

CONTENTS

| | |
|---|-----------|
| Aim of the Programme | 2 |
| Scheme and Syllabus | 3 |
| Syllabi of Courses | 8 |
| Dissertation | 38 |
| Evaluation and Mark Distribution | 39 |

Aim of the programme

The unsustainable management of natural resources hampers human development and exacerbates human inequalities. Pollution, depletion of natural resources, the disintegration of ecological functions, and ineffectual policies are matters of local, regional and global concern. Economic development and rising living standards in the developing world, set against increased pressures on the environment contribute to the urgency of these issues. Preventing further degradation of the environment, and the damage to human society that follows, requires new approaches for sustainable interactions between people and their environment. Sustainability depends on a balancing use and conservation of environmental resources. The challenge to sustainable development is to increase food supply and human welfare, while minimizing and counteracting any negative impacts on the environment.

To find sustainable solutions and improve the quality of human life, we must first understand the processes that sustain natural systems, how these systems function and how they interact with one other and with human society. The Environmental Science MSc Programme develops the understanding of these processes and how in your day-to-day work to apply this knowledge for better natural resource management. During the programme you will learn to analyze and assess environmental systems and problems; be able to propose sustainable solutions; and understand the social complexities and challenges of environmental problems. During the final phase of the

programme, you will produce an independent scientific research project that brings together the critical thinking developed through the individual modules of the programme.

Programme contents

The Environmental Science MSc Programme equips professionals with the necessary capacities by offering a systems approach. This means you will investigate subsystems and their interactions at global, regional and local scale, without losing sight of the overall picture. The programme balances a thorough knowledge of the disciplines taught and the added value of bringing these disciplines together in one coherent programme.

Desired profile

Admission is open to all suitably qualified applicants with a focus and interest to meet future water environmental challenges in the developing world and countries in transition. The programme is intended for students and professionals with an interest in environmental sciences and in maintaining environmental integrity to support human development. Suitable academic backgrounds include a BSc or MSc in natural sciences, chemistry, environmental science, agriculture, geography, environmental economics, planning and management or engineering. Professional experience in a relevant area is desirable.

Basic knowledge of mathematics, physics and chemistry is a prerequisite. Computer literacy is a valuable asset. Good conversational, reading and writing capabilities in the English language are essential in order to successfully complete the study.

Career

Graduates of the Environmental Science programme start or resume a career dealing with water policy and planning, research and/or environmental regulation in the water sector or related sectors such as infrastructure, energy, agriculture or mining. Career paths include, but are not limited to:

- Public administration: central and local governments (urban water and wastewater authorities, water boards, water and environment ministries).
- Private sector, e.g. consulting engineering firms.
- Academia and research institutes.
- NGOs and international organizations (UN, World Bank, OAS etc.).

KERALA UNIVERSITY OF FISHERIES AND OCEAN SCIENCES

M. Sc. ENVIRONMENTAL SCIENCE – SCHEME AND SYLLABUS

| Semester | Course | | No. of Credits | Hrs./ week | Marks | | Total |
|----------|--------------|---|----------------|------------|-------|------|-------|
| | Subject Code | Name | | | Int. | Ext. | |
| I | EVS 2101 | Introduction to Environmental Science: Theory | 3 | 3 | 50 | 50 | 100 |
| | EVS 2102 | Environmental Chemistry | 3 | 3 | 50 | 50 | 100 |
| | EVS 2103 | Environmental Meteorology and Climate Change | 3 | 3 | 50 | 50 | 100 |
| | EVS 2104 | Ecology and Ecosystem dynamics | 3 | 3 | 50 | 50 | 100 |
| | EVS 2105 | Elective 1 -Environmental Statistics and Computer Applications | 3 | 3 | 50 | 50 | 100 |
| | EVS 2106 | Elective II -Natural Resources Management | 3 | 3 | 50 | 50 | 100 |
| | EVS 2107 | Practical I – Environmental chemistry | 2 | 6 | 100 | - | 100 |
| | EVS 2108 | Practical II – Data Analysis | 2 | 6 | 100 | - | 100 |
| | | Total credits (Core) - I Semester Elective | | 16 | | | |

| Semester | Course | | No. of Credits | Hrs./ week | Marks | | Total |
|----------|--------------|------|----------------|------------|-------|------|-------|
| | Subject Code | Name | | | Int. | Ext. | |

| | | | | | | | |
|-----------|----------|---|-----------|----------|-----|----|-----|
| II | EVS 2201 | Environmental Remote Sensing and GIS | 3 | 3 | 50 | 50 | 100 |
| | EVS 2202 | Microbial Ecology | 4 | 3 | 50 | 50 | 100 |
| | EVS 2203 | Advanced Environmental Chemistry: Theory | 3 | 3 | 50 | 50 | 100 |
| | EVS 2204 | Environmental Pollution | 4 | 3 | 50 | 50 | 100 |
| | EVS 2205 | Elective III- Energy and Environment | 3 | 3 | 50 | 50 | 100 |
| | EVS 2206 | Elective IV- Eco-toxicology | 3 | 3 | 50 | 50 | 100 |
| | EVS 2207 | Practical III - Advanced Environmental Chemistry | 2 | 6 | 100 | - | 100 |
| | EVS 2208 | Practical IV - Environmental Microbiology | 2 | 6 | 100 | - | 100 |
| | | Total credits (Core)-II Semester Elective | 18 | 6 | | | |

| Semester | Subject Code | Course Name | No. of Credits | Hrs./week | Marks | | Total |
|----------|--------------|--|----------------|-----------|-------|------|-------|
| | | | | | Int. | Ext. | |
| | EVS 2301 | Environmental Conservation and Sustainable Development | 3 | 3 | 50 | 50 | 100 |
| | EVS 2302 | Environmental Policy and Legislations | 3 | 3 | 50 | 50 | 100 |
| | EVS 2303 | Environmental Impact Assessment | 3 | 3 | 50 | 50 | 100 |

| | | | | | | | |
|------------|-----------------|---|-----------|-----------|-----|----|-----|
| III | EVS 2304 | Environmental Genetics & Biotechnology: Theory | 3 | 3 | 50 | 50 | 100 |
| | EVS 2305 | Elective V Integrated Coastal Zone Management | 3 | 3 | 50 | 50 | 100 |
| | EVS 2306 | Elective VI -Fisheries Oceanography | 3 | 3 | 50 | 50 | 100 |
| | EVS 2307 | Elective VII - Environmental and Occupational Health | 3 | 3 | 50 | 50 | 100 |
| | EVS 2308 | Elective VIII - Environmental modelling | 3 | 3 | 50 | 50 | 100 |
| | EVS 2309 | Practical V - Environmental Biotechnology | 2 | 6 | 100 | - | 100 |
| | | Total credits (Core) - III semester | | 14 | | | |
| | Elective | | 12 | | | | |

| Semester | Course | | No. of Credits | Hrs./week | Marks | | Total |
|----------|--------------|------|----------------|-----------|-------|------|-------|
| | Subject Code | Name | | | Int. | Ext. | |

| | | | | | | | |
|-----------|---|--|-----------|----|-----|-----|-----|
| IV | EVS 2401 | a. Dissertation based on project work* b. Credit seminar based on project work c. Field Survey d. Environmental field diary# *Dissertation (project work in the Department / Universities / Scientific institutes / Industrial organizations etc.) # # Environmental field diary is an event based activity write up: Environmentally important days on which students can organize events/seminars/talks/workshop and record the activity as a diary. These will be organized in the second and third semester of their study and the report submitted in the fourth semester. | 18 | 30 | 200 | 200 | 400 |
| | Total credits (Core) - IV semester | | 18 | | | | |

| | |
|---|-------|
| Total number of credits for all the four semesters (<u>Core courses</u>) | 66 |
| Total number of credits required for the completion of M. Sc. Environmental Science Programme | 72/90 |
| Minimum number of credits to be taken as <u>electives courses</u> | 6 |

KERALA UNIVERSITY OF FISHERIES & OCEAN STUDIES
DEPARTMENT OF ENVIRONMENTAL SCIENCE

Expert Panel who contributed for the Development of Curriculum and Syllabus

1. Prof. N.R Menon, Dean Faculty of Climate Variability & Aquatic Eco Systems, KUFOS, Kochi.
2. Prof. Ammini Joseph, School of Environmental Studies, CUSAT, Kochi.
3. Dr. Kamalakshan Kokkal, Director, Dept. of Science & Technology, Govt of Kerala, Thiruvananthapuram
4. Dr. N.G.K. Pillai, Former Director i/c CMFRI, Kochi.
5. Dr. K.K.C Nair, Former Regional Director, NIO, Kochi.
6. Dr. K.K. Ramachandran, Scientist-F and Scientist-in-charge, Coastal Regulation Zone Lab, National Centre for Earth Science Studies, Thiruvananthapuram
7. Shri.N.N.Raman, Former Director i/c School of Fishery Environment, KUFOS.
8. Dr. S. Rajendran, Adjunct Professor & Head, Coastal and Remote Sensing, KUFOS.
9. Dr. K. Ajith Joseph, Executive Director, Nansen Environmental Research Centre, Kochi.
10. Prof. A.A. Mohammed Hatha, School of Marine Sciences, CUSAT, Kochi.
11. Dr.Sivanandan Achari, Associate Professor, School of Environmental Studies, CUSAT, Kochi.
12. Dr.Anu Gopinath, Assistant Professor, Dept. of Aquatic Environment Management, KUFOS.
13. Dr.Grinson George, Senior Scientist, CMFRI, Kochi.
14. Dr. Deepak George Pazhayamadam, Australia.
15. Prof. Devika Pillai, Director i/c, School of Fishery Environment, KUFOS.

