



NATIONAL EDUCATION POLICY-2020

(NEP-2020)

*Approved
by
BOS - clanna*

ENVIRONMENTAL SCIENCE SYLLABUS

of 5th and 6th Semester

Submitted

to

Davangere University

Davangere-577 007

Davangere University

List of Courses from V and VI Semester for the under graduate Program in ENVIRONMENTAL SCIENCE

Sem	Course Category	Course Code	Course Title	Credits Assigned	Instructional hours per week		Duration of Exam (Hrs.)	Exam/ Evaluation pattern (Marks)		
					Theory	Practical		IA	Exam	Total
ENVIRONMENTAL SCIENCE AND ANOTHER SUBJECT AS DOUBLE MAJOR IN THIRD YEAR										
V	DSC	EVSC9-T	Air Pollution, Water Pollution and Environmental Engineering	4	4		2	40	60	100
		EVSC10-P	Air and Waste Water Analysis	2		4	3	25	25	50
		EVSC11-T	Environmental Chemistry and Instrumentation	4	4		2	40	60	100
		EVSC12-P	Soil analysis, Noise Measurement and Solid Waste Analysis	2		4	3	25	25	50
VI	DSC	EVSC13-T	Environmental Microbiology and Biotechnology	4	4		2	40	60	100
		EVSC14-P	Environmental Microbiology	2		4	3	25	25	50
		EVSC15-T	Environmental Impact Assessment and Environmental Risk Assessment	4	4		2	40	60	100
		EVSC16-P	Methods of Environmental Impact Assessment and Environmental Audit	2		4	3	25	25	50

Note:

1. If any Elective or Vocational course involves theory-cum-practical (2+1 credit), then IA to Exam Marks will be in the ratio of 50:50. The practical part is to be evaluated as part of IA. Semester end examination is only in theory component and questions from practical part, if any.

2. C11, C12, C13 and C14- paper model syllabus given below is designed for single major therefore C11& C13 consists of 3 credits and C12, C14 contains the related practical syllabus respectively. University BoS who choose double major will have to include 4 credit syllabus (one extra unit) for C11 and C13 papers along with the practical experiments in their respective practical papers (C12, C14)

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B.Sc. (Basic/Hons.) Semester 5

Title of the Course: DSC ENV C9-T-AIR POLLUTION, WATER POLLUTION AND ENVIRONMENTAL ENGINEERING

Number of Theory Credits	Number of lecture hours/ semester	Number of practical Credits	Number of Practical hours/ semester
4	60	2	60

Programme Specific Objectives	
PSO1	To develop competency in understanding the concepts of pollution and pollutants.
PSO2	To instil an introductory knowledge of engineering concepts for controlling the pollution.
PSO3	To motivate and inspire to acquire contemporary understanding and skills leading to issue identification.
PSO4	To develop knowledge on act and rules related to pollution.

Programme Outcomes	
PO1	Demonstrate an entry level competence in understanding the environmental pollutants and their impacts.
PO2	Demonstrate the ability to carry out air and water quality analysis in the laboratory and interpret the results.
PO3	Ability to understand the harmful impact of pollutants on environment and human health.
PO4	Be able to understand the existing treatment technologies and scope of developing these methods.

Content of the Course	60 Hours
Unit - 1	
Meteorology: Definition. Significance of meteorology. Meteorological parameters: Solar radiation, Temperature, Humidity (Absolute, Specific & Relative), Wind speed & direction, Pressure and Precipitation. Air pollution: Definition. Sources of air pollution (Point and non-point). Classification of air pollutants – Particulates, gaseous and aerosols. Meteorology of air pollution: Airshed – Concept and Scope. Atmospheric stability, Temperature inversions. Plume Behaviour. Effects of air pollution on humans, plants and materials (CO, CO ₂ , SO _x , NO _x , PAN, Ground level Ozone, PM<10µm, PM<2.5µm, PM<1µm, Acid rain and Photochemical reactions - O ₃ & Smog) in atmosphere. Respiratory and cardiovascular diseases, neuropsychiatric complications, the eyes irritation, skin diseases and long-term chronic diseases. Pneumoconiosis. Automobile pollution: Definition. Sources – Petrol, Diesel, LPG, CNG,	15 H

