



Fergusson College (Autonomous)

Pune

Learning Outcomes-Based Curriculum

for

F. Y. B. Sc.

Environmental Science

With effect from June 2019

Programme Structure

Particulars	Course Code	Title of Paper	No. of Credits
F. Y. B. Sc. Semester I	EVS1101	Earth and Earth Surface Processes	2
	EVS1102	Physics and Chemistry of Environment	2
	EVS1103	Environmental Science Practical - I	2
F. Y. B. Sc. Semester II	EVS1201	Systematics and Biogeography	2
	EVS1202	Water and Water Resources	2
	EVS1203	Environmental Science Practical - II	2

Semester	Course code	Title of Paper	Credits
S. Y. B. Sc. Semester I	EVS2301	Ecology and Ecosystems	3
	EVS2302	Land and soil conservation and management	3
	EVS2303	Practicals based on EVS2301 and EVS2302	2
S. Y. B. Sc. Semester II	EVS2401	Urban Ecosystems	3
	EVS2402	Natural resource management and sustainability	3
	EVS2403	Practicals based on EVS2301 and EVS2302	2

Semester	Course Code	Title	Paper No.	Credits
T. Y. B. Sc. Semester-V	EVS3501	Terrestrial and Aquatic Ecosystems Management	I	3
	EVS3502	Environmental Monitoring	II	3
	EVS3503	Remote Sensing and GIS	III	3
	EVS3504	Environmental Biotechnology	IV	3
	EVS3505	Resource Economics	V	3
	EVS3506	Introduction to Environmental Statistics		3
	EVS3507	Environmental Issues and Solutions	VI	3
	EVS3508	Climate Change and Sustainability		3
	EVS3511	Environmental Science Practical - I		2
	EVS3512	Environmental Science Practical - II		2
	EVS3513	Environmental Science Practical - III		2

T. Y. B. Sc. Semester-VI	EVS3601	Waste Treatment Technology	I	3
	EVS3602	Wildlife Biology and Conservation	II	3
	EVS3603	Environment Impact Assessment and Management	III	3
	EVS3604	Environmental Governance and Ethics	IV	3
	EVS3605	Environmental Toxicology, Health and Safety	V	3
	EVS3606	OR Energy and Environment		3
	EVS3607	Environmental Restoration and Remediation	VI	3
	EVS3608	OR Waste Management in Smart Cities		3
	EVS3611	Environmental Science Practical - IV		2
	EVS3612	Environmental Science Practical - V		2
	EVS3613	Environmental Science Project		2

Programme learning outcomes

PO1	Demonstrate logical understanding of basic concepts, principles and processes underlying the academic field of Environmental Science. Its various subfields includes Ecology, Earth surface processes, Pollution control technology, Environmental health & safety, Environmental laws, Environmental impact assessment, Toxicology, Waste treatment techniques, Renewable and non renewable energy resources, Restoration, Environmental economics, Remote sensing and GIS, Climate change and sustainability, etc.
PO2	This program provides Methodological knowledge that creates different types of professionals in the field of Environmental science and related fields such as Environmental quality monitoring, Conservation Biology, Environmental Health & Safety, Environment Management Systems, etc.
PO3	It is possible to apply knowledge and skills learned from the program to address Environmental issues and challenges for the protection and conservation of available natural resources.
PO4	Use Lab and field techniques relevant to academics and industry, generic skills and global competencies, including knowledge and skills that enable students to undertake further studies in the field of Environmental science. Undertake research and on field activities which develop problem solving abilities required for successful career in Environmental Science.
PO5	Basic concepts and methodology in the field of able to understand by students.
PO6	Students become capable to select the specified field of environment for their higher studies.
PO7	To get expertise in standard evaluation analysis methods for environmental monitoring.
PO8	Understand the concepts and methods from ecological and physical sciences and their application in environmental problem-solving.
PO9	Understand the current and upcoming environmental issues and ways of addressing them, including interactions across local to global scales
PO10	Demonstrate proficiency in quantitative methods, qualitative analysis, critical thinking, and written and oral communication needed to conduct high-level work as interdisciplinary scholars and/or experts

PAPER CODE: EVS1101
Earth and Earth Surface Processes

Objectives

- The paper will introduce students to the basic structure and composition of the Earth and will explore various surface processes and their impact on and role in living systems.
- It will also deal with the interactive processes in the inner as well as outer Earth's surface.