**KERALA UNIVERSITY OF FISHERIES & OCEAN STUDIES
DEPARTMENT OF ENVIRONMENTAL SCIENCE**

SYLLABI OF COURSES

SEMESTER I

EVS 2101: Introduction to Environmental Science

Duration: 1 Semester

Credits: 3

Total Lecture Hours: 54

Syllabus Content

Unit I: Introduction: Definition, principles and scope of environmental science. The ecosystem concept, Abiotic and biotic components. Biomes and Habitats: Classification of biomes – Terrestrial biomes – tundra, taiga, grassland, desert, evergreen and deciduous forests, tropical rain forests and their characteristics – flora and fauna.

Unit II: Environmental Geosciences, Fundamental concepts, Earth Processes-Primary differentiation and formation of core, mantle, crust, atmosphere, hydrosphere and hydrological cycle.

Unit III: Soil Genesis: Weathering processes and soil formation. Soil profile development, Chemical mineralogical composition of soil, Soil classification.

Unit IV: Structure and composition of atmosphere.

Unit V: Aquatic Environment-Classification of aquatic habitats – fresh water : ponds, rivers, lakes, wetlands – their characteristics, wetland systems of India, flora and fauna; marine habitats – pelagic, benthic, inter-tidal, estuarine, Mangroves – their characteristics, flora and fauna.

References:

1. Aravind Kumar, 2007. Prospects and problems of environment.
2. Abbasi,S. 1997. Wetlands of India: Ecology and threats; Discovery Publishing House, New Delhi
3. Rajagopalan R., 2005. Environmental studies:From crisis to cure 4.Iyer,C S P., 1997. Advances in environmental science.
5. Mathur, H S., 1988. Environmental resources:The crisis of development.
6. Singh,JS, Singh,S P and Gupta,S R., 2006. Ecology environment and resource conservation.

Assessment Pattern:

| Examinations | Total Marks |
|-----------------------|-------------|
| Sessionals– Internals | 50 |
| Finals | 50 |

Internals:

| Item | Marks |
|------------|---------------------|
| Attendance | 5 |
| Seminar | 10 |
| Tests | 25 (Average of two) |
| Assignment | 10 |
| Total | 50 |

Finals:

| Item | Marks |
|-------------------|-------|
| Final Examination | 50 |

EVS 2102: Environmental Chemistry

Duration: 1 Semester

Credits: 3

Total Lecture Hours: 54

Syllabus Content

Unit I: Atmosphere-Atmospheric chemistry, reactions in the lower and upper atmosphere, radioactivity in the atmosphere and air pollution chemistry.

Unit II: Hydrosphere: Structure and physico-chemical properties of water and their environmental significance, chemistry of marine and fresh water, role of water in the environment.

Unit III: Lithosphere: Chemical composition of the earth, metals, minerals fossil fuels, and soils.

Unit IV: Principles and Concepts of water, air and soil analyses.

Unit V: Environmental analytical techniques -Titrimetry, gravimetry, colourimetry, spectrophotometry, gas chromatography, atomic absorption spectrophotometry, GLC, HPLC, electrophoresis, X-ray fluorescence, X-ray diffraction, flame-photometry. Principles of Good Laboratory Practices.

References:

1. Manhan, Stanley E., 2000. Environmental chemistry
2. Kudesia, V P., 2000. Environmental chemistry
3. Bailey, Clark and others, 2002. Chemistry of the environment
4. Asim K Das 2010. Environmental chemistry with green chemistry.

Assessment Pattern:

| Examinations | Total Marks |
|------------------------|-------------|
| Sessionals - Internals | 50 |
| Finals | 50 |

Internals:

| Item | Marks |
|------------|-------|
| Attendance | 5 |
| Seminar | 10 |

| | |
|------------|------------------------|
| Tests | 25 (Average of two) |
| Assignment | 10 |
| Total | 50 |

Finals:

| Item | Marks |
|-------------------|-------|
| Final Examination | 50 |

EVS 2103: Environmental Meteorology and Climate Change

Duration: 1 Semester

Credits: 3

Total Lecture Hours: 54

Syllabus Content

Unit I: Definition and branches of meteorology - Definition of weather and climate - Elements of weather and climate: solar radiation, air temperature, atmospheric pressure, wind, humidity, clouds, precipitation and visibility - units of measurement of weather elements.

Unit II: Structure of the atmosphere based on vertical temperature profile. Ionospheres. Composition of the atmosphere - ozone in the atmosphere, aerosols, carbon compounds in the atmosphere and Green House Effect (GHE).

Unit III: Atmospheric pressure and wind: Horizontal distribution of atmospheric pressure at Earth's surface level, semi permanent pressure cells. Global surface winds pattern. General circulation. Indian monsoon: onset, progress and withdrawal south west monsoon over India, north east monsoon - seasons of India - rainfall patterns over India - Influence of El Nino and La Nina on Indian monsoon.

Unit IV: Tropical cyclones: cyclogenesis and movement - cyclones over Indian seas and associated weather - thunderstorms- land and sea breezes - effects of severe weather - flood, land slide, lightning etc.

Unit V: Climate change - preliminary concepts - global warming - anthropogenic causes. Consequences of global warming - sea level rise, changes in rainfall pattern and amount- impact on agriculture, fisheries, industries, human comfort etc.

References:

1. Donald Ahrens C: Essentials of Meteorology - An introduction to the atmosphere (6th Ed.); Brooks/ Cole, Canada (2011)
2. Fredric K. Lutgens: Atmosphere-An introduction to the Meteorology (12th Ed.); Prentice Hall (2014)
3. Houghton J: Physics of Atmospheres (3rd Ed.); Cambridge University Press (2002)
4. Menon P. A.: Our Weather; National Book Trust, India (1989)
5. Seymour L. Hess: Introduction to Theoretical Meteorology; Krieger, New York (2006)

Assessment Pattern:

| Examinations | Total Marks |
|------------------------|-------------|
| Sessionals - Internals | 50 |
| Finals | 50 |

Internals:

| Item | Marks |
|------------|------------------------|
| Attendance | 5 |
| Seminar | 10 |
| Tests | 25 (Average of two) |
| Assignment | 10 |
| Total | 50 |

Finals:

| Item | Marks |
|-------------------|-------|
| Final Examination | 50 |

EVS 2104: Ecology and Ecosystem dynamics

Duration: 1 Semester

Credits: 3

Total Lecture Hours: 54

Syllabus Content

Unit I: History and scope of ecology, Ecological hierarchy-concepts in ecology, autecology, synecology, tolerance range and limiting factors. Concept of habitat, functional role and niche, key stone species, dominant species, ecotone, edge effect.

Unit II: Population structure, population properties and dynamics, models for single and interacting population, stable points, stable cycles, chaos competition, prey predation and mutualism.

Unit III: Community organisation, Ecological succession, primary and secondary processes in successions, models of successions, climax community and types of climax.

Unit IV: Energy input in ecosystem, standing crop, biomass, primary and secondary production, gross and net production, concept of food web, phytoplankton as a primary food web component and recent research on food web dynamics. Net community production, methods of measuring productivity, pattern of primary production and biomass in the major ecosystem of the world, Energy flow, Feedback and control.

Unit V: Biogeochemical cycles, gaseous and sedimentary turnover rate and turnover item. Carbon cycle, nitrogen cycle, sulphur cycle, phosphorus cycle, nutrient budget, man's impact on nutrient cycles. Carbon sequestration.

References:

1. Botkin, Daniel B. 2011. Environmental Science: Earth as a Living Planet, John Wiley and Sons, New Delhi.
2. Chapman, J.L. and Reiss, M. J. 2005. Ecology Principles and Applications, Cambridge University Press, London.
3. Dash, M.C. 1994. Fundamentals of Ecology, Tata McGrawHill, New Delhi.
4. Gunther, O. 1998 Environmental Information Systems. Berlin, New York, Springer.
5. Miller G. Taylor and Scott Spoolman. 2011. Essentials of Ecology, Brooks/Cole Learning, USA.
6. Odum, E.P. 1971. Fundamentals of Ecology, W.B. Saunders Company, Philadelphia.
7. Sharma, P.O. 1996. Environmental Biology, Rastogi Publications, Meerut.
8. Verma, P.S. and V.K. Agarwal. 1985. Principles of Ecology. S. Chand and Company, New Delhi.

