syllabus

UN	Detailed Syllabus of the Unit	CR
1-1	Introduction to environment and society: Introduction to environment and society, Factors affecting environment and society-1 , Factors affecting environment and society-2	<b>CR 01</b>
1-2	<b>Introduction to Terms of Significance:</b> Our Common Future, Introduction to Terms of Significance -1, Introduction to Terms of Significance -2	
1-3	<b>Trade &amp; Environment-</b> Concepts, issues and recent developments- part 1, Trade & Environment- Concepts, issues and recent developments- part 2	
1-4	<b>Protection Acts:</b> Legal Edifice of Environmental Protection, Environmental Impact Assessment Norms and their application in India, The Wild Life Protection Act, 1972	
2-1	<b>The Case of Western Ghats-</b> The Gadgil Report, The Kasturirangan Report	<b>CR 02</b>
2-2	<b>The Forest Conservation Act, 1980, The Water Act, The Air –Prevention &amp; Control of Pollution Act, 1981</b>	
2-3	<b>Seminal Cases in Environmental Protection,</b> The Environment Protection Act, 1986, Environmental Friendly Technologies- Concept and Need, A Consumer Behaviour perspective to Environmental Sustainability	
2-4	<b>Managing our environment for sustainability-</b> 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	<b>Waste Management for Sustainable Development,</b> Environment Friendly practices and the use of Environment Friendly products	<b>CR 03</b>
3-2	<b>Environment Friendly Technologies:</b> 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	<b>Changing Interactions Environmental Education-</b> An Introduction	
3-4	<b>Sensitivity towards environment:</b> 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	<b>Attitude towards protection of the Environment,</b> Critical thinking, utilization of skills and reflective solutions	<b>CR 04</b>
4-2	<b>Local strategies and innovations in Environmental Protection-</b> Part 1, Local strategies and innovations in Environmental Protection- Part 2	
4-3	<b>Active Participation in the resolution of Environmental Challenges-</b> part 1, Active Participation in the resolution of Environmental Challenges-part 2	
4-4	<b>Motivational Sustainability,</b> Environmental Sustainability – the conclusion	



## Learning resource details

LR Code	Title Author	Edition Year	ISBN Publisher
<b>Course Website Link for (1) Mobile and Online Lectures, (2) Discussion Forum for online interaction and (3) Self-Test for each CR Block, Continuous Assessment Test and End Examination</b>			
<b>Text-Books</b>			
EVS515-T01	Environmental Sustainability – Mr. Kailas Ahire	2021	978-9392982101 YCMOU, Nashik
<b>Reference-Books:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS515:RB1	Environmental Science: Toward a Sustainable Future – Richard T. Wright and Dorothy F. Boorse	14th edition (2021)	978-0135908127 Pearson
EVS515:RB2	The Sustainability Handbook: The Complete Management Guide to Achieving Social, Economic, and Environmental Responsibility – William R. Blackburn	3rd edition (2018)	978-0367236013 Routledge
EVS515:RB3	Our Common Future: The World Commission on Environment and Development – Gro Harlem Brundtland	1st edition (1987)	978-0192820808 Oxford University Press
EVS515:RB4	Resilience Thinking: Sustaining Ecosystems and People in a Changing World – Brian Walker and David Salt	1st edition (2006)	978-1597260930 Island Press
EVS515:RB5	The Ecology of Commerce: A Declaration of Sustainability – Paul Hawken	1st edition (1993)	978-0061252792 Harper Business
EVS515:RB6	Planetary Boundaries: Exploring the Safe Operating Space for Humanity – Johan Rockström and others	1st edition (2013)	978-1107695196 Cambridge University Press
EVS515:RB7	Sustainability: A History – Jeremy L. Caradonna	1st edition (2014)	978-0199372409 Oxford University Press
<b>CD / DVD:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS515:CD1			
<b>Web Links:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS515:WL1	<a href="https://SWAYAM.gov.in/nd2_nou20_ag12/preview">https://SWAYAM.gov.in/nd2_nou20_ag12/preview</a>		
<b>OER:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS515:OER1	<a href="https://openstax.org/">https://openstax.org/</a>		
EVS515:OER2	<a href="https://www.merlot.org/">https://www.merlot.org/</a>		

## Course Outcomes

After successful completion of this course, student should be able to –

- Demonstrate a comprehensive understanding of environmental sustainability, including its theoretical foundations, key concepts, and the interconnections between social, economic, and ecological dimensions.
- Possess advanced research skills in environmental sustainability, including the ability to

design and execute research projects, collect and analyze data, and communicate research findings effectively.

- Critically analyze and evaluate sustainability challenges and opportunities, applying systems thinking and interdisciplinary approaches to identify innovative and sustainable solutions.
- Design and implement sustainable management strategies for natural resources, ecosystems, and human systems, integrating social, economic, and environmental considerations.

## EVS516: SOLID & HAZARDOUS WASTE MANAGEMENT

### Programme Information

SN	Description	Details
1	University	Yashwantrao Chavan Maharashtra Open University Nasik - 422 222, Maharashtra, India Website: <a href="http://www.ycmou.ac.in">http://www.ycmou.ac.in</a>
2	School	School of Sciences
3	Discipline	Science
4	Level	PG
5	Course Used in	V152: M.Sc.(Environmental Science) {2023 Pattern}

### Course Information

Sem	Major	Code	Course Name	CR	CST	ST	CA	EE	TM	Type
02	DSE	EVS516	Solid & Hazardous Waste Management	4	12	120	30	70	100	T

### Presumed knowledge and learning objectives

Presumed Knowledge	Learning Objectives
<ul style="list-style-type: none"> <li>A basic knowledge and interest in understanding the waste</li> <li>A basic knowledge and interest in understanding the waste disposal options especially landfills</li> </ul>	<p>The objectives of this course are–</p> <ul style="list-style-type: none"> <li>Explore strategies for waste minimization, waste reduction, and recycling</li> <li>Explore waste-to-energy conversion processes and the concept of the circular economy as a sustainable waste management approach</li> <li>Examine the public health and social implications of improper waste management</li> </ul>

### Units

UN	Name of the Unit	CSs	Questions
01-01	Waste Types, Source & Generation rates	<b>CR 01</b> <b>MLs</b> <b>01-20</b>	As per evaluation pattern, on <b>Each Credit</b> , Student is required to answer
01-02	Effect of waste generation and disposal		
01-03	Waste collection		
01-04	Transfer Station & Waste Characterization		
02-01	Waste Processing	<b>CR 02</b> <b>MLs</b> <b>21-40</b>	<ul style="list-style-type: none"> <li>Very Short Answer Question (VSAQ), of 03 marks</li> <li>Short Answer Question (SAQ), of 05 marks</li> <li>Long Answer Question (LAQ) of 10 Marks</li> </ul> (LAQ may contain sub-questions (a), (b) and so on.)
02-02	Recycling		
02-03	Waste minimization, waste hierarchy, waste audit		
02-04	Hazardous waste		
03-01	Sustainable Municipal Solid Waste Management	<b>CR 03</b> <b>MLs</b> <b>41-60</b>	
03-02	Incineration and Combustion		
03-03	Composting & Vermicomposting		
03-04	Solid waste disposal, open dumping and landfills		
04-01	Municipal waste (management and handling) rules	<b>CR 04</b> <b>MLs</b> <b>61-80</b>	
04-02	Hazardous waste (management and handling) rules		
04-03	Biomedical Waste (management and handling) rules		
04-04	Plastic waste management rules (2016)		

### Detailed Syllabus

UN	Detailed Syllabus of the Unit	CR
1-1	<b>Waste Types, Source &amp; Generation rates:</b> Classification of wastes, Classification of solid wastes, Type based classification, Property based classification, Waste sources, Waste Generation Rate, Factors that affect waste generation rates	CR 01
1-2	<b>Effect of waste generation and disposal:</b> Effects of improper collection or no collection of solid waste from the environment, Traditional Waste disposal, Factors influencing waste generation, Environmental effects of waste generation and disposal, Health effects of waste generation and disposal	
1-3	<b>Waste collection:</b> Elements of waste management, Waste collection - Waste collection containers, vehicles, system, frequency, route, crew, Cost, Analysis of collection time, Management of collection system	
1-4	<b>Transfer Station:</b> Types of transfer station, Design of large transfer station, Problems & Capacity and Benefits of transfer station, Transfer Station Technologies <b>Waste Characterization:</b> Physical characteristic of MSW, Chemical characteristic of MSW, Biological characteristic of MSW	
2-1	<b>Waste Processing:</b> Classification of size reduction, Size reduction - Factors affecting, Energy and force applied, Mechanism, Size reduction laws, equipments, Selection of equipment, Safety issues & systems, Volume reduction – Compaction, Equipment used for compaction	CR 02
2-2	<b>Recycling:</b> Types of Recycling, Steps involved in Recycling process, Recycling Symbols, Benefits of Recycling	
2-3	<b>Waste minimization, waste hierarchy, waste audit:</b> Waste minimization, Hierarchy of waste management, Waste Audit	
2-4	<b>Hazardous waste:</b> Characterization of Hazardous waste, Source, Classification, Collection and storage, Segregation, Transfer station, Treatment and disposal - Physical treatment methods, Chemical treatment methods, Thermal treatment methods, Biological treatment of hazardous wastes, Land disposal	
3-1	<b>Sustainable Municipal Solid Waste Management:</b> Sustainable Municipal Solid Waste Management- Outlook, Approaches to sustainable municipal solid waste management, Addressing Existing MSWM Problems, Critical characteristics for sustainable MSWM	CR 03
3-2	<b>Incineration and Combustion:</b> Process description, Advantages & Disadvantages of incineration, Applicability of Incineration, Incineration systems, Energy content of waste	
3-3	<b>Composting &amp; Vermicomposting:</b> Composting –Types , Benefits, Process, Factors influencing, Methods of aeration, Technical Options for Solid and Liquid Waste Management in Rural Areas Vermicomposting - Phase, Essential conditions for survival worms, Methodology for the production, production Process, Worm harvesting methods, Benefits.	
3-4	<b>Solid waste disposal, open dumping and landfills:</b> Disposal of solid waste, Uncontrolled or open dumping, Problems of open dumping, Controlled dumping or landfills, Landfill site selection and assessment, Considerations of landfill, Types of landfill, Structure of landfill, Waste emplacement & degradation, Factors influencing waste generation	
4-1	<b>Municipal waste (management and handling) rules:</b> Municipal Solid Waste Management Rule, Implementation status of the rule, Revision of MSW rules 2016	CR

4-2	<b>Hazardous waste (management and handling) rules:</b> Need for hazardous waste management and handling rules, Hazardous waste (management and handling) rules of Govt of India (current version 2016)	<b>04</b>
4-3	<b>Biomedical Waste (management and handling) rules:</b> harmful effects of biomedical wastes, implementation of bio-medical wastes handling rules, categories of bio - medical wastes & their treatment and disposal, treatment and disposal, segregation, packaging, transportation and storage.	
4-4	<b>Plastic waste management rules (2016):</b> Plastic waste management rules 2016, Definitions, Conditions of plastic, Plastic waste management, Responsibilities, Protocols for Compostable plastic material, Marking or labelling, Prescribed authority, Registration, Explicit pricing of carry bags, State Level Monitoring Committee, Annual reports	

### Learning resource details

LR Code	Title Author	Edition Year	ISBN Publisher
<b>Course Website Link for (1) Mobile and Online Lectures, (2) Discussion Forum for online interaction and (3) Self-Test for each CR Block, Continuous Assessment Test and End Examination</b>			
<b>Text-Books</b>			
<b>Reference-Books:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS516:RB1	Solid Waste Engineering: A Global Perspective – William A. Worrell, P. Aarne Vesilind, Christian Ludwig	3rd edition 2011	978-0495295835 Cengage Learning
EVS516:RB2	Hazardous Waste Management: An Introduction – Cliff VanGuilder	3rd edition 2016	978-1119089358 John Wiley & Sons
EVS516:RB3	Waste Management Practices: Municipal, Hazardous, and Industrial – John Pichtel	2nd edition 2017	978-1138743646 CRC Press
EVS516:RB4	Introduction to Hazardous Waste Incineration – Charles N. Haas	1st edition 1998	978-1566701961 CRC Press
EVS516:RB5	Integrated Solid Waste Management: Engineering Principles and Management Issues – George Tchobanoglous, Hilary Theisen, Samuel Vigil	1st edition 1993	978-0070632370 McGraw-Hill Education
EVS516:RB6	Handbook of Solid Waste Management – George Tchobanoglous, Frank Kreith	2nd edition 2002	978-0071356238 McGraw-Hill Professional
EVS516:RB7	Hazardous Waste Management – Michael D. LaGrega, Phillip L. Buckingham, Jeffrey C. Evans	2nd edition 2001	978-0070393659 McGraw-Hill Education
<b>CD / DVD:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS516:CD1			
<b>Web Links:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS516:WL1			
<b>OER:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS516:OER1	<a href="https://openstax.org/">https://openstax.org/</a>		
EVS516:OER2	<a href="https://www.merlot.org/">https://www.merlot.org/</a>		

## Course Outcomes

After successful completion of this course, student should be able to –

- Critically analyze waste management challenges and propose appropriate solutions considering environmental, social, and economic factors.
- Characterize different types of solid and hazardous wastes accurately.
- Interpreting waste management regulations and policies to ensure compliance in waste handling and disposal practices.
- Designing waste minimization plans and recycling programs to reduce the environmental impact of waste generation.
- Evaluating and select suitable waste treatment technologies based on the characteristics of the waste and the desired outcomes.