<p style="text-align: center;">Course Outcomes</p> <ul style="list-style-type: none"> • Students will learn the basic structure and composition of the Earth (inner and outer) and will explore various surface processes and their impact on Earth as a system and role in living systems. • Students will understand the soil as an Ecosystem. • Students will be introduced to Earth's atmospheric components related to temperature variation and atmospheric stability. • Practicals based on the paper are designed to make understand the students about applicability of theoretical concepts. • Practicals based on rock cycle will help field identification of rocks, and basic soil characterization and basics of soil quality monitoring. 	<p style="text-align: center;">Suggested Pedagogical Processes</p> <ul style="list-style-type: none"> • Lecture cum demonstration method • Use of ICT • Use of Models • Study visits to understand the soil as an Ecosystem • Use of rock and mineral samples to understand the structure.
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[Credit -2: No. of Lectures 36]

	Title and Contents	No. of Lectures
Unit -I	<p>Introduction to Environment:</p> <ul style="list-style-type: none"> • Fundamentals of Environment • Functions of Environment • Concept of Biosphere • Scope and Importance of Environment. • Environmental Science ,Multidisciplinary and dynamic nature 	6
Unit -II	<ul style="list-style-type: none"> • History of Earth • Theories of Geological evolution • Major changes on the Earth's surface; • Holocene and the emergence of humans, • Geological time scale, Age of reduction and Atmospheric equilibrium • Role of humans in shaping landscapes; Development of cultural landscapes 	6

Unit -III	<p>Earth & it's Structural Components</p> <ul style="list-style-type: none"> • Solar system formation and planetary differentiation; • Orbital Theory • Geological Time Scale • Formation of the Earth: Internal Structure of Earth; Formation and composition of core, mantle, crust. • Theories of geological evolution: Wagener's Continental Drift Theory, Plate Tectonic Theory • Sea floor spreading. Types of Rocks – Igneous, Sedimentary Metamorphic. • Rock cycle. • Rock forming minerals – quartz, feldspar, micas, clay minerals, calcite, dolomite etc. 	6
Unit -IV	<p>Weathering and Soil</p> <ul style="list-style-type: none"> • Soil, Soil Profile, • Soil Formation • Soil classification • Physical & chemical properties of soil • Macro & micro plant nutrients. • Importance and Significance of Soil • Soil erosion Types, causes and effects 	6
Unit -V	<p>Temperature and atmospheric phenomenon</p> <ul style="list-style-type: none"> • Atmosphere: evolution of earth's atmosphere • Composition of atmosphere and its vulnerability to climate change • Stratospheric Ozone <ul style="list-style-type: none"> • Significance • Atmospheric temperature measurement • Instruments; • Methods (maximum, minimum, mean temperature, temperature range); • Factors regulating atmospheric temperature/ temperature controls • Lapse rate and types • Temperature inversion & atmospheric stability 	6
Unit -VI	<p>Atmospheric Pressure and wind</p> <ul style="list-style-type: none"> • Atmospheric pressure on Earth • Introduction; Measurement; Factors affecting the atmospheric pressure • Atmospheric pressure winds • Factors affecting winds • Types of wind 	6

Suggested Readings:

1. Bridge, J., & Demicco, R. 2008. *Earth Surface Processes, Landforms and Sediment deposits*. Cambridge University Press.
2. Duff, P. M. D., & Duff, D. (Eds.). 1993. *Holmes' Principles of Physical Geology*. Taylor & Francis.
5. Keller, E.A. 2011. *Introduction to Environmental Geology* (5th edition). Pearson Prentice Hall.
6. Krishnan, M. S. 1982. *Geology of India and Burma*. CBS Publishers & Distributors.
7. Leeder, M., Arlucea, M.P. 2005. *Physical Processes in Earth and Environmental Sciences*. Blackwell Publishing.
8. Pelletier, J. D. 2008. *Quantitative Modeling of Earth Surface Processes* (Vol. 304). Cambridge: Cambridge University Press. Chicago

PAPER CODE: EVS1102
PAPER-II:
Physics and Chemistry of Environment

Objectives:

- This paper aims to build conceptual understanding of students by exposing them to the basic principles behind various environmental processes.
- The paper has been divided into two sections, with the view to introduce students to the concepts of physics and chemistry associated with particle movement, chemical processes and pollutant chemistry.