Assessment Pattern:

| Examinations | Total Marks |
|------------------------|-------------|
| Sessionals - Internals | 50 |
| Finals | 50 |

Internals:

| Item | Marks |
|------------|------------------------|
| Attendance | 5 |
| Seminar | 10 |
| Tests | 25 (Average of two) |
| Assignment | 10 |
| Total | 50 |

Finals:

| Item | Marks |
|-------------------|-------|
| Final Examination | 50 |

EVS 2105: Environmental Statistics and Computer Applications (3 Credits)-E-I

Unit I: Biostatistics and Computer application, Introduction to sampling methodology, probability.

Unit II: Measures of central tendency and graphical representation of data, contingency tables and chi-square test, difference between sample means: t-test, range tests, correlation measurements and regression analysis.

Unit III: Simple experimental design and analysis of variance, introduction to multivariate methods for biology.

Unit IV: Basic concepts of computer, hardware, operating systems: Windows, Unix and Linux, use of common application software in biology: word processing, spreadsheets, graphics and data base.

Unit V: Introduction to web browsing software and search engines with special reference to online environmental resources.

References:

1. Zar, Jerrold H. (1998). Biostatistical Analysis. Prentice Hall, N.J.
2. Sokal, Robert and James Rohlf (1997). Biometry, Freeman Press, N.Y.
3. Walpole, R. and R. Myers (1993). Statistics for Engineers and Scientists, 5th edn. MacMillan, N.Y.
4. Wayne, R. Ott (1995). Environmental Statistics and Data Analysis, CRC Press.
5. Manly (2001) Statistics for environmental science and management, Chapman and Hall / CRC.
6. Ramsay and Schafer (1997). The Statistical Sleuth, Duxbury Press.

EVS 2106: Natural Resources Management (3 Credits)-E-II

Unit I: Natural Resources : concept and major types of natural resources, land resources; land use and land cover, land use change, drivers of land use change, impact of land use change on environment.

Unit II: Soil and mineral resources: overview of major soil types and mineral deposits in India with special reference to Kerala, Environmental effects of mining; acidic, alkaline and saline soils – reclamation techniques.

Unit III: Water resources : Distribution and extent-global, national and regional; water resources types – surface water, ground water; types of water, global water balance, water availability and uses, freshwater shortages, impact of climate change on freshwater resources, Management and conservation of water resources.

Unit IV: Freshwater fisheries resources and their management, Riverine fisheries resources: Present trend of dwindling fisheries resources, direct and Indirect effects of human intervention in rivers, habitat modification and improvement (rehabilitation of channels and flood plains), protection and restoration of fish movements (different types of fish passes and enhancement of fish migration), management and repair of riverine vegetation, stock enhancement strategies like introduction of new species, pre- and post- stocking management, potential risk of stocking.

Unit V: Coastal and Marine fisheries resources. Important estuarine fishery resources-present productivity level- potential; Problem – management practices. Important finfish and shellfish resources in demersal and pelagic systems; conservation strategies. Sustainability: Principles, social, economic, ecological, biological and legal issues. Fisheries co-management.

References:

1. Blaber JM. 1997. Fish and Fisheries in Tropical Estuaries. Chapman & Hall.
2. Chandra P. 2007. Fishery Conservation, Management and Development. SBS Publ.

3. Dholakia AD. 2004. Fisheries and Aquatic Resources of India. Daya Publ. House.
4. FAO. Technical Papers on Freshwater Fisheries.
5. FAO. Technical Papers on Marine Fisheries.
6. Shanbhogue SL. 2000. Marine Fisheries of India. ICAR.

SEMESTER I PRACTICALS

EVS 2107: Environmental Chemistry (2 Credits)-P-I

Analysis of natural water as per drinking water (BIS) standard- Major physico-chemical parameters – pH, electrical conductivity, redox potential, turbidity, acidity, alkalinity, total hardness, Calcium hardness, Magnesium hardness, Dissolved Oxygen, Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD). Determination of Fe, Na, K, Ca, Chloride, Nitrate, Nitrite, Sulphate, Sodium Absorption Ratio (SAR), Aggressiveness Index. Total Organic Carbon (TOC), Total Dissolved Solids (TDS), MPN Analysis.

Assessment Pattern:

| Examinations | Total Marks |
|-----------------------|-------------|
| Sessionals -Internals | 100 |

Internals:

| Item | Marks |
|-----------------|-------|
| Attendance | 10 |
| Lab performance | 20 |
| Tests | 50 |
| Record | 20 |
| Total | 100 |

EVS 2108: Data Analysis (2 Credits)-P-II

1. **Data types and distributions:** Identifying different types of environmental data (continuous, count, proportion, binary, time series) and their probability distributions, generating random numbers from probability distributions, identifying different types of environmental variables (quantitative and qualitative), using measures of central tendencies and spread (mean, median, mode, skewness, kurtosis).
2. **Exploratory data analysis:** Computation of mean, standard deviation and variance of environmental variables, plotting graphs to understand the nature and structure of data distributions (box plot, histograms and scatterplots), determining the relationship between response and predictor variables (basic linear regression and correlations). Application of tests for identifying outliers and determining whether data belongs to a normal distribution.
3. **Data transformations:** Demonstrating the use and types of data transformations (including their application in presence-absence data). Testing assumptions of statistical tests (normality, linearity, homogeneity of variance) before and after data transformations. Demonstrating the

use of standardization techniques and their effectiveness in making environmental variables comparable.

4. **Confirmatory data analysis:** Application of confidence intervals, distinguishing parametric and non-parametric tests, hypothesis testing and using p-value for inference (Z-test, T-test, Ftest, Chi-square test, Mann-Whitney U test), tests for comparing more than two populations (ANOVA, Kruskal-Wallis test, Friedman test) including post-hoc tests.
5. **Bivariate analysis:** Developing model equations such as for bivariate linear regression, generalised linear modelling (poisson regression and logistic regression) and generalized additive modelling.
6. **Multivariate analysis:** Application of dimension reduction techniques (Principal component analysis, redundancy analysis, factor analysis, discriminant analysis, cluster analysis and multidimensional scaling) and MANOVA.
7. **Time series analysis:** Determining auto-correlation and cross correlations, application of 1) Auto regressive integrated moving average (ARIMA) models and 2) determining common trends in multiple time series using dynamic factor analysis (DFA) or min/max autocorrelation factor analysis (MAFA), 3) Chronological clustering techniques.
8. **Spatial analysis:** Introduction to lattice data, analysis of spatial correlation, plotting hscatterplots, demonstration of variograms, the assumption of stationarity in spatial analysis, use of geo-statistical modelling for predictions (kriging).

Assessment Pattern:

| Examinations | Total Marks |
|-----------------------|-------------|
| Sessionals -Internals | 100 |

Internals:

| Item | Marks |
|-----------------|-------|
| Attendance | 10 |
| Lab performance | 20 |
| Tests | 50 |
| Record | 20 |
| Total | 100 |

SEMESTER II

EVS 2201: Environmental Remote Sensing and GIS

Duration: 1 Semester

Credits: 3

Total Lecture Hours: 54

Syllabus Content

Unit – I: Introduction to Remote Sensing – Energy sources and Radiation principles, Energy equation, EMR and Spectrum – EMR interaction with Atmosphere – Atmospheric Windows - Scattering, Absorption – EMR interaction with Earth surface features; reflection, absorption, emission and transmission – Spectral response pattern –Vegetation, Rocks, Soil, Water bodies – Spectral properties and characteristics.

Unit – II: Introduction- Active, Passive, Optical Remote sensing, Visible, Infrared, thermal, Platforms and sensors- orbit types– Resolution. Microwave Remote sensing sensors, Concept of Microwave Remote sensing, SLAR, SAR Scattro meter – Altimeter, Characteristics, Image interpretation characters.

Unit – III: Land observation satellites, characters and applications, IRS series, LANDSAT series, SPOT series, High resolution satellites, character and applications, CARTOSAT series, IKONOS Series, QUICKBIRD series, Weather/Meteorological satellites, INSAT series, NOAA, GOES, NIMBUS Applications, Marine observation satellites; OCEANSAT.

Unit –IV: Introduction to Geographical Information Systems: Maps and Spatial information – Computer Assisted Mapping and Map Analysis. Components of Geographical Information System – Introduction – GPS satellites – Components – Satellite Ranging – Codes - Basics of Geodesy – Branches, Applications and Observations of Geodesy. Digital Elevation Models: TIN – DEM.