## Semester 03

### EVS601: ENVIRONMENTAL MONITORING AND ENERGY STUDIES

#### Programme Information

SN	Description	Details
1	University	Yashwantrao Chavan Maharashtra Open University Nasik - 422 222, Maharashtra, India Website: <a href="http://www.ycmou.ac.in">http://www.ycmou.ac.in</a>
2	School	School of Sciences
3	Discipline	Science
4	Level	PG
5	Course Used in	V152: M.Sc.(Environmental Science) {2023 Pattern} & V136: M.Sc.(Environmental Science) {2021 Pattern}

#### Course Information

Sem	Major	Code	Course Name	CR	CST	ST	CA	EE	TM	Type
03	DSC	EVS601	Environmental monitoring and Energy studies	4	12	120	30	70	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>The objectives of this course are–</p> <ul style="list-style-type: none"> <li>Acquire Data Analysis and Interpretation</li> <li>Explore Sustainability Strategies</li> <li>Examine Climate Change Mitigation and Adaptation</li> <li>Investigate Technological Innovations</li> <li>Recognize Interdisciplinary Approaches</li> </ul>

#### Units

UN	Name of the Unit	CSs	Questions
01-01	Environmental Quality Assessment and Monitoring	<b>CR 01</b> <b>MLs</b> <b>01-20</b>	As per evaluation pattern, on <b>Each Credit</b> , Student is required to answer
01-02	Methods of assessment of environmental Quality		
01-03	Environmental Impact Assessment		
01-04	Environmental Impact Assessment Techniques		
02-01	About Energy	<b>CR 02</b> <b>MLs</b> <b>21-40</b>	<ul style="list-style-type: none"> <li>Very Short Answer Question (VSAQ), of 03 marks</li> <li>Short Answer Question (SAQ), of 05 marks</li> <li>Long Answer Question (LAQ) of 10 Marks</li> </ul> (LAQ may contain sub-questions (a), (b) and so on.)
02-02	Energy profile of oil and natural gas:		
02-03	Energy resources and their exploitation:		
02-04	Energy use pattern		
03-01	Bio catalysis and nonconventional energy	<b>CR 03</b> <b>MLs</b> <b>41-60</b>	
03-02	Bio-fuel production (bio-ethanol and biodiesel)		
03-03	Production of biodegradable materials		
03-04	Energy Use		
04-01	Energy Conservation and Energy Economics	<b>CR 04</b> <b>MLs</b> <b>61-80</b>	
04-02	Solid wastes		
04-03	Solid waste processing technologies		
04-04	Disposal in landfills		



## 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.	CR 01
1-2	<b>Methods of assessment of environmental quality:</b> 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 - 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.</b>	
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.	CR 02
2-2	<b>Energy profile of oil and natural gas,</b> Indian production and reserves, nuclear option, role of IRDA & MEDA in energy generation.	
2-3	<b>Energy resources and their exploitation:</b> 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	<b>Energy use pattern</b> in different parts of the world and its impact on the environment. CO <sub>2</sub> 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.	CR 03
3-2	<b>Bio-fuel production (bio-ethanol and biodiesel),</b> Biomass, prevention/minimization of hazardous/toxic products. Agricultural related practices and food processing.	
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.	CR 04
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
<b>Course Website Link for (1) Mobile and Online Lectures, (2) Discussion Forum for online interaction and (3) Self-Test for each CR Block, Continuous Assessment Test and End Examination</b>			
<b>Text-Books</b>			
EVS601	Environmental monitoring and Energy studies – Dr. G. M. Pondhe	2022	978-9395855150 YCMOU, Nashik
<b>Reference-Books:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS601:RB1	Environmental Monitoring Handbook – Frank R. Burden and Brian C. Thompson	1st edition, 2012	978-0071777111, McGraw-Hill Education
EVS601:RB2	Air Quality, Fourth Edition – Thad Godish	4th edition, 2014	978-1466553171, CRC Press
EVS601:RB3	Handbook of Water and Wastewater Treatment Plant Operations – Frank R. Spellman	1st edition, 2013	978-1466553379, CRC Press
EVS601:RB4	Introduction to Environmental Monitoring – David Gilbert	1st edition, 2005	978-0415262418, Taylor & Francis
EVS601:RB5	Sustainable Energy - Without the Hot Air – David J.C. MacKay	1st edition, 2009	978-0954452933, UIT Cambridge Ltd
EVS601:RB6	Renewable Energy: Power for a Sustainable Future – Godfrey Boyle	3rd edition, 2012	978-0199545339, Oxford University Press
EVS601:RB7	Energy Studies – Charles J. Kibert	2nd edition, 2016	978-1783534755, Routledge
<b>CD / DVD:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS601:CD1			
<b>Web Links:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS601:WL1			
<b>OER:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS601:OER1	<a href="https://openstax.org/">https://openstax.org/</a>		
EVS601:OER2	<a href="https://www.merlot.org/">https://www.merlot.org/</a>		

## Course Outcomes

After successful completion of this course, student should be able to –

- Evaluating energy systems and identifying opportunities for improving energy efficiency and sustainability.
- Possess strong data analysis and interpretation skills, enabling them to draw meaningful conclusions from environmental and energy data.
- Developing and implement sustainable practices in various industries and organizations, considering environmental and energy factors.
- Comprehending the relationship between energy use, environmental impacts, and climate change, and propose effective strategies for mitigation and adaptation.
- Equipped to assess and implement cutting-edge technologies and innovations to address environmental and energy challenges.

## EVS602: INSTRUMENTATION AND LAB TECHNIQUES

### Programme Information

SN	Description	Details
1	University	Yashwantrao Chavan Maharashtra Open University Nasik - 422 222, Maharashtra, India Website: <a href="http://www.ycmou.ac.in">http://www.ycmou.ac.in</a>
2	School	School of Sciences
3	Discipline	Science
4	Level	PG
5	Course Used in	V152: M.Sc.(Environmental Science) {2023 Pattern} & V136: M.Sc.(Environmental Science) {2021 Pattern}

### Course Information

Sem	Major	Code	Course Name	CR	CST	ST	CA	EE	TM	Type
03	DSC	EVS602	Instrumentation and Lab Techniques	4	12	120	30	70	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>	The objectives of this course are– <ul style="list-style-type: none"> <li>Acquire Instrument Calibration and Maintenance</li> <li>Explore a range of analytical techniques</li> <li>Learn data acquisition methods and advanced data analysis techniques</li> <li>Updated with the latest advancements in instrumentation and lab techniques</li> </ul>

### Units

UN	Name of the Unit	CSs	Questions
01-01	Instrumentation	<b>CR 01</b> <b>MLs</b> <b>01-20</b>	As per evaluation pattern, on <b>Each Credit</b> , Student is required to answer <ul style="list-style-type: none"> <li>Very Short Answer Question (VSAQ), of 03 marks</li> <li>Short Answer Question (SAQ), of 05 marks</li> <li>Long Answer Question (LAQ) of 10 Marks (LAQ may contain sub-questions (a), (b) and so on.)</li> </ul>
01-02	Study of machinery, electric motors		
01-03	Drilling equipment, pumping equipment		
01-04	Calorimetry and Spectro-photometry		
02-01	Microscopy	<b>CR 02</b> <b>MLs</b> <b>21-40</b>	
02-02	Properties of Light		
02-03	Introduction to Scanning electron microscopy		
02-04	Various imaging techniques		
03-01	Nanotechnology	<b>CR 03</b> <b>MLs</b> <b>41-60</b>	
03-02	Nanomaterials		
03-03	Environmental Nano Remediation Technology		
03-04	Nano Filtration		
04-01	Laboratory safety	<b>CR 04</b> <b>MLs</b> <b>61-80</b>	
04-02	Personal Protective Equipment [PPE]		
04-03	Administrative controls		
04-04	Response to specific incidents/ accidents		

### Detailed Syllabus

UN	Detailed Syllabus of the Unit	CR
1-1	<b>Instrumentation</b> - Introduction, scope, use, limitations ,safety	

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.	<b>CR 01</b>
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 Spectro-photometry:</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 spectro-photometry, 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	<b>Properties of Light:</b> Phase contrast, Polarised light, Differential interference contrast, Fluorescence microscopy, Sample preparation and applications	
2-3	<b>Introduction to Scanning electron microscopy</b> , Instrumental details and image formation	
2-4	<b>Various imaging techniques</b> , 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
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<b>Course Website Link for (1) Mobile and Online Lectures, (2) Discussion Forum for online interaction and (3) Self-Test for each CR Block, Continuous Assessment Test and End Examination</b>			
<b>Text-Books</b>			
EVS602	Instrumentation and Lab Techniques – Mr. Kailas Ahire	2022	978-9395855020 YCMOU,Nashik
<b>Reference-Books:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS602:RB1	Environmental Instrumentation and Analysis Handbook – by Randy D. Down	1st edition, 2004	978-0471463418, Wiley
EVS602:RB2	Introduction to Environmental Engineering and Science – Gilbert M. Masters and Wendell P. Ela	3rd edition, 2008	978-0131481930, Prentice Hall
EVS602:RB3	Environmental Sampling and Analysis for Technicians – Maria Csuros	1st edition, 1996	978-1566701801, CRC Press
EVS602:RB4	Environmental Monitoring Handbook – Frank R. Burden and Brian C. Thompson	1st edition, 2012	978-0071777111, McGraw-Hill Education
EVS602:RB5	Handbook of Environmental Analysis: Chemical Pollutants in Air, Water, Soil, and Solid Wastes – Pradyot Patnaik	1st edition, 2000	978-1566704949, CRC Press
EVS602:RB6	Environmental Chemistry: Fundamentals – Jorge N. Beltrán	1st edition, 2019	978-0367137843, CRC Press
EVS602:RB7	Analytical Techniques in Environmental Chemistry: Applications in Environmental and Geosciences – M.R. Abdel-Fattah	1st edition, 2018	978-1119462262, Wiley
<b>CD / DVD:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS602:CD1			
<b>Web Links:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS602:WL1			
<b>OER:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS602:OER1	<a href="https://openstax.org/">https://openstax.org/</a>		
EVS602:OER2	<a href="https://www.merlot.org/">https://www.merlot.org/</a>		

### Course Outcomes

After successful completion of this course, student should be able to –

- Capable of calibrating, maintaining, and troubleshooting instruments to ensure accurate and precise measurements.
- Skilled in using various analytical techniques and selecting the most suitable methods for specific research questions.
- Designing and execute well-structured experiments, applying appropriate statistical techniques to analyze and interpret data.
- Collaborate effectively with researchers from different disciplines, integrating instrumentation and lab techniques to address complex research questions.
- Aware of emerging technologies and their potential applications in scientific research, enabling them to stay at the forefront of advancements.

## EVS603: GREEN CHEMISTRY

### Programme Information

SN	Description	Details
1	University	Yashwantrao Chavan Maharashtra Open University Nasik - 422 222, Maharashtra, India Website: <a href="http://www.ycmou.ac.in">http://www.ycmou.ac.in</a>
2	School	School of Sciences
3	Discipline	Science
4	Level	PG
5	Course Used in	V152: M.Sc.(Environmental Science) {2023 Pattern} & V142: M.Sc.(Chemistry) {2022 Pattern}

### Course Information

Sem	Major	Code	Course Name	CR	CST	ST	CA	EE	TM	Type
03	DSC	EVS603	Green Chemistry	2	6	60	15	35	50	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>	The objectives of this course are– <ul style="list-style-type: none"><li>Acquire knowledge of catalytic processes and green synthesis methods</li><li>Learn about process intensification techniques</li><li>Familiarize with life cycle assessment</li><li>Explore sustainable Green analytical chemistry</li></ul>

### Units

UN	Name of the Unit	CSs	Questions
01-01	Introduction to Green Chemistry	<b>CR 01</b> <b>MLs</b> <b>01-20</b>	As per evaluation pattern, on <b>Each Credit</b> , Student is required to answer <ul style="list-style-type: none"><li>Very Short Answer Question (VSAQ), of 03 marks</li><li>Short Answer Question (SAQ), of 05 marks</li><li>Long Answer Question (LAQ) of 10 Marks (LAQ may contain sub-questions (a), (b) and so on.)</li></ul>
01-02	Need for Green Chemistry		
01-03	Goals of Green Chemistry		
01-04	Principles of Green Chemistry		
02-01	Energy requirements for reactions	<b>CR 02</b> <b>MLs</b> <b>21-40</b>	
02-02	Real world cases		
02-03	Chemical industry		
02-04	Combinatorial green chemistry		

### Detailed Syllabus

UN	Detailed Syllabus of the Unit	CR
1-1	<b>Introduction to Green Chemistry:</b> Principles of Green Chemistry What is Green Chemistry?	<b>CR</b>
1-2	<b>Need for Green Chemistry:</b> Advantages & Disadvantages.	
1-3	<b>Goals of Green Chemistry:</b> Limitations/ Obstacles, In the pursuit of the goals of Green Chemistry.	

1-4	<b>Principles of Green Chemistry:</b> Twelve principles of Green Chemistry with their explanations.	<b>01</b>
2-1	<b>Energy requirements for reactions:</b> Alternative sources of energy: use of microwaves and ultrasonic energy.	<b>CR 02</b>
2-2	<b>Real world cases:</b> (Traditional processes and green ones) Synthesis of Ibuprofen, Adipic acid, disodium iminodiacetate (alternative to Strecker synthesis).	
2-3	<b>Chemical industry :</b> Hazard assessment and mitigation in chemical industry, Future trends in Green Chemistry-oxidation-reduction reagents and catalysts; biomimetic, multifunctional reagents;	
2-4	<b>Combinatorial green chemistry:</b> Proliferation of solventless derivatization. Biomass conversion, emission control and biocatalysis.	

### Learning resource details

LR Code	Title Author	Edition Year	ISBN Publisher
<b>Course Website Link for (1) Mobile and Online Lectures, (2) Discussion Forum for online interaction and (3) Self-Test for each CR Block, Continuous Assessment Test and End Examination</b>			
<b>Text-Books</b>			
EVS603	Green Chemistry		
<b>Reference-Books:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS603-RB1	Anastas, P. T., & Warner, J. C. (1998). Green Chemistry: Theory and Practice.	2014	Oxford University Press
EVS603-RB2	Lancaster, M. (2010). Green Chemistry: An Introductory Text	II Edition 2014	Cambridge RSC Publishing
EVS603-RB3	Ryan, M. A., & Tinnesand, M. (2002). Introduction to Green Chemistry	2015	Washington: American Chemical Society
EVS603-RB4	Clark, J. H., & Macquarrie, D. J. (2002). Handbook of Green Chemistry & Technology. Abingdon:.	2016	Blackwell Publishing
<b>CD / DVD:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS603 -CD1			
<b>Web Links:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS603-WL1			

### Course Outcomes

After successful completion of this course, student should be able to –

- Proficiency in conducting environmental impact assessments of chemical reactions and processes, identifying and addressing potential hazards.
- Capability of designing chemical reactions with green solvents and reaction conditions, minimizing waste and energy consumption.
- Effectively use renewable feedstock's in chemical synthesis, contributing to the development of a bio-based and circular economy.
- Expertise in catalytic processes and green synthesis methods, promoting more sustainable chemical transformations.
- Applying life cycle assessment methodologies to evaluate the environmental impact of



chemical products and processes.

- Utilization of green analytical methods for monitoring and quantifying chemical processes, reducing analytical waste and energy consumption.

