

ENVIRONMENTAL SCIENCE

I Semester Course Structure

#	Course type	Course code	Course Title	Credits	Hrs/wk	Evaluation details
1	Mandatory	ENVVSC01	Divisions of the Environment	4	4	CIA C1-20 C2-20 SEE C3-60
2	Mandatory	ENVVSC02P	Water Quality Analysis	2	4	CIA C1-13 C2-12 SEE C3-25
3	Elective	ENVOEC01	Environmental Conservation Movements	3	3	CIA C1-20 C2-20 SEE C3-60
4	Elective	ENVOEC02	Environment and Sustainable Agriculture	3	3	CIA C1-20 C2-20 SEE C3-60
5	Elective	ENVOEC03	Environmental Pollution	3	3	CIA C1-20 C2-20 SEE C3-60
6	Skill Enhancement Course	ENVSEC01	Air Pollution Monitoring and Control	2	2	CIA C1-10 C2-10 SEE C3-30
7	Skill Enhancement Course	ENVSEC02	Microbial water quality and Bioremediation	2	2	CIA C1-10 C2-10 SEE C3-30

Syllabus
ENVIRONMENTAL SCIENCE
B.Sc., (Basic/ Honors) Semester-I
Theory and Practical

Course code: ENVDSC01

Course Title: DIVISIONS OF THE ENVIRONMENT

(Theory)

COURSE TITLE	Divisions of the Environment
Couse code	ENVDSC01
Course credits	04
Total contact hours	56
Duration of ESA (Hour)	03
Formative assessment marks	40 (40%)
Summative assessment marks	60 (60%)

Content of Theory course- Division of the Environment	56 Hr
Total credits = 4	
Unit 1	14 Hr
<p>Environmental Education: Definition, Aim, Objectives and Scope.</p> <p>Environmental Science: Definition, Aim of study and Scope. Differences between Ecology and Environment; Various approaches of studying Environmental Science. Introduction, foundational concept of ecology and environment, Biotic and abiotic components, ecological dynamics.</p> <p>Components of the Environment: Definitions of Atmosphere, Hydrosphere, Lithosphere and Biosphere - their complex interactions and significance.</p>	
Unit 2	14 Hr
<p>Atmosphere: Evolution of the atmosphere – Principal components – Permanent and variable gases. Structure of the atmosphere on the basis of temperature and composition.</p> <p>Ozone chemistry - Depletion and recovery of stratospheric ozone – monitoring, effects and control measures.</p> <p>Climatology: Differences between weather and climate; Insolation - Factors affecting the distribution. Solar (short-wave) and terrestrial (long-wave) radiations. Earth’s Albedo and Heat budget of the earth. Tropical monsoon climate – Tropical cyclones and their impacts. Weather forecasting and modification. El-Nino and La-Nina effect. Global warming, effects and control measures; Global dimming - Definition, causes and implications; Urban Heat Islands.</p>	
Unit 3	14 Hr
Hydrosphere: Hydrologic cycle - process of heat energy transfer - Radiation,	

<p>Conduction and Convection. Types of lifting and precipitation - Bergeron process – Cloud formation and classification. Forms of condensation; Forms of precipitation. Cloud seeding.</p> <p>Limnology: Definition – Lotic and Lentic environment. Differences between Lotic and Lentic systems.</p> <p>Lotic environment: Springs, Stream profile: Potomom and Rhithron.</p> <p>Lentic environment: Ponds, lakes and estuaries – their types. Photic and thermal stratification of Lentic systems.</p> <p>Marine environment: Zonation, Salinity status of marine environment, biotic communities of oceanic zones, acidification of sea water; ocean currents and tides –significance; Polymetallic nodules.</p> <p>Ground water: Definition. Zonation; Types of wells. Salinization of ground water in coastal regions.</p>	
<p>Unit 4</p>	<p>14 Hr</p>
<p>Lithosphere: Definition. Internal structure of the earth.</p> <p>Endogenic processes: Plate Tectonics – Earthquake and Volcanism – Causes, Effects, and Management.</p> <p>Exogenic processes: River, Sand dunes, Glaciation, Avalanches and Landslides.</p> <p>Mineralogy: Definition. Outline classification of minerals</p> <p>Petrology: Definition. Classification - Igneous, Sedimentary and Metamorphic rocks – their formation – types – uses.</p> <p>Pedology: Soil – definition – formation – soil profile. Types – Alluvial; Black; Red and Laterite; Arid and Desert; Saline and Alkaline; Peaty and Marshy; Grassland, Forest and Mountain Soils. A brief account of Soil biota. Soil weathering and erosion – Types, effects and management.</p>	
<p>References</p> <ul style="list-style-type: none"> • Allaby, M. (2002). Basics of Environmental Science. Routledge. • Barry, G. R. and Chorley, J. R. (2003). Atmosphere, Weather and Climate. Routledge, London. • Critchfield, H. J. (1995). General Climatology. Printice Hall of India. • Horne, A. J., & Goldman, C. R. (1994). Limnology (Vol. 2). New York: McGraw-Hill. • Lutgens, F. K. and Tarbuck, E. J. (1982). Atmosphere – Introduction to Meteorology. Prentice Hall Inc. • Manahan, S. E. (2011). Fundamentals of environmental chemistry. CRC press. Miller, G. T., & Spoolman, S. (2015). Environmental Science. Cengage Learning. Miller, Jr. G. T. (1994). Living in the Environment: Principles, Connections and Solutions. Wadsworth Publishing Co. • Miller, R. W. and Donahue, R. L. (1992). Soils – Introduction to Soils and Plant Growth. Prentice Hall of India. • Mitra, A., & Chaudhuri, T. R. (2020). Basics of Environmental Science. New Central Book Agency. • Nandini, N. (2019). A text book on Environmental Studies (AECC). Sapna Book House, Bengaluru. • Wright, R. T. (2007). Environmental science: toward a sustainable future. Jones & Bartlett Publishers. 	

