Course Structure and Syllabus
of
M.Tech Programme
In

ENVIRONMENTAL SCIENCE AND ENGINEERING

BRANCH: CIVIL ENGINEERING

(From the Session 2018-19)

INDIRA GANDHI INSTITUTE OF TECHNOLOGY, SARANG
(An Autonomous Institute of Government of Odisha)
Dhenkanal, Odisha- 759146
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INDIRA GANDHI INSTITUTE OF TECHNOLOGY, SARANG

M.TECH SYLLABUS for *Specialization*: ENVIRONMENTAL SCIENCE AND ENGINEERING

BRANCH: CIVIL ENGINEERING

First Semester				Second Semester			
Theory				**Theory**			
Course Code	**Course Name**	**L-T-P (Periods/ Week)**	**Credits**	**Course Code**	**Course Name**	**L-T-P (Periods/ Week)**	**Credits**
	Programme Core-1	3-0-0	3		**Programme Core-3**	3-0-0	3
ENC101	Water Supply Engineering			ENC201	Air & Noise Pollution		
	Programme Core-2	3-0-0	3		**Programme Core-4**	3-0-0	3
ENC102	Wastewater Engineering			ENC202	Solid Waste Management		
	Programme Elective-1 (Any One)	3-0-0	3		**Programme Elective-3 (Any One)**	3-0-0	3
ENE101	Environmental Chemistry &Microbiology			ENE201	Hazardous Waste Management		
ENE102	Environmental Law, Regulation & Policy			ENE202	Industrial Pollution Control		
ENE103	Environmental Economics			ENE203	Occupational Health and Safety		
	Programme Elective-2 (Any One)	3-0-0	3		**Programme Elective-4 (Any One)**	3-0-0	3
ENE104	Advanced Water & Wastewater Treatment			ENE204	Environmental Hydraulics		
ENE105	Rural Water Supply and Sanitation			ENE205	Engineering Hydrology		
ENE106	Environmental Ecology			ENE206	Application of Remote Sensing and GIS for Environmental Studies		
GHM101	Research Methodology & Intellectual Property Rights	2-0-0	2		**Audit Course-2 (Any One from the list of Audit Courses)**	2-0-0	0
	Audit Course-1 (Any One from the list of Audit Courses)	2-0-0	0				
	Total (Theory)	**16**	**14**		**Total (Theory)**	**14**	**12**
	Practical/ Sessional				**Practical/ Sessional**		
	Lab-1	0-0-4	2		**Lab-3**	0-0-4	2
ENC103	Environmental Monitoring Lab I			ENC203	Environmental Monitoring Lab II	0-0-4	2
	Lab-2	0-0-4	2		**Lab-4**		
ENC104	Environmental Engineering Design I			ENC204	Environmental Engineering Design II		
				ENJ201	**Mini Project with Seminar**	0-0-4	2
	Total (Practical/ Sessional)	**8**	**4**		**Total (Practical/ Sessional)**	**12**	**6**
	TOTAL	**24**	**18**		**TOTAL**	**26**	**18**
TOTAL SEMESTER CREDITS: 18				TOTAL SEMESTER CREDITS: 18			
TOTAL CUMULATIVE CREDITS: 18				TOTAL CUMULATIVE CREDITS: 36			

INDIRA GANDHI INSTITUTE OF TECHNOLOGY, SARANG

M.TECH SYLLABUS for *Specialization*: ENVIRONMENTAL SCIENCE AND ENGINEERING

BRANCH: CIVIL ENGINEERING

1st Semester

ENC101	Water Supply Engineering	3-0-0	Credits 3

MODULE-I **(11 Hours)**

Quantity of Water: Per-capita water demand, design period, population growth rate, population forecasting, variation in demand. General requirement: Sources of water, aquifers, yield of open wells and tube wells.

MODULE-II **(09 Hours)**

Necessity of treatment, characteristics of water, water quality standards for various water uses, Intake structures – Different types & design criteria, pumping and transportation of water, flow through pipes, pipes in series and pipes in parallel.

MODULE-III **(12 Hours)**

Theory of sedimentation, design concepts of vertical and horizontal flow sedimentation tank. Theory of coagulation, stages of sedimentation aided with coagulation, Coagulants and coagulant aids, calculation of coagulant dose, design of various components. Mechanism of filtration, various types of filter, operational troubles in filters.

MODULE-IV **(10 Hours)**

Disinfection: different types of disinfectants, methods of disinfection, disinfecting action of chlorine, chlorine demand and residual chlorine Water Softening: Ions causing hardness, Langelier index, various methods. Dose calculations Fluoridation and de-fluoridation principles and design. Distribution system design and analysis, determination design capacity of distribution reservoirs and service reservoirs.

Text/Reference Books:

1. Water Supply Engineering, S.K. Garg, Khana Publishers..
2. Water Supply Engineering, B.C. Punmia, Laxmi Publications
3. Environmental Engineering: A Design Approach, Sincero&Sincero, PHI.
4. Water and Wastewater Technology, Hammer & Hammer, PHL
5. CPHEEO Manual, "Water Supply and Treatment", GOI Publications.