<p>Biodiesel, Ethanol, Hydrogen and Fuel cells. Emerging fuels – Biobutanol, Dimethyl ether, Methanol and Renewable hydrocarbon biofuels. Internal Combustion Engines (Two stroke and Four stroke: Carburettor and Fuel Injection systems) – Exhaust emissions, Evaporative emissions and Crankcase blow-by. Effects and control of automobile pollution.</p>	
Unit-2	
<p>Air Pollution Control Engineering; Definition; Sources, Types of emission, Control of emissions from engines Monitoring and Control of Air Pollution: Scope and significance. Air Sampling: Ambient, Indoor and Stack - Gaseous and particulates. National Ambient Air Quality Monitoring Programme (NAQMP) – Introduction, Guidelines for Sampling and Measurement of notified Ambient Air Quality Parameters (NAAQS), National Ambient Air Quality Standards.</p> <p>Bharat Stage Emission Standards (BSES) – Introduction, Timeline of Implementation of BSES in India. Current Emissions norms. Air Quality Indices. Concept of Air Pollution Tolerance Index and Industrial Greenbelts. Gaseous – Absorption, Adsorption and Condensation.</p> <p>Particulate – Settling Chambers, Inertial Separators, Cyclones, Filters (Baghouse), Electrostatic Precipitators and Scrubbers. Salient features of Air Pollution (Prevention and Control) Act, 1981 and latest amendments; National Clean Air Programme 2019 and latest amendments.</p>	15 H
Unit-3	
<p>Water pollution: Definition, Sources (Point and non-point). Classification of Water Pollutants.</p> <p>Heavy metal pollution: Sources/Causes, Effects and Control Measures with reference to Lead and Mercury.</p> <p>Fertiliser pollution: Sources/Causes, Effects and Control Measures with reference to Nitrogen, Phosphorus and Potassium. Agriculture runoff and detergents as pollutants. Eutrophication.</p> <p>Pesticide pollution: Sources/Causes, Effects and Control Measures with reference to Organo-chlorine and Organo-phosphate pesticides.</p> <p>Thermal pollution: Sources/Causes, Effects and Control Measures.</p> <p>Oil pollution: Sources/Causes, Effects and Control Measures.</p> <p>Groundwater pollution: Sources/Causes, Effects and Control Measures with reference to Nitrate, Fluoride and Arsenic.</p> <p>Coliform contamination of water.</p>	15 H
Unit-4	
<p>Water and Wastewater Engineering:</p> <p>Characteristics of potable water: Physical, Chemical and Biological.</p> <p>Characteristics of domestic and industrial wastewater: Physical – Colour, Odour, Turbidity, Temperature and Solids (Dissolved, Suspended, Settleable, Volatile; MLSS & MLVSS); Chemical – Organic, Inorganic and Volatile Organic compounds; and Biological – Coliforms and other organisms.</p> <p>Treatment of water for potable purposes: Intake, screening, aeration, pre-chlorination, coagulation, flocculation, sedimentation, filtration (SSF and RSF), disinfection and distribution.</p> <p>Preliminary and Primary treatment: Screening (fine, medium and coarse – stationary, moving and movable – disposal of screenings), pumping, grit</p>	15 H

removal (sedimentation tank and detritus tank – types; disposal of detritus) and skimming. Secondary treatment: Activated Sludge Process and Trickling filters. Sludge management. Tertiary treatment: Chlorination; Reverse Osmosis, Activated Carbon. Advanced treatment methods: Filtration, ion exchange, activated carbon adsorption, electro dialysis, nitrification, de-nitrification and Phosphorous removal. Other treatment methods: Oxidation ponds; oxidation ditches; septic tanks Anaerobic lagoons, Anaerobic filter reactors and Up-flow anaerobic digesters. Disposal of sewage on land; disposal of sewage by dilution. Salient features of Water Pollution (Prevention and Control) Act, 1974; and its characteristics	
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References