Unit – V: Map projections in GIS – Coordinate System – Georeferencing – Data Structures for Geographic Information Systems – GIS Entities – Point, Lines and Polygon. Data Quality, Errors and Natural Variation: Sources of error – Errors resulting from natural variation and original measurements. Errors arise through processing – Problems and Errors arising from overlay and boundary intersections – raster and vector maps; Errors resulting in raster and vector maps – Errors associated with overlaying two or more polygon networks.

References:

1. Principles of Geographical Information System for Land Resource Assessment, P.A. Burrough, Clarendon Press, Oxford, 1986.
2. Geographic Information Systems, T.R. Smith & Piquet, London Press, 1985.
3. Principles of data base systems, J.D. Ullman, Computer Science Press.
4. Paul Jude Gibson, Introductory Remote Sensing: Principles and Concepts, Routledge, 11 New Fetter Lane, Landon, UK. 2000. ISBN: 0-415-17024-9
5. M. Anji Reddy, Textbook of Remote Sensing and Geographical Information systems, BS Publications, Hyderabad. 2011. ISBN: 81-7800-112-8.
6. A.M.Chandra and S.K. Gosh. Remote Sensing and GIS, Narosa Publishing Home, New Delhi 2009.
7. Thomas M. Lillesand, Ralph W. Kiefer, Jonathan W. Chipman, Remote sensing and image interpretation John Wiley & Sons, 2008.

Assessment Pattern:

| Examinations | Total Marks |
|------------------------|-------------|
| Sessionals - Internals | 50 |
| Finals | 50 |

Internals:

| Item | Marks |
|------------|---------------------|
| Attendance | 5 |
| Seminar | 10 |
| Tests | 25 (Average of two) |

| | |
|------------|----|
| Assignment | 10 |
| Total | 50 |

Finals:

| Item | Marks |
|-------------------|-------|
| Final Examination | 50 |

EVS 2202: Microbial Ecology

Duration: 1 Semester

Credits: 4

Total Lecture Hours: 54

Syllabus Content

Unit I: History and Development of Microbiology and Microscopy - Prokaryotic cell structure and function – Microbial Nutrition and Growth - Environmental factors affecting growth and control of microorganisms by physical and chemical agents. Microbial taxonomy.

Unit II: Microorganisms and Environment - Marine Microbiology – bacterial productivity and trophic relationships in the marine environment – Harmful algal blooms, Biogeochemical cycles in the marine environment.

Unit III: Aquatic Microbiology – Microflora of Fresh water and Estuarine Environment - Microbial pollution of natural waters, Pathogenic organisms in the freshwater environment, Sewage and waste water treatment.

Unit IV: Soil Microbiology – Soil microorganisms, Factors affecting the growth and survival of soil microbes, Microbial interactions in the rhizosphere soil. Biogeochemical cycles, Biofertilizers, Biopesticides, Bioremediation of polluted soil ecosystems.

Unit V: Microbiology of the Extreme environments – Archaeobacteria, Adaptations for survival in the extreme environment. Microbial interactions in the environment – symbiotic, beneficial and harmful.

References

1. Microbiology 5th Edition (2002) by Prescott, Harley and Klein. McGraw Hill Publishers, New York, USA.
2. Environmental Microbiology by Allan Varnam and Malcolm Evans, Manson Publishing, UK.
3. Microbial Ecology – Fundamentals and application – by Atlas and Bartha, 2nd Edition, Benjamin Cummins.
4. Industrial Microbiology by L.E. Cassida Jr.
5. Microbiological examination of water and waste water by Maria Csuros and CsabaCsuros, Lewis Publishers, Washington.

6. Laboratory methods in food and dairy microbiology by W.H. Harrigan and Margarete E MacCance, Academic Press, London.

Assessment Pattern:

| Examinations | Total Marks |
|------------------------|-------------|
| Sessionals - Internals | 50 |
| Finals | 50 |

Internals:

| Item | Marks |
|------------|------------------------|
| Attendance | 5 |
| Seminar | 10 |
| Tests | 25 (Average of two) |
| Assignment | 10 |
| Total | 50 |

Finals:

| Item | Marks |
|-------------------|-------|
| Final Examination | 50 |

EVS 2203: Advanced Environmental Chemistry: Theory

Duration: 1 Semester

Credits: 3

Total Lecture Hours: 54

Syllabus Content

Unit I: Analytical Instrumentations in Environmental Chemistry: Practices commonly followed selection of analytical techniques in regards to analysis, sampling and preservation practices. Uncertainty analysis and their propagations in determinations. Statistical treatment of test data; student t test, pooled t test & ANOVA. Theory, instrumentation and applications of Nephelometry, turbidimetry & flame photometry. Study of calibration graphs.

Unit II: UV- Visible Absorption Spectrometry- Theory, Instrumentation and applications & FTIR Spectrometry; Theory, instrumentation and applications for analyzing water, air and soils. Determination of iron and phosphate in natural water, air and soil.

Unit III: Theory, instrumentation and applications of flame photometry for the analysis of water, air and soils. Fluorescence spectrometry- Theory, Instrumentation and applications for the analyses of environmental samples.

Unit IV: Atomic Spectroscopic Techniques in Environmental Analyses - Theory, instrumentation and applications of Atomic Absorption Spectrometry (AAS):, Thermal AAS, Cold Vapor AAS, Interferences in AAS. Atomic Emission Spectrometry: Theory, Instrumentation and applications of Flame photometry, Flame Emission Spectrometry, Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-AES) and ICP/MS.

Unit V: Chromatographic Techniques in Environmental Analyses. Gas– Liquid Chromatography (GLC), Instrumentations for GLC- columns, stationary phases, detectors, applications. Gas – Solid Chromatography (GSC), Liquid chromatography (LC): High-Pressure Liquid Chromatography (HPLC), column efficiency in Liquid Chromatography (LC). LC-MS and its applications in air, water and soil analyses.

References

1. APHA Standards Methods for the Examination of Water and Wastewater Analysis, 22nd Edition, APHA. Washington DC.
2. Mendam, R.C. Denny, J.D. Barnes and J.K. Thomas (2007), Vogel's text book of Quantitative Chemical Analysis, 5th impression, Dorling Kindersley (India) Pvt. Ltd.
3. Douglas A. Skoog, F. James Holler and Stanley R. Crouch (2016) Instrumental Analysis, 3rd Indian Reprint, Brooks/Cole, a part of Cengage Learning.
4. Roger N. Reeve (2016/available latest), Introduction to Environmental Analysis, John Wiley & Sons Ltd., Chichester.
5. Douglas A. Skoog, F. James Holler and Timothy A. Nieman (1998/latest 2016), Principles of Instrumental Analysis, Fifth Edition, Saunders College Publishing.
6. Donald L. Pavia, Gary M. Lampman and George S. Kriz (2001/ latest 2016), Introduction to Spectroscopy, Third Edition, Harcourt College Publishers.
7. Dudley H. Williams and Ian Flemming (1991/ latest 2016), Spectroscopic methods and organic chemistry, Fourth Edition, Tata McGraw Hill Publishers.

Assessment Pattern:

| Examinations | Total Marks |
|------------------------|-------------|
| Sessionals - Internals | 50 |
| Finals | 50 |

Internals:

| Item | Marks |
|------------|-------|
| Attendance | 5 |
| Seminar | 10 |

| | |
|------------|------------------------|
| Tests | 25 (Average of two) |
| Assignment | 10 |
| Total | 50 |

Finals:

| Item | Marks |
|-------------------|-------|
| Final Examination | 50 |

EVS 2204: Environmental Pollution

Duration: 1 Semester

Credits: 4

Total Lecture Hours: 54

Syllabus Content

Unit I: Radiation- Sources in natural environment – Mechanism of radiation on living system Atmospheric, Aquatic and biological pathways and transport. Carbon and Tritium dating – Nuclear reactors, Probable sources of contamination. Radiation hazards. Radioactivity risk assessment.

Unit II: Water pollution- Sources and consequences. Chemical, Ecological and biochemical aspects. Characteristics of domestic, industrial, agricultural wastes, plastics. Chemical and bacteriological sampling and analysis; water quality parameters; criteria and standards, sewage and industrial waste water treatment methods. Case studies.

Unit III: Atmospheric pollution – definition, primary and secondary pollutants, criteria pollutants, sources and classification of air pollutants, Radioactive and thermal pollution sources and their effects on surrounding environment, natural and anthropogenic sources of pollution, air quality and emission standards, global implication of air pollution (Greenhouse gases, ozone layer depletion, photochemical smog and ozone, acid rain), transport and dispersion of pollutants - effect of meteorological and topographical factors, sampling of gaseous and particulate pollutants, their analysis, air quality models and its objectives, different types of models and its classification, Air pollution control equipments, national air monitoring programme, effects of air pollutants on humans, animals, plants and properties.

