

Ahmednagar Jilha Maratha Vidya Prasarak Samaj's
New Arts, Commerce and Science College, Ahmednagar
(Autonomous)

(Affiliated to Savitribai Phule Pune University, Pune)



Choice Based Credit System (CBCS)

Framework for Syllabus

Master of Science (M.Sc.)

Implemented from

Academic year 2022 -23

Ahmednagar Jilha Maratha Vidya Prasarak Samaj's
New Arts, Commerce and Science College, Ahmednagar
(Autonomous)

Board of studies in Environmental Science

Sr. No.	Name	Designation
1.	Dr. Satish D.Kulkarni	Chairman
2.	Prof.Dr. N.R.Bandella	Academic Council Nominee
3.	Dr. Nilesh Wagh	Academic Council Nominee
4.	Dr, Deepali Nimbalkar	Vice-Chancellor Nominee
5.	Dr. D. D.Ahire	Member
6.	Dr. A.P.Pandit	Member
7.	Prof.Dr. D.C. Meshram	Member (co-opt)
8.	Dr. Ashish V.Mane	Member (co-opt)
9.	Mr. Kaliprasad Ningurkar	Alumni
10.	Dr. Prakash Mundhe	Industry Expert

M Sc. Part I Environmental Science

Semester-I

Course Type	Course Code	Course Title	Credits
DSCC-01 (04)	MSC-EN111T	Environmental Biology & Biodiversity	04
DSCC-02 (04)	MSC-EN112T	Environmental Physics & Chemistry	04
DSCC-03 (04)	MSC-EN113T	Environmental Geosciences	02
DSCC-04 P	MSC-EN114 P	Environmental Sciences Practical based on EN-111	02
DSCC-05 P	MSC-EN115 P	Environmental Sciences Practical based on EN-112	02
DSCC-06 P	MSC-EN116P	Environmental Sciences Practical based on EN-113	02
DECC-01 T	MSC-EN117 T(A)	Environmental Statistics	02
DECC-01 T	MSC-EN117 T(B)	Atmospheric Science	02
DECC-02 P	MSC-EN118 P(A)	Practical based on EN-117 (A)	02
DECC-02 P	MSC-EN118 P(B)	Practical based on EN-117 (B)	02
GE-01	MSC-EN119T	Environmental Instrumentation	02
TOTAL			22

Semester-II

Course Type	Course Code	Course Title	Credits
DSCC-07 (04)	MSC-EN211T	Water & Soil Pollution: Management & Mitigation	04
DSCC-08 (04)	MSC-EN212T	Air, Noise & Radiation Pollution: Management & Mitigation	04
DSCC-9(04)	MSC-EN213T	Environmental Law, Ethics & Policy	02
DSCC-10 P	MSC-EN214 P	Environmental Sciences Practical based on EN- 211	02
DSCC-11 P	MSC-EN215 P	Environmental Sciences Practical based on EN-212	02
DSCC-12 P	MSC-EN216P	Environmental Sciences Practical based on EN-213	02
DECC-03 T	MSC-EN217 T(A)	Forestry and Habitat Management	02
DECC-03 T	MSC-EN217 T(B)	Water and waste water Technology	02
DECC-04 P	MSC-EN218 P(A)	Practical based on EN-217 (A)	02
DECC-04 P	MSC-EN 218 P(B)	Practical based on EN-217 (B)	02
GE-02	MSC-EN219T	Research Methodology	02
TOTAL			22

M Sc. Part II Environmental Science

Semester-III

Course Type	Course Code	Course Title	Credits
DSCC-13 T	MSC-EN311 T	EIA & Environmental Audit	04
DSCC-14 T	MSC-EN312 T	Remote Sensing & GIS	04
DSCC-15 T	MSC-EN313 T	Restoration Ecology and Watershed Management	02
DSCC-16 P	MSC-EN314 P	Practical based on EN- 311 T	02
DSCC-17 P	MSC-EN315 P	Practical based on EN-312 T	02
DSCC-18 P	MSC-EN316 P	Practical based on EN-313 T	02
DECC-05 T	MSC-EN317 T(A)	Environmental Biotechnology -I	02
DECC-05 T	MSC-EN317 T(B)	Environmental policy, Climate change and Sustainability	02
DECC-06 T	MSC-EN 318 IT(C)**	In-plant training & Report	02
GE-03	MSC-EN319T	CETP-STP-ETP Operation and Maintenance	02
TOTAL			22

Semester-IV

Course Type	Course Code	Course Title	Credits
DSCC-19 T	MSC-EN411 T	Solid & Hazardous Waste Management	04
DSCC-20 T	MSC-EN412 T	Renewable and Non-renewable energy	04
DSCC-21 T	MSC-EN413 T	Environmental Toxicology and Health	02
DSCC-22 P	MSC-EN414 P	Practical based on EN- 411 T	02
DSCC-23 P	MSC-EN415 P	Practical based on EN-412 T	02
DSCC-24 P	MSC-EN416 P	Practical based on EN- 413 T	02
DECC-07 T	MSC-EN417 T(A)	Environmental Biotechnology -II	02
DECC-07 T	MSC-EN417 T(B)	Environmental Economics	02
DECC-08 PR	MSC-EN 418PR(C)**	Project Work/Dissertation	02
GE-04	MSC-EN419T	Basics in Industrial Safety	02
TOTAL			22

Opt any one from EN-417A or B

**EN-418 is compulsory course

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Details of Syllabus

Masters of Science (M.Sc.)

Implemented from

Academic year 2022 -23

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Prologue/ Introduction of the programme:

M.Sc. in Environmental Science happens to be a 4-semester course spread across 2 years and is mostly full time. Candidates enrolled in the course have the option of specializing in many different areas such as Ecology, Engineering, Chemistry and, Biology Conservation. After completing this course, the postgraduates usually engage in research with respect to the protection of natural resources and the discovery of new resources, management and control of waste (domestic and industrial) and even opt for environmental conservationist or engineer, etc. This a newly emerging domain in the science field especially in the wake of greater awareness about environmental issues in today's technologically driven world. To understand the unique adjustments and modifications in the environment and its effect on organism's especially agricultural species, this dimension of scientific study has gained momentum of late. This field has become a prominent part of biology and biomedical research.

The course plans to address the developing requirement for skilled experts in the public eye for applying best administration rehearses attracted from different orders to make inventive answers for a maintainable future. M.Sc. Environmental Science program plans to create prepared experts who are furnished to manage the logical, lawful, financial, mechanical, and approach-based concerns identified with the condition and asset the board. M.Sc. Environmental Science program additionally expects to build up an all-encompassing way to deal with natural and asset-based issues in understudies from various scholarly, social, and expert foundations. The educational program has been structured basically on the idea of reasonable improvement in a between disciplinary system, with an accentuation on research and application.

Programme outcomes (Pos) (M.Sc. Environmental Science):

PO.1. Ability of Problem Analysis: Student will be able to analyse the problems of physical as well as cultural environments of both rural and urban areas. Moreover, they will try to find out the possible measures to solve those problems.

PO.2. Conduct Social Survey Project: They will be eligible for conducting social survey project, which is necessity for the assessment of development status of a particular group or section of the society.

PO.3. Individual and teamwork: Works effectively as an individual and as a member or leader in diverse teams and in multidisciplinary settings.