<p>Course outcomes:</p> <ul style="list-style-type: none"> • It will help in conceptual understanding of students by exposing them to the basic principles behind various environmental processes. • Students gain knowledge about the concepts of physics and chemistry associated with environmental components and processes in different spheres like atmosphere, lithosphere and hydrosphere. • Understand the basics of environmental pollutants, their processing in environment and impact on living and nonliving thing. • Orientation of students towards finding better solutions for environmental problems 	<p>Suggested pedagogical Processes:</p> <ul style="list-style-type: none"> • Demonstrate and explain practices in current topics with help of videos, PowerPoint presentations and notes. • Field oriented case studies will be given much emphasis. • Group discussion methods will be followed for clear-cut identification of outcomes of given topics • Students will be asked to refer standard formats and research articles to get updated knowledge • Various methods will be understood by using on-paper studies and problem solutions • Concept understanding through creation of models, charts, diagram
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[Credit -2: No. of Lectures 36]

	Title and Contents	No. of Lectures
Unit -I	<p>Fundamentals of environmental physics</p> <ul style="list-style-type: none"> • Basic concepts of light and matter • Introduction to the concept of absorption and transmission of light • Beer–Lambert law, scattering of light • Basic concepts of pressure, force, work and energy • Concept of heat transfer, conduction, convection • concept of temperature, lapse rate (dry and moist adiabatic) • Laws of thermodynamics; concept of heat and work 	6
Unit -II	<p>Fundamentals of Environmental Chemistry</p> <ul style="list-style-type: none"> • Solution concentration (Normality, Molarity, Molality, ppm, Equivalent weight etc.) • Types of chemical reactions 	6

	<ul style="list-style-type: none"> acids, bases and salts, solubility products solutes and solvents Redox reactions concepts of pH and pE, 	
Unit -III	Physics and Chemistry of Atmosphere <ul style="list-style-type: none"> Pollutants in Atmosphere Photochemical Reactions Involved in Atmosphere Aerosols, Particles, Ions and Radicals in Atmosphere Smog and Acid Rain Plume Behavior Asian Brown Cloud and Great Smog of London Climate Change and Atmosphere 	6
Unit -IV	Chemistry of Water <ul style="list-style-type: none"> Properties of Water Hydrogen Bonding in Water Changes in Properties of Water on Addition of Solute Water Reactive Substances Solubility of Rules Analysis of Water Chemistry Chelating Agents and Environmental Applications 	6
Unit –V	Chemistry of Environmental pollutants : from Industrial and agriculture sector <ol style="list-style-type: none"> Heavy Metals <ul style="list-style-type: none"> Chemistry of Pb, Hg, and other heavy metals Bioaccumulative property and biomagnification Effect on human health Prevention and control measures Case studies. Chemical pesticides: <ul style="list-style-type: none"> Classification: based on chemical properties and target pest Bioaccumulation and biomagnification of pesticides Effects on human health Prevention and control measures. Case studies. 	6
Unit –VI	Chemistry of Environmental pollutants from domestic sector: <ol style="list-style-type: none"> Soaps and Detergents <ul style="list-style-type: none"> Need, classification, characteristics and composition. Environmental impact and toxicity of soaps and detergents Food additives and contaminants: <ul style="list-style-type: none"> Preservatives, flavoring agents, coloring agents, adulterants properties and their effects Plastic : <ul style="list-style-type: none"> Types of plastics its impact on environment. Plastic pollution: causes, prevention and control 	6
Suggested Readings: <ol style="list-style-type: none"> Beard, J.M. 2013. <i>Environmental Chemistry in Society</i> (2nd edition). CRC Press. Boeker, E. & Grondelle, R. 2011. <i>Environmental Physics: Sustainable Energy and Climate</i> 		

Change. Wiley.