Unit IV: Noise pollution- Basic properties of sound waves-plane and spherical waves, sound pressure and intensity levels, decibel, effect of meteorological parameters on sound propagation, Measurement and analysis of sound, A weighted sound level, Equivalent sound pressure level (Leq), Noise pollution level (NPL), Sound exposure level (SEL), Traffic noise index (TNI), Day-Night level, Noise sources; Noise control and abatement measures; sound absorption coefficient (ast), sound absorbing materials, reverberation time, acoustic silencers, mufflers, barriers, vibration and impact isolation, anechoic chamber. Environmental problems associated with noise pollution.

Unit V: Soil pollution- Responses of plants to soil pollution, changes in soil characteristics, by waste disposal, sanitary landfills, mining wastes, and human activities, plants and animals in degraded soil; soil pollution.

References:

1. Mahajan S.P. (1998). Pollution control in process industries, Tata McGraw Hill, New Delhi.
2. Nylie C. Brady (1996). The Nature and Properties of Soil, 10th Ed., Prentice Hall of India Pvt. Ltd.
3. Parsons, S.A. and Jefferson, B. (2006). Introduction to potable water treatment processes, Blackwell Publishing.
4. Rao, C.S. (1995). Environmental Pollution Control Engineering, 3rd Ed., Wiley Eastern Ltd. New Age International Pvt. Ltd.
5. Raymond W. Miller and Roy L. Donalvee (1997). Soils in Our Environment, 7th Ed, Prentice Hall of India Pvt. Ltd.
6. Sharma.B.K. (2001). Water Pollution. Goel Pub. House. Meerut.
7. Wadhwa Y. (2009). Air Pollution: Causes and Control. Cyber Tech Publications, New Delhi.
8. Luyben, W. L. Process Modeling Simulation and Controls for Controls for Chemical Engineers, Mc. Graw Hill Book Co.

Assessment Pattern:

| Examinations | Total Marks |
|------------------------|-------------|
| Sessionals - Internals | 50 |
| Finals | 50 |

Internals:

| Item | Marks |
|------------|------------------------|
| Attendance | 5 |
| Seminar | 10 |
| Tests | 25 (Average of two) |
| Assignment | 10 |
| Total | 50 |

Finals:

| Item | Marks |
|-------------------|-------|
| Final Examination | 50 |

EVS 2205: Energy and Environment (3 Credits) – E-III

Unit I: First and second law of thermodynamics, heat transfer processes.

Unit II: Sun as source of energy, nature of its radiation, heat budget of the earth, earth's temperature and atmosphere. Photosynthesis, food-chains.

Unit III: Energy resources and their exploitation. Conventional and non-conventional energy sources: Fossil fuels-coal, oil and nature gas: hydroelectric power: tidal, wind, geothermal energy: biomass: solar collectors, photovoltaics, solar ponds: nuclear-fission and fusion, magnetohydrodynamic power (MHD).

Unit IV: Resources of energy, energy use pattern in different parts' of the world and its impact on the environment.

Unit V: Environmental implications of energy use, CO₂ emission in atmosphere, thermal pollution, radioactivity from nuclear reactors, fuel processing and radioactive waste, hazards related to hydropower. Radioactivity risk assessment, Environmental effects of radioactivity.

References:

1. Boyle, G., Bob Everett and J. Ramage. 2003. Energy System and Sustainability, Oxford University Press, New York.
2. Sudhakara Reddy, B.P. Balachandra. 2006. Energy, Environment and Development, Narosa Publishing House Pvt. Ltd., New Delhi.

EVS 2206: Eco-toxicology (3 Credits) – E-IV

Unit I: Introductory Remarks: Thrust on biochemical degradation of pollutants inside the cell as well as cellular interactions with the pollutants. Pollutant interaction with biological system at different levels, for example, organism, organs, and cell organelles. Bioconversion of pollutants: active vs. inactive process; enzymic degradation by monooxygenases; role of cytochrome P 450 and its multiple form.

Unit II: Metal toxicity: chemical form, metal bio-macromolecule interaction, teratogenicity and carcinogenicity. Cellular/Tissue injury: altered membrane permeability, free radical formation, lipid peroxidation, lysosomal degradation, superoxide dismutase.

Unit III: Principles in toxicology; Animal management in toxicological evaluation; Animal toxicity tests; Statistical concepts of LD₅₀; Dose-effect and Dose response relationship; Frequency response and cumulative response; Biological and chemical factors and influence toxicity; Bio-transformation and Bio-accumulation. Influence of ecological factors on the effects of toxicity.

Unit IV: Pollution of the Ecosphere by industries; Global dispersion of toxic substance; Dispersion and circulating mechanisms of pollutants; degradable and non-degradable toxic substances; food chain. Eco-system influence on the fate and transport of toxicants.

Unit V: Aquatic toxicity tests; Statistical tests; Response of planktons to toxicants; EC50; Photosynthetic bacteria; Bio-absorption of heavy metals. Information management system in Ecotoxicology.

References:

1. Newman, Michael, 1998. Fundamentals of ecotoxicology.
2. Moriarty, F., 1993. Ecotoxicology.
3. Doffs, John H 2009. Concepts in toxicology .
4. Crosby, Donald G, 1998. Environmental toxicology.
5. Calow, P. 1994. Handbook of Ecotoxicology. Blackwell Scientific Publications, London.
6. Forbes, V.E. and T.L. Forbes. 1994. Ecotoxicology in Theory and Practice. Chapman & Hall, London.
7. Hayes, W.A. 2001. Principles and Methods of Toxicology, CRC, USA.
8. Jacobson-Kram, D. 2006. Toxicological testing handbook: Principles, Applications and Data Interpretation, Taylor and Francis, New York.
9. Klaassen, C.D. and Watkins, J.B. 2003. Essentials of Toxicology, McGrawHill Professional, New Delhi.
10. Levin, S.A. and M.A. Harwell, J.R. Kelley and K.D. Kembell. 1989. Ecotoxicology: Problems and Approaches. Springer-Verlag, New York.
11. Pery, G. 1980. Introduction to Environmental Toxicology, Elsevier, Amsterdam.
12. Walker, C.H., R.M. Sibly, S.P. Hopkin and D.B. Peakall. 2012. Principles of Ecotoxicology, CRC Press, New York.
13. Wright, D.A. and Welbourn, P. 2002. Environmental Toxicology, Cambridge University Press, London.

SEMESTER II PRACTICALS

EVS 2207: Advanced Environmental Chemistry (2 Credits)-P-III

1. Structural determination of surface functional groups of a soil/clay sample using FTIR Spectra and the interpretation of results.
2. Nephelometric analysis of an industrial wastewater sample for its turbidity
3. Determination of sodium, potassium, calcium and magnesium of drinking water, groundwater, estuarine water, wastewater and seawater by flame photometry
4. Determination of Iron present in drinking water, groundwater, estuarine water, wastewater and seawater by spectrophotometry.
5. Determination of phosphate present in drinking water, groundwater, estuarine water, wastewater and seawater by spectrophotometry.
6. Determination of nitrite and nitrate present in drinking water, groundwater, estuarine water, wastewater and seawater by spectrophotometry.

7. Analysis of air for suspended particulate matter (SPM), carbon dioxide, oxides of nitrogen and hydrogen sulphide by conventional method using high volume sampler.
8. Determination of Kjeldahl nitrogen by conventional wet method.

Assessment Pattern:

| Examinations | Total Marks |
|-----------------------|-------------|
| Sessionals -Internals | 100 |

Internals:

| Item | Marks |
|-----------------|-------|
| Attendance | 10 |
| Lab performance | 20 |
| Tests | 50 |
| Record | 20 |
| Total | 100 |

EVS 2208: Environmental Microbiology (2 Credits)-P-IV

1. Introduction to Microbiology lab and basic equipments
2. Ubiquity of Microorganisms in the environment and aseptic techniques
3. Pure culture techniques and Microscopy
4. Isolation and enumeration of bacteria from Environmental Samples (Marine, Fresh Water, Soil and Food)
5. Identification of bacteria – Staining techniques – Simple stain, Gram stain, spore stain, capsule stain and negative staining.
6. Identification of bacteria – Bacterial Motility and Biochemical tests (Catalase, Oxidase and O/F test)
7. Isolation and enumeration of Fungi from Environmental samples – Microscopic observation of important classes of fungi.
Effect of environmental parameters (temperature, pH and salt) on microbial growth.
8. Water quality analysis – MPN of total and faecal coliforms. Membrane filter technique.

9. Important biochemical reactions of pathogenic bacteria – IMViC tests. Reactions on triple sugar iron agar, urease agar and carbohydrate fermentation tests.
10. Antibiotic sensitivity testing –Disk diffusion method.