## EVS604: LAB ACTIVITIES ON EVS601 & EVS602

### Programme Information

SN	Description	Details
1	University	Yashwantrao Chavan Maharashtra Open University Nasik - 422 222, Maharashtra, India Website: <a href="http://www.ycmou.ac.in">http://www.ycmou.ac.in</a>
2	School	School of Sciences
3	Discipline	Science
4	Level	PG
5	Course Used in	V152: M.Sc.(Environmental Science) {2023 Pattern} & V136: M.Sc.(Environmental Science) {2021 Pattern}

### Course Information

Sem	Major	Code	Course Name	CR	CST	ST	CA	EE	TM	Type
03	DSC	EVS604	Lab Activities on EVS601 & EVS602	4	24	120	50	50	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>	The objectives of this course are– <ul style="list-style-type: none"> <li>• Acquire Data Analysis and Interpretation</li> <li>• Explore Sustainability Strategies</li> <li>• Examine Climate Change Mitigation and Adaptation</li> <li>• Learn data acquisition methods and advanced data analysis techniques</li> <li>• Updated with the latest advancements in instrumentation and lab techniques.</li> </ul>

### Detailed Syllabus

UN	Detailed Syllabus of the Unit	CR
<b>EVS601: Environmental monitoring and Energy studies</b>		
1-1	Interpretation of Aerial photographs and preparing weather report based on it.	<b>CR 01</b>
1-2	Determination of relative humidity from the atmosphere.	
1-3	Determination of particulate matter from the industrial area by High Volume Sampler/Settling method.	
1-4	Determination of Salinity of water by volhard's method.	
1-5	Determination of Cation-exchange capacity, moisture content, alkalinity/acidity of soil sample	
1-6	To prepare the station based wind rose for an area.	
1-7	Determination of Residual Chlorine from drinking water using colorimetric method.	
<b>EVS601: Environmental monitoring and Energy studies</b>		

2-1	Determination of hydrocarbon from fuel gas using Orsat's apparatus.	<b>CR 02</b>
2-2	Study of solar cells.	
2-3	Conversion of biomass to alcohol.	
2-4	Case studies on energy efficiency analysis.	
2-5	Study of various agro wastes as substrates for biofuel production.	
2-6	Biological degradation of recalcitrant biomass.	
2-7	Case studies on energy use patterns across the globe.	

### EVS602: Instrumentation and Lab Techniques

	<b>Chromatography</b>	<b>CR 03</b>
3-1	Separation of a mixture of two amino acids by ascending and horizontal paper chromatography	
3-2	Separation of a mixture of two sugars by ascending paper chromatography	
3-3	Separation of a mixture of o-and p-nitrophenol or o-and p-aminophenol by thin layer chromatography (TLC)	
	<b>UV/Visible spectroscopy</b>	
3-4	Study the 200-500 nm absorbance spectra of $\text{KMnO}_4$ and $\text{K}_2\text{Cr}_2\text{O}_7$ (in 0.1 M $\text{H}_2\text{SO}_4$ ) and determine the $\lambda_{\text{max}}$ values. Calculate the energies of the two transitions in different units ( $\text{J molecule}^{-1}$ , $\text{kJ mol}^{-1}$ , $\text{cm}^{-1}$ , eV).	
3-5	Study the pH-dependence of the UV-Vis spectrum (200-500 nm) of $\text{K}_2\text{Cr}_2\text{O}_7$ .	
3-6	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.	

### EVS602: Instrumentation and Lab Techniques

	<b>Colourimetry</b>	<b>CR 04</b>
4-1	Verify Lambert-Beer's law and determine the concentration of $\text{CuSO}_4$ / $\text{KMnO}_4$ / $\text{K}_2\text{Cr}_2\text{O}_7$ in a solution of unknown concentration	
4-2	Determine the concentrations of $\text{KMnO}_4$ and $\text{K}_2\text{Cr}_2\text{O}_7$ in a mixture.	
4-3	Study the kinetics of iodination of propanone in acidic medium.	
4-4	Determine the amount of iron present in a sample using 1, 10-phenanthroline.	
4-5	Determine the dissociation constant of an indicator (phenolphthalein).	
4-6	Study the kinetics of interaction of crystal violet/ phenolphthalein with sodium hydroxide.	
4-7	Analysis of the given vibration-rotation spectrum of $\text{HCl(g)}$	
	<b>Microscopy</b>	
4-8	Preparation of media for microbial culture, Isolation and culturing of microbes from soil / water samples, Gram Staining.	

### Learning resource details

LR Code	Title Author	Edition Year	ISBN Publisher
<b>Course Website Link for (1) Mobile and Online Lectures, (2) Discussion Forum for online interaction and (3) Self-Test for each CR Block, Continuous Assessment Test and End Examination</b>			



<b>Text-Books</b>			
EVS604	Lab Activities on EVS601 & EVS602 – Dr. Anita V. Handore, Dr. Rajib Karmakar	2022	Publication 2496 YCMOU,Nashik
EVS601	Environmental monitoring and Energy studies – Dr. G. M. Pondhe	2022	978-9395855150 YCMOU,Nashik
EVS602	Instrumentation and Lab Techniques – Mr. Kailas Ahire	2022	978-9395855020 YCMOU,Nashik
<b>Reference-Books:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS604:RB1	Environmental Monitoring Handbook – Frank R. Burden and Brian C. Thompson	1st edition, 2012	978-0071777111, McGraw-Hill Education
EVS604:RB2	Air Quality, Fourth Edition – Thad Godish	4th edition, 2014	978-1466553171, CRC Press
EVS604:RB3	Handbook of Water and Wastewater Treatment Plant Operations – Frank R. Spellman	1st edition, 2013	978-1466553379, CRC Press
EVS604:RB4	Introduction to Environmental Monitoring – David Gilbert	1st edition, 2005	978-0415262418, Taylor & Francis
EVS604:RB5	Sustainable Energy - Without the Hot Air – David J.C. MacKay	1st edition, 2009	978-0954452933, UIT Cambridge Ltd
EVS604:RB6	Renewable Energy: Power for a Sustainable Future – Godfrey Boyle	3rd edition, 2012	978-0199545339, Oxford University Press
EVS604:RB7	Energy Studies – Charles J. Kibert	2nd edition, 2016	978-1783534755, Routledge
EVS604:RB8	Environmental Instrumentation and Analysis Handbook – by Randy D. Down	1st edition, 2004	978-0471463418, Wiley
EVS604:RB9	Introduction to Environmental Engineering and Science – Gilbert M. Masters and Wendell P. Ela	3rd edition, 2008	978-0131481930, Prentice Hall
EVS604:RB10	Environmental Sampling and Analysis for Technicians – Maria Csuros	1st edition, 1996	978-1566701801, CRC Press
EVS604:RB11	Environmental Monitoring Handbook – Frank R. Burden and Brian C. Thompson	1st edition, 2012	978-0071777111, McGraw-Hill Education
EVS604:RB12	Handbook of Environmental Analysis: Chemical Pollutants in Air, Water, Soil, and Solid Wastes – Pradyot Patnaik	1st edition, 2000	978-1566704949, CRC Press
EVS604:RB13	Environmental Chemistry: Fundamentals – Jorge N. Beltrán	1st edition, 2019	978-0367137843, CRC Press
EVS604:RB14	Analytical Techniques in Environmental Chemistry: Applications in Environmental and Geosciences – M.R. Abdel-Fattah	1st edition, 2018	978-1119462262, Wiley
<b>CD / DVD:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS604:CD1			
<b>Web Links:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS604:WL1			
<b>OER:</b> Explore additional details and reinforce learning, with this optional learning resource!			

EVS604:OER1	<a href="https://openstax.org/">https://openstax.org/</a>		
EVS604:OER2	<a href="https://www.merlot.org/">https://www.merlot.org/</a>		

## Course Outcomes

After successful completion of this course, student should be able to –

- Evaluating energy systems and identifying opportunities for improving energy efficiency and sustainability.
- Possess strong data analysis and interpretation skills, enabling them to draw meaningful conclusions from environmental and energy data.
- Developing and implement sustainable practices in various industries and organizations, considering environmental and energy factors.
- Proficiently acquire and analyze data, presenting the results effectively using appropriate visualization methods and statistical tools.
- Collaborate effectively with researchers from different disciplines, integrating instrumentation and lab techniques to address complex research questions.
- Aware of emerging technologies and their potential applications in scientific research, enabling them to stay at the forefront of advancements.

## EVS605: RESEARCH PROJECT

### Programme Information

SN	Description	Details
1	University	Yashwantrao Chavan Maharashtra Open University Nasik - 422 222, Maharashtra, India Website: <a href="http://www.ycmou.ac.in">http://www.ycmou.ac.in</a>
2	School	School of Sciences
3	Discipline	Science
4	Level	PG
5	Course Used in	V152: M.Sc.(Environmental Science) {2023 Pattern}

### Course Information

Sem	Other	Code	Course Name	CR	CST	ST	CA	EE	TM	Type
03	RP	EVS605	Research Project	4	12	120	50	50	100	PW

### 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>	The objectives of this course are– <ul style="list-style-type: none"> <li>Gain expertise in Research Design and Methodology</li> <li>Acquire skills in collecting and analyzing data</li> <li>Learn effective time management and project planning skills</li> <li>Develop problem-solving skills and the ability to adapt research strategies</li> </ul>

### Guidelines

No	Guidelines for the Students and Study Centers for the conduct of Project
1	The “Project Work” course aims 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	This course is based on preliminary research oriented topics both in theory and experiment. The subject expert/ counsellor will act as supervisors for the projects. Project shall be on the current and relevant topics and issues. Project topic is jointly finalized by the student and the project supervisors through discussion. At the completion of the project by the semester end, the student will submit a Project Report in the form of Dissertation which will be examined by the examiners. The end examination shall consist of (a) Presentation and (b) Comprehensive viva-voce.
3	Students are expected to work on “Project Work” for about 6 hours per week (About 2 hour’s self-study at residence and 12 hours in counselling session at study centre), during a semester. <b>Thus only those projects, demanding such study efforts on all those activities, listed in above, should be selected.</b>
4	<b>A single student will have to do a project.</b> Since. The student invests his energy, time and resources in a project. The project therefore should, have important focus on some relevant practical aspects. This will help student to justify his efforts on project.
5	Employed Students are allowed to complete “Project Work” in the industry where he/ she is employed or his/ her 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 “Project Guide”.
6	Study centre 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>
7	<b>The Project Work must involve practical research work related to your selected discipline.</b>
8	Students have to finance expenditure on “Project” by his own. Hence students should select those projects, accordingly.
9	Each “Project Guide” may be assigned <b>maximum</b> 5 students.
10	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.
11	<p>There project report should be file bound/spiral bound/hard bound and should have following format</p> <ul style="list-style-type: none"> <li>• <b>Title Page/Cover page</b></li> <li>• <b>Certificate endorsed by Project Guide/Supervisor, Learner Support Center Coordinator and Head</b></li> <li>• <b>Declaration for followed ethical practice and non-plagiarism</b></li> <li>• <b>Acknowledgement</b></li> <li>• <b>Abstract of the project</b></li> <li>• <b>Table of Contents</b></li> <li>• <b>List of Figures</b></li> <li>• <b>List of Tables</b></li> <li>• <b>Chapters of Project Report –</b></li> </ul> <p><b>Chapter 1: Introduction:</b> Background of the project, Need for the project, Brief idea of the project, Literature review, Aims and Objectives of the project</p> <p><b>Chapter 2: Design and Methodology:</b> overview of the complete project, the scientific principles involved in the design of the project, Block Diagrams, Experimental/Theoretical Methodology/Circuit/Model/ materials required, etc.</p> <p><b>Chapter 3: Testing, Conduct of Experiment/ Module:</b> Actual conduct of experiment, measurements, observations, etc.</p> <p><b>Chapter 4: Analysis of Data:</b> Analysis of the data and observations received during experimentation</p> <p><b>Chapter 5: Results, Discussion and Conclusions:</b> 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, reference books, journals, websites, magazines and data manuals used, etc.</p>
12	<b>Project Report 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 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 Project Work. <b>Even student must bring his own copy during this end examination.</b>							
13	<p><b>Project Report Format:</b></p> <ol style="list-style-type: none"> <li><b>The project report should be printed on only right side of A4 size (210 mm ´ 297 mm) paper. There is no minimum or maximum page number limit for the “Project Report”, but report of minimum 50–70 pages is expected. University recommends only flexible binding for the “Project Report”. But, if student wishes, he may also use spiral binding.</b></li> <li><b>Margins should be as follows:-</b> <ul style="list-style-type: none"> <li><b>Left Margin : 40mm</b></li> <li><b>Right Margin : 20mm</b></li> <li><b>Top Margin : 20mm</b></li> <li><b>Bottom Margin : 27mm</b></li> </ul> </li> <li><b>Header should not be used. Footer, containing page number at the center should only be used, with footer margin of 25mm.</b></li> <li><b>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 ‘Fig C.F’, where ‘C’ is chapter number and ‘F’ is figure number. Figure number ‘F’ is reset back to 1 for each new chapter.</b></li> </ol> <p><b>Page Sequence: (1) Cover page as per specimen 1 (2) Certificate page as per specimen 2 (3) Acknowledgement page for the help offered by individuals and institution (4) Content page as per specimen 3. Following suggested scheme of chapters in project report then follows these first 4 pages.</b></p>							
14	<p><b>Specimen of Pages</b></p> <p><b>Specimen 1</b></p> <p><b>Project Title- M.Sc. in .....</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 Learner Support Center–</b></p> <p><b>Yashwantrao Chavan</b></p> <p><b>Maharashtra</b></p> <p><b>Open University</b></p> <p><b>20... - ...</b></p>	<p><b>Specimen 2</b></p> <p><b>Certificate</b></p> <p>This is to certify that</p> <p>Mr/Ms.....</p> <p>.....(PRN ....)</p> <p>has successfully completed a project entitled "....."</p> <p>in partial fulfilment for the requirement of</p> <p><b>Master of Science in .....</b></p> <table border="1"> <tr> <td colspan="2">Signature with Date</td> </tr> <tr> <td>Project Guide</td> <td>LSC Coordinator</td> </tr> <tr> <td>Internal Examiner</td> <td>External Examiner</td> </tr> </table>	Signature with Date		Project Guide	LSC Coordinator	Internal Examiner	External Examiner
Signature with Date								
Project Guide	LSC Coordinator							
Internal Examiner	External Examiner							

## Course Outcomes

After successful completion of this course, student should be able to –

- Demonstrating a high level of research competence, having successfully planned and executed a master's-level research project.
- Honed their critical thinking abilities, demonstrated by the comprehensive literature review and critical analysis of research findings.
- Proficient in selecting appropriate research design and methodologies, ensuring the research is well-structured and methodologically sound.
- Demonstrating expertise in collecting and analyzing data, utilizing appropriate statistical or qualitative analysis techniques.
- Developing effective project management skills, successfully meeting research milestones and completing the project within the given timeframe.
- Problem-solving abilities, adapting their research strategies to overcome challenges encountered during the research process.