PO.4. Application of modern instruments: Students will be able to apply various modern instruments for data collection and field survey.

PO.5. Application of GIS and modern Geographical Map Making Techniques: Students will learn how to prepare map based on GIS by using the modern geographical map-making techniques.

PO.6. Critical Thinking: Students will be able to understand and solve the critical problems of physical and cultural environment.

PO.7. Development of Observation Power: As a student of Geography, they will be capable to develop their observation power through field experience and in future, they will be able to identify the socio-environmental problems of a locality.

PO.8. Development of Communication Skill and Interaction Power: After the completion of the course, they will be efficient in their communication skill as well as power of social interaction.

PO.9. Effective Citizenship: Demonstrate empathetic social concern and equity centred national development and the ability to act with an informed awareness of issues and participate in civic life through volunteering.

PO.10. Enhancement of the ability of Management: Demonstrate knowledge and understanding of the management principles and apply these to their own work, as a member and leader in a team, to manage projects. They will perform effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO.11. Ethics: Recognize different value systems including your own, understand the moral dimensions of your decisions and accept responsibility for them.

PO.12. Understand Environmental Ethics and Sustainability: Understand the impact of the acquired knowledge in societal and environmental contexts and demonstrate the knowledge of need for sustainable development.

PO.13. Self-directed and Life-long Learning: Acquire the ability to engage in independent and life-long learning in the broadest context social, environmental and technological changes.

PO.14. Presentation Skill: Students are being able to understand and write effective reports and design credentials, make effective demonstrations, give and receive clear instructions.

EN-2022

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Syllabus of M.Sc. Environmental Science
(Under Faculty of Science)**

**M Sc. Part II
Environmental Science**

Semester-III

Course Type	Course Code	Course Title	Credits
DSCC-13 (04)	MSC-EN311T	EIA & Environmental Audit	04
DSCC-14 (04)	MSC-EN312T	Remote Sensing & GIS	04
DSCC-15 (04)	MSC-EN313T	Restoration Ecology and Watershed Management	02
DSCC-16 P	MSC-EN314 P	Practical based on EN- 311	02
DSCC-17 P	MSC-EN315 P	Practical based on EN-312	02
DSCC-18 P	MSC-EN316P	Practical based on EN-313	02
DECC-05 T	MSC-EN317 T(A)	Environmental Biotechnology –I	02
DECC-05 T	MSC-EN317 T(B)	Environmental policy, Climate change and Sustainability	02
DECC-06 T	MSC-EN 318IT(C)**	In-plant training & Report	02
GE-03	MSC-EN319T	CETP-STP-ETP Operation and Maintenance	02
TOTAL			22

Opt any one from EN- 317A or B

***EN-318 is compulsory course*

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Semester –III	Paper -I
Course Code: MSC-EN311T	Title of the Course: EIA & Environmental Audit
Credits: 04	Teaching Hours: 60

Course outcomes (Cos):

- To understand the basics of Environmental impact studies
- To understand the legal framework for EIA studies
- To know the various procedure used in EIA studies
- The student will aware regarding the preparation of EIA report
- Students will understand the Environmental audit and its type

Unit. No.	Name of the Unit	Course contents	Number of lectures
1	Introduction	<ul style="list-style-type: none"> • Definition, aims and objectives of EIA. • Concept and Scope of EIA. Evolution of EIA in India. • Benefits of EIA. Drawbacks in EIA process. 	4
2	Legislation and Procedures	<ul style="list-style-type: none"> • National Environmental Policy Act (NEPA) of 1969, USA. EIA notification 1994, 2006 and 2020 (draft) for india. • EIA legislative requirements and administrative procedures in India / States of India. • Accreditation of EIA consultants by Quality Control of <ul style="list-style-type: none"> ▪ India 	8
3	Methodology	<ul style="list-style-type: none"> • Importance of Baseline data collection for EIA procedure • Guidelines used for collection of baseline data for <ul style="list-style-type: none"> • different environment • Scoping, Screening, Prediction and Mitigation in air, water, soil, noise and biological environment. • Methods – adhoc, matrix, checklist, overlays and network 	10
4	Prediction and assessment of impacts	<ul style="list-style-type: none"> • Air, water, noise, biological, cultural and socio-economic. • Case studies of EIA- • sugar and distillery, • projects of road /dams • urban development • petrochemical/ chemical industry • New air port set up 	8

5	Public participation and report writing	<ul style="list-style-type: none"> Public participation in environmental decision making, regulatory requirement, techniques, advantages and disadvantages of public participation, Preparation and writing of EIA report 	08
6	Environmental management plan	<ul style="list-style-type: none"> Planning and selection of appropriate resource management procedures for – Water, air, land, soil, solid wastes. Resources recovery and reuse, Occupational safety and health. Risk assessment. Disaster management plan. Prevention, maintenance and operation of environment control systems. Socio-economic factors – human settlements, culture, occupation, water, electricity supply, transport systems, education, communication, health care facilities. 	10
7	Environmental Audit	<ul style="list-style-type: none"> Definition and its importance for industries. Audit tools and technology Audit methodology and basic structure of audit. Elements of an audit process and its importance. Environment Audit in India – Development of environmental auditing in India, Concept of ISO 14000, requirements of Rule 14 for environmental audit under Environmental Protection Act, 1986. Types of audits- Environment Compliance Audit..signatory, consumption <ul style="list-style-type: none"> audit, pollution audit, hazardous audit, solid waste audit, disposal audit, cost audit, investment audit, voluntary audit 	12

Reference Books:

- Handbook of Environmental Impact Assessment (Volume 1 — EIA: Process, Methods and Potential & Volume 2 — EIA in Practice: Impact and Limitations), Judith Petts *Vol. 02, No. 03, pp. 449-451 (2000)*
- Environmental Impact assessment – Lawry w. canter Second Edition, Mc Graw Hill publication, india
- Environmental Impact assessment Raman, N.s. Gajbhiye and khandeshwar I.K. international publication house, new delhi
- Principles and Application of Environmental Impact Assessment (EIA) : Publisher : Benard aOmoyeni; ISBN:978-978-948-354-9 edition (30 October 2015)
- Environmental Impact Assessment: Raman, N.S. and Rao, Y.R. LAXMI PUBLICATIONS PVT. LTD

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Syllabus of M.Sc. Environmental Science

(Under Faculty of Science)

Semester –III	Paper -II
Course Code: MSC-EN312T	Title of the Course: Remote Sensing & GIS
Credits: 04	Teaching Hours: 60

Course outcomes (Cos):

- Students will acquire the basic information of remote sensing
- Understand the various platform, orbit and sensor used in RS and GIS
- Understanding the importance and interpretation of aerial photograph and its interpretation
- Understand the basics of GIS and Data structures in GIS and Acquisition of spatial data