Assessment Pattern:

| Examinations | Total Marks |
|-----------------------|-------------|
| Sessionals -Internals | 100 |

Internals:

| Item | Marks |
|-----------------|-------|
| Attendance | 10 |
| Lab performance | 20 |
| Tests | 50 |
| Record | 20 |
| Total | 100 |

SEMESTER III

EVS 2301: Environmental Conservation and Sustainable Development

Duration: 1 Semester

Credits: 3

Total Lecture Hours: 54

Syllabus Content

Unit I: Water Conservation: Current status of water resources, Global and National water budget, Watershed Management - Definition and principles of watershed management, morphological characteristics of watershed, classification of watershed and its management. Design of grassed waterway, graded and contour bunds, terraces. Water harvesting-rain water harvesting and recycling run-off collection.

Unit II: Mineral Conservation: Reserves and resources of world mineral supplies - Types of Minerals, Use and exploitation, Assessment of Indian mineral resources. Mineral resources of Kerala. Major mineral industries. Future mineral consumption and Indian economy - Energy demand and future supply. Environmental effects of extracting and using mineral resources Prevention of environmental hazards due to mining and atomic energy - Marine mineral resources and its sustainable utilization

and conservation methods. Approaches in mineral resource management - ecological approach; economic approach; ethnological approach; integrated resource management strategies.

Unit III: Biodiversity Conservation: Organisms-evolution and distribution in space and time: elements of energy flow, conservation and preservation: response of ecosystem to exploitation: convergence and divergence in species: diversity and the food chains: sustainable exploitation and development: wild-life conservation. Conservation-depletion rates model using fish stock as example.

Unit IV: The concept of sustainable development temporal and spatial dimensions; currencies for evaluations of sustainable development - Biophysical measurements; Environmental degradations and conservation issues; Global change and sustainability issues: Climate change, biological invasion, Bio-diversity concerns; Ecosystem and social processes.

Unit V: Rehabilitation of degraded rural landscape, (b) Rehabilitation of unbalanced soils, (c) Rehabilitation of specialized habitats, for example, Water bodies, mangroves, wet lands. (d) Mined area rehabilitation participatory research and education environmental decision making with people initiatives. Ramsar Convention on Wetlands.

References

1. P.W. Atkins and J de Paula. Physical Chemistry, 9thedn., Oxford University Press, 2010
2. S. Glasstone. Introduction to Electrochemistry, Nabu Press, 2014.
3. G.W. Castellan. Physical Chemistry, 3rdedn., Addison Wesley, 1983
4. F. Daniels and R.A. Alberty. Physical Chemistry, 6thedn., John Wiley, 1984
5. A.A. Frost and R.G. Pearson. Kinetics and Mechanisms, John Wiley, 1961
6. K.J.H. Laidler. Chemical Kinetics, Tata McGraw Hill, 1993
7. S. Glasstone. Textbook of Physical Chemistry, Macmillan India Ltd., 1995
8. Santra S.C., 2016 Environmental Science. New Central Book Agency (P) Ltd.
9. Mineral Economics by Sinha R.K. and Sharma N.L: Oxford and IBH, 1970.
10. World mineral suppliers by Govett. G.J.S and Govett M.H: Elsevier Amsterdam, 1976.
11. Economic Mineral deposits (Revised) by Jonsen, M.L.S and Bateman, A.M: John Wiley And Son, 1981.
12. Geology for Engineers by Blyth, I.G.H and De Freitas, M.H: ELBS Publications, 1992.

Assessment Pattern:

| Examinations | Total Marks |
|------------------------|-------------|
| Sessionals - Internals | 50 |
| Finals | 50 |

Internals:

| Item | Marks |
|------------|------------------------|
| Attendance | 5 |
| Seminar | 10 |
| Tests | 25 (Average of two) |

| | |
|------------|----|
| Assignment | 10 |
| Total | 50 |

Finals:

| Item | Marks |
|-------------------|-------|
| Final Examination | 50 |

EVS 2302: Environmental Policy and Legislations

Duration: 1 Semester

Credits: 3

Total Lecture Hours: 54

Syllabus Content

Unit I:International Environmental Laws: Evolution and development of International Environmental laws with reference to Stockholm Conference, Nairobi Declaration, Rio Conference, Rio+5 and the Rio+10, etc. Concept of agreement and treaty, Johannesburg treaty, GAAT and Environment, CITES, Montreal Protocol, Kyoto Protocol. Global environmental issues and International laws to control Global warming, Ozone depletion Acid rains, , CITES etc. Role of UN authorities in protection of Global Environment, Multinational authorities and agreements, future of International laws.

Unit II:Historical Background of constitutional provisions, Article 14, 15, 19, 21, 32,39, 47, Article 48(A), Art. 49, Art.51A (g) as fundamental duties of citizen and directive principles of state policy, Art.243, 243(G) and (W), Art. 246, 248 and other articles related to Environment, Writ provisions for the protection of environment: Nature, standing and doctrine of Pro Bono Publico, Judicial response.

Unit III:Environmental laws in India: Environmental Policy and laws. Statutory protection of the Human Environment: such as Indian Penal Code, Factories Act, Motor Vehicle Act, Hazardous Waste legislation for pollution abatement. Objectives of the Anti-pollution Acts. Institutional mechanism created under these acts and role and contribution in combining environmental pollution.

Unit IV:National Environmental Protection Legislations: The Water (Prevention and control of Pollution) Act 1974; The Air (Prevention and Control of Pollution) Act 1981; The Environment (Protection) Act 1986; Forest Act 1927; Forest Conservation Act 1980; The Wild life Protection Act 1972(2002 Amendment); Biodiversity Act 2002; The Noise Pollution (Regulation) 2000. Coastal Regulation Zone Notification 1991 & 2011, Need of CRZ rules for regulation the activities in coastal zone, Statutory provisions in IPC and CRPC. Environment related provisions in Public Liability Insurance Act, National Policy on EIA and Regulatory Framework: Rule & regulations of central & state Government and Central & State pollution control boards for Safeguard for Environmental Protection.

Unit V:Kerala State Environmental Regulations and Legislations: The KMMC Rules 1967,Public Health Act,Kerala Forest (Amendment Act), 2010,The Kerala Water (Prevention and Control of Pollution) Appellate Authority Rules, 1977,The Kerala protection of river banks and Regulation of removal of sand Act, 2001,The Kerala ground water (control and regulation) Act, 2002,The Kerala Forest (Vesting and Management of Ecologically Fragile Lands) Act, 2003,Kerala Municipality Building (Amendment) Rules, 2004 - RAINWATER HARVESTING,The Kerala Land Reforms (Amendment) Act, 2005,The Kerala Tourism (Conservation and Preservation of Areas) Act, 2005,The Kerala Irrigation and Water Conservation (Amendment) Act, 2006,Ban on plastics with thickness below 30 micron,Kerala Conservation of Paddy Land and Wetland Bill, 2007.

References:

1. Environmental Law and Policy of India ,Diwan,S. and Rosencranz, A,2001, Oxford University Press.
2. Environmental Policy in India, Shekhar Singh, IIPA, New Delhi
3. Declaration of :The Stockholm Conference,Rio, Rio+5 and Rio +10
4. Our Common Future,WECD,1991
5. Universal Environment and Pollution Law Manual , S.K.Mohanty,1998
6. Legal Aspects of Environmental Pollution and Management ,S.M.Ali,1992

Assessment Pattern:

| Examinations | Total Marks |
|-----------------------|-------------|
| Sessionals– Internals | 50 |
| Finals | 50 |

Internals:

| Item | Marks |
|------------|------------------------|
| Attendance | 5 |
| Seminar | 10 |
| Tests | 25 (Average of two) |
| Assignment | 10 |
| Total | 50 |

Finals:

| Item | Marks |
|-------------------|-------|
| Final Examination | 50 |

EVS2303: Environmental Impact Assessment

Duration: 1 Semester

Credits: 3

Total Lecture Hours: 54

Syllabus Content

Unit I: Introductory background: Perspective on Environment and Development. Nature and purpose of Environment laws; Origin, Principles and purpose of Environmental Impact assessment. EIA and sustainable development; EIA and project planning and implementation; EIA and building rules in India. Classification of projects for EIA.

Unit II: Process and Methods of EIA: Stages, Scoping, Alternatives, Impact Identification, Establishing the Environmental base line. Impact prediction, evaluation and mitigation. Criteria and standards for assessing significant Impact. Cost- Benefit Analysis and valuation of Environmental Impacts. Public Participation, presentation and review. EIA monitoring and auditing.

Unit III: EIA and Risk assessment and risk management: mitigation measures: comparison of alternatives: review and decision making: compensatory actions: green belts: review of procedures, practices and guidelines in India.

Unit IV: Case studies: river valley projects: thermal power plants: mining projects: oil refineries and petrochemicals; Tourism; development of Ports and Harbours.