3. Connell, D.W. 2005. *Basic Concepts of Environmental Chemistry* (2nd edition). CRC Press.

4. Forinash, K. 2010. *Foundation of Environmental Physics*. Island Press.

5. Girard, J. 2013. *Principles of Environmental Chemistry* (3rd edition). Jones & Bartlett.

6. Harnung, S.E. & Johnson, M.S. 2012. *Chemistry and the Environment*. Cambridge University Press.

7. Hites, R.A. 2012. *Elements of Environmental Chemistry* (2nd edition). Wiley & Sons.

8. Manhan, S. E. 2000. *Fundamentals of Environmental Chemistry*. CRC Press.

9. Pani, B. 2007. *Textbook of Environmental Chemistry*. IK international Publishing House.

10. Sodhi G.S. 2009. *Fundamental concepts of Environmental Chemistry*. Narosa publishing house.

PAPER CODE: EVS1103
PAPER-III: ENVIRONMENTAL SCIENCE PRACTICAL - I
[Credit -2: No. of Practicals Any 10]

Objectives:

- Practical course introduces students to techniques in soil analysis.
- The course is a helpful to study various types of rocks and minerals and should be able to identify with characteristics
- The students will be introduced to basic weather parameters as well as monitoring with the help of automatic weather station.

Course outcome:

- Practicals based on the theory paper are designed to make students to understand about applicability of theoretical concepts related to Soil as an Ecosystem
- The more focus is given on actual performance and handling of instruments required soil analysis.
- The students will individually able to perform these practicals under faculty guidance.

Title of Experiment / Practical

1	Laboratory safety rules and introduction to laboratory equipments
2	Identification of different Rock specimens from their physical Properties.
3	Identification of different Mineral specimens from their physical Properties
4	Practical based on Weathering
5	Visit to Weather Station (Demo working)
6	Collection and preservation of water and soil samples (Field Practical).
7	Study of Physical properties of soil.(Textural classification)
8	Determination of pH & Electrical Conductivity from soil sample.
9	Estimation of the Moisture Content & Water Holding Capacity of Soil.
10	Determination of Organic Content from soil.

11	Determination of Ca and Mg from given soil sample
12	Estimation of lapse rate
13	Identification of food adulteration
14	Use of social media for e-networking and dissemination of ideas on environmental issues

**FIRST YEAR B.Sc.
SEMESTER – II**

PAPER CODE: EVS1201

PAPER –I: SYSTEMATICS AND BIOGEOGRAPHY

Objectives:

- This course will discuss principles and applications of environmental biology, classical and modern day Systematics to classification of living organisms, develop understanding of historical and contemporary patterns of distributions of organisms, and design effective conservation strategies using bio geographic theories in an era of global change and large scale human induced degradation

<p>Course outcomes:</p> <ul style="list-style-type: none"> • Students will learn applications of environmental biology, classical and modern day Systematics to classification of living organisms. • They will develop understanding of historical and contemporary patterns of distributions of organisms, and design effective conservation strategies using bio geographic theories in an era of global change and large scale human induced degradation 	<p>Suggested Pedagogical Processes:</p> <ul style="list-style-type: none"> • Lecture cum demonstration method • Use of ICT • Use of Models • Concept understanding through creation of models, charts, diagram • Use of Web portals for classification and taxonomic updates
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[Credit -2: No. of Lectures 36]

	Title and Contents	No. of Lectures
Unit –I SEQUENCE CHANGED	<p>Introduction</p> <ul style="list-style-type: none"> • Principles of Environmental Biology • Branches, Scope and Importance in today’s context from environmental point of view. • Concepts and components: Biological spectrum (atom to biosphere), Habitat, Carrying Capacity etc. and Earth spheres. • Charles Darwin’s Voyage of HMS Beagle – His theory of ‘Survival of the Fittest’. Humans in Environment 	6
Unit -II	<p>Origin of Life</p> <ul style="list-style-type: none"> • Origin of Life; Evolution of Life through the geological time i.e. – Eras, Periods, Epochs; Events of (Evolutionary) ‘Explosions’ and ‘Mass Extinctions’ & Paleontological Evidences for these. • The current 'Mass Extinction' with reference to rate of extinction, factors responsible and possible remedies 	6
Unit –III	<p>Biogeography</p> <ul style="list-style-type: none"> • A glimpse of the present day distribution of Life on Earth; The factors responsible –Geological - Barriers and Bridges, Climatic - Barriers and Bridges Evolutionary - Speciation etc. 	6