## EVS606: SUSTAINABLE MANAGEMENT OF BIODIVERSITY

### Programme Information

SN	Description	Details
1	University	Yashwantrao Chavan Maharashtra Open University Nasik - 422 222, Maharashtra, India Website: <a href="http://www.ycmou.ac.in">http://www.ycmou.ac.in</a>
2	School	School of Sciences
3	Discipline	Science
4	Level	PG
5	Course Used in	V152: M.Sc.(Environmental Science) {2023 Pattern} & V136: M.Sc.(Environmental Science) {2021 Pattern}

### Course Information

Sem	Major	Code	Course Name	CR	CST	ST	CA	EE	TM	Type
03	DSE	EVS606	Sustainable Management of Biodiversity	4	12	120	30	70	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>	The objectives of this course are– <ul style="list-style-type: none"> <li>Analyze the various Threats to Biodiversity</li> <li>Explore different conservation strategies</li> <li>Examine national and international Legislation and Policy</li> <li>Acquire skills in biodiversity assessment methods</li> <li>Explore ethical dilemmas related to biodiversity management</li> </ul>

### Units

UN	Name of the Unit	CSs	Questions
01-01	Prelude to biodiversity	<b>CR 01</b> <b>MLs</b> <b>01-20</b>	As per evaluation pattern, on <b>Each Credit</b> , Student is required to answer
01-02	Ecosystem		
01-03	Introduction to Forest Biodiversity		
01-04	Introduction to Wetland Biodiversity		
02-01	Genetic resources	<b>CR 02</b> <b>MLs</b> <b>21-40</b>	<ul style="list-style-type: none"> <li>Very Short Answer Question (VSAQ), of 03 marks</li> <li>Short Answer Question (SAQ), of 05 marks</li> <li>Long Answer Question (LAQ) of 10 Marks</li> </ul> (LAQ may contain sub-questions (a), (b) and so on.)
02-02	Agro biodiversity		
02-03	Animal Genetic Resources		
02-04	Germplasm		
03-01	Drivers of biodiversity loss	<b>CR 03</b> <b>MLs</b> <b>41-60</b>	
03-02	Biodiversity Hotspots		
03-03	Impact of Climate Change		
03-04	Invasive Species		
04-01	Biodiversity conservation and sustainable management	<b>CR 04</b> <b>MLs</b> <b>61-80</b>	
04-02	Sustainable Management of Biodiversity		
04-03	International Instruments to Conserve Biological Diversity		
04-04	National Instruments to Conserve Biological Diversity		



## 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	<b>Ecosystem</b> Services, Biodiversity in India	
1-3	<b>Introduction to Forest Biodiversity,</b> Biodiversity in Tropical Forest , Biodiversity in Subtropical and Temperate Forest	
1-4	<b>Introduction to Wetland Biodiversity,</b> 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	<b>Agro biodiversity,</b> Crop Domestication	
2-3	<b>Animal Genetic Resources,</b> Fish Genetic Resources	
2-4	<b>Germplasm:</b> 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	<b>Biodiversity Hotspots,</b> Threats to Biodiversity Hotspots in India	
3-3	<b>Impact of Climate Change</b> on Biodiversity	
3-4	<b>Invasive Species</b> 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	<b>Sustainable Management of Biodiversity-</b> An Ecosystem Approach, Role of Traditional Knowledge in Biodiversity Conservation, Community Based Ecosystem Conservation, Gender and Biodiversity Conservation	
4-3	<b>International Instruments to Conserve Biological Diversity,</b> Convention of Biological Diversity, Millennium Developmental Goals/Sustainable Development Goals and Biodiversity	
4-4	<b>National Instruments to Conserve Biological Diversity,</b> National Biodiversity Act 2002, Governance of Biodiversity in India	

## Learning resource details

LR Code	Title Author	Edition Year	ISBN Publisher
<b>Course Website Link for (1) Mobile and Online Lectures, (2) Discussion Forum for online interaction and (3) Self-Test for each CR Block, Continuous Assessment Test and End Examination</b>			
<b>Text-Books</b>			
EVS606–To1	Sustainable Management of Biodiversity – Dr. Jagruti Chavan	2022	978-9395855716 YCMOU, Nashik
<b>Reference-Books:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS606:RB1	Sustainable Management of Biodiversity – Michael J. Manfredo, Jerry J. Vaske, Daniel J. Decker, and Esther A. Duke	1st edition, 2017	978-1138184147, Routledge
EVS606:RB2	Biodiversity: An Introduction – Kevin J. Gaston and John I. Spicer	3rd edition, 2018	978-1119580201, Wiley-Blackwell

EVS606:RB3	Principles of Conservation Biology – Martha J. Groom, Gary K. Meffe, and C. Ronald Carroll	4th edition, 2014	978-0878935970, Sinauer Associate
EVS606:RB4	Sustaining Life: How Human Health Depends on Biodiversity – Eric Chivian and Aaron Bernstein	1st edition, 2008	978-0195175097, Oxford University Press
EVS606:RB5	Conservation Biology: Foundations, Concepts, Applications – Fred Van Dyke	2nd edition, 2008	978-1405107375, Springer
EVS606:RB6	The Biology of Rarity: Causes and consequences of rare—common differences – V. Geist and F. Walther	1st edition, 2019	978-3030132240, Springer
EVS606:RB7	Biodiversity and Conservation – Michael J. Jeffries	2nd edition, 2018	978-1138559985, Routledge
<b>CD / DVD:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS606:CD1			
<b>Web Links:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS606:WL1	<a href="https://swayam.gov.in/nd2_nou20_bt02/preview">https://swayam.gov.in/nd2_nou20_bt02/preview</a>		
<b>OER:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS606:OER1	<a href="https://openstax.org/">https://openstax.org/</a>		
EVS606:OER2	<a href="https://www.merlot.org/">https://www.merlot.org/</a>		

### Course Outcomes

After successful completion of this course, student should be able to –

- Assessing and analyzing threats to biodiversity, identify vulnerable species and ecosystems, and propose strategies for their protection.
- Designing and implementing biodiversity conservation plans and projects, taking into account ecological, social, and economic factors.
- Understanding the legal and policy frameworks governing biodiversity conservation and be able to assess their effectiveness and applicability.
- Comprehend the economic aspects of biodiversity conservation, including the valuation of ecosystem services, and integrate economic considerations into conservation planning.

## EVS607: ENVIRONMENTAL MANAGEMENT

### Programme Information

SN	Description	Details
1	University	Yashwantrao Chavan Maharashtra Open University Nasik - 422 222, Maharashtra, India Website: <a href="http://www.ycmou.ac.in">http://www.ycmou.ac.in</a>
2	School	School of Sciences
3	Discipline	Science
4	Level	PG
5	Course Used in	V152: M.Sc.(Environmental Science) {2023 Pattern}

### Course Information

Sem	Major	Code	Course Name	CR	CST	ST	CA	EE	TM	Type
03	DSE	EVS607	Environmental Management	4	12	120	30	70	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>The objectives of this course are–</p> <ul style="list-style-type: none"> <li>Enhance critical thinking skills to identify and analyze environmental issues, propose solutions, and make informed decisions</li> <li>Explore the legal and ethical aspects of environmental management and understand the regulatory framework governing environmental practices.</li> <li>Study the economic aspects of environmental management, including cost-benefit analysis and valuing ecosystem services</li> </ul>

### Units

UN	Name of the Unit	CSs	Questions
01-01	Importance of Environmental Management	<b>CR 01</b> <b>MLs</b> <b>01-20</b>	As per evaluation pattern, on <b>Each Credit</b> , Student is required to answer <ul style="list-style-type: none"> <li>Very Short Answer Question (VSAQ), of 03 marks</li> <li>Short Answer Question (SAQ), of 05 marks</li> <li>Long Answer Question (LAQ) of 10 Marks</li> </ul> (LAQ may contain sub-questions (a), (b) and so on.)
01-02	Current status of Environment in India (Air and Water)-I		
01-03	Current status of Environment in India (Waste Management and Energy)-II		
01-04	Current status of Environment in India (Biodiversity and Climate Change) -III		
02-01	Introduction to Environmental Impact Assessment (EIA)	<b>CR 02</b> <b>MLs</b> <b>21-40</b>	
02-02	EIA Notification 1994		
02-03	EIA Notification 2006		
02-04	Unified EIA Notification 2006 inclusive of Amendments		
03-01	Environment Clearance Process in India	<b>CR 03</b> <b>MLs</b> <b>41-60</b>	
03-02	Procedure of Environment clearance of Category B (Building and Construction) and B1 Projects in India		

03-03	Environmental Clearance for category B2 and mining of minor mineral Projects		
03-04	Environmental Auditing		
04-01	Green Buildings	<b>CR 04</b> <b>MLs</b> <b>61-80</b>	
04-02	GRIHA Rating of Green Buildings		
04-03	Concept of Smart Cities in India		
04-04	Green Belt Development		

### Detailed Syllabus

UN	Detailed Syllabus of the Unit	CR
1-1	<b>Importance of Environmental Management:</b> Scope, Need of Public awareness, Importance of Public awareness, Indian Government initiatives towards public awareness.	<b>CR 01</b>
1-2	<b>Current status of Environment in India (Air and Water)-I:</b> Air – Air Quality in India, Air Pollution management Policies in India, Water related Issue – Status of water distribution in India, Rainfall, Groundwater, ground water contamination, River Pollution in India, policies for controlling River and water Pollution.	
1-3	<b>Current status of Environment in India (Waste Management and Energy)-II:</b> Waste Generation and Management in India, Status of Energy resources in India, Other Major Environmental Issue.	
1-4	<b>Current status of Environment in India (Biodiversity and Climate Change) –III:</b> Project Tiger, Project Elephant, Project Rhino (Indian Rhino Vision (IRV) 2020), Ganga Dolphin Conservation, Indian Crocodile Conservation Project, New Initiatives and Efforts by Ministry of Environment, Forest and Climate Change	
2-1	<b>Introduction to Environmental Impact Assessment (EIA):</b> Evolution of EIA, Definition, Objectives, Methods to carry out, Hierarchy in EIA, Types, Steps in EIA, Advantages, EIA in India	<b>CR 02</b>
2-2	<b>EIA Notification 1994:</b> Ministry Of Environment And Forests Environment Impact Assessment, Notification, Schedule I, Schedule II, Application Form, Amendments in EIA 1994, Major differences between EIA Notifications of 1994 and 2006	
2-3	<b>EIA Notification 2006:</b> Constraints in EIA Notification 1994, Objectives, Salient features, Summary of EIA notification 2006, copy of notification, Schedule, Appendix VI, Application, Stages, Grant or Rejection, Validity Prior Environmental Clearance (EC), Post Environmental Clearance Monitoring Transferability of Environmental Clearance (EC), Introduction of new category B2 in Schedule and formation of DEIA and DEAC,	
2-4	<b>Unified EIA Notification 2006 inclusive of Amendments:</b> Notification, Requirements, State Level EIA Authority, Categorization of projects and activities, Screening, Scoping and Appraisal Committees, Preparation and presentation of EIA report and Environment Management Plan (EMP), Integration of environmental condition in building bye-laws.	
3-1	<b>Environment Clearance Process in India:</b> Stake holders/ authorities are involved in the Environment Clearance process, Process of Environmental Clearance/ Appraisal, Stages in the Prior Environmental Clearance (EC) Process for	<b>CR 03</b>

	Category 'A' Projects, Appendix – III, IIIA, IV, V, VI.	
3-2	<b>Procedure of Environment clearance of Category B (Building and Construction) and B1 Projects in India:</b> Environment clearance/Appraisal Process for category B1 and B (Building and construction Projects) at State Level, Appendix – II, XVI	
3-3	<b>Environmental Clearance for category B2 and mining of minor mineral Projects:</b> Procedure for environmental clearance for B2 category projects, Procedure for environmental clearance for mining of minor minerals, including cluster, Appendix – VII, VIII, IX, X, XI.	
3-4	<b>Environmental Auditing:</b> Origin, Scope, Objectives, Methodology, Approaches, Benefits of Environmental Auditing, Distinctions between an environmental review and an environmental audit, Environmental Audit Programme in India, 0. Ministry of Environment And Forests Notification, Form V	
4-1	<b>Green Buildings:</b> Defining, Goals, Features, Strategies and Practices for Green Building Construction, Green Building – Indian Context, Steps for designing, Rating System in India, Green Buildings in India, Initiatives for Promotion of Green Building Projects in India.	<b>CR 04</b>
4-2	<b>GRIHA Rating of Green Buildings:</b> GRIHA - Projects Eligible for Rating, Criteria of the Rating System, Rating of Very Small Buildings, Main Benefits of Rating of a Green Building	
4-3	<b>Concept of Smart Cities in India:</b> Smart Cities around the world, What is the concept of Smart Cities in India?, Smart City's features, Coverage and Duration, Strategy, List of 98 Cities selected under Smart Cities Mission, List and Profile of 20 cities selected for first phase of smart cities mission.	
4-4	<b>Green Belt Development:</b> History, Particular Species used, Criticism, Case Study, The Green Belt debate, Guidelines, Regulations and Future Challenges, Precautions, Future challenges for Green Belt land	

### Learning resource details

LR Code	Title Author	Edition Year	ISBN Publisher
<b>Course Website Link for (1) Mobile and Online Lectures, (2) Discussion Forum for online interaction and (3) Self-Test for each CR Block, Continuous Assessment Test and End Examination</b>			
<b>Text-Books</b>			
<b>Reference-Books:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS607:RB1	Environmental Science: Earth as a Living Planet – Daniel B. Botkin and Edward A. Keller	9th Edition 2014	978-1118427554 John Wiley & Sons
EVS607:RB2	Environmental Management: A Core Text for O Level and IGCSE – O'Sullivan, Gallagher, and Greener	3rd Edition 2013	978-0198398041 Oxford University Press
EVS607:RB3	Environmental Management: Principles and Practice – Stuart R. Jenkins and Peter M. Higgins	2nd Edition 2019	978-1138502239 Routledge

EVS607:RB4	Introduction to Environmental Management: Second Edition – Paul R. Misani and Lisa M. Gorski	2nd Edition 2013	978-1420087951 CRC Press
EVS607:RB5	Environmental Management: Science and Engineering for Industry – Bansi Lal and S. C. Sharma	1st Edition 2012	978-8174092728 Anshan Publishing
EVS607:RB6	Sustainability: A Comprehensive Foundation - by Tom Theis and Jonathan Tomkin	1st Edition 2017	978-1947172039 OpenStax
EVS607:RB7	Principles of Environmental Management: The Greening of Business – Peter P. Rogers and Donald A. F. Davies	1st Edition 2015	978-1482210019 CRC Press
<b>CD / DVD:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS607:CD1			
<b>Web Links:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS607:WL1			
<b>OER:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS607:OER1	<a href="https://openstax.org/">https://openstax.org/</a>		
EVS607:OER2	<a href="https://www.merlot.org/">https://www.merlot.org/</a>		

## Course Outcomes

After successful completion of this course, student should be able to –

- **Develop Sustainable Management Plans:** Create comprehensive and sustainable environmental management plans to address specific environmental issues.
- **Evaluate Environmental Impacts:** Assess the environmental impact of projects and policies using various assessment methods and models.
- **Design Effective Policy Proposals:** Formulate evidence-based environmental policies and strategies that address societal and ecological needs.
- **Conduct Research and Analysis:** Independently conduct research, analyze data, and draw conclusions to contribute to the field of environmental studies.
- **Engage with Stakeholders:** Effectively engage and collaborate with diverse stakeholders, including government agencies, NGOs, and local communities.
- **Communicate Environmental Issues:** Articulate complex environmental issues to various audiences and advocate for sustainable solutions.
- **Apply Ethical and Legal Principles:** Demonstrate an understanding of the ethical and legal considerations in environmental management and policy.