Course code: ENVDSC01P

Course Title: WATER QUALITY ANALYSIS

(Practical)

COURSE TITLE	WATER QUALITY ANALYSIS – PRACTICALS
Couse code	ENV <u>D</u> SC01P
Course credits	02
Total contact hours	56 (4 h/ week)
Duration of ESA (Hour)	3
Formative assessment marks	25 (50%)
Summative assessment marks	25 (50%)

Content of Practical course- Water Quality analysis	
Total Teaching Hours = 56; Total Credits = 2	56 Hr
List of experiments to be conducted	
<ol style="list-style-type: none">1. Sampling technique of water2. Determination of pH – pH metric method3. Determination of Electrical Conductance – Conductivity meter method4. Estimation of Turbidity – Nephelometric method5. TS, TSS & TDS – Gravimetric and Filtration method6. Estimation of Acidity – Alkalimetric method / CO₂ – NaOH titration method7. Estimation of Alkalinity – Acidimetric method8. Estimation of Hardness – EDTA Complexometric method9. Estimation of Chlorides – Argentometric method10. Estimation of Dissolved Oxygen – Modified Winkler’s method11. Estimation of Nitrates – Phenoldisulfonic Acid method12. Estimation of Fluorides–Fluoride meter method/SPADNS Reagent method13. Estimation of Sulphates – Barium chloride method	
References <ul style="list-style-type: none">• Nandini, N. (2009). Handbook on water quality monitoring and Assessment. Sapna Book House, Bengaluru.• Sawyer, C. N. and Mc Carty, P. L. (1978). Chemistry for Environmental Engineering. Mc Graw – Hill International.• Saxena M M. (1990). Environmental Analysis: Water, Soil and Air. Edition, 2. Publisher, Agro Botanical Pub.• Standard Methods for Examination of Water and Wastewater. (2017). APHA – WEF.• Trivedi, P. K. and Goel, P. K. (1984). Chemical and Biological Methods of Water Pollution Studies. Environmental Publication.• Zhang, C. (2007). Fundamentals of environmental sampling and analysis. John Wiley & Sons.	

Open Elective Course Code: ENVOEC01

Course Title: ENVIRONMENTAL CONSERVATION MOVEMENTS

(Theory)

COURSE TITLE	Environmental Conservation Movements
Couse code	ENVOEC01
Course credits	03
Total contact hours	42
Duration of ESA (Hour)	03
Formative assessment marks	40%
Summative assessment marks	60%

Content of Theory course- Environmental Conservation Movements	42 Hr
Total credits =3	
Unit 1	14 Hr
<p>Environment: Definition, role of environment in shaping civilisations. Interrelations between civilisation and environment – ecological economic and socio-cultural.</p> <p>Industrial revolution and environmental pollution. Globalisation and environmental pollution. Modern agriculture and environmental degradation.</p> <p>Development: Definition, Growth and development. Population growth and its impact on natural resources, Modernization and population. Causes for industrialization, changing life styles, regulatory aspects of industrialization, overall impact of industrialization on quality of human life, negative impacts of industrialization and urbanization.</p>	
Unit 2	14 Hr
<p>Development and Environment: Types of development. Sustainable development – Need, relevance in contemporary society.</p> <p>Principles of Sustainable Development: History and emergence of the concept of Sustainable Development, Definitions, Environmental issues and crisis, Resource degradation, greenhouse gases, desertification, invasive species, wildlife depletion and social insecurity.</p> <p>United Nations Sustainable Development Goals. Strategies for implementing eco-development programmes, Sustainable development through - trade, economic growth, carrying capacity and public participation.</p>	
Unit 3	14 Hr
<p>People movements: Types – Concept of environmental movements, Definition, levels of collective action, the local grassroots movement level; the social movement level; a cycle of protest.</p> <p>Environmental Movements: United Nations Conference on Human Environment, 1972 – 'Limits to Growth'. The Brundtland Commission, 1987 – 'Our Common</p>	

Future'. The United Nations Conference on Environment and Development, 1992.

Environmental Movements of India: Bishnoi Movement, The Chipko Movement, Appiko Movement, Silent Valley Movement, Narmada Bachao Andolan, Jungle Bachao Andolan, Beej Bachao Andolan.

Urban-based Environmental Movements – Local case studies.

References

- Bindra, P. S. (2017). The Vanishing: India's Wildlife Crisis. Penguin Random House India.
- Climate Change: Science and Politics. (2021). Centre Science and Environment, New Delhi.
- Edwards, Andres R. (2005). The Sustainability Revolution: Portrait of a Paradigm Shift. New Society Publishers.
- Flanders, L. (1997). The United Nations' department for policy coordination and sustainable development (DPCSD). Global Environmental Change, 7(4), 391-394.
- McNeill, John R. (2000). Something New Under the Sun: An Environmental History of the Twentieth Century.
- Nagendra, H., & Mundoli, S. (2019). Cities and canopies: trees in Indian cities. Penguin Random House India Private Limited.
- Nepal, Padam. (2009). Environmental Movements in India: Politics of Dynamism and Transformations, Authors press, Delhi.
- Rachel Carson. (2002). Silent spring. Houghton Mifflin Harcourt.
- Rajit Sengupta and Kiran Pandey. (2021). State of India's Environment 2021: In Figures. Centre Science and Environment.
- Sustainable development in India: Stocktaking in the run up to Rio+20. (2011). TERI for MoEF&CC.