- Anjaneyulu Yerramilli. (2019). Air Pollution Prevention and Control Technologies. BS Publications. 1-828.
- Bhatia, S. C. (2003). Managing Industrial Pollution. Macmillan India Ltd.
- Crites, R. and George, T. 1998). Small and Decentralised Wastewater Management Environmental Noise Pollution and its Control. Anmol Publications.
- Garg, S.K. (1990). Environmental Engineering Vol I & II Sewage Disposal and Air Pollution Engineering, Khanna Publ. Delhi.
- J. Paul Guyer. (2021). An Introduction to Air Pollution Control Engineering. UNICORN Publishing Group. 1-182.
- Perkins, H. C. (1974). Air Pollution. Mc Graw – Hill Kogakusha Ltd.
- Phiri, N. B. (2021). Factors Affecting Tutoring Effectiveness in Finance-Related Modules. University of Johannesburg (South Africa).
- Rao, M. N. and Rao, H. V. N. (1988). Air Pollution. Tata McGraw – Hill Publishing Co. Ltd.
- Santra, C. S. (2001). Environmental Science. (1st Ed.), New Central Book Agency.
- Stern, A. C. (1986). Air pollution Vol. I – VIII. Academic Press Inc.

Content of Practical Course 5: List of Experiments to be conducted

DSC ENV C10-P-AIR AND WASTEWATER ANALYSIS

(Total Teaching Hours = 60; Total Credits = 2)

13 experiments can be chosen from the list below and incorporated into the syllabus delivered in different Institutions based on the availability of resources.

1. Study of meteorological parameters – Light, Temperature, Pressure and Rain fall
2. Study of meteorological parameters – Relative Humidity, Wind Speed and Direction
3. Construction of a Wind rose
4. Sampling techniques of air
5. Determination of Particulate Matter
6. Determination of Sulphur-di-oxide in ambient air
7. Determination of Nitrogen-di-oxide in ambient air
8. Determination of Carbon-di-oxide in ambient air
9. Calculate Air Quality Indices from secondary data sources
10. Sampling techniques of waste water
11. Determination of total solids in wastewater
12. Determination of Chromium in liquid effluents
13. Determination of Copper in liquid effluents
14. Determination of Iron in liquid effluents
15. Determination of BOD
16. Determination of COD

References

Donn, W. L. 1975. Meteorology. McGraw – Hill Book Co.

Harrison, R. M. and Perry, R. 1986. Handbook of Air Pollution Analysis. Chapman and Hall.

Katz, M. 1969. Measurement of Air Pollutants. WHO.

NEERI Manual. 1982. Air Quality Monitoring. NEERI Publications.

Sawyer, C. N. and Mc Carty, P. L. 1978. Chemistry for Environmental Engineering. McGraw – Hill International.

Stern, A. C. 1986. Air pollution Vol. I – VIII. Academic Press Inc.

Standard Methods for Examination of Water and Wastewater. 2012. APHA – WEF.

**Title of the Course: DSC ENV C11-T-ENVIRONMENTAL CHEMISTRY
AND INSTRUMENTATION**

Number of Theory Credits	Number of lecture hours/ semester	Number of practical Credits	Number of Practical hours/ semester
4	60	2	60

Programme Specific Objectives	
PSO1	To develop competency in understanding the chemistry and the processes in environment.
PSO2	To instil knowledge about the chemistry of soil and water.
PSO3	To develop competency in understanding the instruments used for analysis and the principles for developing the instruments.
PSO4	To be able to employ the developed skills in real-time situations.

Programme Outcomes	
PO1	Demonstrate competence in understanding the concepts and chemistry of elements interacting in the environment.
PO2	Demonstrate the ability to carry out data collection procedures and analysis in field conditions/laboratories and make appropriate interpretations.
PO3	Be able to develop competence and academic skills in handling advance instruments.
PO4	To be able to apply skills in accordance with guidelines/standards prescribed by statutory authorities.