## EVS6o8: RENEWABLE ENERGY STUDIES

### Programme Information

SN	Description	Details
1	University	Yashwantrao Chavan Maharashtra Open University Nasik - 422 222, Maharashtra, India Website: <a href="http://www.ycmou.ac.in">http://www.ycmou.ac.in</a>
2	School	School of Sciences
3	Discipline	Science
4	Level	PG
5	Course Used in	V152: M.Sc.(Environmental Science) {2023 Pattern}, V153: M.Sc (Physics) {2023 Pattern}, V156: M.Sc.(Botany) {2022 Pattern}, V141: M.Sc (Physics) {2022 Pattern}

### Course Information

Sem	Major	Code	Course Name	CR	CST	ST	CA	EE	TM	Type
03	DSE	EVS608	Renewable Energy Studies	4	12	120	30	70	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>	The objectives of this course are– <ul style="list-style-type: none"> <li>Gain a solid understanding of various renewable energy technologies</li> <li>Familiar with energy policies and regulations</li> <li>Assess the environmental impact of renewable energy technologies</li> <li>Develop research skills to conduct independent studies</li> </ul>

### Units

UN	Name of the Unit	CSs	Questions
01-01	Indian Energy Scenario	<b>CR 01</b> <b>MLs</b> <b>01-20</b>	As per evaluation pattern, on <b>Each Credit</b> , Student is required to answer
01-02	Various types of energy sources		
01-03	Energy Security		
01-04	Non Renewable Energy sources & Renewable Energy sources		
02-01	Importance of Solar Energy	<b>CR 02</b> <b>MLs</b> <b>21-40</b>	<ul style="list-style-type: none"> <li>Very Short Answer Question (VSAQ), of 03 marks</li> <li>Short Answer Question (SAQ), of 05 marks</li> <li>Long Answer Question (LAQ) of 10 Marks</li> </ul> (LAQ may contain sub-questions (a), (b) and so on.)
02-02	Basics of Heat transfer		
02-03	Solar Radiation and Its Measurements		
02-04	Selective coatings		
03-01	Solar Photovoltaics (SPV)	<b>CR 03</b> <b>MLs</b> <b>41-60</b>	
03-02	Application of SPV		
03-03	Solar Thermal Devices and Systems		
03-04	Solar Devices		
04-01	Bio Energy, Biogas, Biofuel	<b>CR 04</b> <b>MLs</b> <b>61-80</b>	
04-02	Hydrogen Energy		
04-03	Wind Energy		
04-04	Energy Storage		

## Detailed Syllabus

UN	Detailed Syllabus of the Unit	CR
1-1	<b>Indian Energy Scenario:</b> Role of energy in economic development and social transformation, Energy and Gross Domestic product (GDP), Gross National Product (GNP) and its dynamics	CR 01
1-2	<b>Various types of energy sources:</b> Energy sources and overall energy demand, Availability of energy sources, Energy consumption in various sectors and its changing pattern, projected energy demands	
1-3	<b>Energy Security:</b> Energy for security and security of energy, Energy consumption and its Impact on environmental climatic change, Future Energy Option: Sustainable development, Energy crisis, Transition from carbon Free technologies, Parameters of transition, Carbon credits.	
1-4	<b>Non Renewable Energy sources :</b> Coal, Oil, Natural gas, Nuclear power, Hydroelectricity, <b>Renewable Energy sources:</b> Solar ,Wind, Biomass, Tidal, Ocean wave, Ocean thermal, Geothermal and other, Depletion of energy sources and impact of exponential rise in energy, consumption on economics of India and on international relations.	
2-1	<b>Importance of Solar Energy :</b> Nature of solar radiation, Sun as a fusion reactor, special distribution of extraterrestrial radiation	CR 02
2-2	<b>Basics of Heat transfer:</b> Heat and Thermodynamics: Basic units, dimensions, Concept of heat, energy and work, Ideal gas flow, 1st and 2nd law of thermodynamics. <b>Types of heat transfer:</b> Conductive, Radioactive, Convective	
2-3	<b>Solar Radiation and Its Measurements:</b> Estimation of extraterrestrial solar radiation, Radiation on horizontal and titled surfaces, Beam, diffuse, global radiation and their measurement.	
2-4	<b>Selective coatings:</b> Ideal characteristics of selective coating for various applications, Types of selective coatings, materials and techniques for selective coatings, Effect of selective coating on the efficiency of solar collectors.	
3-1	<b>Solar Photovoltaics (SPV):</b> Solar Photovoltaics (SPV) Conversion, Basic principles, Types of solar cell materials, Fabrication of solar photovoltaic cells, solar cell parameters and characteristics, Block diagram of general SPV conversion system and their characteristics, Different configurations	CR 03
3-2	<b>Application of SPV:</b> Such as street light, water pumps, Radio/TV, Small capacity power generation, Solar Photovoltaic (SPV) Systems Designing : Load estimation, selection of inverters, battery sizing, array sizing	
3-3	<b>Solar Thermal Devices and Systems :</b> Different types of collectors, Flat plate collector(Basic principle, construction), Energy balance equation of steady state, Testing, Methods to reduce losses	
3-4	<b>Solar Devices:</b> Solar cookers, Domestic hot water system, Solar dryers, solar pond, Solar still, Solar furnace, Solar refrigeration, Solar concentrators, systems based on use of solar concentrators	
4-1	<b>Bio Energy:</b> Biomass, Generation and utilization, Property of biomass, Agriculture crop and Forestry residues used as fields. Physical, Chemical and biological conversion of biomass into useful form of energy. Gasification, Biomass gasifiers and types. <b>Biogas:</b> Generation of biogas, Aerobic and anaerobic bioconversion process. Substances used to produce biogas, Digesters and their designs, Pyrolysis and gasification, Fermentation process <b>Biofuels:</b> Types of biofuels, Production processes, Biofuel applications	CR 04
4-2	<b>Hydrogen Energy:</b> Hydrogen Fuel: Importance of Hydrogen as a future fuel,	



	Sources of Hydrogen, Fuel of vehicles, Hydrogen production : Production of Hydrogen by various methods, Direct electrolysis of water, decomposition of water, Biological and biochemical methods of hydrogen production, Hydrogen storage : Gaseous, Cryogenic and Metal hydride. Utilization of hydrogen : Fuel cell – Principle, construction and applications	
4-3	<b>Wind Energy:</b> Introduction, Basic principle of wind energy conversion, Extraction of maximum power from wind and its dependence on various parameters. Wind Mills : Types of wind mills, Vertical axis and Horizontal axis wind mills their performance, Merits and Demerits, Limitations of wind energy conversions	
4-4	<b>Energy Storage:</b> Types of energy storage systems : sensible and latent heat storage systems, Electric energy storage systems, Chemical energy storage systems, Heat exchanges, Hydro-storage, solar pond as a energy storage, Green house	

### Learning resource details

LR Code	Title	Edition	ISBN
	Author	Year	Publisher
<b>Text-Books</b>			
EVS608	-		
<b>Reference-Books:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS608 –RB1	Solar Energy Thermal Processes – J.A. Duffie and W.A. Beckman	1980	John Wiley and Sons
EVS608–RB2	Heat and Thermodynamics, – M.W. Zemansky		McGraw Hill Publication
EVS608–RB3	Renewable Energy Sources and Conversion Technology, - N.K. Basal, M. Kleeman And S.N.Srinivas	1996	Tata Energy Research Institute, New Delhi
EVS608–RB4	Renewable Energy Technology: A practical guides of beginners, – Chetan Singh Solanki		PHI Learning Private-Ltd., New Delhi
EVS608–RB5	Non-conventional Energy sources, - G. D. RAI		Khanna Publishers, Delhi
EVS608–RB6	Solar Energy Utilization, - G.D.Rai		Khanna Publishers, Delhi
<b>CD / DVD:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS608 - CD1			
<b>Web Links:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS608-WL1			

### Course Outcomes

After successful completion of this course, student should be able to –

- Critically analyze and evaluate different renewable energy technologies and their suitability for specific contexts.
- Capability of planning, designing, and managing renewable energy projects, considering technical, economic, and regulatory aspects.
- Demonstrating an understanding of the environmental and social implications of renewable energy deployment and make informed decisions to minimize negative impacts.
- Navigating energy policies and regulations and advocate for sustainable and renewable energy initiatives.

## Semester 04

### EVS609: ENVIRONMENTAL MICROBIOLOGY AND TOXICOLOGY

#### Programme Information

SN	Description	Details
1	University	Yashwantrao Chavan Maharashtra Open University Nasik - 422 222, Maharashtra, India Website: <a href="http://www.ycmou.ac.in">http://www.ycmou.ac.in</a>
2	School	School of Sciences
3	Discipline	Science
4	Level	PG
5	Course Used in	V152: M.Sc.(Environmental Science) {2023 Pattern} & V136: M.Sc.(Environmental Science) {2021 Pattern}

#### Course Information

Sem	Major	Code	Course Name	CR	CST	ST	CA	EE	TM	Type
04	DSC	EVS609	Environmental Microbiology and Toxicology	4	12	120	30	70	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>	The objectives of this course are– <ul style="list-style-type: none"> <li>Explore the Pollutant Biodegradation</li> <li>Gain knowledge of the principles of environmental toxicology</li> <li>Acquire skills in environmental sampling techniques</li> <li>Explore bioremediation approaches</li> </ul>

#### Units

UN	Name of the Unit	CSs	Questions
01-01	Environmental Microbiology	<b>CR 01</b> <b>MLs</b> <b>01-20</b>	As per evaluation pattern, on <b>Each Credit</b> , Student is required to answer  <ul style="list-style-type: none"> <li>Very Short Answer Question (VSAQ), of 03 marks</li> <li>Short Answer Question (SAQ), of 05 marks</li> <li>Long Answer Question (LAQ) of 10 Marks</li> </ul> (LAQ may contain sub-questions (a), (b) and so on.)
01-02	Microbial activities, Microbial diversity and Metabolism		
01-03	Microbial population and community dynamics		
01-04	Effects and measurement of environmental determinants		
02-01	Bio-indicators	<b>CR 02</b> <b>MLs</b> <b>21-40</b>	
02-02	Determination of microbiological quality		
02-03	Biosensor		
02-04	Bio-transformation, bio-accumulation and bio-magnification		
03-01	Toxicology	<b>CR 03</b> <b>MLs</b> <b>41-60</b>	
03-02	Environmental Toxicology - 1		
03-03	Nontoxicity		
03-04	Carcinogenesis		
04-01	Environmental Toxicology - 2	<b>CR 04</b> <b>MLs</b> <b>61-80</b>	
04-02	Safety regulations		
04-03	Pollution of the ecosphere		
04-04	Degradable and non- degradable		

## Detailed Syllabus

UN	Detailed Syllabus of the Unit	CR
1-1	<b>Environmental Microbiology:</b> Introduction to Microbiology –Definition, history, scope, limitations	CR 01
1-2	<b>Microbial activities, Microbial diversity and Metabolism:</b> Photosynthesis, respiration, heterotrophic potential, specific enzyme assays, 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	
1-3	<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	
1-4	<b>Effects and measurement of environmental determinants:</b> 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 ILD 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	CR 04

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
<b>Course Website Link for (1) Mobile and Online Lectures, (2) Discussion Forum for online interaction and (3) Self-Test for each CR Block, Continuous Assessment Test and End Examination</b>			
<b>Text-Books</b>			
EVS609	Environmental Microbiology and Toxicology – Dr. Anita V. Handore, Dr. Rajib Karmakar	2022	978-9392982583 YCMOU,Nashik
<b>Reference-Books:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS609:RB1	Environmental Microbiology: From Genomes to Biogeochemistry – Eugene L. Madsen	2nd edition, 2019	978-1119448216, Wiley-Blackwell
EVS609:RB2	Environmental Microbiology – Raina M. Maier, Ian L. Pepper, and Charles P. Gerba	3rd edition, 2014	978-0123946263, Academic Press
EVS609:RB3	Manual of Environmental Microbiology – Christon J. Hurst et al.	4th edition, 2016	978-1555816021, ASM Press
EVS609:RB4	Principles of Environmental Toxicology – I.E. Nirmal Kumar and B. Vidyavathi (, ISBN:	1st edition, 2012	978-1842657776, Alpha Science International Ltd
EVS609:RB5	Casarett & Doull's Toxicology: The Basic Science of Poisons – Curtis D. Klaassen	9th edition, 2018	978-1259863745, McGraw-Hill Education
EVS609:RB6	Environmental Toxicology and Chemistry – Donald G. Crosby	5th edition, 2017	978-1466553348, CRC Press
EVS609:RB7	Introduction to Environmental Toxicology: Molecular Substructures to Ecological Landscapes – Wayne Landis, Ruth Sofield, and Ming-Ho Yu	5th edition, 2018	978-1498773879, CRC Press
<b>CD / DVD:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS609:CD1			
<b>Web Links:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS609:WL1			
<b>OER:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS609:OER1	<a href="https://openstax.org/">https://openstax.org/</a>		
EVS609:OER2	<a href="https://www.merlot.org/">https://www.merlot.org/</a>		

## Course Outcomes

After successful completion of this course, student should be able to –

- Proficiency in understanding microbial processes for pollutant biodegradation and the potential for using microorganisms in environmental cleanup.
- Comprehending microbial interactions and their significance in environmental processes, ecosystem stability, and pollutant transformations.
- Possess expertise in environmental toxicology, analyzing the impacts of pollutants on microorganisms and ecosystems.
- Skilled in environmental sampling and laboratory analysis, effectively quantifying microbial populations and pollutant levels.
- Apply microbial bio-indicators to assess environmental health, contributing to pollution monitoring and remediation efforts.

