PONDICHERRY UNIVERSITY
School of Life Sciences

DEPARTMENT OF ECOLOGY &
ENVIRONMENTAL SCIENCES

CURRICULUM FOR
M.Sc. PROGRAM
IN
ENVIRONMENTAL SCIENCES
2019-20 onwards
PONDICHERRY UNIVERSITY
School of Life Sciences
Department of Ecology & Environmental Sciences

Master of Science in Environmental Sciences

PROGRAM OBJECTIVES

The objectives of the MSc Environmental Sciences are:

1. to provide students the fundamental concepts and principles of environment
2. to make students aware of the importance of environment and its conservation
3. to introduce the modern tools and techniques available to study and understand the environment
4. to teach field techniques, sample collection, mapping and analysis
5. to make students to take up research and teaching in environmental sciences

PROGRAM OUTCOME

The students will

1. understand the concepts and principles of environment
2. understand the structural and functional aspects of environment and the need for its conservation
3. be familiar with modern tools and techniques and their appropriate use to conduct research.
4. be aware of the suitable use of field techniques, sample collection, mapping, analysis and interpretation.
5. be able to take up research and teaching in environmental sciences.
## PONDICHERRY UNIVERSITY

**School of Life Sciences**  
**Department of Ecology & Environmental Sciences**

### Curriculum for  
**M.Sc. Environmental Sciences**  
**2019-2020 onwards**

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Total Credit for Hard Core courses = 48  
Total Credit for Soft Core courses = 24  
Total Credit requirements = 72
FUNDAMENTALS OF ECOLOGY AND ENVIRONMENTAL SCIENCES
EVNS: 401
CREDITS: 3

COURSE OBJECTIVE: To introduce the basics of Ecology and Environmental Sciences to students coming from different background.

UNIT-I Introduction to Ecology & environmental sciences; Principles and Scope of Ecology Structure and Functions of Ecosystems- Abiotic and Biotic components, Flow of energy and cycling of materials; water, carbon, nitrogen and phosphorus, Trophic pyramids and food webs; Ecosystems Types and Diversity, Alterations of ecosystem function: acid rain, nuclear winter, global warming and ozone hole, an overview of IPCC. (8 Hours)


UNIT-III Populations and communities; Birth, death and population size, age structure; Trends in human population growth; Malthusian growth. Intraspecific interactions and density dependence, Parasitism, Prey-predator relationships, Interspecific interactions; Commensalism, mutualism, competition and predation. Species diversity, community stability and disturbance (8 Hours)

UNIT-IV Aquatic and terrestrial communities; rare communities; deep earth, deep sea floor, volcanoes. Primary productivity; basic concepts, Ecological succession inland, water; concepts, Invasive species and control (8 Hours)

UNIT-V Practical and Field Experiments using standard methods; Estimation of density and relative abundance of species using quadrats and plotless methods. Estimation of species diversity: introduction to indices. Estimation of primary productivity. Ecological adaptations of the Plant and animal species in the hydrophytes, mesophytes and xerophytes. (8 Hours)

Text books:

Reference books:

COURSE OUTCOME: The students will understand the basics of Ecology & Environmental Sciences.
BIOSTATISTICS

COURSE OBJECTIVES: To introduce the statistics for ecological and environmental data analysis.

UNIT-I Fundamentals of Biostatistics; sampling, Data collection and recording, central tendency-concept; arithmetic mean, mode, median for ungrouped and grouped data. Probability Rules and Theoretical Distributions: Basic probability rules, expectation, conditional probability; Probability distributions – Binomial, Poisson, Normal and Log-normal distributions; Fitting of probability distributions to environmental data. (8 Hours)

UNIT-II Sample survey: Need and Purpose of sampling, Sampling with and without replacement, Population and sample; Population parameters; Environmental sampling design - Methods for selecting sampling locations and times; Different techniques of sampling – simple random sampling, stratified random sampling, systematic sampling, two stage sampling, compositing and three-stage sampling; Relative advantages and disadvantages of different techniques. (8 Hours)