Unit. No.	Name of the Unit	Course contents	Number of lectures
1.	Aerial photography and Air Photo Interpretation	<ul style="list-style-type: none"> • Basic geometric characteristics of aerial photographs. Scale, resolution, overlaps, flight • planning, Measurement of height on aerial photograph, Principle of relative tonality, • minimum mapping unit, Photo interpretation elements for visual interpretation 	4
2.	Basics of remote sensing	<ul style="list-style-type: none"> • Definition, EMR spectrum, Radiation laws, Active and passive remote sensing: Optical, • Thermal, Microwave, Resolution of Remote sensing data: Spatial, Spectral, Radiometric and Temporal, Spectral signatures, Hyper-spectral sensing 	5
3.	Interaction of EMR with the earth's surface and atmosphere	<ul style="list-style-type: none"> • Energy response mechanism: Reflection, Absorption, Transmission, Scattering, Refraction, Reflectance, Emission and scattering, Bi-directional Reflection Distribution Function (BRDF), • Atmospheric windows. 	04
4.	Platforms, Orbits and Sensors:	<ul style="list-style-type: none"> • Types of platform; Geostationary orbit and Sun-synchronous Polar orbit; • Multi spectral scanning, Scanning Systems (Push broom and Whiskbroom); • sensors- LISS III, LISS IV, PAN, WIFS, Carto-sat, Landsat, IKONOS, SRTM, ASTER GDEM 	07
5.	Digital Image Processing and	<ul style="list-style-type: none"> • Factors governing Interpretability, Elements of image interpretation. Image correction, • rectification and enhancement technique, Image fusion, 	06

	Interpretation	<ul style="list-style-type: none"> image contrast stretching and image filtering. Image classification. 	
6.	Basics of GIS	<ul style="list-style-type: none"> Definition and Objectives of GIS, Concept of space and time, components of GIS, basic entities of GIS: line point and polygon. Map Projection: Conical, Azimuthal and Cylindrical. LCC Projection, UTM and Polyconic projections. Types of Datum. 	08
7.	Data structures in GIS and Acquisition of spatial data	<ul style="list-style-type: none"> Raster data, Vector data, comparative overview. Non-spatial data - Hierarchical, Network and relational data. Scanning, Geo-referencing, concept of layer, digitizing, error detection and correction, concept and type of topology. 	08
8.	Spatial Analysis	<ul style="list-style-type: none"> Vector based: Overlays operations- point in polygon, line in polygon, polygon in polygon; single layer operations and Multilayer operations. Raster based: Map algebra, Grid based operations, Local, Focal, Zonal and Global functions. Buffering, Network Analysis, Terrain Analysis, Digital Terrain Models and generation of Thematic maps. 	10
9.	Applications of RS and GIS in Environmental Issues	<ul style="list-style-type: none"> Land use-land cover changes: Natural hazards and hazard management, floods, landslides and other natural hazards, monitoring water quality and soil quality, mineral exploration, lithological and structural mapping, Use of GIS to represent environmental status and highlight environmental issues. 	08

- Lillisand, T. M. and Keifer, R. W. (1990): Remote Sensing and Image interpretation, John Willey and Sons, New York
- Joseph G. (2003): Fundamentals of Remote Sensing, Universities Press, Hyderabad.
- Haywood, Ian (2000): Geographical Information Systems, Longman
- Chang, Kang-taung (2002): Introduction to Geographic Information Systems, Tata McGraw-Hill.
- Burroughs, P. A (1986): Principles of Geographical Information Systems for land Resource Assessment, Oxford University Press.
- Gupta, R. P. 2003. Remote sensing geology, Springer, New York
- Barrett, E. C. and Curtis, L. F. 1999. Introduction to environmental remote sensing. Chapman and Hall

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Semester –III	Paper -III
Course Code: MSC-EN313T	Title of the Course: EN313 Restoration Ecology and Watershed Management
Credits: 02	Teaching Hours: 30

Course outcomes (Cos):

- To understand the significance of restoration ecology
- Understanding the Restoration of urban eco-system, biodiversity and habitat
- Student will aware of Water balance studies and harvesting methods
- To understand the Watershed management practices used

Unit. No.	Name of the Unit	Course contents	Number of lectures
1	Introduction And steps in eco-restoration	<ul style="list-style-type: none"> • Eco Restoration: definition, principles, significances, guidelines, • Identifying problem, assessment of project sites and parameters, • identifying threats, methods available for restoration, selection of • restoration methods, monitoring techniques for effective • restoration 	06
2	Applications of eco-restorations	<ul style="list-style-type: none"> • Restoration of urban eco-system: water (lakespond, river) and wastewater (Sewage and industrial effluent), • Biodiversity restoration, ecosystem on hill region, Eco-restoration of mines (open cast), restoration of solid waste dumping sites, • Improving aesthetics by partial restoration at industrial sites • Restoration of other natural habitats/eco-systems) Mangroves, grasslands, wetland 	06
3	Concept of watershed management	<ul style="list-style-type: none"> • Definition, principle, objectives, Water shed morphology and characterization (with respect to size, elevation & slope, aspects & orientation, watershed shape, drainage network), 	08

		<ul style="list-style-type: none"> • Collection, storage, dispersal, habitat, Attenuation response, • flushing, etc. Engineering surveys involved in watershed • development: Topographical survey, drainageline survey, contour • survey, common instruments used for survey. • Hydrological survey: Methodology for groundwater investigation, • investigation of surface springs, vertical distribution of ground water 	
4	Water balance studies and harvesting methods	<ul style="list-style-type: none"> • Water balance and hydrologic equation, inflow to the watershed, outflow from the watershed. Water harvesting methods: traditional water harvesting structures • such as nadis, Khadin, Rapats, Lakes, etc. contour bunding, graded bunds /field • bunds, land leveling or terracing, farm ponds; 	04
	Water harvesting in streams	<ul style="list-style-type: none"> • Biological measures, check dam, gully plug, Gabion • structure, Overflow weir, earthen dam, Underground bandhara. Soil and water • conservation aspects: contour trenches, continuous contour benches, live hedges, • infiltration pit, in situ conservation through <ul style="list-style-type: none"> ▪ appropriate cultivation practices 	06

Reference Books

1. Restoration of Nature by Prakash Gole
2. Restoration Ecology the new frontier – edited by Jelte Van Andel and James Aronson – Wiley-Blackwell publication ISBN 9781444336368
4. A source book for Ecological Restoration by Foundation for Ecological Security 2008
5. Foundations of Restoration Ecology (The Science and Practice of Ecological Restoration Series) - Donald A. Falk, Margaret Palmer, Joy Zedler, Richard J. Hobbs
6. Watershed manual by BK Kakde (BAIF and LEAD India publication)
7. Water Harvesting and Sustainable Supply in India by RN Athavale Centre for Environment Education ISBN: 8170337526
8. Watershed Hydrology by Peter Black ; Lewis Publishers: ISBN 1575040271
9. Soil and water conservation engineering by R. Suresh – Standard Publishers and Distributors ISBN 8180140008

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Semester –III	Paper –IV
Course Code: MSC-EN314P	Title of the Course: EN 314 Practical based on EN-311 Environmental EIA and Environmental Audit
Credits: 02	Total hours -60 Total Practical: (12x 4= 48 Hours) Internal and External evaluation =12 hours

Course outcomes (Cos):

- How the baseline data of the project will come to know?
- To know the various methods used in base line data collection
- How to prepare the EIA reports?
- Student will understand the legal framework constituted in India

Unit	Title	No. of practical
	Inventory data collection and its interpretation of – <ul style="list-style-type: none"> • Air • Water • Soil • Noise • Biodiversity • Groundwater • Urban Settlement • Highways • Dam 	9
	Legal framework for EIA in India	1
	EIA report Writing	1

