

References:

1. Asthana D.K. and Meera Asthana., 2006. A text Book of Environmental Studies, S. Chand & Co. Ltd., New Delhi.
2. Clemente, J. 2016. Earth and Environmental Sciences, Intech Publishers.
3. Dar, I.A. 2016. Earth and Environmental Science, Intech Publishers.
4. Reed Wicander and James and S. Monroe. 2002. Essentials of Geology, Wadsworth Publishing Co.
5. Richard, J. and Ordway, D. Earth Science and the Environment, Van Nostrand and Company, London.
6. Rose, D.A. Introduction to Oceanography.
7. Valdia, K.S. 1987. Environmental Geology.
8. Venkat Reddy and Winker, H.G.F. 1988. Petrogenesis of Metamorphic Rocks. McGraw Hill Publishers.
9. Venkat Reddy. 1995. Engineering Geology for Civil Engineers, Oxford and IBH Publ., Co. Pvt. Ltd., New Delhi.

ESH413 ENVIRONMENTAL MICROBIOLOGY AND BIOTECHNOLOGY 52 hrs.

Course Outcomes:

CO1 Study types of microorganisms, sterilization and culturing techniques.

CO2 Describe the adaptive mechanisms of microorganisms in the extreme environments.

CO3 Study in detail milk, air, soil and water microbiology and bioremediation techniques.

CO4 Describe the role of microbes in degradation of waste.

CO5 Get knowledge on microbiological aspects of environment which support employability.

CO6 Understand biotechnological aspects which help in entrepreneurship.

UNIT I (13 hours)

Classification and characteristics of microorganisms. Microbial growth and growth curves, sterilization, culturing techniques and identification of microbes. Soil microflora and methods of their estimation. Biological nitrogen fixation (symbiotic and non-symbiotic), microbial phosphorus solubilization and their importance in soil fertility and agriculture. Microbes in water and methods of their estimation (e.g. MPN), drinking water standards, water-borne diseases and prevention.

UNIT II (13 hours)

Microbial symbiosis, mutualism, plant-microbe interactions (e.g. mycorrhizas), animal-microbe interactions (human, ruminants and non-ruminants). Microbes in hydrothermal vents and coral reefs – adaptive mechanisms. Microorganisms as bio-indicators in the environment. Milk microflora and their estimation. Microflora of air and methods of their estimation, air-borne diseases and prevention.

UNIT III (13 hours)

Bioremediation: Microbial bioremediation – *in situ* and *ex situ* bioremediation, phytoremediation, advantages and disadvantages. Biogas production and utilization. Biosensors and biochips –types, and applications. Intellectual property rights, traditional

knowledge digital library (TKDL), biopiracy, bioterrorism and biowarfare.

UNIT IV (13 hours)

Biotechnological approaches for the degradation of waste – pesticides, plastic, hydrocarbons, petrochemicals, tannery wastes, textiles, dyes, detergents, distillery and paper. Mariculture-mollusc culture, crustacean culture, seaweed culture, finfish culture, biomolecules from marine organisms. Biofertilizer - importance and classification, vermicomposting. Microbial mining, biofilms, biofouling and its prevention, microbial influenced corrosion and remedies.

References:

1. Arora, D.R. and Aora, B. 2012. Text Book of Microbiology, CBS Publ. & Dist. Pvt. Ltd., New Delhi.
2. Brock, T.B. and Madigon, M.T. Biology of microorganisms, Prentice Hall.
3. Cambell, R. Microbial Ecology. Blackwell Scientific Publ., London.
4. Dubey, R.C. Text book of Biotechnology.
5. Indu Shekhar Thakur. Text book of Environmental Biotechnology.
6. Pelzar. Text book of Microbiology.
7. Pradipta Kumar Mohapatra. Text book of Environmental Biotechnology.
8. Sharma, P.D. Environmental Microbiology.
9. Singh S.N. and Tripathi R.D. Environmental bioremediation technologies.
10. Singh, B.D. Text book of Environmental Biotechnology.

SOFT CORE COURSES

ESS414 ENVIRONMENTAL STATISTICS

39 hrs.

Course Outcomes:

CO1 Learn applications of matrices in environmental impact assessment and management.

CO2 Gain the knowledge of fundamental aspects of environmental statistics.

CO3 Learn the statistical packages available for environmental data analysis.

CO4 Learn sampling techniques in the field of Environmental Science.

UNIT I (13 hours)

Types of sampling. Descriptive vs. Inferential Statistics. Measures of location - mean, median, mode. Measures of dispersion - variance, standard deviation, range and interpercentile ranges. Dispersion Percentages, skewness, concepts of outliers. 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. Graphs and Displays-Introduction, z-Scores and Percentile Ranks, Stem and Leaf Displays.

UNIT II (13 hours)

Matrices and Determinants: Types of matrices, addition and subtraction of matrices. Multiplication of a matrix by a scalar. Products of matrices. Evaluation of 2×2 determinants. Inverse of 2×2 matrices. Combinations of transformations. Eigenvalue. Applications of