Course Outcomes: At the end of the course, students will be able to

1. Compute the quantity of water required to be supplied by a water supply system using the knowledge of water demand and population forecasting.
2. Comprehend the various stages of water supply i.e. source, collection, treatment and distribution.
3. Design water treatment units and analyse existing and design new distribution networks.
4. Understand the characteristics of water and gather knowledge on drinking water standards.

ENC102	Wastewater Engineering	3-0-0	Credits 3

MODULE-I **(11 Hours)**

Wastewaters: sources, nature and characteristics, estimation of quantities of waste water, flow rate and fluctuations, quantities of storm water, Systems of sanitation, combined and separate sewerage systems, their relative merits, Design of combined and separate systems

MODULE-II **(09 Hours)**

Sewer materials, Sewer appurtenances, Construction and maintenance of sewers and pumping of sewage, Analysis of waste water: determination of BOD, COD, Solids and volatile solids and their significance, BOD progression and its formulations.

MODULE-III **(12 Hours)**

Design of waste water treatment systems-Primary, secondary and tertiary treatments, screens, grit chambers, sedimentation tanks, chemical precipitation, Biological treatment-objectives.

MODULE-IV **(10 Hours)**

Methods and design of activated sludge and trickling filter units, Sewage sludge-its treatment, disposal and reuse, Effluent standards and its disposal.

Text/Reference Books:

1. Sewage Disposal and Air Pollution Engineering, S.K. Garg, Khana Publishers.
2. Wastewater Engineering, B.C. Punmia, Laxmi Publications
3. Wastewater, Treatment, Disposal and Reuse, Mtcalf& Eddy
4. Water and Wastewater Technology, Hammer & Hammer, PHI

Course Outcomes: At the end of the course, students will be able to

1. Compute the quantity of domestic sewage and storm drainage and design sewerage and drainage networks.
2. Determine the physical, chemical and biological characteristics of wastewater.
3. Comprehend the fundamental scientific processes underlying the design and operation of various unit operations in a wastewater treatment plant.
4. To manage, degrade and dispose of sludge produced in biological treatment units.
5. Reuse wastewater after proper treatment.

ENE101	Environmental Chemistry & Microbiology	3-0-0	Credits 3

MODULE-1 **(11 Hours)**

Symbol, valency, formula, chemical equations and their balancing, law of conservation of mass, atomic mass, molecular mass, equivalent mass, law of equivalence, modes of expressing concentration of solutions, Chemical bonding, chemical equilibrium, equilibrium constant, Lechatelier's principle.

MODULE-II **(09 Hours)**

Ionic equilibrium, common ion effect, diverse ion effect, solubility, ionic product, solubility product, Acid, bases and salt, Arrhenius theory, buffer solution, alkalinity, acidity, carbonate system, chemical kinetics, order and molecularity of chemical reactions

MODULE-III **(12 Hours)**

Chemical thermodynamics: work done, internal energy, enthalpy, entropy, Gibbs free energy, specific heat, Electrochemistry: Electrochemical cell, Galvanic cell, Conductance, Equivalent conductance, specific conductance, Nernst's equation, Nuclear Chemistry: Nuclear fusion, Nuclear fission, artificial transmutation of elements. Chlorine Chemistry, Nitrogen chemistry

MODULE-IV **(10 Hours)**

Introduction, the bacteria, the fungi, the algae, protozoa and other higher forms, viruses, pathogens and disease, microbial growth and enumeration, environmental influences, control of microorganisms

Text/Reference Books:

1. Chemistry for Environmental Engineering and Science, Sawyer and Mccarty, TMH.
2. Microbiology for Environmental Scientists and Engineers, A.F. Gaudy, McGraw-Hill Int Edition.
3. Environmental Chemistry, Benerjee, PHI
4. Microbiology Demystified, Betsy, Tom, Keogh and James, TMH

Course Outcomes: At the end of the course, students will be able to

1. Gather the basic knowledge of chemistry required to be applied in various sections of Environmental Engineering.
2. Prepare standard and stock solution for performing various laboratory tests.
3. Improve welfare and sustainability of our society by applying their chemical knowledge.
4. Demonstrate that microorganisms have an indispensable role in the environment, including elemental cycles, biodegradation, etc.

ENE102	Environmental Law, Regulation & Policy	3-0-0	Credits 3

MODULE-I **(11 Hours)**

Introduction, environmental laws and policies – role of government. Environmental laws for managing Air, water, land, wastewater, solid waste.

MODULE-II **(09 Hours)**

Environmental laws for managing hazardous waste, natural resources, energy, ecology and environment.

MODULE-III **(12 Hours)**

Environmental guidelines and regulations, environmental auditing, monitoring, reporting, economics and accounting.

MODULE-IV **(10 Hours)**

Theories of corporate strategy and environmental policy; Beyond environmentalism, sustainability issues; Role of government and non-government organizations and citizens.