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Semester –III	Paper -V
Course Code: MSC-EN315P	Title of the Course: EN315 Practical based on EN-312 Remote Sensing and GIS
Credits: 02	Total hours -60 Total Practicals:. (12x 4= 48 Hours) Internal and External evaluation =12 hours

Course outcomes (Cos):

- **Understanding aerial image reading and interpretation**
- **Understand the use of QGIS software in data framing and interpretation**
- **To understand the importance of Geo-referencing**

□

Unit	Title	No. of practical
	Aerial photo image interpretation	2
	Aerial photo geometry, scale, measurement of relief numerical	1
	GPS: collection of field data	2
	Installation and familiarization with QGIS free software	1
	. Browsing and downloading data: From LANDSAT, BHUVAN	1
	Topo sheet, Geo referencing Topo sheet Digitization & Preparation of map and map layout	2
	Satellite image registration.	1
	Satellite image enhancement and correction tools	2
	Image classification: Supervised and unsupervised Satellite image interpretation	2

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Semester –III	Paper -VI
Course Code: MSC-EN316P	Title of the Course: EN 316 Practical based on EN-313 Restoration Ecology and watershed Management
Credits: 02	Total hours -60 Total Practicals:. (12x 4= 48 Hours) Internal and External evaluation =12 hours

Course outcomes (Cos):

- **To understand the mapping of geographical area in watershed management**
- **To understanding and marking and estimation of watershed area from provided map**
- **To study the factors affecting on deterioration of ecosystem**
- **To prepare environmental management plan for degraded site**

Unit	Title	No. of practical
	Mapping of watershed (marking of ridge areas and drainage lines), estimating area and slope.	2
	i) Watershed Planning exercises at micro watershed level, ii) Location specific with identifying specific Watershed interventions required.	2
	Delineation of watersheds using topo sheets and estimating of perimeter, area and slope	1
	Surveying and preparation of watershed map	1
	Quantitative analysis of watershed characteristics and parameter	
	i) Rapid site assessment and data interpretation of any degraded ecosystem (field visit) -Solid waste management ii) Rapid site assessment and data interpretation of any degraded ecosystem (field visit) -Stone quarry or river/stream basin	2

	Use of algae for the removal of pollutant from aquatic resources	1
	Use of aquatic plant for the removal of excessive nutrient from aquatic resources	1
	Use of microbial flora for removal of heavy metals	1
	Use of microbial flora for removal of oil contamination	1
	Prepare the inventory of indigenous and exogenous plantation in restoration of degraded land	1
	Prepare the report on invasive species in degraded site	1

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Semester –III	Paper –VII(A)
Course Code: MSC-EN317 (A)T	Title of the Course: EN-317 Environmental Biotechnology -I
Credits: 02	Teaching Hours: 30

Course outcomes (Cos):

- To understand the basics of microbiology
- To know the application of biotechnology in environment conservation programme
- Student will learn about the environmental quality monitoring, and remediation measures.
- Students will understand the concept of bio-mining and bioleaching

Unit. No.	Name of the Unit	Course contents	Number of lectures
1	Introduction	<ul style="list-style-type: none"> • Domains of life, General characters, important uses and harmful effects of a) Protozoa b) algae, • c) fungi, d) bacteria, e) Viruses • The scope of environmental biotechnology; • Concept and broad outlines of various application areas 	4
2	Microbial Ecology and Biotechnology	<ul style="list-style-type: none"> • Microorganisms and Symbiosis, • Microbial Resources & Environmental Continuum, • Xenobiotic degradation, Biomining and Bioleaching 	4
3.	Bio-tools	<ul style="list-style-type: none"> • Bioindicator, Biomarker, Biosensors, Principle, Types, Applications • Bio-monitors for detecting environmental Contaminants and remediated sites 	6
4	Wastewater Treatment techniques	<ul style="list-style-type: none"> • Aerobic & Anerobic Processes, • Activated sludge process, • Trickling Filter, • CSTR, • UASB, • Fluidized Beds, • Rotating Biological Contractor. 	4

5	Bio-energy	<ul style="list-style-type: none"> • Biomass composition and types; • Energy plantation, its advantages and disadvantages • Waste to Energy Conversion and energy conservation and Management 	6
6	Biofuels	<ul style="list-style-type: none"> • Alternative source of fuel production; • Mechanism of various biofuel productions. • Fermentation technology using bioreactors, • Biomethanation, Bioethanol, Biohydrogen 	6

. Reference books

1. Rittman, B.E. & McCarty, P.L. 2001. Environmental Biotechnology. Principles and Applications. McGraw-Hill, New York. 6. Scagg, A.H. 2005. Environmental Biotechnology. Oxford University Press
2. Wainwright, M. 1999. An Introduction to Environmental Biotechnology. Springer.
3. Jordening, H.J. & Winter J. 2005. Environmental Biotechnology: Concepts and Applications. John Wiley & Sons.

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Semester –IV	Paper –VII(B)
Course Code: MSC-EN317T(B)	Title of the Course: EN 317 (B) Environmental policy, Climate change and Sustainability
Credits: 02	Teaching Hours: 30

Course outcomes (Cos):

- To understand global warming and its impact
- Students will aware regarding the climate change and its impact on various sectors
- To know the various declaration made by IPCC regarding the climate change
- Role of UNFCCC and the various protocol for mitigation of climate change
- To understand the basic composition and related theories.
- To understand the climate change and economics.
- Understand the mitigation policies regarding Climate change

Unit. No.	Name of the Unit	Course contents	Number of lectures
1	Classification of Climate	Need & Objectives of Classification <ul style="list-style-type: none"> • Basics of Classification: • Climatic Types & their Distribution • Tropical Rainforest (Wet) Climate ,Tropical Wet & Dry Climate(AW) , Savannah Climate. • Koppen's classification of Climate ,Advantages & Disadvantages of Koppen's Classification • Trewartha's Classification of Climate 	06
2	Climate Change	Impact of climate change on- <ul style="list-style-type: none"> • Natural Vegetation, Agriculture, Animal Husbandry, 	06

		Housing, diseases, Urban Planning, Biodiversity and Coastal environment	
3	Climate Change Impacts and their Policies	<ul style="list-style-type: none"> • Stockholm Declaration 1972, Nairobi Declaration 1982, • Earth Summit Rio 1992, • Kyoto Protocol 1997, • Copenhagen Summit 2008, • Durban Summit 2011, • Paris agreement 2015. • Role of : IPCC, UNFCCC in climate change 	06
4	Climate Economics	<ul style="list-style-type: none"> • carbon Sequestration; Role of agricultural land in carbon sequestration; Concept of Carbon footprint, carbon credits and carbon trading • Concept of water footprint, water trading and its relationship to climate change • Mitigation Measures at Different scales- Global, National, Organizational, Individual. 	06
5	Indian government role in mitigation of climate change programme.	<ul style="list-style-type: none"> • National Solar Mission and Enhanced Energy Efficiency mission. • National Mission on Sustainable Habitat National Mission for Sustaining Himalayan Ecosystem (NMSHE) • National Mission for a Green India and Sustainable Agriculture. • National Water Mission • National Mission on Strategic Knowledge for Climate Change (NMSKCC). 	06