Content of the Course	60 Hours
Unit - 1	
Fundamentals of Environmental Chemistry: Concept and scope and of Environmental chemistry, Environmental segments, Structure of atoms, Gibbs energy, chemical potential, acid-base reactions, solubility of gases in water, the carbonate system, unsaturated and saturated hydrocarbons, radioisotopes in the environment. Water chemistry- Water molecules and unique properties of water -specific heat, latent heat, thermal conductivity, expansion and freezing of water. Chemical reaction-acid base reactions in water.	15 H
Unit-2	
Atmospheric chemistry: Composition of elements in the atmosphere. Classification of elements, Definition, sources and types – gaseous pollutants and particulate matter; chemical speciation. Particles, ions and radicals in the atmosphere. Chemical processes for formation of inorganic and organic particulate matters. Thermochemical and photochemical reactions in the atmosphere. CFCs-types naming of CFCs and Ozone chemistry, Chemistry of air pollutants (Primary and secondary) and aerosols, Photochemical smog, London Smog and other case studies. Chemistry of acid rain formation and mechanism, ozone depletion mechanism.	15 H

Unit-3	
<p>Physico-Chemical Characteristics of Water Quality: Physical Parameters- Colour, temperature, taste and odour, turbidity, conductivity, hydrogen ion concentration (pH), total solids, suspended and dissolved solids. Chemical Parameters- Acidity, alkalinity, hardness, chlorides, fluorides, dissolved oxygen, Heavy metals and metalloids. Concept of DO, BOD, COD and measurements.</p> <p>Chemical Properties of soil; Chemical composition of soil. Soil colloids, properties of soil colloids, ion exchange of soil- factors affecting cation and anion exchange capacity of soil. Soil solution, soil reaction pH, factors affecting soil reaction pH. Formation of acid soils, characteristics of acidic soils harmful for plant growth. Control measure of soil acidity. Characteristics and formation of saline and alkaline soil, effect of soil salinity & alkalinity on plant growth. Control measures of soil salinity.</p>	15 H
Unit-4	
<p>Advanced instrumentation: Various ranges of electromagnetic radiation, Interaction of electromagnetic radiation with matter, Introduction to UV and X-ray spectroscopy and its applications in Environmental Science, Nephelometry, Atomic Absorption Spectroscopy and Atomic emission spectroscopy and Flame emission spectroscopy-Principle, instrumentation and applications in Environmental sample analysis, Concept of Solvent extraction, Thin Layer Chromatography and Ion Exchange Chromatography, Basic concept of HPLC and Gas chromatography.</p>	15 H

References

- Ajay Kumar Bhagiand Chatwal, G.R. Text book of Environmental Chemistry.
- Bhatia, S.C. 2011. Environmental Chemistry, CBS Publishers.
- Day, A.K. 1984. Environmental Chemistry, Willey Eastern, III Ed.
- Faust, S.D. and Dly, O.M. 1983. Chemistry of water treatment.
- Manahan, S.E. 2000. Environmental Chemistry, 7th Ed., Lewis Publications, Florida, U.S.A.
- Sharma, B.K. and Kaur. 1995. Environmental Chemistry, Goel Publishing House, Meerut.
- Sawyer, C.N., Mc Marty, P.L. and Perkin G.F. 1994. Chemistry for Environmental Engineering, II Ed., Mc Graw Hill.
- Tyagi, O.D. and Mehra, M. 1990. Environmental Chemistry, Anmol Publications

Content of Practical Course 5: List of Experiments to be conducted
DSC ENV C12-P–SOIL ANALYSIS, NOISE MEASUREMENT AND SOLID
WASTE ANALYSIS

(Total Teaching Hours = 60; Total Credits = 2)

13 experiments can be chosen from the list below and incorporated into the syllabus delivered in different Institutions based on the availability of resources.

1. Sampling techniques of Soil
2. Determination of Soil Moisture and Texture
3. Determination of Specific Gravity of Soil
4. Determination of Particle Density of Soil
5. Determination of Water Holding Capacity of Soil
6. Characterization of Solid Wastes
7. Determination of pH and Electrical Conductivity in Soil/Refuse matter
8. Determination of Calcium and Magnesium in Soil/Refuse matter
9. Determination of Lime Content in Soil/Refuse matter
10. Determination of Organic Carbon in Soil/Refuse matter
11. Determination of available Nitrogen in Soil/Refuse matter
12. Determination of available Phosphorus in Soil/Refuse matter
13. Determination of available Potassium in Soil/Refuse matter
14. Determination of C/N ratio in Soil/Refuse matter

References

- Baruah, T. C. and Barthakur, H. P. 1997. Textbook of Soil Analysis. Vikas Publishing House Pvt. Ltd.
- Daji, J.A. 1988. Textbook of Soil Science. Media Promoters and Publishers.
- Firman, E. B. 1964. Chemistry of Soils. Oxford IBH Publishing Co.
- Jackson, M. L. 1973. Soil – Chemical Analysis. Prentice Hall Publications.
- Miller, R. W. and Donahue, R. L. 1992. Soils – Introduction to Soils and Plant

Growth. Prentice Hall of India.