UNIT-III Sampling distribution and Test of Significance: Parameter and statistics; Sampling distribution, Standard error and its uses; Concept of t-distribution, F-distributions, Chi Square distribution without derivation and their applications; Null hypothesis and uses of t-test, F-test, $X^2$-tests; Test of significance of large samples. Correlation and Regression: Bi-variate data and scatter diagram; Simple (linear) correlation and regression; Coefficient of correlation and regression and their properties; Fitting of regression line; Multiple and partial correlations and regressions. (8 Hours)

UNIT IV Analysis of Variance: Different types of models used in AOV; Basic assumptions and its violation; One and two way classified data; Application of AOV to environmental data. Distribution- Normal, t and chi square test; Difference among means: f-test: 1 way ANOVA. Computer applications in environmental modeling, Computer based modeling for population and population studies. (8 Hours)

UNIT-V Multivariate analysis, hypothesis testing Model fitting; Biometry – principles and concepts; Matrices, simultaneous linear equations; tests of hypothesis and significance, time series analysis- moving averages (3 and 5 unit cycles); current development in the subject. (8 Hours)

Text books:

Reference Books:

COURSE OUTCOME: The students will be able to select appropriate statistical tool and to do statistical analysis on a proper dataset.
ENVIRONMENTAL LAW, POLICY AND EQUITY

EVNS: 403  
CREDITS: 3

COURSE OBJECTIVE: To make students aware of Indian as well as International environmental laws and their importance.


UNIT–III Equity Environment versus Development: Importance of critical review of plan with respect to local, regional & immediate & long term gains & Effect of development. Comparison between a Exploitation and safe guard for conservation, b. rate of utilisation and regeneration, c. natural and manmade growth, d. Survival need of mankind and protection of Environment Integration of development with carrying capacity of environment Case study of current issue Requirement of Rule 14 for Environmental audit under Environment protection Act 1986; Rule & regulation & guidelines given for disposal of hazardous protection waste, municipal solid wastes & bio-medical waste. (8 Hours)


Text Books

[6]

Reference Books

COURSE OUTCOME: Students will know the national and international environmental laws, national environmental policy and sustainable development.
ENVIRONMENTAL POLLUTION AND MITIGATION

EVNS: 404

COURSE OBJECTIVES: To impart students the different types of pollution, causes and mitigation strategies.

Unit I Air: Natural and anthropogenic sources of pollution. Primary and secondary pollutants. Transport and diffusion of pollutants. Gas laws governing the behaviour of pollutants in the atmosphere. Methods of monitoring and control of air pollution, SO$_2$, NO$_x$, CO, SPM. Effects of pollutants on human beings, plants, animals, materials and climate. Acid Rain, Air quality standards (8 hours)

Unit II Water-Types, sources and consequences of water pollution. Water quality standards, Sewage and wastewater treatment and recycling, Human use of surface and ground waters, Ground water pollution. Soil Pollution control. Industrial waste effluents and heavy metals, their interaction with soil components. Soil micro-organisms and their functions, degradation of different insecticides fungicides and weedicides in soil Different kinds of synthetic fertilizers (NP &K) and their interactions with different components of soil (8 hours)

Unit III Solid Wastes-Sources and generation of solid waste, Different methods of disposal and management of solid wastes (Hospital wastes and Hazardous wastes) Recycling of waste materials. Waste minimization technologies (8 hours)

UNIT IV Noise-Sources of noise pollution measurement of noise and indices, Effect of meteorological parameters on noise proposition. Noise exposure levels and standards. Noise control and abatement measures. Impact of noise on human health (8 hours)

UNIT V Marine- Ocean pollution by toxic wastes Sources of marine pollution and control. Criteria employed for disposal of pollutants in marine system-coastal management. Radioactive pollution radioactive waste and radioactivity from nuclear reactors and Thermal Pollution (8 hours)

Text Books:
1. Rieuwerts, J, 2015, The Elements of Environmental Pollution, Routledge Taylor & Francis Group, UK
2. Hill, MK. 2010 Understanding Environmental Pollution, Cambridge University Press, UK

Reference Books:

COURSE OUTCOME: The students will be aware of the types of pollutants, sources, impacts and mitigation practices.
LAB / FIELD WORK - 1

EVNS: 405 CREDITS: 2

INTRODUCTION TO ECOLOGY AND ENVIRONMENTAL SCIENCES – FIELD VISIT

a. Field visit to forest patch – data collection and report preparation
b. Field visit to wetland – data collection and report preparation
c. Field visit coast - data collection and report preparation

ENVIRONMENTAL POLLUTION AND MITIGATION – LAB

a. Jar test experiments – Optimization of coagulant, pH and dose
b. Determination of residual chlorine
c. Determination of total dissolved solids / suspended solids
d. Determination of volatile suspended solids
e. Biotreatment of textile / dairy / paper industrial effluent
f. Production of biogas from different organic waste materials
g. Exercises on estimation, composition and segregation of solid waste
h. An air quality survey report of an area
i. Design of point of use (POU) water treatment systems
j. Industry visit/ Minor project
ENVIRONMENTAL MANAGEMENT

EVNS: 411

CREDITS: 3

Objective: To be conversant with the basic principles and techniques of Environment Management Tools, Industrial Ecology and Environmental Economics.

UNIT-I Environmental priorities and sustainable development, Concept and strategies of sustainable environment, Master equation for the estimation of total environmental impact, Technological evolution, Analogy of biological ecology and industrial ecology, Food webs and Industrial Eco parks, Industrial symbiosis-Kalundborg – a case study. (8 Hours)


UNIT-III Environment Management System, Tool box for environmental management – Environmental auditing & Standards. Ecological foot print, Cleaner Production- Principles of green chemistry and green engineering. (8 Hours)

UNIT-IV Environmental Economics - Market failure, Externalities, Common goods and public goods, Ecosystem valuation, Solution to correct externalities – Environmental regulation, Quotas on pollution, Taxes and tariff on pollution, Pigovian tax, Ecological Economics (8 Hours)

UNIT-V Sustainable Tourism, Net metering, Green politics, Marginal Abatement Cost (MAC), Pollution haven hypothesis, Renewable energy commercialization. Carbon emission trading, Carbon footprint, Low-carbon economy. (8 Hours)

Text Books

Reference Books:
COURSE OUTCOME: The students will learn how to apply innovative and modern solutions for a sustainable economy, society and environment.
ENVIRONMENTAL IMPACT ASSESSMENT

**EVNS: 412**

**CREDITS: 3**

**COURSE OBJECTIVE:** To provide theoretical and as well as practical knowledge, to plan and carry out an environmental impact assessment and environmental management plans in compliance with the environmental clearance procedures in India.

**UNIT – I** Development Projects and Impacts; EIA and types of EIA methods; definition of EIA & EIS. Negative & positive aspects & uncertainties in EIA, Historical synopsis; Approach to EIA studies – mandatory requirements, project screening, scoping. Environmental baselines, best practices, terms of reference; Phases of EIA – Identification, Prediction, Evaluation, Decision Making and Post impact Monitoring the question of Significance; Complexities in environmental measurement; Special issues & concerns for different type of projects. (8 Hours)

**UNIT – II** Review of methodologies of EIA: Impact Identification Techniques – Checklists, Matrices, Map Overlays, Networks, Leopold Matrix; Environmental Evaluation System; Economic Approaches to EIA (Cost Benefit with market and shadow prices); Ecological Mapping; Global Change Assessment & Estimation Developing an Ecological Perspective to EIA. (8 Hours)

**UNIT – III** National Policy on EIA and Regulatory Framework: Environmental Impact Assessment Notification 2006 and Coastal Zone Notification 1991; Environmental Clearance Process in India; Legislative requirements (discharge requirements and area restrictions); Environmental Appraisal procedure for mining, industrial, thermal power, nuclear power and multipurpose river valley projects; Central & State pollution control boards for Safeguard for Environmental Protection. (8 Hours)


**Text Books**

**Reference Books**
2. Welsh Office, 1989. Environmental Assessment – A guide to the procedure, DoE,

**COURSE OUTCOME:** Students will be equipped to identify environmentally sound technologies or policies to resolve environmental problems
SUSTAINABLE DEVELOPMENT

EVNS: 413                  CREDITS: 3

COURSE OBJECTIVE: To introduce the student to the Concept and History of Sustainable development and appreciate the intricacies involved in the march towards this goal.