Open Elective Course Code: ENVOEC02**Course Title: ENVIRONMENT AND SUSTAINABLE AGRICULTURE****(Theory)**

COURSE TITLE	Environment and Sustainable Agriculture
Couse code	ENVOEC02
Course credits	03
Total contact hours	42
Duration of ESA (Hour)	03
Formative assessment marks	40%
Summative assessment marks	60%

Content of Theory course- Environment and Sustainable Agriculture	42 Hr
Total credits =3	
Unit 1	14 Hr
<p>Environment – Definition, scope and significance.</p> <p>Agriculture – Definition, scope and significance. Environmental basis for agriculture and food. Agricultural patterns in India. Socio-economic pressures on agriculture. Food security and food scarcity.</p> <p>Types of agriculture – rain-fed cultivation and irrigation – water intensive agriculture – Reservoirs and ground water exploitation. Conventional and mechanised agriculture.</p> <p>Natural and chemical agriculture. Subsistence and commercial agriculture. Environmental effects of land use and landscape changes.</p>	
Unit 2	14 Hr
<p>Environmental determinants of agriculture – role of rainfall, humidity, wind, topography and edaphic factors in crop selection.</p> <p>Animal husbandry – Dairy and poultry – role of transboundary species of cattle in Indian scenario.</p> <p>Pisciculture – Environmental effects of intensive pisciculture.</p> <p>Agricultural biodiversity: Crop diversity – Definition and significance. Poly culture and mono culture. Influences of green revolution on modern agricultural practices of India – Loss of agrobiodiversity – Influence of transboundary crops. Agricultural biotechnology – Genetically Modified Crops – Influence on environment. Pollination crisis. Integrated pest management.</p>	
Unit 3	14 Hr
Environmental impacts of agriculture – Loss of biodiversity – soil salinity– fertiliser	

and pesticide pollution, Climate change and global warming. Erosion and problems of deposition in irrigation systems. Desertification. Biomagnification – Case studies.

Contemporary issues and management – Farmer distress – market mechanisms – natural farming methods/organic farming. Urban agriculture and hydroponics.

Ecological principles of farming – Sustainable agriculture – Significance of indigenous crops and cattle varieties. Watershed management. Agricultural policies of India.

References

- Altieri, M. A. (2018). *Agroecology: the science of sustainable agriculture*. CRC Press.
- Campanhola, C., & Pandey, S. (Eds.). (2018). *Sustainable food and agriculture: An integrated approach*. Academic Press.
- de Zeeuw, H., & Drechsel, P. (Eds.). (2015). *Cities and agriculture: Developing resilient urban food systems*. Routledge.
- Eric Lichtfouse, Mireille Navarrete, Philippe Debaeke, Souchere Ve´ronique, Caroline Alberola. (2009). *Sustainable Agriculture*. Springer Science & Business Media.
- Kazim B. Rahim Debash Sarkar Bidhan Chand. (2012). *Sustainable Agriculture and Environment*. New Delhi Publishers.
- Satyanarayana, T., Johri, B. N., & Prakash, A. (Eds.). (2012). *Microorganisms in sustainable agriculture and biotechnology*. Springer Science & Business Media.
- Songstad, D. D., Hatfield, J. L., & Tomes, D. T. (Eds.). (2014). *Convergence of food security, energy security and sustainable agriculture (Vol. 67)*. New York: Springer.

Open Elective Course Code: ENVOEC03
Course Title: ENVIRONMENTAL POLLUTION

(Theory)

COURSE TITLE	Environmental Pollution
Course code	ENVOEC03
Course credits	03
Total contact hours	42
Duration of ESA (Hour)	03
Formative assessment marks	40%
Summative assessment marks	60%

Content of Theory course- Environmental Pollution	42 Hr
Total credits =3	
Unit 1	14 Hr
<p>Environmental pollution: Definition, Types. Environmental contaminants and environmental pollutants. Classification of pollutants – on the basis of physical properties and forms of their existence. Primary and secondary pollutants, degradable and non-degradable, point and non- point sources of pollution.</p> <p>Xenobiotics and persistent organic chemicals. Characteristics of pollution–Large production quantities, usage involving leakages, toxicity, persistence and accumulation.</p> <p>Air pollution: Definition, sources of air pollution and their effects on flora, fauna, human-beings and materials. Indoor pollution, automobile pollution, ozone depletion and recovery, global warming and climate change. London smog, Bhopal gas tragedy, Visakhapatnam gas leak and endosulphan tragedy in Karnataka. Air quality standards – NAAQS, AQI, Bharat Stage - VI Emission standards. Air pollution control measures</p>	
Unit 2	14 Hr
<p>Water pollution: Definition, sources of water pollution and their effects on flora, fauna, human-beings and materials. Surface water pollution – Dissolved oxygen, biochemical oxygen demand and chemical oxygen demand. Agriculture runoff and detergents as pollutants. Eutrophication. Heavy metal pollution – Minamata episode.</p> <p>Ground water pollution – fluoride, nitrate, Arsenic pollution and their control. Water quality criteria – specifications for drinking and inland surface waters. Water Quality Indices.</p>	