Rowell, T. L. 1994. Soil Sciences – Methods and Applications. Longman Scientific and Technical.

Content of Practical Course 6: List of Experiments to be conducted

DSC ENV C14-P-ENVIRONMENTAL MICROBIOLOGY

(Total Teaching Hours = 60; Total Credits = 2)

1. Best practices for microbiology laboratories
2. Microscopy – Study of Simple and Compound microscopes
3. Sterilization techniques and preparation of culture media – Broth and Solid media
4. Isolation of Bacteria from Water/Wastewater – Serial dilution technique
5. Identification of Bacteria – Colony characteristics
6. Identification of Bacteria by gram staining technique
7. Isolation of Fungi from Soils – Pour plate method
8. Identification of Fungi – Lactophenol cotton blue staining
9. Study of Root Nodule Bacteria – Gram staining
10. Study of Endomycorrhiza (VAM)
11. Estimation of Coliform Group of Bacteria – MPN Technique
12. Estimation of Coliform Group of Bacteria – MF Technique
13. Estimation of Faecal Coliform in water
14. Construction of bacterial growth curves – pH – Broth culture
15. Minimum Inhibitory Concentrations (MICs) of heavy metals on bacteria

References

- Aneja, K. R. 1996. Experiments in Microbiology, Plant Pathology, Tissue Culture and Mushroom Cultivation. Wishwa Prakashan.
- Benson, H. J. 1998. Microbiological Applications – Laboratory Manual in General Microbiology. McGraw-Hill Publications.
- Bhattacharyya, B. N. 1993. Experiments with Microorganisms. Emkay Publications.
- Standard Method for Examination of Water and Wastewater. 2017. APHA – WEF.

B.Sc. Semester 6

Title of the Course: DSC ENV C15–T–ENVIRONMENTAL IMPACT ASSESSMENT AND ENVIRONMENTAL RISK ASSESSMENT

Number of Theory Credits	Number of lecture hours/ semester	Number of practical Credits	Number of Practical hours/ semester
4	60	2	60

Programme Specific Objectives	
PSO1	To develop competency in understanding the process of assessing the Environmental Impact.
PSO2	To instil a knowledge on methodologies used for assessing Environmental Impact.
PSO3	To motivate and inspire to acquire contemporary understanding and skills leading to issue identification and conservation.
PSO4	To inculcate creativity and innovative spirit in identifying appropriate assessment tools.

Programme Outcomes	
PO1	Demonstrate competence in understanding the reports of Environmental Impact assessment of a project.
PO2	Demonstrate the ability to carry out data collection procedures and analysis in field conditions/laboratories and make appropriate interpretations required for EIA.
PO3	Ability to understand the procedure to conduct an audit.
PO4	Demonstrate the ability to carry out risk analysis adhering to the laws.

Content of the Course	60 Hours
Unit - 1	
Environmental Impact Assessment (EIA): Definition, principle, process and importance of an EIA. Salient features of EIA. Utilities of EIA. EIA Notification, 2006 and subsequent amendments. Components of EIA – Air, Water, Noise, Land, Biological environment, Socio-economic and Health Environment. Participants of an EIA. Steps in an EIA – Screening, Scoping & consideration of alternatives, Baseline data collection, Impact prediction, Assessment of alternatives, Delineation of mitigation measures, preparation of environmental impact statement, Public hearing, Environment Management Plan, Decision making and Monitoring the clearance conditions.	15 H
Unit-2	
EIA Methodologies: Rapid and Comprehensive EIA. Characteristics of methods of Impact Identification. Criteria for the selection of EIA methodology – General, impact identification, impact measurement, impact interpretation and evaluation and impact communication. Methods of Impact Identification - Adhoc methods, Checklist methods,	15 H