References :

1. Alternative Energy: S. Vandana; APH Publishing Corporation
2. Solar Energy: Fundamentals and Applications, by Garg & Prakash, Tata McGraw-Hill Education, 2000
3. Nuclear Energy – Principles, practice and prospects: S. K. Agarwal; APH Publishing Corporation
4. Bio-Energy Resources: Chaturvedi; Concept Pub.
5. The Atmosphere – Lutgens & Tarbuck
6. IPCC Reports on Climate Change
7. Fundamentals of Environmental Science: A Global Concern Cunningham & Cunningham
8. Environmental Science – Daniel Chiras (Case Studies
9. Climatology- D.S. Lal , Shraddha Publication , Allahabad
10. Physical Geography- Majid Husain, Rawat Publication, Jaipur

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Semester –III	Paper -VIII
Course Code: MSC-EN318 P	Title of the Course: EN318- Practicals In-plant Training
Credits: 02	Total hours -60 Total Practicals: (12x 4= 48 Hours) Internal and External evaluation =12 hours

Course outcomes (Cos):

- To understand the the function and processing of administration
- Acquire the knowledge of instrumentation, process, methodology
- Student will prepare report
- Participate in EHS related activities in organization

Unit	Title	No. of Hours 30
1.	<p>SUMMER INTERNSHIPS / IN-PLANT TRAINING (2 CREDITS)</p> <ul style="list-style-type: none"> • Students are expected to spend a minimum of 30 days during their semester break under the guidance of a competent professional / scientist at a research institute or research centre with the aim of learning techniques and their applications. • The assessments should be based on supervisor's feedback, • submission of a training report and a open presentation and Viva-voce. 	

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Semester –III	Paper -IX
Course Code: MSC-EN319T	Title of the Course :EN319- CETP-STP-ETP Operation and Maintenance
Credits: 02	Teaching Hours: 30

Course Outcome :

- To understand the unit operation in industries for waste water treatment
- To know the various machinery used in waste water treatment
- Understanding the troubleshooting of effluent treatment plant
- Precautionary measures and troubleshooting of effluent treatment plant

nit. No.	Name of the Unit	Course contents	Number of lectures
1.	Introduction of industrial wastewater	<ul style="list-style-type: none"> • Introduction and type of wastewater from different sector and its characteristics • Introduction of wastewater parameters considered in Effluent Treatment Plant (pH, BOD, COD, Ammoniac Nitrogen, TSS, TDS.etc) • Collection and conveyance of wastewater, types of collection systems, wastewater conveyance systems 	06
2.	Introduction to operation of effluent treatment plant	<ul style="list-style-type: none"> • I Introduction of Unit Operations • Introduction of Unit Processes • Introduction of various treatment process (Preliminary Treatment, Primary Treatment, Secondary Treatment, Tertiary Treatment) • Introduction of mechanism of Physicochemical, Biological Treatment, Advanced Oxidation or Tertiary Treatment • Laws, regulations and Environment Standards • Preparation of ETP/ CETP flowchart 	06
3.	Introduction of plant's equipment	<ul style="list-style-type: none"> • I Introduction of Pumps/Motors/Blowers/Gearbox • II Introduction of Units such as Screens (Coarse/Fine Bar screens, Manual/Mechanically operated), Sump and Pumping Stations including Pumps, Motors and Panels 	06

		<ul style="list-style-type: none"> • (Centrifugal Horizontal / Vertical Turbine) • Introduction of Valves (Sluice gates, non-return, Reflux) • Introduction of Pipes/Specials and Pipe Joints • Introduction of Sludge Sump, Sludge Pump, Secondary Sludge Sump • Introduction of Aerators 	
4.	Introduction of troubleshooting of effluent treatment plant	<ul style="list-style-type: none"> • Troubleshooting of Primary Units • Troubleshooting of Secondary Units • Troubleshooting of Tertiary Units • Troubleshooting of Sludge Treatment Units • Commissioning and Shutdown of Effluent Treatment Plant 	06
5.	Introduction to occupational health & safety	<ul style="list-style-type: none"> • Introduction and Necessity to Occupational Health and Safety • Introduction of Hazards associated with ETP Operation • Introduction to basic first aid and firefighting • How to control fire at workplace • Do's and Don'ts in ETP Operation for Safety • Personnel Protective Equipment (PPE) for ETP Operation & Maintenance • Safe Handling of Chemicals such as Chlorine, PAC, FeSO₄, FeCl₃, Alum, Lime 	06

References :

1. Frank R. Spellman - Handbook of Water and Wastewater Treatment Plant Operations, CRCpress, London
2. Syed R Qasim -1985 Wastewater treatment plants 2 nd edition , CRC press London
3. Naresh Singh (Author)-2017 Handbook of Water and Wastewater Treatment Plant Operations
Publisher : Oxford Book Company (1 January 2017 ISBN-10 : 9350303574, ISBN-13 : 978-9350303573
4. Kumar Garg 1977 Environmental Engineering Water Supply Engineering

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Semester-IV

Course Type	Course Code	Course Title	Credits
DSCC-19 (04)	MSC-EN411T	Solid & Hazardous Waste Management	04
DSCC-20 (04)	MSC-EN412T	Renewable and Non-renewable energy	04
DSCC-21(04)	MSC-EN413T	Environmental Toxicology and Health	02
DSCC-22 P	MSC-EN414 P	Environmental Sciences Practical based on EN- 411	02
DSCC-23 P	MSC-EN415 P	Practical based on EN-412	02
DSCC-24 P	MSC-EN416P	Practical based on EN- 413	02
DECC-07 T	MSC-EN417 T(A)	Environmental Biotechnology -II	02
DECC-07 T	MSC-EN417 T(B)	Environmental Economics	02
DECC-08 PR	MSC-EN 418PR(C)**	Project Work/Dissertation	02
GE-04	MSC-EN419T	Basics in Industrial Safety	02
TOTAL			22

Opt any one from EN-417A or B

***EN-418 is compulsory course*

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Semester -IV	Paper –I
Course Code: MSC-EN411T	Title of the Course: Solid & Hazardous Waste Management
Credits: 04	Teaching Hours: 60

Course outcomes (Cos):

- Understanding The characteristics of solid waste management and factors affecting on it
- Understanding the the methods of MSW and BMW characteristics and disposal methods
- Students will know the implication of e-waste and plastic waste
- Understanding the legal framework for disposal and treatment of solid and hazardous waste

Unit. No.	Name of the Unit	Course contents	Number of lectures
1	Introduction	<ul style="list-style-type: none"> • Definition, Source and type based classification, chemical and physical composition, Environmental and health impacts due to solid waste and its handling of it. • Characterization: physical & chemical characteristics, • implications for solid waste management. • Factors affecting solid waste management: <ul style="list-style-type: none"> • Climate, • financial, • cultural • constraint, • quality and quantity of waste. 	8
2	Municipal Solid Waste and Biomedical waste management	<ul style="list-style-type: none"> • Generation, Collection, segregation, Transportation, Transfer stations, processing and disposal. Assessment of existing situation & possible areas for improvement • : Define, scope, categorization, segregation, packaging/colour coding and container used, treatment, transport and disposal, status in India 	8
3	Hazardous waste management and Industrial solid waste	<ul style="list-style-type: none"> • Identification and sources, characteristics and categorization, Collection, segregation, packaging, labelling, transportation, processing (3R), • risk assessment and waste management treatment and disposal, • storage and leak detection, Site selection criteria, manifest system and records, 	8