Soil pollution: Definition, sources and types. Soil pollutants – metals, inorganic ions and salts; and organic substance. Effects of pollution on soil health and productivity. Effects of pesticides on soil. Soil erosion, types and control.	
Unit 3	14 Hr
<p>Noise pollution: Definition, sources and effects. Noise induced hearing loss. Decibel scale. Noise control measures.</p> <p>Solid waste pollution: Definition, origin, classification and characteristics of solid waste. Segregation, collection, transportation and disposal of solid waste. Solid waste treatment and disposal – Composting, open dumping, sanitary landfill, incineration, recycling and recovery.</p> <p>E-waste: Definition, sources, composition, recycling and disposal methods. Hazardous waste: Definition, sources, classification, effects and disposal methods.</p>	
<p>References</p> <ul style="list-style-type: none"> • Bhatia H. S. (2003). A Textbook on Environmental Pollution and Control. Galgotia Publications Private Limited, Delhi. • Mark L. Brusseau, Ian L. Pepper and Charles P. Gerba. (2019). Environmental and Pollution Science. Academic Press. • Marquita K. Hill. (2012). Understanding Environmental Pollution. Cambridge University Press • Nandini, N. (2019). A text book on Environmental Studies (AECC). Sapna Book House, Bengaluru. • Peirce, J. J., Vesilind, P. A., & Weiner, R. (1998). Environmental pollution and control. Butterworth-Heinemann. • Rachel Carson. (2002). Silent spring. Houghton Mifflin Harcourt. • Rajit Sengupta and Kiran Pandey. (2021). State of India's Environment 2021: In Figures. Centre Science and Environment. • Trivedi P. R. (2004). Environmental Pollution and Control. Ashish Publishing House - APH Publishing Corporation. • Yogendra N Srivastava. (2009). Environmental Pollution. Ashish Publishing House. APH Publishing Corporation. 	

Skill enhancement course: Course Code: ENVSEC01

Course Title: AIR POLLUTION MONITORING AND CONTROL

(Theory)

COURSE TITLE	Air Pollution Monitoring and Control
Couse code	ENVSEC01
Course credits	02
Total contact hours	28
Duration of ESA (Hour)	03
Formative assessment marks	40%
Summative assessment marks	60%

Content of Theory course- Air Pollution monitoring and control	28 Hr
Total credits =2	
Unit 1	14 Hr
<p>Introduction: Definitions, types of air pollutants, Effect of Air pollution on plants, animals, humans, biodiversity and agriculture. Sources of air pollution: Point source, area source, Volume source; criteria pollutant, Air Quality Index, Ambient air quality standards, Vehicle emission standards</p> <p>The Air (Prevention and Control of Pollution) Act 1981; The Environment (Protection) Act 1986 and the Rules there after; Initiatives like Ecomarks, ; Noise Pollution (Regulation and Control) Rules 2000</p>	
Unit 2	14 Hr
<p>Air pollution sampling methods: Sampling from point sources (Stack Monitoring, vehicles), ambient sampling methods. Online and offline sampling instruments for gaseous and particulate air pollutants</p> <p>Air pollution control methods: industrial source control technology: Cyclone, Electrostatic Precipitator, Bag house Filter, Venturi Scrubber – principle and use, its limitations.</p>	
<p>Text Books</p> <ul style="list-style-type: none"> • Air Pollution, Health and Environmental impacts. Bholra R. Gurjar, Lucia T. Molina, Chandra S. P. Ojha, 2010, CRC press. • Air Pollution and Control Engineering, Ed. S. Anand Kumar Varma, Publisher: Sri Krishna Hitech Publishing company Pvt. Ltd. ISBN: 978-81-942267-2-7 	
References:	

- Allegrini I, De Santis F. (Ed), Urban Air Pollution: Monitoring and Control Strategies
- Springer Clarke A.G. , Industrial Air Pollution Monitoring, Springer
- Air Pollution Control Technology Manual, International Environmental cooperation towards sustainable development

Skill enhancement course: Course Code: ENVSEC02

Course Title: MICROBIAL WATER QUALITY AND BIOREMEDIATION (Theory)

COURSE TITLE	Microbial water quality and Bioremediation
Couse code	ENVSEC02
Course credits	02
Total contact hours	28
Duration of ESA (Hour)	03
Formative assessment marks	40%
Summative assessment marks	60%

Content of Theory course- Microbial water quality & bioremediation	28 Hr
Total credits =2	
Unit 1	14 Hr
<p>Microbial water quality: Overview of standards of water in relation to public health - Detection and control of micro-organisms in environmental fresh water, in source and drinking water; Potable and non-potable water; Methods of water sampling for pollution analysis.</p> <p>Methods of monitoring; Biological methods; Detection methods for DO, BOD, Pathogen monitoring by heterotrophic plate count; Multiple tube method; Membrane filtration methods;, PCR, Gene probe technology etc.; Strategies for controlling pathogen transfer; Chemical methods- Detection methods for COD, pH, alkalinity, TSS, TDS, Total organic carbon, oil, grease etc.</p>	
Unit 2	14 Hr
<p>Environmental health safety: Physicochemical characteristics and treatment strategies for effluent generated by Distillery and fermentation industry; Fertilizers and pesticide manufacturing industries; Dyes and dye intermediate producing industries and textile industries; Paper and pulp industries; Tanneries; Pharmaceuticals; Thermal power plants; Food and dairy industries.</p>	
<p>References:</p> <ul style="list-style-type: none"> • Allegrini I, De Santis F. (Ed), Urban Air Pollution: Monitoring and Control Strategies • Springer Clarke A.G. , Industrial Air Pollution Monitoring, Springer 	

- Routledge Handbook of Water and Health, J. Bartram editor. Routledge, New York. Available online through UNC Libraries
- Principles of Public Health Microbiology [Paperback], Robert S. Burlage, Jones & Bartlett Learning; 1st edition (May 4, 2011). ISBN-10: 0763779822. ISBN-13: 978- 0763779825.