Unit V: Issues and problems in Environmental assessment; challenges in implementation of EIA

References:

1. Charles, H. Eccleston (2011) *Environmental Impact Assessment*, CRC Press, New York.
2. Anjaneyulu, Y. and Manickam W. (2010) *Environmental Impact Assessment Methodologies*, BSP Books Pvt. Ltd., Hederabad
3. Lawrence, D. P. (2003) *Environmental Impact Assessment: Practical Solutions to Recurrent Problems*, John Wiley and Sons, New Delhi.
4. Glasson, Therivel and Chadwick (1999) *An Introduction to Environmental Impact Assessment*, UCLA, Los Angeles.
5. Morris, P. and R. Therivel (2001), *Methods of Environmental Impact Assessment*, Spoon Press.
6. Carter, L. (1996) *Environmental Impact Assessment*, McGraw Hill, New Delhi.
7. Anjaneyulu, Y. (2002) *Environmental Impact Assessment Methodologies*, B.S. Publications, New Delhi.
8. Weston, J. (1997) *Planning and EIA in Practice*, Longman.
9. Jos Arts and Angus Morrison-Saunders (2004) *Assessing Impact - Handbook of EIA and SEA follow-up*, Earthscan, London.
10. website of MoEF, GOI, New Delhi
11. Srivastava, D. C. (2005) *Readings in Environmental Ethics: Multidisciplinary perspectives*, Rawat Publications, Jaipur.

Assessment Pattern:

| Examinations | Total Marks |
|------------------------|-------------|
| Sessionals - Internals | 50 |
| Finals | 50 |

Internals:

| Item | Marks |
|------------|------------------------|
| Attendance | 5 |
| Seminar | 10 |
| Tests | 25 (Average of two) |
| Assignment | 10 |
| Total | 50 |

Finals:

| Item | Marks |
|-------------------|-------|
| Final Examination | 50 |

EVS2304: Environmental Genetics & Biotechnology

Duration: 1 Semester

Credits: 3

Total Lecture Hours: 54

Syllabus Content

Unit I: Introduction, Central dogma of molecular genetics, Experiments to show DNA as the genetic material, DNA replication, Nature of Genetic code. Mutation and Environmental mutagens: Occurrence, kinds of Mutation, spontaneous & induced Mutation, Mutagens, detection of Mutation, Lethal Mutations, Phenotypic effects of Mutation.

Unit II: Environmental Biotechnology : Definition, principles, scope – role of biotechnology in environmental protection; Bioremediation : Principle, types, Microbial, phyco-, zoo- and phytoremediation; biodegradation of organic pollutants : aerobic, anaerobic, co-metabolic; Biofertilizers and biopesticides : types; production and role in IPM; genetically engineered organisms – Bt toxin gene.

Unit III: Biotechnology for solid waste management : sanitary landfilling; Biocomposting– aerobic, anaerobic; vermicomposting; Biomethanation. Biotechnology for wastewater treatment : Microbial

processes in wastewater treatment; microbial biofilm and wastewater treatment; secondary treatment systems; nutrient removal through biomass production.

Unit IV: Biodegradation of persistent organic pollutants : microbial adaptations; enzymes catalyzing biodegradation; pathways of degradation; molecular aspects of biodegradation; Biosensors, biochips, biosurfactants – microbial production and their role in bioremediation.

Unit V: Microbial transformation of heavy metals : heavy metal tolerance; metal-microbe interactions; immobilization and transformation of metals; genetic aspects of resistance; applications in metal removal; Bioleaching and biomining. Bioenergy - Biofuel and biodiesel : biogas, butanol, biodiesel, ethanol, biohydrogen; bioenergy from wastes; Ecofriendly products : Biopolymers and bioplastics.

References:

1. Agarwal, S.K. 1998. Environmental Biotechnology. APH Publishing corporation, New Delhi
2. Baker, K.H. and D.S. Herson. 1994. Bioremediation. McGraw Hill Inc. New York.
3. Hoffmann, A.A. (1993). Evolutionary Genetics and Environmental Stress. Oxford University Press.
4. Jogdand, S.N. 1995. Environmental Biotechnology-Industrial Pollution Management. Himalaya Publishing House, Bombay.
5. Lehninger, A.L. 1998. Principles of Biochemistry. C.B.S Publishers & Distributors. Delhi.
6. Pradipta Kumar Mohapatra. 2006. Text Book of Environmental Biotechnology. I.K International Publishing House Pvt. Ltd. New Delhi.
7. Ram Kumar. 2000. Environmental Biodegradation. Sarup and Sons, New Delhi.
8. Reza Marandi and Ali Shaeri. 2009. Environmental Biotechnology. SBS Publishers and Distributors Pvt. Ltd. New Delhi.
9. Rick Lewis. 1998. Human Genetics - Concepts and Applications- 3rd Edition.
10. Strick Berger. 1996. Genetics. Prentice Hall of India, New Delhi.

Assessment Pattern:

| Examinations | Total Marks |
|------------------------|-------------|
| Sessionals - Internals | 50 |
| Finals | 50 |

Internals:

| Item | Marks |
|------------|------------------------|
| Attendance | 5 |
| Seminar | 10 |
| Tests | 25 (Average of two) |
| Assignment | 10 |
| Total | 50 |

Finals:

| Item | Marks |
|-------------------|-------|
| Final Examination | 50 |

EVS2305: Integrated Coastal Zone Management (3 Credits) - E-V

Unit I: Coastal natural resources systems: flora and fauna, trophic relationship, nutrient production, cycle and transport; Mangrove ecosystem - species diversity and distribution of mangroves in India, Other inter-tidal system- Seagrass system, Coral reef system, Sandy beach system, Lagoon and estuary system.

Unit II: Developmental activities and biodiversity loss: Ecological issues, Nonsustainable development, Pollution, threats to biodiversity, habitat destruction, Depletion of fisheries resources, impacts of global environment changes.

Unit III: Multiple uses of the Coastal Zone, Urban settlement, Industrial development, waste disposal, Shore protection works, ports and marine transportation. Land transportation infrastructure, Water control and supply projects, sea fisheries, Aquaculture, Coastal forest industries, Coastal agriculture, industries.

Unit IV: Coastal Zone Management: Integrated Coastal Zone Management (ICZM): its need and benefits, Principles, Goals and objectives of the ICZM programme; Scope, Extent of jurisdiction, Boundaries of the coastal zone, policies and planning for coastal resource management; Management mechanisms- Pollution control, Protected areas (sanctuaries, marine parks and biosphere reserves), Protection from natural hazards; Socioeconomic impacts and its assessment, Disaster management for coastal environment.

Unit V: Coastal tourism: Beach resorts, restaurants and parks within the coastal zone as per existing rules and regulations. Impact of pollution on coastal resources.

References:

1. Brahtz JFP. 1972. Coastal Zone Management. UN Department of International Economic & Social Affairs, New York.
2. Cairns J Jr. 1994. Implementing Integrated Environmental Management Virginia Tech. University.
3. Clark JR. 1992. Integrated Management of Coastal Zones. FAO Fisheries Tech. Paper No. 327, Rome.
4. Coastal Area Management and Development 1982. UN Department of International Economic & Social Affairs, New York.
5. David S & Jeremy P. 2001. Inshore Fisheries Management. Methods and Technologies in Fish Biology and Fisheries. Vol. II. Kluwer.
6. Khanna BK. 2000. All You Wanted to Know About Disasters. New India Publ. Agency.

EVS 2306: Fisheries Oceanography (3 Credits)-E-VI

Unit I: Oceanographic factors in fisheries: Effects of physicochemical and biological oceanographic factors on adaptation, behaviour, abundance and production of aquatic organisms.

Unit II: Space and time scales in oceanographic analysis; Speed and magnitude of short-term changes in the ocean; Synoptic oceanographic analysis – currents, waves, tides, amplitudes, stratification, related chemical factors, upwelling and circulation patterns.

Unit III: Forecasting systems: Fisheries forecasts – interpretation and use of ocean thermal structure in fisheries; Fisheries forecasting system in India and other countries – remote sensing; Global Positioning System (GPS). Application of Remote Sensing in fisheries; Application of echo-sounders and SONAR.

Unit IV: Coastal fishery: Coastal fishery and hydrography- introduction, scope and factors affecting; shoreline protection and influence of developmental activities on coastal hydrography. EEZ and territorial waters.

Unit V: Factors affecting marine fisheries: Environmental factors influencing the seasonal variations in fish catches in the Arabian Sea and the Bay of Bengal.