## EVS610: ENVIRONMENTAL ISSUES AND HUMAN HEALTH

### Programme Information

SN	Description	Details
1	University	Yashwantrao Chavan Maharashtra Open University Nasik - 422 222, Maharashtra, India Website: <a href="http://www.ycmou.ac.in">http://www.ycmou.ac.in</a>
2	School	School of Sciences
3	Discipline	Science
4	Level	PG
5	Course Used in	V152: M.Sc.(Environmental Science) {2023 Pattern} & V136: M.Sc.(Environmental Science) {2021 Pattern}

### Course Information

Sem	Major	Code	Course Name	CR	CST	ST	CA	EE	TM	Type
04	DSC	EVS610	Environmental Issues and Human Health	4	12	120	30	70	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>	The objectives of this course are– <ul style="list-style-type: none"> <li>Acquire knowledge of epidemiological research methods</li> <li>Explore the impacts of climate change on human health</li> <li>Examine environmental policies, regulations, and international agreements</li> <li>Explore global environmental health challenges and approaches</li> </ul>

### Units

UN	Name of the Unit	CSs	Questions
01-01	Environmental pollution	<b>CR 01</b> <b>MLs</b> <b>01-20</b>	As per evaluation pattern, on <b>Each Credit</b> , Student is required to answer
01-02	Air sampling and monitoring techniques		
01-03	Noise Pollution		
01-04	Noise control and abatement measures		
02-01	Aquatic Pollution	<b>CR 02</b> <b>MLs</b> <b>21-40</b>	<ul style="list-style-type: none"> <li>Very Short Answer Question (VSAQ), of 03 marks</li> <li>Short Answer Question (SAQ), of 05 marks</li> <li>Long Answer Question (LAQ) of 10 Marks (LAQ may contain sub-questions (a), (b) and so on.)</li> </ul>
02-02	Soil Pollution		
02-03	Radioactive Pollution		
02-04	Biological effects of radiation and ecosystem		
03-01	Contemporary and emerging environmental issues of local, regional and global significance I	<b>CR 03</b> <b>MLs</b> <b>41-60</b>	
03-02	Contemporary and emerging environmental issues of local, regional and global significance II		
03-03	Basic principle of environmental health		
03-04	Industrial Toxicology		
04-01	Health maintenance	<b>CR 04</b> <b>MLs</b> <b>61-80</b>	
04-02	Treatment of variation		
04-03	Hazard evaluation		
04-04	Environmental and occupational risk assessment		

## Detailed Syllabus

UN	Detailed Syllabus of the Unit	CR
1-1	<b>Environmental pollution</b> -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.	<b>CR 01</b>
1-2	<b>Air sampling and monitoring techniques</b> - settle able and suspended particulate matter - dust fall jar and impingement method, high volume air sampler	
1-3	<b>Noise Pollution:</b> Definition, sources and terminology; types of noise; Measurement of noise; Noise indices, noise exposure level and impact on Human beings and climate.	
1-4	<b>Noise control and abatement measures.</b>	
2-1	<b>Aquatic Pollution:</b> Definition, sources and classification of aquatic pollutants. Consequences of pollution on surface, subsurface and mariner water sources.	<b>CR 02</b>
2-2	<b>Soil Pollution</b> – definition, sources and classification of soil pollutants and their impact on soil and plants. Bacteriological sampling and analysis of soil quality	
2-3	<b>Radioactive Pollution:</b> Definition, radioactivity, radionuclides, radiation emissions, sources, radioactive decay and buildup.	
2-4	<b>Biological effects of radiation and ecosystem.</b> Radiation exposure standards, radioactive pollution and pollution control measures. Biological dosimetry.	
3-1	<b>Contemporary and emerging environmental issues of local, regional and global significance I:</b> Linkage between population, development & environment and climate change.	<b>CR 03</b>
3-2	<b>Contemporary and emerging environmental issues of local, regional and global significance II:</b> stratospheric Ozone depletion, water resources, environmental toxicants & human health, biodiversity conservation and environmental episodic events etc.	
3-3	<b>Basic principle of environmental health:</b> Physiological responses of man to relevant stresses in the environment, causes and effects of pollution.	
3-4	<b>Industrial Toxicology</b> - 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	<b>Health maintenance:</b> Survey, analysis and recommendations regarding health and safety problems in the working and living environment.	<b>CR 04</b>
4-2	<b>Treatment of variation,</b> with demographic, vital statistics and epidemiological data.	
4-3	<b>Hazard evaluation</b> in polluted environment with specific emphasis on radiological health.	
4-4	<b>Environmental and occupational risk assessment</b> -Introduction, definition, measures of control	



## Learning resource details

LR Code	Title Author	Edition Year	ISBN Publisher
<b>Course Website Link for (1) Mobile and Online Lectures, (2) Discussion Forum for online interaction and (3) Self-Test for each CR Block, Continuous Assessment Test and End Examination</b>			
<b>Text-Books</b>			
EVS610	Environmental Issues and Human Health – Dr. G. M. Pondhe	2022	978-9395855037 YCMOU,Nashik
<b>Reference-Books:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS610:RB1	Environmental Health: From Global to Local – Howard Frumkin, Robert J. Geller, and Jonathan I. Levy	3rd edition, 2016	978-1118984765, Jossey-Bass
EVS610:RB2	Environmental Health: Third Edition – Dade W. Moeller	3rd edition, 2018	978-0674055307, Harvard University Press
EVS610:RB3	Introduction to Environmental Health – Richard R. Skolnik	2nd edition, 2018	978-1284090209, Jones & Bartlett Learning
EVS610:RB4	Environmental Health: From Science to Society – Howard Frumkin	3rd edition, 2016	978-1118984765, Jossey-Bass
EVS610:RB5	Human Health and the Environment: A Turn-of-the-Century Perspective – Andrew H. VanGuilder and James W. Ramsey	2nd edition, 1998	978-0070661825, McGraw-Hill
EVS610:RB6	Environmental Science for Environmental Management – by Timothy O'Riordan and Tim Lenton	2nd edition, 2013	978-1139184973, Routledge
EVS610:RB7	Our Global Environment: A Health Perspective – Anne Nadakavukaren	8th edition, 2015	978-1111990831, Wadsworth Publishing
<b>CD / DVD:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS610:CD1			
<b>Web Links:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS610:WL1			
<b>OER:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS610:OER1	<a href="https://openstax.org/">https://openstax.org/</a>		
EVS610:OER2	<a href="https://www.merlot.org/">https://www.merlot.org/</a>		

## Course Outcomes

After successful completion of this course, student should be able to –

- Possess skills in designing, conducting, and analyzing epidemiological studies related to environmental health issues.
- Applying health impact assessment methodologies to evaluate and inform environmental projects and policies.
- Comprehending the health impacts of climate change, identifying vulnerable populations and proposing adaptation strategies.
- Analyze environmental policies and regulations and understand their implications for public health and environmental protection.
- Skilled in engaging with communities, advocating for environmental justice, and promoting public awareness of environmental health issues.



## EVS611: LAB ACTIVITIES ON EVS609 & EVS610

### Programme Information

SN	Description	Details
1	University	Yashwantrao Chavan Maharashtra Open University Nasik - 422 222, Maharashtra, India Website: <a href="http://www.ycmou.ac.in">http://www.ycmou.ac.in</a>
2	School	School of Sciences
3	Discipline	Science
4	Level	PG
5	Course Used in	V152: M.Sc.(Environmental Science) {2023 Pattern} & V136: M.Sc.(Environmental Science) {2021 Pattern}

### Course Information

Sem	Major	Code	Course Name	CR	CST	ST	CA	EE	TM	Type
04	DSC	EVS611	Lab Activities on EVS609 & EVS610	4	24	120	50	50	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>	The objectives of this course are– <ul style="list-style-type: none"> <li>Explore the Pollutant Biodegradation</li> <li>Gain knowledge of the principles of environmental toxicology</li> <li>Acquire skills in environmental sampling techniques</li> <li>Explore bioremediation approaches</li> </ul>

### Detailed Syllabus

UN	Detailed Syllabus of the Unit	CR
<b>EVS609: Environmental Microbiology and Toxicology</b>		
	<b>Environmental Microbiology</b>	<b>CR 01</b>
1-1	Isolation and enumeration of microbes from environmental samples	
1-2	Cultural characteristics of isolated microbes	
1-3	Evaluation of anti-microbial chemical agents	
1-4	Effect of environment on microbes	
1-5	Determination of Bi-phasic growth curve	
1-6	Enrichment of purple non-sulphur bacteria	
<b>EVS609: Environmental Microbiology and Toxicology</b>		
	<b>Environmental Toxicology</b>	<b>CR 02</b>
2-1	Estimation of metals in soil, plants and animal tissue	
2-2	Estimation of reducing sugars in toxic waste	
2-3	Estimation of protein from toxic waste	
2-4	Case studies on environmental effects of pesticides	
2-5	Modeling of pollutant dispersion	
2-6	Toxico-genomic and pharmaco-genomic evaluation of pollutants	

EVS610: Environmental Issues and Human Health		
3-1	Case study on the health effects of pesticide exposure on farm workers, considering both acute and chronic effects and discussing potential mitigation strategies.	CR 03
3-2	Explore the aftermath of the Bhopal gas leak in India, write a report on the immediate health impacts and the ongoing health challenges faced by survivors.	
3-3	Investigate the correlation between air pollution levels in urban areas and the write a report on prevalence of respiratory diseases like asthma, focusing on both short-term and long-term effects.	
3-4	Examine the health consequences of the Chernobyl nuclear disaster, write a report on considering the impacts of radiation exposure on local populations and the environment.	
3-5	Case Study on the effects of plastic pollution on marine ecosystems	
3-6	Case Study on the potential transfer of toxins up the food chain, with a focus on its impacts on human health through seafood consumption.	
EVS610: Environmental Issues and Human Health		
4-1	Explore how deforestation alters ecosystems, write a report on affecting disease vectors' habitat and subsequently leading to increased transmission of diseases like malaria or Lyme disease.	CR 04
4-2	Investigate the health risks associated with heatwaves, particularly for vulnerable populations such as the elderly, low-income individuals, and those without access to air conditioning.	
4-3	Analyze the effects of mercury contamination in fish on Indigenous communities that rely on traditional fish-based diets, highlighting the health risks and cultural implications.	
4-4	Explore and write a report on the health risks faced by informal workers in developing countries who are involved in e-waste recycling, often without proper safety measures.	
4-5	Case study on the health and socioeconomic impacts of oil spills on coastal communities, addressing both immediate consequences and long-term recovery efforts.	
4-6	Case Study of Delhi's Air Quality Crisis	

### Learning resource details

LR Code	Title Author	Edition Year	ISBN Publisher
<b>Course Website Link for (1) Mobile and Online Lectures, (2) Discussion Forum for online interaction and (3) Self-Test for each CR Block, Continuous Assessment Test and End Examination</b>			
<b>Text-Books</b>			
EVS612-P01	Environmental Microbiology and Toxicology – Dr. Anita V. Handore, Dr. Rajib Karmakar	2022	Publication 2496 YCMOU, Nashik
EVS609-T01	Environmental Microbiology and Toxicology – Dr. Anita V. Handore, Dr. Rajib Karmakar	2022	978-9392982583 YCMOU, Nashik
EVS610-T02	Environmental Issues and Human Health – Dr. G. M. Pondhe	2022	978-9395855037 YCMOU, Nashik

<b>Reference-Books:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS611:RB1	Environmental Microbiology: From Genomes to Biogeochemistry – Eugene L. Madsen	2nd edition, 2019	978-1119448216, Wiley-Blackwell
EVS611:RB2	Environmental Microbiology – Raina M. Maier, Ian L. Pepper, and Charles P. Gerba	3rd edition, 2014	978-0123946263, Academic Press
EVS611:RB3	Manual of Environmental Microbiology – Christon J. Hurst et al.	4th edition, 2016	978-1555816021, ASM Press
EVS611:RB4	Principles of Environmental Toxicology – I.E. Nirmal Kumar and B. Vidyavathi (, ISBN:	1st edition, 2012	978-1842657776, Alpha Science International Ltd
EVS611:RB5	Casarett & Doull's Toxicology: The Basic Science of Poisons – Curtis D. Klaassen	9th edition, 2018	978-1259863745, McGraw-Hill Education
EVS611:RB6	Environmental Toxicology and Chemistry – Donald G. Crosby	5th edition, 2017	978-1466553348, CRC Press
EVS611:RB7	Introduction to Environmental Toxicology: Molecular Substructures to Ecological Landscapes – Wayne Landis, Ruth Sofield, and Ming-Ho Yu	5th edition, 2018	978-1498773879, CRC Press
<b>CD / DVD:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS611:CD1			
<b>Web Links:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS611:WL1			
<b>OER:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS611:OER1	<a href="https://openstax.org/">https://openstax.org/</a>		
EVS611:OER2	<a href="https://www.merlot.org/">https://www.merlot.org/</a>		

## Course Outcomes

After successful completion of this course, student should be able to –

- Proficiency in understanding microbial processes for pollutant biodegradation and the potential for using microorganisms in environmental cleanup.
- Comprehending microbial interactions and their significance in environmental processes, ecosystem stability, and pollutant transformations.
- Possess expertise in environmental toxicology, analyzing the impacts of pollutants on microorganisms and ecosystems.
- Skilled in environmental sampling and laboratory analysis, effectively quantifying microbial populations and pollutant levels.
- Apply microbial bio-indicators to assess environmental health, contributing to pollution monitoring and remediation efforts.