	<ul style="list-style-type: none"> • Biogeography – The meaning; Biographical profile of the world and India; The physical, microbial, floral and faunal characteristics of each Biogeographical zone. 	
Unit –IV	Taxonomy <ul style="list-style-type: none"> • Taxonomic Principles - aim, objectives, hierarchy, kingdoms. • History; Linnaeus system of classification; Bentham & Hooker system of classification. • Components of systematic - characterization, classification, identification & nomenclature • .The concept of species- morphological, biological, phylogenetic, ecological etc 	6
Unit –V	Classification <ul style="list-style-type: none"> • Classification based on form - • Plants - algae, bryophyte, Pteridophytes, gymnosperm angiosperm (monocot & dicot) • Animals – Invertebrates - arthropods - insects Vertebrates – fishes, amphibians, reptiles, birds & mammals. • Microbes – viruses, bacteria & fungi • Life Forms on Earth - i)Terrestrial Life forms - floral & faunal ii)Aquatic (fresh water & marine) life forms - floral & faunal 	6
Unit –VI	Ecological Adaptations <ul style="list-style-type: none"> • Ecological Adaptations under various environmental conditions – • In plants - hydrophytes, mesophytes, epiphytes, xerophytes & halophytes • In animals - mimicry, vestigiality etc. 	6
Suggested Readings: <ol style="list-style-type: none"> 1. Lomolino, M.V., Riddle, B.R., Whittaker, R.J. & Brown, J.H. 2010. <i>Biogeography</i> (4th edition).Sinauer Associates, Sunderland. 2. Mani, M.S. 1974. <i>Ecology and Biogeography in India</i>. Dr. W Junk Publishers., The Hague. 3. Singh, G. 2012. <i>Plant Systematics: Theory and Practice</i> (3rd edition). Oxford & IBH Pvt. Ltd., New Delhi. 4. Wheeler, Q.D. & Meier R. 2000. <i>Species Concepts and Phylogenetic Theory: A Debate</i>. Columbia University Press, New York. 5. Williams, D. M., Ebach, M.C. 2008. <i>Foundations of Systematics and Biogeography</i>. Springer. 6. Wilkins, J. S. 2009. <i>Species: A History of the Idea</i> (Vol. 1). University of California Press. 		

PAPER CODE: EVS1202
PAPER –II WATER AND WATER RESOURCES

Objectives:

- The paper introduces students to the hydrological cycle, properties of water, physicochemical and biological water quality assessment and indices, types of water resources, their use and management.
- It will also highlight the problems associated with water shortages in India and Familiarizes students with case studies on international and national conflicts on water.

Course Outcomes:

- Students will learn to the hydrological cycle, properties of water, physicochemical and biological water quality assessment and indices, types of Water resources, their use and management.
- Understand the process and of water quality monitoring.
- Students will understand water resource, its utilization and management along with problems associated with it.
- Students will be introduced to the problems associated with water shortages in India and familiarizes students with case studies on international and national conflicts on water.

[Credit -2: No. of Lectures 36]

	Title and Contents	No. of Lectures
Unit -I	<p>Evolution of Hydrosphere</p> <ul style="list-style-type: none"> • Classification of water resources (oceans, rivers, lakes and wetlands). • Hydrological cycle –Introduction & significance • Evaporation; Factors affecting the rate of evaporation, potential evapotranspiration(PE) • Condensation; Factors affecting the rate of condensation; Forms of condensation – dew, frost, fog & cloud. • Precipitation; Factors affecting precipitation; Forms of precipitation – rain, drizzle, snow, hail, sleet etc. 	6
Unit -II	<p>Water Quality Monitoring</p> <ul style="list-style-type: none"> • Objectives of water quality monitoring • Collection and preservation of water samples • Water sampling: sampling frequency, water samplers, • Types of samples-Grab, composite, integrated • Water quality parameters :Methods of analysis and significance and water quality standards. <ul style="list-style-type: none"> a) Physical: temperature, colour, odour, total dissolved solids and total suspended solids b) Chemical: major inorganic and organic constituents, dissolved gases, DO, COD, BOD, acidity and alkalinity, electrical conductivity c) Biological: MPN, SPC, plankton etc. • Preparation of monitoring report • Water Quality Indicators 	6