#	Course type	Course code	Course Title	Credits	Hrs/wk	Evaluation details
1	Mandatory	ENVDSC02	Ecology-Theory and Practice	4	4	C1-20 CIA C2-20 SEE C3-60
2	Mandatory	ENVDSC02P	Ecological Analysis	2	4	C1-13 CIA C2-12 SEE C3-25
3	Elective	ENVOEC04	Climate Change and its Implications	3	3	C1-20 CIA C2-20 SEE C3-60
4	Elective	ENVOEC05	Environment and Public Health in Contemporary Society	3	3	C1-20 CIA C2-20 SEE C3-60
5	Elective	ENVOEC06	Wildlife and Conservation	3	3	C1-20 CIA C2-20 SEE C3-60

SYLLABUS
Theory and Practical
ENVIRONMENTAL SCIENCE
B.Sc., (Basic/ Honors) Semester-II

Course code: ENV DSC02

Course Title: ECOLOGY – THEORY AND PRACTICE

(Theory)

COURSE TITLE	Ecology- Theory and Practice
Course code	ENV DSC02
Course credits	04
Total contact hours	56
Duration of ESA (Hour)	03
Formative assessment marks	40 (40%)
Summative assessment marks	60 (60%)

Content of Theory course- Ecology Theory and Practice	56 Hr
Total credits = 4	
Unit 1	14 Hr
<p>Levels of organization, Ecology: Divisions of Ecology - approaches in studying Ecology.</p> <p>Ecosystems – Definitions. Classification of ecosystem – Terrestrial and Aquatic with their divisions. Structure of the ecosystem - Function of ecosystem - food chain – food web – bio-magnification. Ecological pyramids – Types.</p> <p>Biogeochemical cycles: Classification. Carbon and Phosphorus cycles – anthropogenic influences on these cycles.</p> <p>Energy flow in an ecosystem – productivity - trophic levels; Study of pond and crop land ecosystems; homeostasis and feedback mechanisms.</p>	
Unit 2	14 Hr
<p>Community Ecology: Definition, Characteristics of a Community – Species diversity, growth form and structure, dominance, relative abundance, trophic structure.</p> <p>Population Ecology: Definition, Characteristics of Population: Density – Natality – Mortality – Age distribution – Growth form-Population Equilibrium – Biotic potential – Carrying capacity – Dispersal – Dispersion – Population fluctuations – Population regulation.</p>	
Unit 3	14 Hr

<p>Ecological succession – Primary and Secondary succession – Natural and man-influenced succession, – Hydrarch and Xerarch - Climax vegetation and their theories; Ecotone and Edge effect; Ecological equivalents; Ecotypes and Ecophenes; Ecological indicators.</p> <p>Ecological Niche: Concept and Types of niches: Spatial, Trophic and Multidimensional – Niche parameters: Form, Position and Width – Niche Partitioning - Realized and Fundamental Niche.</p> <p>Biomes: Definition and concept. Classification of biomes.</p>	
<p>Unit 4</p>	<p>14 Hr</p>
<p>Biotic and Abiotic factors: Influence Temperature, Wind and Water, Edaphic, Topographic on flora and fauna.</p> <p>Concept of Limiting Factors: Liebig’s Law of Minimum; Shelford’s Law of Tolerance and the combined concept.</p> <p>Evolution: Definition – Darwin’s postulates - Natural selection – Types – Industrial Melanism - Pesticide resistance.</p> <p>Co-evolution; Mimicry – Batesian and Mullerian mimicry, warning colouration.</p>	
<p>References</p> <ul style="list-style-type: none"> • Agarwal, K. C. (1999). Environmental Biology. Agro Botanica. • Beck, W. S., Liem, K. F. and Simpson, G. G. (1991). Life – Introduction to Biology. Harper Collins Publications. • Chapman, J. L. and Reiss, M. J. (1995). Ecology – Principles and Applications. Cambridge University Press. • Dash, M. C. (2001). Fundamentals of Ecology. Tata McGraw-Hill Publishing Co. • Kormondy, E. J. (1996). Concepts of Ecology. Prentice Hall of India. • Mamta Rawat, Sumit Dookia and Chandrakasan Sivaperuman. (2015). Aquatic Ecosystem: Biodiversity, Ecology and Conservation. Springer publication. • McCleery, Robert A., Moorman, Christopher, Peterson, M. Nils (Eds.). (2014). Urban Wildlife Conservation - Theory and Practice. Springer publication. • Odum, E. P. (1971). Fundamentals of Ecology. W.B. Saunders Co. • Raven, P. H. and Johnson, G. B. (1995). Biology. Wm. C. Brown Publications. Ricklefs, R. E. and Miller, (1999). Ecology. W.H. Freeman and Co. • Smith, T. M. and Smith, R. L. (2007). Elements of Ecology. Pearson Education. • Taylor, T. J., Green, N. P. O. and Stout, G.W. (1998). Biological Science Soper, R.(ed.). Cambridge University Press. • Wallace, R. A. (1990). Biology – The World of Life. Harper Collins Publications. 	