## EVS612: RESEARCH PROJECT

### Programme Information

SN	Description	Details
1	University	Yashwantrao Chavan Maharashtra Open University Nasik - 422 222, Maharashtra, India Website: <a href="http://www.ycmou.ac.in">http://www.ycmou.ac.in</a>
2	School	School of Sciences
3	Discipline	Science
4	Level	PG
5	Course Used in	V152: M.Sc.(Environmental Science) {2023 Pattern}

### Course Information

Sem	Other	Code	Course Name	CR	CST	ST	CA	EE	TM	Type
04	RP	EVS612	Research Project	6	18	180	75	75	150	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</li> </ul>	<p>The objectives of this course are–</p> <ul style="list-style-type: none"> <li>Gain expertise in Research Design and Methodology</li> <li>Acquire skills in collecting and analyzing data</li> <li>Learn effective time management and project planning skills</li> <li>Develop problem-solving skills and the ability to adapt research strategies</li> </ul>

### Guidelines

No	Guidelines for the Students and Study Centers for the conduct of Project
1	The “Project Work” course aims 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	This course is based on preliminary research oriented topics both in theory and experiment. The subject expert/ counsellor will act as supervisors for the projects. Project shall be on the current and relevant topics and issues. Project topic is jointly finalized by the student and the project supervisors through discussion. At the completion of the project by the semester end, the student will submit a Project Report in the form of Dissertation which will be examined by the examiners. The end examination shall consist of (a) Presentation and (b) Comprehensive viva-voce.
3	Students are expected to work on “Project Work” for about 6 hours per week (About 2 hour’s self-study at residence and 12 hours in counselling session at study centre), during a semester. <b>Thus only those projects, demanding such study efforts on all those activities, listed in above, should be selected.</b>
4	<b>A single student will have to do a project.</b> Since. The student invests his energy, time and resources in a project. The project therefore should, have important focus on some relevant practical aspects. This will help student to justify his efforts on project.
5	Employed Students are allowed to complete “Project Work” in the industry where he/ she is employed or his/ her 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 “Project Guide”.
6	Study centre 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>
7	<b>The Project Work must involve practical research work related to your selected discipline.</b>
8	Students have to finance expenditure on “Project” by his own. Hence students should select those projects, accordingly.
9	Each “Project Guide” may be assigned <b>maximum</b> 5 students.
10	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.
11	<p>There project report should be file bound/spiral bound/hard bound and should have following format</p> <ul style="list-style-type: none"> <li>• <b>Title Page/Cover page</b></li> <li>• <b>Certificate endorsed by Project Guide/Supervisor, Learner Support Center Coordinator and Head</b></li> <li>• <b>Declaration for followed ethical practice and non-plagiarism</b></li> <li>• <b>Acknowledgement</b></li> <li>• <b>Abstract of the project</b></li> <li>• <b>Table of Contents</b></li> <li>• <b>List of Figures</b></li> <li>• <b>List of Tables</b></li> <li>• <b>Chapters of Project Report –</b></li> </ul> <p><b>Chapter 1: Introduction:</b> Background of the project, Need for the project, Brief idea of the project, Literature review, Aims and Objectives of the project</p> <p><b>Chapter 2: Design and Methodology:</b> overview of the complete project, the scientific principles involved in the design of the project, Block Diagrams, Experimental/Theoretical Methodology/Circuit/Model/ materials required, etc.</p> <p><b>Chapter 3: Testing, Conduct of Experiment/ Module:</b> Actual conduct of experiment, measurements, observations, etc.</p> <p><b>Chapter 4: Analysis of Data:</b> Analysis of the data and observations received during experimentation</p> <p><b>Chapter 5: Results, Discussion and Conclusions:</b> 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, reference books, journals, websites, magazines and data manuals used, etc.</p>
12	<b>Project Report 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 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.

13	<p>Study center should preserve their copy of, all project reports, till the end examination of Project Work. <b>Even student must bring his own copy during this end examination.</b></p> <p><b>Project Report Format:</b></p> <ol style="list-style-type: none"> <li>The project report should be printed on only right side of A4 size (210 mm ´ 297 mm) paper. There is no minimum or maximum page number limit for the “Project Report”, but report of minimum 50–70 pages is expected. University recommends only flexible binding for the “Project Report”. But, if student wishes, he may also use spiral binding.</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 ‘Fig C.F’, where ‘C’ is chapter number and ‘F’ is figure number. Figure number ‘F’ is reset back to 1 for each new chapter.</li> </ol> <p>Page Sequence: (1) Cover page as per specimen 1 (2) Certificate page as per specimen 2 (3) Acknowledgement page for the help offered by individuals and institution (4) Content page as per specimen 3. 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 .....</b>  <b>Submitted by</b>  <b>Name of Student-</b>  <b>Name of Project Guide-</b>  <b>Name of the Learner</b>  <b>SupportCenter–</b></p> <p><b>YashwantraoChavan</b>  <b>Maharashtra</b>  <b>Open University</b>  <b>20... - ...</b></p>	<p><b>Specimen 2</b></p> <p><b>Certificate</b></p> <p>This is to certify that</p> <p>Mr/Ms.....</p> <p>.....(PRN ....)</p> <p>has successfully completed a projectentitled ". ....."</p> <p>in partial fulfilment for the requirement of</p> <p><b>Master of Science in .....</b></p> <table border="1"> <tr> <td colspan="2">Signature with Date</td> </tr> <tr> <td>Project Guide</td> <td>LSC Coordinator</td> </tr> <tr> <td>Internal Examiner</td> <td>External Examiner</td> </tr> </table>	Signature with Date		Project Guide	LSC Coordinator	Internal Examiner	External Examiner
Signature with Date								
Project Guide	LSC Coordinator							
Internal Examiner	External Examiner							

## Course Outcomes

After successful completion of this course, student should be able to –

- Demonstrating a high level of research competence, having successfully planned and executed a master's-level research project.
- Honed their critical thinking abilities, demonstrated by the comprehensive literature review and critical analysis of research findings.
- Proficient in selecting appropriate research design and methodologies, ensuring the research is well-structured and methodologically sound.
- Demonstrating expertise in collecting and analyzing data, utilizing appropriate statistical or qualitative analysis techniques.
- Developing effective project management skills, successfully meeting research milestones and completing the project within the given timeframe.
- Problem-solving abilities, adapting their research strategies to overcome challenges encountered during the research process.



## EVS613: STATISTICAL APPROACHES AND MODELLING IN ENVIRONMENTAL SCIENCES

### Programme Information

SN	Description	Details
1	University	Yashwantrao Chavan Maharashtra Open University Nasik - 422 222, Maharashtra, India Website: <a href="http://www.ycmou.ac.in">http://www.ycmou.ac.in</a>
2	School	School of Sciences
3	Discipline	Science
4	Level	PG
5	Course Used in	V152: M.Sc.(Environmental Science) {2023 Pattern} & V136: M.Sc.(Environmental Science) {2021 Pattern}

### Course Information

Sem	Major	Code	Course Name	CR	CST	ST	CA	EE	TM	Type
04	DSE	EVS613	Statistical Approaches and Modelling in Environmental Sciences	4	12	120	30	70	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>	The objectives of this course are– <ul style="list-style-type: none"> <li>Acquire a comprehensive understanding of advanced statistical techniques</li> <li>Develop the ability to identify and define environmental problems</li> <li>Gain practical experience with statistical software packages and modeling tools</li> <li>Evaluate existing statistical methods and environmental models</li> </ul>

### Units

UN	Name of the Unit	CSs	Questions
01-01	Basics of Statistics	<b>CR 01</b> <b>MLs</b> <b>01-20</b>	As per evaluation pattern, on <b>Each Credit</b> , Student is required to answer
01-02	Statistical methods		
01-03	Dispersion		
01-04	Probability		
02-01	Correlation	<b>CR 02</b> <b>MLs</b> <b>21-40</b>	<ul style="list-style-type: none"> <li>Very Short Answer Question (VSAQ), of 03 marks</li> <li>Short Answer Question (SAQ), of 05 marks</li> <li>Long Answer Question (LAQ) of 10 Marks</li> </ul> (LAQ may contain sub-questions (a), (b) and so on.)
02-02	Regression		
02-03	Testing of hypothesis		
02-04	Bioassay		
03-01	Introduction-Environmental modelling	<b>CR 03</b> <b>MLs</b> <b>41-60</b>	
03-02	Models in environmental science emphasizing – Linear model		
03-03	Models in environmental science emphasizing – Chemical transport model		
03-04	Models in environmental science emphasizing – Inverse model		
04-01	Elementary concepts	<b>CR 04</b> <b>MLs</b> <b>61-80</b>	
04-02	The building blocks & transformation processes		
04-03	Environmental modelling		
04-04	Air quality modelling		



## Detailed Syllabus

UN	Detailed Syllabus of the Unit	CR
1-1	<b>Basics of Statistics:</b> Sampling data, types of data, method of collection and recording	<b>CR 01</b>
1-2	<b>Statistical methods:</b> Measures of central tendencies - mean, median, mode.	
1-3	<b>Dispersion:</b> measures of dispersion range, quartile, deviation, mean deviation and standard deviation, Absolute and relative measures of dispersion, skewness and kurtosis.	
1-4	<b>Probability:</b> 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	<b>Correlation:-</b> Types of correlation, method of studying correlation, scathes diagram, Karl person's Coefficient of correlation, Spearman's Rank correlation, multiple.	<b>CR 02</b>
2-2	<b>Regression:</b> Uses of regression and properties.	
2-3	<b>Testing of hypothesis:</b> Meaning, Types of hypothesis, level of significance, large sample list of mean, proportions, equality of means.	
2-4	<b>Bioassay-</b> Principle, history, classification, examples	
3-1	<b>Introduction-Environmental modelling:</b> scope and problem definition, goals and objectives, definition; modelling approaches– deterministic, stochastic and the physical approach; applications of environmental models; the model building process	<b>CR 03</b>
3-2	<b>Models in environmental science emphasizing (a) linear models</b> (mathematical principles, time evolution operator, eigenvalues and eigenvectors; Markov chains)	
3-3	<b>(b) chemical transport models</b> including basic principles and numerical methods,	
3-4	<b>(c) inverse modeling</b> (optimal estimation, Kalman filter, adjoint methods).	
4-1	<b>Elementary concepts, laws , theories and processes</b>	<b>CR 04</b>
4-2	<b>The building blocks:</b> 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 <b>transformation processes</b> –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	<b>Environmental modelling</b> – 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
<b>Course Website Link for (1) Mobile and Online Lectures, (2) Discussion Forum for online interaction and (3) Self-Test for each CR Block, Continuous Assessment Test and End Examination</b>			
<b>Text-Books</b>			
EVS613	Statistical Approaches and Modelling in Environmental Sciences – Mr. Kailas Ahire	2022	978-9395855976 YCMOU, Nashik
<b>Reference-Books:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS613:RB1	Statistical Methods in Environmental Science – Otis D. Duncan	1st edition, 1996	978-0471128444, Wiley
EVS613:RB2	Statistics for Environmental Science and Management – Bryan F.J. Manly	2nd edition, 2008	978-1420077497, CRC Press
EVS613:RB3	Introduction to Environmental Statistics – Ronald A. Powell	3rd edition, 2015	978-1482247756, CRC Press
EVS613:RB4	Statistical Methods in Water Resources – Wallace H. Reed	2nd edition, 1993	978-0873716038, American Society of Civil Engineers
EVS613:RB5	Applied Environmental Statistics: A Distributional Approach – S. Rao Jammalamadaka and Claudio Agostinelli	2003	978-0471190458, Wiley
EVS613:RB6	Statistics for Environmental Engineers – Dennis R. Helsel and Robert M. Hirsch	2nd edition, 2002	978-1566705373, CRC Press
EVS613:RB7	Statistical Techniques in Geographical Analysis – Dennis Wheeler and Peter Haggett	2nd edition, 2005	978-0470849824, Wiley
<b>CD / DVD:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS613:CD1			
<b>Web Links:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS613:WL1			
<b>OER:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS613:OER1	<a href="https://openstax.org/">https://openstax.org/</a>		
EVS613:OER2	<a href="https://www.merlot.org/">https://www.merlot.org/</a>		

## Course Outcomes

After successful completion of this course, student should be able to –

- Applying advanced statistical methods to analyze complex environmental datasets and draw meaningful conclusions from the results.
- Using statistical analysis and modeling outputs to support evidence-based decision-making in environmental management and policy development.
- Integrating their statistical expertise with environmental sciences knowledge, contributing to holistic solutions for environmental challenges.

## EVS614: DISASTER MANAGEMENT

### Programme Information

SN	Description	Details
1	University	Yashwantrao Chavan Maharashtra Open University Nasik - 422 222, Maharashtra, India Website: <a href="http://www.ycmou.ac.in">http://www.ycmou.ac.in</a>
2	School	School of Sciences
3	Discipline	Science
4	Level	PG
5	Course Used in	V152: M.Sc.(Environmental Science) {2023 Pattern}

### Course Information

Sem	Major	Code	Course Name	CR	CST	ST	CA	EE	TM	Type
04	DSE	EVS614	Disaster Management	4	12	120	30	70	100	T

### Presumed knowledge and learning objectives

Presumed Knowledge	Learning Objectives
<ul style="list-style-type: none"> <li>A basic knowledge and interest in understanding the waste</li> <li>A basic knowledge and interest in understanding the waste disposal options especially landfills</li> </ul>	<p>The objectives of this course are–</p> <ul style="list-style-type: none"> <li>Assess the environmental consequences of disasters on ecosystems</li> <li>Gain insights into the importance of disaster preparedness, contingency planning, and resource allocation to improve disaster response and recovery.</li> <li>Learn about various disaster response strategies</li> <li>Explore strategies to involve local communities in disaster risk reduction efforts</li> </ul>

### Units

UN	Name of the Unit	CSs	Questions
01-01	Disasters and Disaster Management	<b>CR 01</b> <b>MLs</b> <b>01-20</b>	As per evaluation pattern, on <b>Each Credit</b> , Student is required to answer
01-02	Paradigm Shift in Disaster Management		
01-03	Hazard, Vulnerability and Risks		
01-04	Policy Planning Issues and Institutional Framework in Disaster Management		
02-01	Disaster Management of Radiological, Nuclear and Biological Disasters	<b>CR 02</b> <b>MLs</b> <b>21-40</b>	<ul style="list-style-type: none"> <li>Very Short Answer Question (VSAQ), of 03 marks</li> <li>Short Answer Question (SAQ), of 05 marks</li> <li>Long Answer Question (LAQ) of 10 Marks</li> </ul> (LAQ may contain sub-questions (a), (b) and so on.)
02-02	Disaster Management for Landslides and Avalanches		
02-03	Disaster Management for Earthquakes		
02-04	Disaster Management for Floods		
03-01	Prevention and Management of Heat Waves	<b>CR 03</b> <b>MLs</b> <b>41-60</b>	
03-02	School Safety and Disaster Resilience		
03-03	Disaster Relief and Rehabilitation		
03-04	Post Disaster Needs Assessment		
04-01	Post Disaster Relief and Health Care Management	<b>CR 04</b> <b>MLs</b> <b>61-80</b>	
04-02	Dead Bodies and Animal Carcass Management		
04-03	Mainstreaming Disaster Risk Reduction in Developmental Planning		
04-04	Role of National and International NGOs/Civil Societies in Disaster Management		