UNIT –I Introduction and History: Brundtland, Rio, SDGs

UNIT –II Basic Concepts, Strategies and Measurement Efficiency and Innovation, Green Growth and Rebound

UNIT –III Sufficiency, Income and Labor, Consumption Patterns and Lifestyles; Poverty and Inequality

UNIT –IV Instruments for SD Governance, Education and Science System Climate Change & Biodiversity

UNIT –V Industrial and Corporate Perspectives.

Text Books


Reference Books


COURSE OUTCOME: The student would be able to understand the basic concept of Sustainable Development (SD), the environmental, social and economic dimensions; be able to comprehend the conflicts which are involved in the SD concept on the national as well as on the global scale
LAB / FIELD WORK – 2

EVNS: 414

CREDITS: 2

ENVIRONMENTAL MONITORING AND ASSESSMENT – LAB

a. Spectrophotometric Methods of Estimation: Fluoride, Nitrate, Phosphate
c. Estimation of sulphate by turbidimetry.
d. Sampling and analysis of SO2, CO2, NOX, HC
e. Determination of
f. SPM in ambient air by high volume sampler, (ii) PM2.5, PM 10
g. Water quality analysis: Determinations of DO, BOD, COD, TKN, TDS, TSS, turbidity, conductivity, alkalinity, acidity, nitrate, chloride, total hardness - Instrumental and wet chemical methods of analysis.
h. Detection and estimation of noise pollution
i. Physical, Chemical and Biological properties of soil: Collection, particle size analysis (silt and clay), Soil profile, water holding capacity, density, porosity, pH, conductivity, NPK, TOC.
j. Analysis of heavy metals (Hg, Pb, Cd)
k. Basic Environmental Microbiology - Preparation of culture media, Membrane Filter Technique, Bacteriological analysis of wastewater (Coliforms, E. coli, Streptococcus) – MPN.

ENVIRONMENTAL IMPACT ASSESSMENT – MINI PROJECT

a. Field work,
b. Data collection
c. Analysis
d. Mapping
e. Report submission
GEOGRAPHICAL INFORMATION SYSTEM

EVNS: 501

CREDITS: 3

COURSE OBJECTIVE: To instruct the students about the basics of Geographical Information systems and enable them to make effective use of Open source software QGIS/GRASS

UNIT –I Cartography - Scale, Coordinate Systems, Projections Essential Map Elements -Map Design and Layout - Attribute data for Thematic Mapping -Data Classification

UNIT –II GIS Vector Data Model - Topology, Shape files -Generalization Problems – Selection Methods - Overlay Operations

UNIT –III GIS Raster Data Model, Raster Analysis

UNIT –IV QGIS – elements – using QGIS

UNIT –V GRASS – elements – using GRASS

Practical:
1. Introduction to QGIS software
2. Introduction to GRASS software
3. Map reading – SOI topographical map
4. Geometric correction of SOI topographical map
5. Map Editing – Working with editing tools
6. Digitization of feature from SOI topographical map
7. Digitization of feature from Satellite data
8. Editing Attribute data
9. Editing map symbols and labels
10. Map composition

Text Books


Reference Books


COURSE OUTCOME: Student would be fluent in the use of GIS
CLIMATE CHANGE, ADAPTATION AND MITIGATION

EVNS: 502  CREDITS: 3

COURSE OBJECTIVE: To make students aware of scenario of climate change and to provide exposure on discussions happening at national and international levels

UNIT – I A simple example of global change: stratospheric ozone depletion – impacts and policy responses; A complex example of enhanced greenhouse effect- fundamentals of the climate system – changing composition of the atmosphere from human population growth & activities – climate variability in the last millennium and the recent climate record – future emissions and future climate. (8 Hours)