		<ul style="list-style-type: none"> Indian scenario, Responsibilities of various authorities Pulp and paper, Sugar, thermal power station, textile, food processing, mining, agriculture, etc. 	
4.	Electronic waste management:	<ul style="list-style-type: none"> A growing problem, sources, segregation, collection, recovery of valuable materials, treatment and disposal method 	4
5.	Plastic waste management	<ul style="list-style-type: none"> types of plastic, sources, the problem of plastic waste, degradation of plastics, recycling & alternatives to plastic, Maharashtra Plastic Ban notification 2018 	4
6.	Treatments and disposal methods of waste	<ul style="list-style-type: none"> Waste processing, Recovery of biological and chemical conversion products composting, bio-methanation, RDF system, hydrolysis, Pyrolysis, plasma gasification, incineration, sanitary landfills. Resource conservation and recycling 	10
7.	Hazardous and other Wastes (Management & Transboundary Movement) Rules, 2016	<ul style="list-style-type: none"> Hazardous Waste Management Rules for- safe handling, generation, processing, treatment, package, storage, transportation, use reprocessing, collection, conversion, and offering for sale, destruction and disposal of Hazardous Waste 	8
8.	Construction and demolition waste and batteries management	<ul style="list-style-type: none"> Legal aspects Technical Guidelines Recycling(rules and regulations) 	6

Reference Books:

- 1.M.S. Bhatt and Asherefillian. 2012. Solid Waste Management: An Indian Perspective.
2. S. Bhatia. 2007. Solid and Hazardous Waste Management. Atlantic publication.
3. Goel, Sudha (Ed.). 2017. Advances in Solid and Hazardous Waste Management
4. M.N. Rao & Razia Sultana. Solid and Hazardous Waste Management
5. M. . Rao Raia sultanari Harsha Kotanil hah Naresh Davergave. 2016. Solid and Hazardous Waste Management: Science and Engineering. 1st Edition. Butterworth-Heinemann publication.
6. George Tchobanoglous & George Tchobanoglous. 2002. Handbook of Solid Waste Management. 2nd edition. McGraw- Hill publication

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Semester –IV	Paper –II
Course Code: MSC-EN412T	Title of the Course: EN412 Renewable and Non-renewable energy
Credits: 04	Teaching Hours: 60hrs

Course outcomes:

- To understand human development index and energy consumption pattern
- Information related with non-renewable energy and its impact on HDI
- Renewable energy importance and its methods of harvesting

Unit. No.	Name of the Unit	Course contents	Number of Lectures
1	Energy indicator for development:	<ul style="list-style-type: none"> • Human development index,(HDI) definitions, Human energy requirement, Energy use pattern and its impact on the environment; • Energy use pattern in India. Sources of energy and their classification; Energy forms and transformation. 	06
2	Fossil Fuels	<ul style="list-style-type: none"> • Classification, composition, physiochemical characteristics; Energy content of coal, petroleum and natural gas; Formation, reserves, exploration/ mining and uses of Coal, Oil and Natural gas; • Environmental problems associated with exploration / mining, processing, transportation and uses 	07
3	Solar Energy	<ul style="list-style-type: none"> • Sun as source of energy: source of sun's energy solar spectrum • solar radiation – absorption, reflection, scattering and diffusion in the atmosphere, • Renewable Energy Integration and Decentralized Generation Systems. • Harnessing of solar energy, Photovoltaics, Solar collectors and concentrators, Solar thermal energy, Solar electricity generation, Solar heaters, dryers, and cookers • Energy Storage Systems and Fuel Cells • Energy in Buildings • Energy Planning and Economics and Energy Field Visits/Industrial Training. 	12

4	Hydroelectricity	<ul style="list-style-type: none"> Principles of generation of hydroelectric power hazard related to hydropower generation and distribution, environmental impact. 	06
5	Geothermal Energy	<ul style="list-style-type: none"> Introduction Resources- crust, mantle, high temperature aquifers, low temperature aquifers, reserves; Harnessing of geothermal energy – problems and prospects Nature of fields, Comparison of Flashed Steam and Total Flow Concept, Turbines used in Geothermal Energy Power Plant, advantages and disadvantages of geothermal energy, Geothermal energy prospect in India. 	12
6	Hydrothermal Energy	<ul style="list-style-type: none"> Hydrothermal energy; Tidal and wave energy, Problems and prospects. Small-Hydro and Other Hydrothermal Power Plant: Vapour Dominated - High Pressure and Low Pressure Liquid Dominated – Single Flash, Double Flash and Binary System 	09
7	Nuclear energy	<ul style="list-style-type: none"> Fission and fusion, Nuclear fuels, – Mining and processing of Uranium –concentration, refining, enrichment, fuel fabrication and fuel cycle; Nuclear reactors and radioactive waste; Environmental implications. 	08

References :

- Renewable Energy – Environment and Development: M. Dayal; Konark Pub. Pvt. Ltd.
- Alternative Energy: S. Vandana; APH Publishing Corporation
- Solar Energy: Fundamentals and Applications, by Garg & Prakash, Tata McGraw-Hill Education, 2000
- Nuclear Energy – Principles, practice and prospects: S. K. Agarwal; APH Publishing Corporation
- Bio-Energy Resources: Chaturvedi; Concept Pub.
- National Energy – policy, crisis and growth: V S. Mahajan; Ashis Publishing House
- Geography and Energy – Commercial energy systems and national policies: J.D. Chapman

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Semester –IV	Paper –III
Course Code: MSC-EN413T	Title of the Course: EN-413 Environmental Toxicology and Health
Credits: 02	Teaching Hours: 30 Hrs

Course outcomes (Cos):

- To understand the significance of environmental toxicology
- Importance of Occupational health hazards and safety measures
- To understand the safety measures and risk assessment at workplace
- To know the legal framework available in India for safety at workplace

Unit. No.	Name of the Unit	Course contents	Number of lectures
1	Introduction, Measurement and Evaluation of toxicity	<ul style="list-style-type: none"> • Fundamental of toxicology, Basic concepts, toxicity and its impacts. Nature of toxic effects, Acute and Chronic. • Industrial toxicants and hazardous materials. • Hazardous Measurement of toxicity- LD50, LC50, Nature of dosage-response relationship. Use of dosage-response information, Factors influencing toxicity., • Physiological and metabolic effects of toxicants on human being; -VOC and organic solvents, used in industry, and • Heavy metals -Hg, As, Cr, Cu, Pb, Al, Zn etc. • Effects of Mutagenic, carcinogenic compound and Anti-cancer drugs on human health. 	5
2	Toxicity testing, Guideline	<ul style="list-style-type: none"> • National Regulatory Guidelines (FSSAI, GOTS, CPCB, CDSCO) • International Regulatory Guidelines (US FDA, OECD, US EPA, ICH, TTC) 	6
4	Health Hazards and Occupational Toxicology	<ul style="list-style-type: none"> • Identification of potential, health hazards in industrial and development projects, reduction strategies: • Occupational hazards- Physical hazards, Chemical hazards, Biological hazards, Mechanical hazards, Psychosocial hazards 	7