Course code: ENV DSC02P

Course Title: ECOLOGICAL ANALYSIS

(Practical)

COURSE TITLE	Ecological Analysis
Course code	ENV DSC02P
Course credits	02
Total contact hours	56
Duration of ESA (Hour)	03
Internal assessment marks	25 (50%)
Examination assessment marks	25 (50%)

Content of Practical course- Ecological analysis		
Total Teaching Hours = 56;	Total Credits = 2	56 Hr
List of experiments to be conducted		
<ol style="list-style-type: none">1. Sampling technique of phytoplankton2. Sampling technique of zooplankton3. Quantitative estimation of phytoplankton – Sedgwick-Rafter method4. Quantitative estimation of zooplankton – Sedgwick-Rafter method5. Determination of organic pollution – Palmer’s Algal Pollution index6. Estimation of primary productivity of a pond – Light and Dark bottle method7. Estimation of primary productivity of terrestrial vegetation – Chlorophyll method8. Estimation of primary productivity of grasses – Harvest method9. Study of plant community – Individual count method/Quadrat method10. Study of animal community – Line transect method11. Determination of species diversity indices –Simpson and Shannon's Wiener Index12. Estimation of carbon capture and storage of trees13. Identification of ecological indicators		
References		
<ul style="list-style-type: none">• Michael, P. (1986). Ecological Methods for Field and Laboratory Investigations. Tata Mc Graw-Hill Publishing Co. Ltd.• Rolan, R. G. (1973). Laboratory and Field Investigations in General Ecology. Macmillan Co.• Standard Method for Examination of Water and Wastewater. (2017). APHA – WEF.• Subrahmanyam, N. S. and Sambamurty, A. V. S. S. (2000). Ecology. Narosa Publishin House.• Trivedi, P. K. and Goel, P. K. (1984). Chemical and Biological Methods of Water Pollution Studies. Environmental Publications.		

Open Elective Course Code: ENVOEC04

Course Title: CLIMATE CHANGE AND ITS IMPLICATIONS

(Theory)

COURSE TITLE	Climate Change and Implications
Course code	ENVOEC04
Course credits	03
Total contact hours	42
Duration of ESA (Hour)	03
Formative assessment marks	40 (40%)
Summative assessment marks	60 (60%)

Content of Theory course- Climate change and its implications	42 Hr
Total credits =3	
Unit 1	14 Hr
<p>Climate Change: Definition, scope and facts of climate change. Origin and evolution of the earth's atmosphere. Composition and thermal structure of atmosphere; Weather and climate; Meteorological parameters - temperature, pressure, precipitation, humidity, wind speed & direction. Introduction to the effects of various anthropogenic activities on earth's atmosphere.</p> <p>Monsoons – Definition, Indian monsoons – seasons: Cold weather season (Winter), the hot weather season (Summer), season of advancing monsoon (The rainy season) and season of retreating monsoon (The transition season). Cyclones of the Indian region; El-Niño, La Nina and their impacts.</p>	
Unit 2	14 Hr
<p>Greenhouse effect and global warming: Definition, impacts, major greenhouse gases, sources and sinks of greenhouse gases; Urban Heat Islands; Ozone layer depletion and recovery, issues and remedies; ground level ozone and air pollution; global dimming. Carbon footprint.</p> <p>Impacts of global climate change: Increased surface mean temperature, insect outbreaks, vector borne/zoonotic diseases, forest fire, reduced water availability, influence on agriculture, increase in floods and drought incidences, loss of biodiversity and extinction of species, sea level rise. Climate change and food security. Vulnerable populations – The Kiribati story.</p>	
Unit 3	14 Hr
Climate change and policy frameworks – History of international climate change policies. United Nation Framework Convention on climate change (UNFCCC), The	

United Nations Conference on Environment and Development, Intergovernmental Panel on Climate Change (IPCC), Ministry of Environment, Forests & Climate Change (MoEF & CC), National Action Plan on Climate Change (NAPCC), Agenda 21, The Kyoto protocol, Paris agreement. Overview of Conference of Parties (CoP). Evolution of climate change negotiations.

Climate change adaptation and mitigation: Definition, scope and objectives. Linkages between development, climate change impacts, their mitigation and adaptation. Clean Development Mechanisms; Green Climate Fund, The Adaptation Fund. United Nations Sustainable Development Goals. Role of individuals in achieving Sustainable Development Goals.

References

- Abhishek Tiwary and Jerem Colls. (2010). Air Pollution: Measurement, Modelling and Mitigation. III Edition, Routledge Publication.
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Open Elective Course Code: ENVOEC05**Course Title: ENVIRONMENT AND PUBLIC HEALTH IN CONTEMPORARY SOCIETY (Theory)**

COURSE TITLE	Environment and Public Health in Contemporary Society
Course code	ENVOEC05
Course credits	03
Total contact hours	42
Duration of ESA (Hour)	03
Formative assessment marks	30 (30%)
Summative assessment marks	70 (70%)

Content of Theory course- Environment and Public Health in Contemporary Society. Total credits =3	42 Hr
Unit 1	14 Hr
Environment and public health: Definitions of health and disease. Perspectives on individual health: Nutritional, socio-cultural and developmental aspects, Dietary diversity for good health; Human developmental indices for public health. Effect of quality of air, water and soil on human health. Diseases in contemporary society: Need for good health - factors affecting health. Types of diseases - deficiency, infection, pollution diseases - allergies, respiratory, cardiovascular and cancer. Personal hygiene- food- balanced diet. Health effects of smoking, drugs and alcohol consumption.	
Unit 2	14 Hr
Malnutrition: Vitamin deficiency diseases and Mineral deficiency diseases; Folic acid requirement during pregnancy; Food Safety- Adulterants and preservatives; Pesticide Toxicity: Endosulfan and DDT; Genetically Modified Food. Non-communicable diseases and Lifestyle diseases - Diabetes and Hypertension. Communicable diseases: Definition, mode of transmission – pandemic, epidemic and endemic diseases. Vector borne diseases: Plague and Malaria; emerging diseases: Dengue, Chikungunya, Zika, Ebola, Swine Flu, Bird Flu, Severe Acute Respiratory Syndrome (SARS), Middle East Respiratory Syndrome (MERS); Zoonosis- Leptospirosis; Kyasanur Forest Disease (KFD) Toxoplasmosis and Nipah.	