References:

1. Grasshoff K, Ehrhardt M & Kremling V. 1983. Methods of Seawater Analysis. Verlag Chemie.
2. Kennish MJ. 1989. Practical Handbook of Marine Science. CRC Press.
3. Laevastu T & Hayes ML. 1981. Fisheries Oceanography and Ecology. Fishing News Books.
4. Lalli CM & Parsons TR. 1993. Biological Oceanography: An Introduction. Elsevier.
5. Miller CB. 2004. Biological Oceanography. Blackwell.
6. Reddy MPM. 2007. Ocean Environment and Fisheries. Science Publ.

EVS 2307: Environmental and Occupational Health (3 Credits) – E-VII

Unit I: Basic principle of environmental health. Physiological responses of man to relevant stresses in the environment. Cases and effects of pollution.

Unit II: Industrial Toxicology: Study of environmental dose effect relationships. Evaluation of toxicity and threshold limits. Principles and methods of occupational health. The relationship of occupation of hygiene and safety and disease.

Unit III: Health maintenance: Survey, analysis and recommendations regarding health and safety problems in the working and living environment.

Unit IV: Biostatistics, epidemiology: Application of statistical methods to medical records in the study of health problems of human population in a given environment. Treatment of variation, with demographic, vital statistics and epidemiologic data.

Unit V: Hazard evaluation in polluted environment with specific emphasis on radiological health. Industrial hygiene technology-laboratory remains illustrating the principles, methods of recognizing evaluating and controlling environmental hazards like air pollution, etc.

References:

1. Kemm, J; Parry, J; Palmer, S (2004). Health Impact Assessment: Concepts, theory, techniques and applications, Oxford University Press, New York. 63
2. Pandey, K, Shukla, J.P and Trivedi, S.P (2005). Fundamentals of Toxicology. New Central Book Agency (P) Ltd., Kolkata.
3. Park, K. (2005). Park's Text Book of Preventive and Social Medicine, 18th Edition. M/s. Banarsidas- Bhanot Publishers, Jabalpur.
4. Paul, N. Chermisnoff (1997). Health and Toxicology - Advances in Environmental Control Technology Series, Gulf Publishing Company, Texas, U.S.A.
5. Santra, S.C. (2004). Environmental Science. New Central Book Agency (P) Ltd. Kolkata.
6. Yashpal, W (2009). Air Pollution: Causes and Control. Cyber Tech Publications, New Delhi.

EVS 2308: Environmental Modelling (3 Credits) – E-VIII

Unit I: Introduction to programming- algorithms, data structures, control structures, introduction to linux and matlab. Introduction to modeling principles- Newton's laws of motion governing fluid flow- basic hydro dynamic equations, model calibration, model validation and model applications,

Unit II: model parametrisation, boundary conditions, simple numerical schemes in modeling- simple procedures for solving differential equations, finite difference methods, finite element methods, Data requirements in modeling, Introduction to Calculus methods and linear Algebra, matrices. Introduction to scientific computing.

Unit III: Numerical methods- numerical optimization, Bayesian methods, basic approximations and assumptions in environmental modeling, Horizontal and vertical grids in model calibration

Unit IV: types of models- Numerical models, Statistical model, Graphic model and Analog models, scaled models, important parameters of modeling- model domain, scale and resolution, Model dimensions and coordinates, model fitting.

Unit V: simple dispersion, diffusion models, Concepts of water quality and air quality models, Basic principles of hydrological modeling and hydro dynamical modeling- concepts of coastal and estuarine water modeling. Demonstration of simple two dimensional model tools and applications.

References:

1. Barnsley, M. J., 2007, Environmental Modeling: A Practical Introduction, CRC Press, 432pp.
2. Boas, M. L., 1985, (2nd ed) Mathematical Methods in the Physical Sciences, Wiley, 793pp.
3. Boeker, E. and van Grondelle, R., 2001, Environmental Science, Physical Principles and Applications, 2nd ed, Wiley.
4. Gauch, H., 2002, Scientific Method in Practice, CUP.
5. Gershenfeld, N., 2002, The Nature of Mathematical Modelling, CUP.
6. Goodchild, M.F., Parks, B.O. and Steyaert, L.T. 1993 Environmental Modelling with GIS, Oxford: Oxford University Press.
7. Hardisty et al., 1993, Computerised Environmental Modelling: A practical introduction using Excel, John Wiley and Sons.
8. Monteith, J. L. and Unsworth, M. H., Principles of Environmental Physics, Edward Arnold.

9. Sivia, D. S., with J. Skilling, 2008 (2nd ed) Data Analysis: A Bayesian Tutorial, OUP, 246pp.
10. Wainwright, J. and Mulligan, M., 2004, Environmental modelling: finding simplicity in complexity, Chichester, Wiley.

SEMESTER III PRACTICALS

EVS2309: Environmental Biotechnology (2Credits)-P-V

1. Genomic and plasmid DNA isolation
2. PCR and gel electrophoresis
3. Restriction digestion
4. Cloning
5. Single-cell protein production
6. Case studies on wastewater treatment/recirculatory systems
7. Quantification of N fixation, nitrification;
8. Screening of microbes for biodegradation properties.

Assessment Pattern:

| Examinations | Total Marks |
|-----------------------|-------------|
| Sessionals -Internals | 100 |

Internals:

| Item | Marks |
|-----------------|-------|
| Attendance | 10 |
| Lab performance | 20 |
| Tests | 50 |

| | |
|--------|-----|
| Record | 20 |
| Total | 100 |

SEMESTER- IV- DISSERTATION

6 MONTHS PROGRAMME

In the fourth semester students need to do project work of 6 months duration, which can be done either at KUFOS or at any other scientific institutions/ university/ research centres. The project has got internal as well as external evaluation. The mark for internal examination is 200 and external mark is also 200 with total of 400 marks for project. The project must be evaluated by a committee consisting of the head of the department, internal examiner/ guide and an external examiner appointed by university authorities.

EVS 2401: Projects*

- a. **Dissertation based on project work**
- b. **Credit seminar based on project work**
- c. **Field Survey**
- d. **Environmental field diary #**

* Preferably should be done in recognized sister institutions.

Assessment Pattern:

| | Total Marks |
|-------------------------------|--------------------|
| Sessionals - Internals | 200 |
| Finals | 200 |
| Total | 400 |

Internals:

| Item | Marks |
|---------------------|--------------|
| Originality | 50 |
| Presentation | 100 |
| Work/Report | 50 |
| Total | 200 |

Finals:

| Item | Marks |
|--------------------|-------|
| Project Evaluation | 100 |
| Presentation | 100 |
| Total | 200 |

EVALUATION AND MARK DISTRIBUTION

The evaluation of each course shall contain two parts – Internal Assessment and External Assessment.

External: Internal Ratio

➤ **50:50 - For all courses**

INTERNAL ASSESSMENT

The Sessional evaluation is to be done by continuous assessment of the following components. The components of the evaluation for theory and practical and their weights are as below.

Distribution of internal marks:

1. For all courses

- Attendance - 5 marks
 - Assignment - 10 marks
 - Seminar - 10marks
 - Test paper - 25marks (Average of 2)
- Total – 50 Marks**

2. ForPracticals

- Attendance – 10 Marks
- Lab performance – 20 Marks
- Tests - 50Marks
- Record – 20 Marks **Total -100 Marks**

Distribution of Marks for Assignments and Seminars:

- Assignments

| Components | Marks |
|-------------|-------|
| Punctuality | 4 |

| | |
|---------|----|
| Content | 6 |
| Total | 10 |

➤ **Seminars**

| Components | Marks |
|--------------|-------|
| Content | 4 |
| Presentation | 6 |
| Total | 10 |

Environmental field diary is an event based activity write up: Environmentally important days on which students can organize events/seminars/talks/workshop and record the activity as a diary. This will be observed in the second and third semester of their study and the report submitted in the fourth semester.

| | |
|---|--------------------------------|
| World Water Day | 03-22: March 22 |
| Earth Day | 04-22: April 22 ^[2] |
| World Fish Migration Day | April 21, 2018 |
| International Day for Biological Diversity (World Biodiversity Day) | 05-22: May 22 |
| Bike-to-WorkDay | 05: third Friday in May |
| World Environment Day | 06-05: June 5 |
| World Oceans Day | 06-08: June 8 |
| World Population Day | 07-11: July 11 |
| International Day for the Preservation of the Ozone Layer | 09-16: September 16 |

| | |
|--|---|
| World Water Monitoring Day | 09-18: September 18 |
| Zero Emissions Day[5] | 09-21: September 21 |
| Car Free Day | 09-22: September 22 |
| Ecological Debt Day (Earth Overshoot Day) | 09-23: September 23 in 2008, but receding |
| World Environmental Health Day | 09-26: September 26 since 2011 (IFEH) |
| World Rivers Day | 09: last Sunday in September |
| World Habitat Day | 10: first Monday in October |
| International Day for Natural Disaster Reduction | 10: second Wednesday in October , October 13. |
| Sustainability Day | 10: fourth Wednesday of October |
| International Day of Climate Action | 10-24: October 24 |