		<ul style="list-style-type: none"> • asbestosis, anthracosis, byssinosis, bagassosis, Farmers' lung • Occupational Cancer- Skin cancer, Lung cancer, Bladder cancer, Leukaemia • 	
5	Health and Safety Risk Management	<ul style="list-style-type: none"> • HIRA (hazard identification risk assessment) • Risk identification, allocation and mitigation strategies, responsibilities and authority. • Potential of health risks in industrial and development processes, local and national policies. • Public awareness and participation in prevention procedures. • Industrial environmental conditions, emissions and noise abatement 	6
6	Occupational health and safety legislation in India	<ul style="list-style-type: none"> • Overview of the existing OHS legislation in India • The Factories Act • The Mines Act • The Workmen's Compensation Act • The Employees' State Insurance Act • Present status of OHS legislation in India 	6

Reference Books

1. Casarett and Doull's Toxicology: The Basic Science of Poisons 8TH EDITION , tata McGraw Hill Publication , New Delhi
2. Jasen Armstrong Toxicology Handbook 3rd Edition – 2015

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Semester –IV	Paper -IV
Course Code: MSC-EN414P	Title of the Course: EN 414 Practical based on EN-411 Solid & Hazardous Waste Management
Credits: 02	Total hours -60 Total Practical: (12x 4= 48 Hours) Internal and External evaluation =12 hours

Course outcomes (Cos):

- Student will understand the methods of segregation and treatments of solid waste disposal
- Practical will provide the importance of solid waste as compost
- Student will estimate the potential of energy recovery from solid waste
- Analysis of domestic and industrial waste characteristics.

Unit	Title	No. of practical
1.	Study of moisture content in solid waste	1
2.	Estimation of calorific value of solid waste	1
3.	Estimation of organic carbon in compost	1
4.	Preparation of chart of biomedical waste inventory in local area	1
5.	Preparation of solid waste segregation methods in waste disposal site	1
6.	Prepare the data inventory of E waste generation in college area	1
7.	Short report preparation on Hazardous waste management act - 2016	1
8.	Write the report on disposal guidelines of battery and plastic Waste	1
9.	Visit to industrial Solid and hazardous waste disposal site	1
10.	Visit to domestic and Biomedical waste treatment site	1

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Semester –IV	Paper –V
Course Code: MSC-EN415P	Title of the Course: EN 415 Practical based on EN-412 Renewable and Non-renewable energy
Credits: 02	Total hours -60 Total Practicals:. (12x 4= 48 Hours) Internal and External evaluation =12 hours

Course Outcome:

- The student will estimate the calorific value of various fuels.
- Understanding the phenomenon of wind mill installation and functioning
- Acquiring the information of bioconversion methods used in disposal of solid waste.
-

Sr.No.	Title	Unit
1.	Estimation of calorific value from anthracite and bituminous coal	1
2.	Estimation of heat, combustion of fuel sample	1
3.	Study of carbonization process in wood pyrolysis (charcoal preparation)	1
4.	Analysis of wind power available for installation of windmill	1
5.	Estimation of average daily solar radiation with help of sunshine recorder	1
6.	To calculate the lux intensity at various day time availability with lux meter.	1
7.	Estimation of bioconversion ratio of biological degraded residues	1
8.	Analysis of Saponification value of oil by KOH method	1
9.	Visit to wind power mill station	1
10.	Prepare a short report on household solar gadgets	1
11.	Visit to hydroelectricity unit and prepare a report on it	1
12.	Calculating half-life period of provided radioactive substances	1

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Semester -IV	Paper –VI
Course Code: MSC-EN416P	Title of the Course: EN 416 Practical based on EN- 413 Environmental Toxicology and Health
Credits: 02	Total hours -60 Total Practicals: (12x 4= 48 Hours) Internal and External evaluation =12 hours

Course outcomes (Cos):

- To understand the phytotoxicology experiment in laboratory
- Effect of heavy metals and behavioral symptoms observation in lab experiment
- To understand the Occupational environment and its importance in industries
- To understand the importance of fire and safety by demo experiments

Unit	Title	No. of Practical
	Study on effect of heavy metal toxicants on the germination of seeds	1
	Determination of LC 50 of any toxicant.	1
	Estimation of any toxicant by agar diffusion assay.	1
	Effect of Heavy Metal toxicants on the behavior pattern of Earthworm.	1
	Basic Toxicity Assays: Ames Assay	1
	Basic Toxicity Assays: MTT assay	1
	Basic Toxicity Assays Comet Assay	1
	First Aid Practices	1
	Safety Practices in scientific Laboratories.	1
	Demonstration of Fire Protection (fire extinguishers, Fire hydrant system, sprinkler system, fire alarm)	2
	Industrial visit for occupation health and safety management. Hazard and risk analysis - a industrial case study	1

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Semester –IV	Paper –VII (A)
Course Code: MSC-EN 417T	Title of the Course: EN-417 (A) Environmental Biotechnology-II
Credits: 02	Teaching Hours: 30hrs.

Course outcomes (Cos):

- The student will learn methods of biodegradation physical/chemical environments.
- Students will understand the phenomenon of phytoremediation.
- Students will understand the concept of bioethics, biosafety and IPR.
- Students learn about different methods of nanotechnology.
- Students learn about various techniques of composting.

Unit. No.	Name of the Unit	Course contents	Number of Lectures
1	Biodegradation/ Phytoremediation	<ul style="list-style-type: none"> <input type="checkbox"/> Biodegradation Concept, Introduction to contaminants, Strategies of degradation, Environmental effects on microbial degradation, <input type="checkbox"/> Kinetics of Biodegradation, Polymer Cycling & Degradation <input type="checkbox"/> Phytoremediation: Principle, Mechanism, Types, Processes, Advantages & Disadvantages, <input type="checkbox"/> Metal Phytoremediation. 	6
2	Bioremediation	<ul style="list-style-type: none"> • Principles, Factors and Strategies, • Bioremediation Of Heavy Metals:- Environmental Modification, Removal and Recovery, • Solid Waste- Solid Waste, Generation, Composition, • Solid Waste Disposal and different biological techniques of degradation 	6
3	Bio fertilizers & Bio pesticides	<ul style="list-style-type: none"> • Bio fertilizers - Perspective, Types, Potential Use , Nitrogen Fixation 	6

		<ul style="list-style-type: none"> • Composting - Technology, Composting Processes and factors influencing composting • Vermicomposting: Chemical characteristics • Operating procedure. • Bio-pesticides - Concept, Manufacturing, Classification of Biological Pest Control • Integrated Pest Management: - Concept, IPM-factors and components, • Biological Measures and Monitoring • Molecular Resistance Management - BT- Plant Pesticides, • Resistance Development, EPA- Registration 	
4	Bioethics, Biosafety, IPR	<ul style="list-style-type: none"> • Bioethics- Genetically Modified Plants (GMP), Genetically Modified Animals (GMA), Genetically Modified Microorganisms (GMMs), Agriculture & Healthcare. • Biosafety:- Biosafety, Cartagena Protocol, Biosafety Regulations. • IPR:- Biotechnology Innovation, Patent Consideration, • Patented Products & Process, • Intellectual Property Right- India, • IPR- Advantages. 	06