<p>Unit 3</p> <p>Occupational health: Sick Building Syndrome; Noise and Radiation; Ergonomics - Stress and Fatigue; Carpal tunnel syndrome (CTS); Methyl mercury and cerebral palsy; Synergistic effect; Irritable bowel syndrome; Crohn's disease.</p> <p>Environmental Sanitation and Hygiene: Safe disposal of human excreta; Solid waste disposal; Sanitation value chain.</p> <p>Drug safeties: Thalidomide Tragedy; Antibiotic stewardship; New Delhi Antibiotic-Resistant superbug</p>	<p>14 Hr</p>
<p>References</p> <ul style="list-style-type: none"> • Akhtar, R. (Ed.). (2019). Extreme weather events and human health: International case studies. Springer Nature. • Bedi and Yashpal. (1971). Handbook of Hygiene and Public Health. Atma Ram & Sons, Delhi. • Kessel, A. (2006). Air, the environment and public health. Cambridge University Press. • Lopez, R. P. (2012). The built environment and public health (Vol. 16). John Wiley & Sons. • Nandini N. (2018). Environment and public Health. Sapna Book House, Bengaluru. • O'Carroll, P. W., Yasnoff, W. A., Ward, M. E., Ripp, L. H., & Martin, E. L. (Eds.). (2003). Public health informatics and information systems. • Park, K. (2009). Park's Textbook of Preventive and Social Medicine, 20th Edition. Misc Publication. • Rajit Sengupta and Kiran Pandey. (2021). State of India's Environment 2021: In Figures. Centre Science and Environment, New Delhi. • Van den Bosch, M., & Bird, W. (Eds.).(2018). Oxford textbook of nature and public health: The role of nature in improving the health of a population. Oxford University Press. • Walton, M. (2017). One Planet, One Health. Sydney University Press. 	

Open Elective Course Code: ENVOEC06
Course Title: WILDLIFE AND CONSERVATION

(Theory)

COURSE TITLE	Wildlife and Conservation
Couse code	ENVOEC06
Course credits	03
Total contact hours	42
Duration of ESA (Hour)	03
Formative assessment marks	40 (40%)
Summative assessment marks	60 (60%)

Content of Theory course- Wildlife and Conservation Total credits =3	42 Hr
Unit 1	14 Hr
<p>Wildlife: Definition, significance – Values of wildlife: Ecological, Economic, Cultural, Aesthetic, Scientific, Recreational and Medicinal. Biogeographical zones of India. Significant wildlife of India. Causes for wildlife depletion – HIPPO (Habitat destruction, Invasive species, Pollution, Population (human overpopulation), Overharvesting by hunting and fishing. Forest fires and wildlife depletion. Effects of depletion of wildlife – Ecological, Economic Socio-cultural. Urban wildlife. Human-wildlife conflict and management.</p> <p>Categories of Wildlife: IUCN Red data categories - Extinct, Extinct in wild, critically endangered, Endangered, Vulnerable, Near threatened, Least concerned, Data deficient, Not evaluated. IUCN Red data book. Keystone species, Flagship species, Umbrella species. Priority species, Indicator species.</p>	
Unit 2	14 Hr
<p>Wildlife conservation: Need for conservation of wildlife. History of wildlife conservation in India. Biosphere reserves, National parks, Wildlife sanctuaries, wildlife reserves, protected areas, privately owned wildlife reserves &, Single species/single habitat-based conservation areas, Area of special scientific interest (ASSI). Conservation practices - Ex-situ and in-situ conservation. Captive breeding - Role of Zoos in conservation. Community conserved areas – Devarakadu and Pavitra Vana. Case studies: Project tiger, Project elephant. Role of BSI and ZSI in conservation.</p>	