Unit –III	Surface and subsurface water <ul style="list-style-type: none"> • Introduction to surface and ground water • Surface and ground water pollution • Water table; vertical distribution of water • Formation and properties of aquifers techniques for ground water recharge. • Wetlands and their importance. 	6
Unit –IV	Oceanography and related resources <ul style="list-style-type: none"> • Oceanography: principles and scope • Physical and chemical properties of seawater • Marine Ecosystems: vertical stratification • Marine resources: commercial use of marine resources • Threats to marine ecosystems and resources: overexploitation, pollution due to ballast water, oil spills, microplastics etc. Case studies • Marine research institutes in India 	6
Unit –V	Humans and Water <ul style="list-style-type: none"> • Demand for Water in India • Water Footprint • Water Quality Standards in India • Hot Spots of Surface Water • Role of State in Water Resource Management • Traditional Water Harvesting Systems in India • Environmental Status Report of Rivers 	6
Unit –VI	Water Resources and Related Issues <ul style="list-style-type: none"> • Water Resources of India • Interlinking of Rivers • National Water Policy of India • Water Scarcity: Social Impacts and Ecological Losses • Conflicts over Water Sharing: Local, National and International • Surface and Groundwater Pollution: Case Studies 	6

Suggested Readings:

1. Bansil, P.C. 2004. *Water Management in India*. Concept Publishing Company, India.
2. Brebbia, C.A. 2013. *Water Resources Management VII*. WIT Press.
3. CEA. 2011. *Water Resources and Power Maps of India*. Central Board of Irrigation & Power.
4. Grumbine, R.E. & Pandit, M.K. 2013. Threats from India's Himalaya dams. *Science* **339**:
5. Loucks, D.P., Stedinger, J.R. & Haith, D. A. 1981. *Water Resource Systems Planning and Analysis*. Englewood Cliffs, NJ, Prentice Hall.
6. Mays, L.W. 2006. *Water Resources Sustainability*. The McGraw-Hill Publications.
7. Schward & Zhang, 2003. *Fundamentals of Groundwater*. John Willey and Sons.
8. Souvorov, A.V. 1999. *Marine Ecologonomics: The Ecology and Economics of Marine Natural Resource Management*. Elsevier Publications.
9. Vickers, A. 2001. *Handbook of Water Use and Conservation*. Water Plow Press.

PAPER CODE: EVS1203
PAPER –III: ENVIRONMENTAL SCIENCE PRACTICAL - II
[Credit -2: No. of Practicals 10]

Objectives:

- Practical course introduces students to techniques in water analysis.
- The course is a helpful to study various adaptation strategies of plants as well as animals.
- The students will be introduced to field techniques.

Course Outcomes:

- Practicals based on the theory paper are designed to make students to understand about applicability of theoretical concepts related to Water as a Resource.
- The more focus is given on actual performance and handling of instruments required Water analysis.
- Practicals based on the theory course (122) are helpful in understanding basics of water quality monitoring
- Practicals based on theory course (121) will help in identification of various plants, animals and their strategies to adapt to specific Biogeographical condition in laboratory as well as in field.

Title of Experiment/ Practical	
1	Determination of pH & Electrical Conductivity from water.
2	Determination of Alkalinity from water.
3	Determination of Total Hardness (Ca & Mg) from water.
4	Determination of Chlorides from water.
5	Determination of TDS, TSS & TS from water
6	Determination of Turbidity in water by Secchi disc (Field practical).
7	Determination of Calcium Carbonate from given soil sample
8	Determination of Boron from given soil sample.
9	Study of Plant Fossil Forms from different geological periods/visit to Paleo-botanical museum
10	Collection and characterisation of planktons/plant bio-indicators from Eutrophic lake (Field Practical).
11	Study of Plant Adaptations under various environmental conditions (Hydrophytes, mesophytes, epiphytes, halophytes & xerophytes).
12	Study of Animal Adaptations under various ecological conditions (Mimicry & vestigiality).
13	Study of Plant & Animal Diseases (one each of viral, bacterial & Fungal).
14	Identifying native plants for plantation with respect to geography and climate.