Reference Books :

- 1G M Evans, J C Furlong, Environmental Biotechnology-Theory and Applications, John Wiley & Sons, e-book, 2003.
2. Hans-Joachim Jordening, Josef Winter, Environmental Biotechnology: Concepts and Applications, John –Wiley and Sons, 2006.
3. Indu Shekhar Thakur, Environmental Biotechnology: Basic concepts and Applications, I K Internationals Pvt. Ltd., 2006
4. A H Scragg, Environmental Biotechnology, Longman, 1999,
5. Recent reviews from scientific journals.
6. Manahan, S.E. 1997. Environmental Science and Technology. Lewis, New York.
7. Environmental Biotechnology – A.K. Chatterjee
8. Environmental Biotechnology (second edition) – Alan Scragg
9. Environmental Biotechnology – Bimal C. Bhattacharyya, Rintu Banerjee
10. Handbook of Environmental Biotechnology- S.C. Bhatia
11. Environmental Microbiology- Raina M. Maier, Ian

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Semester -IV	Paper –VII(B)
Course Code: MSC-EN417 (B)T	Title of the Course: EN-417 Environmental Economics
Credits: 02	Teaching Hours: 30hrs

Course outcomes (Cos):

- To understand the basics of environmental economics
- To understand the Public goods, Externalities and Market failure
- To understand the Incentives and Subsidies and available Policy Options

Unit. No.	Name of the Unit	Course contents	Number of lectures
1	Environmental Economics	<ul style="list-style-type: none"> • Origin of basic economics, definitions, scope and importance. • Importance of Environmental economics aspects in ancient, medieval and modern age. • The Economy and the Environment: • Two Parts of a Whole –Interlinkages between the economy and the environment. • SDG implementation and environmental economics 	8
2	Micro Foundations of Environmental Economics	<ul style="list-style-type: none"> • Micro Foundations of Environmental Economics - Theory of Public goods, Externalities and Market failure. • The Problem of Social Cost - Design of Environmental Policy. • Global and Indian perspective of environmental economics. 	8
3	Economic Instruments for Environmental Protection	<ul style="list-style-type: none"> • GDP, NNP, GHI, Green GDP, HDI, Green Economy • Linear Economy and Circular Economy (Advantages and disadvantages) • Adoption circular economy and it's benefits • Command & Control versus Incentives and Subsidies - Available Policy Options • Effectiveness of these instruments, International Comparisons 	8
4	Economics of Natural Resource Exploitation	<ul style="list-style-type: none"> • Renewable and Non-Renewable Resources – Methods of valuation of Environmental Costs and Benefits. • Economic Growth and the Environment. • Foreign Direct Investment Inflow and the Environmental quality. 	6

Reference books

2. Hanley, Nick, Jason F. Shogren & Ben White: Environmental Economics in Theory and Practice, New Delhi: Macmillan –India, 1997.
3. James, D.E., Economic Approaches to Environmental Problems: Techniques and Results of Empirical Analysis, Elsevier Scientific Publishing Co., 1978.
4. Nash, R.F., The Rights of Nature: A History of Environmental Ethics, University of Wisconsin, 1989.
5. Whytte, Anne, V. and Ian Burton (eds), Environmental Risk Assessment, John Wiley & Sons, 1980.
6. Allen V. Kneese and James L. Sweeney, eds. Handbook of Natural Resource and Energy Economics, Chapters 2,12,14,17, North Holland, 1985.
7. Fisher, A.C., Environment and Resource Economics, Selected readings, New Horizon in Environmental Economics, Ed. W.E. Oates, 1995

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Semester -IV	Paper –VIII
Course Code: MSC-EN418 P	Title of the Course: Practical's in EN-418 Dissertation / Project
Credits: 02	Total hours -60 Total Practical:. (12x 4= 48 Hours) Internal and External evaluation =12 hours

Course outcomes (Cos):

- Student will understand the importance of scientific referencing with relevance to research topic
- Understanding the optimization of processes and methodologies
- Understands the use of secondary data, statically analysis and software application in interpretation of data
- Student will acquire the skill of scientific writing

Unit	Title	No. of Hours 30
1.	<ul style="list-style-type: none"> • Total Duration of work – minimum 120 Days • Referencing / previous literature survey • Development of technique, data collection and/or analysis, laboratory work, reporting results and discussing it in context to existing knowledge. • The assessments should be based on supervisor's feedback, continuous progress assessments by departmental faculty • submission of a master's dissertation thesis • open presentation and Viva voce 	

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Semester -IV	Paper –IX
Course Code: MSC-EN419 T	Title of the Course: Practical's in EN-419 Basics in Industrial Safety
Credits: 02	Total hours -30 Hours

Course Outcome:

- Students will well know about the Leadership Qualities.
- By learning this course student become aware of hazards & operational hazard
- Student will aware regarding safety equipment and PPE
- Student will understand the types of fire and its accidents

Unit. No.	Name of the Unit	Course contents	Number of lectures
1	Introduction	<ul style="list-style-type: none"> • Meaning and importance of safety, identification of potential safety and health hazards in industrial and development projects. • Reduction strategies, policies and legislation, international and national perspective. 	6
2	Safety Education and Training	<ul style="list-style-type: none"> • Safety standards and management systems, • ISO 45001:2018 (difference between OSHA and ISO) • Industrial health safeguards and implementation mechanisms. Environmental & Safety policy and its implementation • Safety as a tool for maximizing production and sustainable development. • Element of training cycle- • Training Need Assessment (TNA), • Tool Box Talks, Safety Kaizen, One Point Lessons, etc. • Audio Visual Publicity, • other Promotional Methods. 	6
3.	Process Safety Management	<ul style="list-style-type: none"> • Hazard Identification and Risk Assessment (HIRA), • Operating procedures and safe work practices, , • Emergency management, • Auditing, • Management review and continuous improvement. 	6

4.	Safety Equipment's	<ul style="list-style-type: none"> • Hard Hats, • Leggings, Foot Guards, and Safety Shoes, • Earplugs and Earmuffs, • Gloves, • Eye Protection, • Surgical Face Masks, • Respirators, • Face Shields. 	6
5	Fire & Explosion	<ul style="list-style-type: none"> • Classification of fires, Fire protection: Design of building, plant, exits, etc. for fire safety, • Fire-resistance of building materials, Fire-doors and firewalls, • Salient features of fire, • Fire-fighting systems: Different types of portable fire extinguishers, • Fire hydrant system, Fire monitors, sprinkler system and deluge system, Carbon-dioxide flooding system, Foam Pourer system. 	6

References:

1. Industrial Accident Prevention By H.W. Heinrich, Dan Petersen, and Nestor Roos McGraw-Hill Book Company, New York / New Delhi.
2. Loss Control Management By Frank E. Bird, Jr. & Robert G. Loftus Institute Press, Loganville, Georgia (USA).
3. Industrial Safety and Environment By A.K. Gupta Laxmi Publications, New Delhi.
4. Industrial Safety: Concepts and Practices By K.T. Kulkarni Pune Vidyarthi Griha Prakashan, 1786, Sadashiv Peth, Pune.
5. A Course in Industrial Safety By K.U. Mistry NKM Publishers, Ahmedabad.