<p>People and conservation: Traditional knowledge, Traditions and cultures, Women and people's participation in managing protected areas. Role of NGOs in conservation. Conservation Institutions – Bird Life International, GEF, IUCN, UNEP, WCS, WWF; BNHS, WTI.</p>	
<p>Unit 3</p>	<p>14 Hr</p>
<p>Wildlife tourism: Definition, scope and relevance. Role of Zoos and Botanical parks in tourism and awareness creation. Bird and butterfly watching. Positive and negative impacts of wildlife tourism. Conflicts related to wildlife tourism.</p> <p>Wildlife trade and legislation: Wildlife trade and impacts. The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Wildlife Trade Monitoring Network (TRAFFIC). Salient features of Indian wildlife act 1972.</p>	
<p>References</p> <ul style="list-style-type: none"> • Bindra, P. S. (2017). The Vanishing: India's Wildlife Crisis. Penguin Random House India. • Donald Letcher Goddard and Sam Swope. (1995). Saving Wildlife: A Century of Conservation. Wildlife Conservation Society. • E.P. Gee. (2002). The Wild Life of India. HarperCollins India • Goutam Kumar Saha , Subhendu Mazumdar. (2017). Wildlife Biology: An Indian Perspective, PHI Learning Pvt. Ltd. India • Herbert H. T. Prins, Jan Geu Grootenhuis and Thomas T. Dolan. (2000). Wildlife Conservation by Sustainable Use. Springer publication. • Jedediah F. Brodie, Eric S. Post, and Daniel F. Doak. (2012). Wildlife Conservation in a Changing Climate. The University of Chicago Press. • Manfredo, Michael J. (2008). Who Cares About Wildlife? Springer publication. • Morrison, M.L., Block, W.M., Strickland, M.D., Collier, B.A., Peterson, M.J. (2008). Wildlife Study Design, Springer publication. • Nagendra, H., & Mundoli, S. (2019). Cities and canopies: trees in Indian cities. Penguin Random House India Private Limited. • Roth, Harald H., Merz, Gu" nter (Eds.). 1997. Wildlife Resources - A Global Account of Economic Use. Springer publication. • Underkoffler, Susan C, Adams, Hayley R. (Eds.). (2021). Wildlife Biodiversity Conservation - Multidisciplinary and Forensic Approaches, Springer publication. 	

UNDER GRADUATE B. Sc. Basic/ Honors SEMESTER (I & II)
ENVIRONMENTAL SCIENCE
QUESTION PAPER PATTERN for DSC

TIME: 2 h

MAX. MARKS: 60

NOTE: ALL SECTIONS ARE COMPULSORY

SECTION – A

I. Answer any FIVE of the following

5 x 2 = 10

- 1.
- 2.
- 3.
- 4.
- 5.
- 6.
- 7.

SECTION – B

II. Answer any FOUR of the following

4 x 5 = 20

- 1.
- 2.
- 3.
- 4.
- 5.
- 6.

SECTION-C

III. Answer any THREE of the following

3 X 10= 30

- 1.
- 2.
- 3.
- 4.

Marks assigned for semester end examination

Marks for Theory exam:	60 Marks
Internals for Theory paper:	40 Marks
Total:	100 Marks

Semester end Practical examination

Marks for Practical exam:	25 Marks
Internals for Practical:	25 Marks
Total:	50 Marks

UNDER GRADUATE B. Sc. Basic/ Honors SEMESTER (I & II)
ENVIRONMENTAL SCIENCE
QUESTION PAPER PATTERN for Open Elective (OE)

TIME: 2 h

MAX. MARKS: 60

NOTE: ALL SECTIONS ARE COMPULSORY

SECTION – A

I. Answer any FIVE of the following

5 x 2 = 10

- 1.
- 2.
- 3.
- 4.
- 5.
- 6.
- 7.

SECTION – B

II. Answer any FIVE of the following

5 x 6 = 30

- 1.
- 2.
- 3.
- 4.
- 5.
- 6.

SECTION-C

III. Answer any TWO of the following

2 x 10 = 20

1. Question from Unit-I
2. Question from Unit-II
3. Question from Unit-III

Marks assigned for semester end examination

Marks for Theory exam:	60 Marks
Internals for Theory paper:	40 Marks
Total:	100 Marks

UNDER GRADUATE B. Sc. Basic/ Honors SEMESTER (I & II)
ENVIRONMENTAL SCIENCE
QUESTION PAPER PATTERN for SEC
SEC-

TIME: 1 h

MAX. MARKS: 30

NOTE: ALL SECTIONS ARE COMPULSORY

SECTION – A

I. Answer any FIVE of the following

5 x 2 = 10

- 1.
- 2.
- 3.
- 4.
- 5.
- 6.
- 7.

SECTION-B

II. Answer any TWO of the following

2 x 5= 10

- 1.
- 2.
- 3.
- 4.

SECTION-C

III. Answer any ONE of the following

1 x 10= 10

- 1.
- 2.

Marks assigned for semester end examination

Marks for Theory exam:	30 Marks
Internals for Theory paper:	20 Marks
Total:	50 Marks

UNDER GRADUATE B. Sc. Basic/ Honors SEMESTER (I & II)
ENVIRONMENTAL SCIENCE
QUESTION PAPER PATTERN for Practical for DSC

TIME: 3/4 h

MAX. MARKS: 25

- | | |
|-----------------------------------------------------------------------------------------------------|-----|
| 1. 1. Write the procedure for the estimation/determination/identification of X in the given sample. | 3 M |
| 2. Major experiment | 8 M |
| 3. Spotters | 4 M |
| 4. Viva | 5 M |
| 5. Records: | 5 M |

Total:

25 Marks

Marks assigned for semester end Practical examination

Marks for Practical exam:	25 Marks
Internals for Practical paper:	25 Marks
Total:	50 Marks

UNDER GRADUATE B. Sc. Basic/ Honors SEMESTER (I & II)
for DSC, OE and SEC

Distribution of the Internal Assessment Marks for DSC

#	Assessment Method	Marks
1	Assignment	10
2	Internal Tests	20
3	Seminar/Group discussion	10
	Total	40 Marks

Distribution of the Internal Assessment Marks for Open Elective (OE)

#	Assessment Method	Marks
1	Assignment	10
2	Internal Tests	20
3	Seminar/Group discussion	05
4	Lab/Field visit	05
	Total	40 Marks

Distribution of the Internal Assessment Marks for SEC

#	Assessment Method	Marks
1	Assignment	05
2	Internal Tests	10
3	Seminar/Group discussion	05
	Total	20 Marks