Matrices methods, Networks methods and Overlay methods. Environmental index using factor analysis, Cost-benefit analysis, Predictive or Simulation methods. Case Studies: Industry, Housing and Multipurpose Dams.	
Unit-3	
Environmental Audit: Concept, Aims and Objectives; Elements of Environmental audit - Internal and External audit. Types of Environmental Audit: Environmental Compliance Audits, Environmental Management Audits and Functional Environmental Audits. Water audit, Energy audit, Health & Safety audit and Waste & Waste Minimisation audit. Audit procedure: Pre-audit activities, On-site activities and Post-audit activities. Evaluation of Audit data and Preparation of audit report.	15 H
Unit-4	
Environmental Risk Assessment Hazard identification and risk assessment - Quantitative and Qualitative risk assessment. Quantitative - Hazard Identification and Risk Analysis (HIRA). Qualitative - Hazard and Operability Analysis (HAZOP), Job Safety Analysis (JSA), Fault Tree Analysis (FTA) and Event Tree Analysis (ETA). Disaster management plan - Off-site emergency plan and On-site emergency plan Occupation, Health and Safety Management Plan, PPEs, Fire Safety, Chemical and Biological Hazards. Safety Management and Laws - Factories Act; Manufacture, Storage and Import Hazardous Chemical Rules.	15 H

References

- Anjaneyalu, Y. and Valli Manickam. 2014. Environmental Impact Assessment Methodologies. BS Publications, Hyderabad.
- Baldwin, J. H. 1988. Environmental Planning and Management. International Book Distributors.
- Barthwal, R.R. 2009. Environmental Impact Assessment. New Age International publication.
- Canter, L. W. 1996. Environmental Impact Assessment. McGraw Hill Inc.
- Rao, P. S. B. and Rao, P. M. (Eds). 2001. Environment Management and Audit. Deep and Deep Publications Pvt. Ltd.
- Rau, J. G. and Wooten, D. C. 1980. Environmental Impact Analysis Handbook. McGraw Hill.
- Santra, S. C. 2001. Environmental Science, New Central Book Agency (P) Ltd.
- Shrivastava, A. K. 2003. Environment Impact Assessment. APH Publishing Corporation.
- Trivedi, P. R. 2004. Environmental Impact Assessment. APH Publishing Corporation.

Content of Practical Course 6: List of Experiments to be conducted

DSC ENV C16–P–METHODS OF ENVIRONMENTAL IMPACT ASSESSMENT AND ENVIRONMENTAL AUDIT

(Total Teaching Hours = 60; Total Credits = 2)

1. Study of recent EIA notification and guidelines
2. Baseline data collection and analysis
3. Study of impact identification methods - Checklists
4. Study of impact identification methods - Matrices
5. Study of impact identification methods - Networks
6. Study of cost-benefit analysis of development project
7. Study of socio-economic impacts - Questionnaire method
8. Study of health impacts - Questionnaire method
9. Study of Environmental Risk Assessment – Data sheet method
10. Study of Environmental audit methods - Water audit
11. Study of Environmental audit methods - Wastewater audit
12. Study of Environmental audit methods - Energy audit – Electricity
13. Study of Environmental audit methods - Energy audit – fossil fuels
14. Study of Environmental audit methods – Solid Waste audit

References

- Arts, J., & Morrison-Saunders, A. (Eds.). (2012). Assessing impact: handbook of EIA and SEA follow-up. Routledge.
- Barton, H., & Bruder, N. (2014). A guide to local environmental auditing. Routledge.
- Carroll, B., & Turpin, T. (2002). Environmental impact assessment handbook: A practical guide for planners, developers and communities. Thomas Telford.
- Erickson, P. A. (1994). A practical guide to environmental impact assessment. Academic Press Inc..
- Munier, N. (2004). Multicriteria environmental assessment: a practical guide. Springer Science & Business Media.

Nelson, D. D. (1998). International environmental auditing. Government Institutes.

Rathi, A. K. A. (2021). Handbook of Environmental Impact Assessment: Concepts and Practice. Cambridge Scholars Publishing.

Thompson, D., & Wilson, M. J. (1994). Environmental auditing: theory and applications. Environmental Management, 18(4), 605-615.



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