UNIT – II Impacts on earth system and society; Impact- regional, national, global; ecosystems; agriculture and food security; sea level rise; acid rain; ocean acidification, coral bleaching; human health; Forestry and Fishery. (8 Hours)

UNIT – III Understanding Vulnerability: Key concepts of Sensitivity and Vulnerability – Adaptive capacity, Resilience and Coping ranges and Critical Thresholds; Determinants of vulnerability and adaptive capacity; Variations among regions and sectors; Conceptual framework for assessing vulnerability to climate change; Necessity for adaptation to climate variability; Adaptation types and forms- planned versus autonomous adaptation; No-regrets adaptation options. (8 Hours)

UNIT – IV Assessing Impacts and Vulnerabilities: Climate change scenarios and Vulnerability; Methods of Vulnerability Assessment; Indicators of vulnerability and livelihood; Climate sensitivity analysis; Uncertainties in prediction and detection; Vulnerabilities and adaptation practices in forestry, agriculture, soil & land, water resources; Measures for heat waves, coastal inundation – cities – critical infrastructure; Global Policy on Climate and Adaptation. (8 Hours)

UNIT – V Policy responses and mitigation strategies to a changing planet – Energy options and making decisions; IPCC assessments and scenarios; Kyoto protocol; REDD, REDD+, CDM, International Geosphere and Biosphere Programme (IGBP) and other planned interventions. (8 Hours)

Text Books
1. Rathinasamy, M, Chandramouli S. Phanindra K.B.V.N. Uma Mahesh 2018, Resources and Environmental Engineering II: Climate and Environment

Reference Books
1. Climate Change and Biodiversity; By Thomas E. Lovejoy, Lee Jay Hannah Published by Yale University Press, 2006 ISBN 0300119801, 80300119800 418 pages.


**COURSE OUTCOME:** Students would be able to address climate change mitigation and adaptation issues
RENEWABLE ENERGY TECHNOLOGY

EVNS: 503  
CREDITS: 3

COURSE OBJECTIVE: To enable an understanding of renewable energy in the broadest terms.

UNIT-I Wind energy - Wind energy resources, power in wind, wind turbine design considerations, grid connected wind farms, hybrid power systems, economics of wind power systems, economic analysis methods, wind energy conversion system. (8 Hours)

UNIT-II Solar energy – Introduction, Earth’s orbit, solar constant and solar spectra, solar angles, collector angles, solar irradiance, photovoltaic energy conversion, types of photovoltaic systems; solar thermal electric power plant - solar thermal systems, environmental impact. (8 Hours)

UNIT-III Bio Fuels – Biomass as a source energy, types of biomass, energy content of biomass, harvesting methods of biomass, conversion of biomass, thermos-chemical conversion of biomass, biodiesel production, bioethanol production, forest biomass production, forest species, environmental impact resulting from the generation and exploitation of forest biomass. (8 Hours)

UNIT-IV Ocean and Small hydro energy systems – Marine energy, understanding the power of marine energy, global development of marine energy, ocean wave energy, ocean tide energy, mathematical modelling of tidal schemes, global environmental impact; low power hydro plants, micro hydro plants. (8 Hours)

UNIT-V Energy planning for renewable energy systems – Modern power electronic technology for renewable energy sources, future trends in wind-power technology, power electronics in photovoltaic systems, recent trends in energy storage technologies, power quality instrumentation, regulatory framework, energy resource allocation, region dependent development in energy planning. (8 Hours)

Text Books


Reference Books


COURSE OUTCOME: Students will be able to define the different key renewable energy technologies, will have a broad appreciation of the potential applications for renewable energy technologies and will understand the strengths and weaknesses of the different renewable energy technologies.
LAB / FIELD WORK – 3

EVNS: 504

CREDITS: 2

1. CLIMATE CHANGE, ADAPTATIONS AND MITIGATION – MINI PROJECT

   a. Field work,
   b. Data collection
   c. Analysis
   d. Mapping
   e. Report submission

2. RENEWABLE ENERGY TECHNOLOGY – INDUSTRIAL VISIT

   a. Data collection
   b. Analysis
   c. Report submission