## Detailed Syllabus

UN	Detailed Syllabus of the Unit	CR
1-1	<b>Disasters and Disaster Management:</b> Crisis, Emergency, Disaster and Catastrophe, Disaster management cycle, Disaster Management - In the Indian Context, History of DM in India, Agencies involved in Disaster Management in India.	CR 01
1-2	<b>Paradigm Shift in Disaster Management:</b> Paradigm shift in Disaster Management – Theoretical Background, Pressure and Release model, Access Model, The Approach. Global initiatives on Paradigm Shift – Developmental processes, Disaster research and awareness, Paradigm shift in the Indian context	
1-3	<b>Hazard, Vulnerability and Risks:</b> Context of Hazards, Typology of hazards, Event Tree, Fault tree, Vulnerability in the context of disasters, Measuring vulnerability, Typology of vulnerability, Vulnerability assessment and approaches, Risk Perception, Risk Assessment and Approaches	
1-4	<b>Policy Planning Issues and Institutional Framework in Disaster Management:</b> Emergence of Policy Planning Issues at the International Level, Policy Planning and Institutional Framework at National Level, Disaster Management Act, 2005, National Disaster Management Authority (NDMA), National Executive Committee, NIDM, NDRF, National Advisory Committee, National Crisis Management Committee, State Disaster Management Authority, State Executive Committee, District Disaster Management Authority	
2-1	<b>Disaster Management of Radiological, Nuclear and Biological Disasters:</b> Nuclear and Radiological Emergency - The Indian Perspective on Radiological and Nuclear Emergencies, Preparedness for Nuclear Power Plants, Plant Emergency, On-Site & Off-Site Emergencies, Preparedness for Nuclear/Radiological Emergencies, Biological Disasters - Causes of Biological Disasters, Mitigation Measures, Nodal Agency.	CR 02
2-2	<b>Disaster Management for Landslides and Avalanches:</b> Landslides – Causes, Major landslides in recent years, Avalanches – Causes, Landslides and Avalanches in the Indian Context, Prevention and Management, Protection against avalanches, NDMA guidelines for landslides and avalanches in India, Measures for rehabilitation	
2-3	<b>Disaster Management for Earthquakes:</b> Earthquakes and the Earth System, Measuring Earthquake, Cascading Hazards, Earthquake Risk Management, Construction Codes, National Building Code, Role of Reconnaissance Missions in updating Building codes, Institutional Framework for Seismic Risk Management in India, Earthquake Preparedness, Response & Recovery	
2-4	<b>Disaster Management for Floods:</b> Flood and its impacts, Types of Floods, Affects of floods, Flood Risk Management & its Evolution, Characteristics of Better Flood Risk Management, Floods in India, Flood Management Initiatives, Indian Riverine Flood Management- Ganges and Brahmaputra	
3-1	<b>Prevention and Management of Heat Waves:</b> Criterion for heat wave in India, Impact of heat wave on human health, Vulnerability of heat wave in Indian Context, Management & Prevention Heat wave, Urban Heat Island Effect, Heat Waves Response in India, Probing Heat Wave management	CR 03
3-2	<b>School Safety and Disaster Resilience:</b> Sendai Framework (SFDRR) and School Safety, Disaster Education for Strengthening Resilience, Multidimensional impact & developing School Safety Programme, National School Safety Programme, Operational components of NSSP	

3-3	<b>Disaster Relief and Rehabilitation:</b> Disaster Relief - International Laws pertaining to Disaster Response, Humanitarian Principles, Disaster Relief – Materials and Guidelines, Disaster Relief- key components, Disaster Rehabilitation, PDNA & Rehabilitation	
3-4	<b>Post Disaster Needs Assessment:</b> History of Evolution, Necessity of PDNA, Sendai Framework for Disaster Risk Reduction and PDNA, Methodology followed for Post Disaster Needs Assessment, Tools to conduct PDNA, Disaster-Response type of assessment, Post Disaster assessment, Challenges.	
4-1	<b>Post Disaster Relief and Health Care Management:</b> Post disaster relief – Process, Relief cycle, Disaster Relief Network, Logistics Strategies, Post disaster health care management - Public health approach, Guidelines to address public health in post disaster situations	<b>CR 04</b>
4-2	<b>Dead Bodies and Animal Carcass Management:</b> Management of Dead Bodies and Animal Carcass- Basic Concept, Existing Manuals and Guidelines on the Disposal of Dead Bodies and Animal Carcasses Management, Dead body management - Methods and procedures, Other factors to be considered during dead body management, Recommendations for managing dead body after natural disasters, Animal Carcasses Management	
4-3	<b>Mainstreaming Disaster Risk Reduction in Developmental Planning:</b> Mainstreaming Disaster Risk Reduction, Objectives of Mainstreaming DRR, Components of Mainstreaming, Sector wise Mainstreaming DRR	
4-4	<b>Role of National and International NGOs/Civil Societies in Disaster Management:</b> National Policy on Disaster Management 2009, NDMA Guidelines on Role of NGOs in Disaster Management (Draft)2015, National Disaster Management Plan 2016, Role identification of NGOs/Civil Society Organizations	

### Learning resource details

LR Code	Title Author	Edition Year	ISBN Publisher
<b>Course Website Link for (1) Mobile and Online Lectures, (2) Discussion Forum for online interaction and (3) Self-Test for each CR Block, Continuous Assessment Test and End Examination</b>			
<b>Text-Books</b>			
<b>Reference-Books:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS614:RB1	Textbook of Disaster Management – A.K. Shrivastava	4th edition, 2022	978-8122432717 Pearson
EVS614:RB2	Disaster Management: Principles and Practices – Surendra Singh,	5th edition, 2021	978-9352811794 PHI Learning
EVS614:RB3	Disaster Management: Theory and Practice – S.K. Jain	3rd edition, 2021	978-8125928828 Khanna Publishers
EVS614:RB4	Disaster Management: Concepts, Approaches and Strategies – R.K. Gupta	2nd edition, 2020	978-9388595916 Springer
EVS614:RB5	Disaster Management: A Systems Approach – S.K. Dubey,	2nd edition, 2020	978-8131710833 McGraw-Hill Education

EVS614:RB6	Disaster Management: An Interdisciplinary Approach – P.K. Mishra,	2nd edition, 2019	978-9388707353 Springer
EVS614:RB7	Disaster Management: A Practical Approach – D.P. Singh,	2nd edition, 2019	978-9389853572 Pearson
<b>CD / DVD:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS614:CD1			
<b>Web Links:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS614:WL1			
<b>OER:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS614:OER1	<a href="https://openstax.org/">https://openstax.org/</a>		
EVS614:OER2	<a href="https://www.merlot.org/">https://www.merlot.org/</a>		

## Course Outcomes

After successful completion of this course, student should be able to –

- **Critical Thinking:** Analyze complex disaster scenarios and identify potential risks and vulnerabilities, evaluating the ecological and societal implications.
- **Problem-solving:** Develop practical solutions and strategies for disaster preparedness, response, and recovery, taking into account environmental considerations.
- **Communication:** Effectively communicate disaster-related information and recommendations to diverse audiences, including policymakers, communities, and stakeholders.
- **Interdisciplinary Approach:** Integrate knowledge from various disciplines, such as environmental science, geography, sociology, and policy studies, to address multi-faceted disaster challenges.
- **Ethics and Social Responsibility:** Recognize the ethical dimensions of disaster management and consider social equity and justice in disaster response and recovery efforts.
- **Research Skills:** Conduct research on disaster management topics, utilizing appropriate methodologies and data analysis techniques to support evidence-based decision-making.



## EVS615: MEDICINAL PLANTS & THEIR APPLICATIONS

### Programme Information

SN	Description	Details
1	University	Yashwantrao Chavan Maharashtra Open University Nasik - 422 222, Maharashtra, India Website: <a href="http://www.ycmou.ac.in">http://www.ycmou.ac.in</a>
2	School	School of Sciences
3	Discipline	Science
4	Level	PG
5	Course Used in	V152: M.Sc.(Environmental Science) {2023 Pattern}, V156: M.Sc.(Botany) {2023 Pattern}, V144: M.Sc.(Botany) {2022 Pattern}

### Course Information

Sem	Major	Code	Course Name	CR	CST	ST	CA	EE	TM	Type
04	DSE	EVS615	Medicinal Plants & Their Applications	4	12	120	30	70	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>	The objectives of this course are– <ul style="list-style-type: none"> <li>Develop Advanced Botanical Knowledge</li> <li>Gain Knowledge of Phytochemistry and Active Constituents</li> <li>Explore Pharmacological Actions</li> <li>Analyze Therapeutic Applications</li> <li>Examine the quality control, safety, and regulatory aspects of medicinal plant products</li> </ul>

### Units

UN	Name of the Unit	CSs	Questions
01-01	History Of Medicinal And Aromatic Plants	<b>CR 01</b> <b>MLs</b> <b>01-20</b>	As per evaluation pattern, on <b>Each Credit</b> , Student is required to answer
01-02	Herbal Industry		
01-03	Importance Of Medicinal Plants		
01-04	Indigenous systems of medicine		
02-01	Poisonous And Allergic Plants	<b>CR 02</b> <b>MLs</b> <b>21-40</b>	<ul style="list-style-type: none"> <li>Very Short Answer Question (VSAQ), of 03 marks</li> <li>Short Answer Question (SAQ), of 05 marks</li> <li>Long Answer Question (LAQ) of 10 Marks</li> </ul> (LAQ may contain sub-questions (a), (b) and so on.)
02-02	Plant Allergens		
02-03	Remedial Plants		
02-04	Psychoactive Plants		
03-01	Marine Drugs, Natural Pesticides And Antibiotics	<b>CR 03</b> <b>MLs</b> <b>41-60</b>	
03-02	Natural pesticides		
03-03	Antibiotics		
03-04	Trade and commerce of medicinal plants of India		
04-01	Herbal medicine	<b>CR 04</b> <b>MLs</b> <b>61-80</b>	
04-02	Study of few commercial /raw drugs/ medicinal plants		
04-03	Traditional Agriculture Practices in Ancient India		
04-04	Aspects of Biodiversity		



## Detailed Syllabus

UN	Detailed Syllabus of the Unit	CR
1-1	<b>History Of Medicinal And Aromatic Plants:</b> - History of medicinal and aromatic plants - some important terms used in herbal medicine	CR 01
1-2	<b>Herbal Industry:</b> WTO Indian scenario- Prospects and constraints, export and import status; AAYUSH– Amchi (Tibetan), Ayurveda, Unani, Siddha and Homoeopathy; Chinese; Bach’s flower remedy; Aromatherapy.	
1-3	<b>Importance Of Medicinal Plants:</b> Relevance of herbal medicine as primary health care package; sources of information on medicinal plants; Organization of information in database (national and international)	
1-4	<b>Indigenous systems of medicine:</b> Causes for the decline and the current scenario in Indigenous systems of medicine; a comparative evaluation of accessibility and benefits of different systems of medicine	
2-1	<b>Poisonous And Allergic Plants:</b> Poisonous plants – classification; chemical constituents, symptoms, treatment and systematic description of some poisonous plants - Papaver somnifera, Calotropis gigantea, Gloriosa superba, Digitalis purpurea, Datura metel, Strychnos nux-vomica	CR 02
2-2	<b>Plant Allergens:</b> Types and classification; description, symptoms, chemical constituents and treatment of the following allergic plants - Parthenium hysterophorus, Urtica sp., Acacia sp., Eucalyptus globulus, Arachis hypogaea and Solanum.	
2-3	<b>Remedial Plants:</b> Heart, respiratory, skin, cancer, autoimmune, and liver diseases; nutraceuticals and cosmeceuticals; Vrikshayurveda - herbal remedies for plant disease.	
2-4	<b>Psychoactive Plants:</b> Classification; stimulants, nootropic plants (Plants for mental health), hallucinogens, depressants and anti-depressants.	
3-1	<b>Marine Drugs, Natural Pesticides And Antibiotics:</b> Marine Drugs – Introduction, Classification – antimicrobial, anti-inflammatory, antispasmodic, antiparasitic, anticancer, cardiovascular, insecticide, anticoagulants, marine toxins.	CR 03
3-2	<b>Natural pesticides</b> – Introduction, method of pest control, classification, essentials of a good pesticide, pesticide and environment, examples – Pyrethrum (flowers), Derris (root), Nicotiana and Azadirachta (leaf) and Cymbopogon (Citronella oil).	
3-3	<b>Antibiotics</b> – Introduction and classification – Aminoglycosides, Cephalosporins, Tetracyclines and Penicillins.	
3-4	<b>Trade and commerce of medicinal plants of India</b> – Potentials of medicinal plants – WHO and Indian Scenario	
4-1	<b>Herbal medicine</b> – A natural resource; commercial and medicinal uses of medicinal plants in India	CR 04
4-2	<b>Study of few commercial /raw drugs/ medicinal plants</b> - Usnea; Drynaria; Pinus; Vincarosea; Rauwolfiaserpentina; Withaniasomnifera; Coleus forskohlii; Emblica officinalis; Saracaasoca; Aloe vera; Glycyrrhizaglabra; Commiphoramukul, Bosweliaserrata.	
4-3	<b>Traditional Agriculture Practices in Ancient India:</b> Traditional Agriculture Practices in Ancient India	
4-4	<b>Aspects of Biodiversity:</b> Some aspects of Biodiversity and Indian Traditions.	

## Learning resource details

LR Code	Title Author	Edition Year	ISBN Publisher
<b>Course Website Link for (1) Mobile and Online Lectures, (2) Discussion Forum for online interaction and (3) Self-Test for each CR Block, Continuous Assessment Test and End Examination</b>			
<b>Text-Books</b>			
EVS615-T01	Medicinal Plants & Their Applications – Dr. Madhukar Bhagwan Patil, Dr. Amanulla Khan N.K. Pathan,	2023	978-9395855648 YCMOU, Nashik
<b>Reference-Books:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS615:RB1	Glossary of Indian medicinal plants – R.N.Chopra, S.L.Nayar and I.C.Chopra.	1956	C.S.I.R, New Delhi.
EVS615:RB2	The indigenous drugs of India – Kanny, Lall, Dey and Raj Bahadur.	1984	International Book _Distributors.
EVS615:RB3	Herbal plants and Drugs – Agnes Arber.	1999	Mangal Deep Publications.
EVS615:RB4	Ayurvedic drugs and their plant source. – V.V. Sivarajan and Balachandran Indra.	1994	Oxford IBH _publishing Co
EVS615:RB5	Ayurveda and Aromatherapy – Miller, Light and Miller, Bryan.	1998	Banarsidass, Delhi.
EVS615:RB6	Principles of Ayurveda – Anne Green.	2000	Thomsons, ondon.
EVS615:RB7	Pharmacognosy, – Dr.C.K.Kokate et al.	1999	Nirali Prakashan
<b>CD / DVD:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS615:CD1			
<b>Web Links:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS615:WL1			
<b>OER:</b> Explore additional details and reinforce learning, with this optional learning resource!			
EVS615:OER1	<a href="https://openstax.org/">https://openstax.org/</a>		
EVS615:OER2	<a href="https://www.merlot.org/">https://www.merlot.org/</a>		
<b>Course Outcomes</b>			
After successful completion of this course, student should be able to –			
<ul style="list-style-type: none"> <li>• Demonstrating expert knowledge of medicinal plants, including their identification, phytochemistry, and pharmacological properties.</li> <li>• Critically evaluate scientific literature on medicinal plants and apply evidence-based approaches to healthcare decision-making.</li> <li>• Applying medicinal plant knowledge to various healthcare settings, such as herbal medicine, phytotherapy, and dietary supplement formulations.</li> <li>• Designing and conduct research studies related to medicinal plants, contributing to the advancement of knowledge in this field.</li> <li>• Aware of the importance of sustainability and biodiversity conservation in the context of using medicinal plants.</li> <li>• Contributing to the development of new medicinal plant-based products, therapies, or research methodologies, leading to advancements in the field.</li> </ul>			

**End of Documents**