Text/Reference Books:

1. Environmental Law, Sengar, PHI.
2. Environmental Regulation: Law, Science, and Policy, Schroeder, Miller, Leape, Aspen Publishing.
3. Environmental Law in India, P. Leelakrishnan, Universal law Publishing Company.

Course Outcomes: At the end of the course, students will be able to

1. Have sound Knowledge of Laws, regulations and policies pertaining to environment.
2. Lead teams for environmental management.
3. Make sustainable development.

ENE103	Environmental Economics	3-0-0	Credits 3

MODULE-I **(11 Hours)**

Introduction to Environmental Economics: Scope of the problem, Interaction between economy and environment, Economist's perspectives on environmental problems. Brief idea about Quality of natural Environment and Environmental problems (Air Pollution, Water Pollution, Toxic Emission, ecosystem health).

MODULE-II **(09 Hours)**

Introduction to Environmental Policy Instruments: Choice of policy instrument, command and control instruments, taxation, tradable permits, Environmental performance bonds. Public and environmental goods, negative externality and market failure, Internalization Environmental Valuation: Contingent valuation methods, travel cost method, hedonic price method. Economics of natural resources: Natural Resources (renewable and non-renewable), Population dynamics, extraction of non-renewable resources, depletion, resource modelling.

MODULE-III **(12 Hours)**

Green and Natural resource accounting: GDP, NDP and sustainable development, Environmental accounting

Social efficiency and benefit-cost analysis: Efficiency and competitive markets, supply, demand and efficiency, benefit and cost analysis. Sustainable development and irreversibility in environmental policy: definition, economical efficiency, economic growth and environment.

MODULE-IV **(10 Hours)**

Global Environmental Issues and policies: Climate Change: Causes; possible effects; costs of mitigating greenhouse gas emissions; Carbon Trading, adaptation measures, Design of international agreements, Environmental conflict, bargaining and cooperation, Environmental issues and policies in India

Text/Reference Books:

1. Kolstad, C.D., 2000, Environmental Economics, Oxford University Press.
2. Conrad, J. M. (1999). Resource Economics. Cambridge University Press.
3. Hanley, N., Shogren, J. F., and White, B. (1997). Environmental economics in theory and practice. Oxford university press, New York.
4. M. Common and S. Stagi, (2005).Ecological Economics an introduction, Cambridge University Press.
5. R. Quentin Grafton, WiktorAdamowicz (2004). The economics of the environment and natural resources, Wiley Blackwell Publication.
6. Baumol,W.J., and E.E.Oates, 1988, The Theory of Environmental Policy, Cambridge University Press.
7. Titenberg,T., 1998, Environmental Economics and Policy, Addision-Wesley.

Course Outcomes: At the end of the course, students will be able to

1. Make cost effective design of various environmental structures.
2. Work towards cost optimization by pollution minimization.

ENE104	Advanced Water & Wastewater Treatment	3-0-0	Credits 3

MODULE-I **(11 Hours)**

Conventional water and waste water treatment methods, their capabilities and limitations, Need for advanced treatment of water and waste water.

MODULE-II **(09 Hours)**

Advanced water treatment- Iron and manganese removal, colour and odour removal, activated carbon treatment, carbonate balance for corrosion control, ion exchange, electro-dialysis, reverse osmosis and modern methods and fluoride management.

MODULE-III **(12 Hours)**

Advanced waste water treatment- Nutrient control in effluents, Nitrogen and phosphorus removal methods including biological methods, Methods for the removal of heavy metals, oil and refractory organics, Microsreening, ultra-filtration, centrifugation and other advanced physical methods- aerobic digestion, anaerobic filtration, rotating biological contractor, novel methods of aeration etc.

MODULE-IV **(10 Hours)**

Combined physico-chemical and biological processes, Activated carbon treatment, chlorination of waste water, Pure oxygen systems, Filtration for high quality effluents, Multistage treatment systems, Land treatment and other resources recovery systems

Text/Reference Books:

1. Industrial Pollution Control, W.W. Eckenfelder, McGraw Hill International Edition.
2. Advances in water and wastewater Treatment Technologies, Matsuo, Hanaki, Takizawa, Elsevier publication. .
3. Wastewater, Treatment, Disposal and Reuse, Mtcalf& Eddy

Course Outcomes: At the end of the course, students will be able to

1. Access the need for advance treatment of water and wastewater.
2. Understand the theory behind the design of advanced water and wastewater treatment methods.

ENE105	Rural Water Supply and Sanitation	3-0-0	Credits 3

MODULE-I **(11 Hours)**

Environmental sanitation in Rural and Urban Areas-concepts and importance: Environmental Sanitation,History of sanitation,Rural and Urban Sanitation, changing concept in public health and environmental sanitation,importance of environmental sanitation,Disease &Env. Sanitation,public awareness and role of env.

MODULE-II **(09 Hours)**

Water uses drinking water, potable water for livestock, agricultural water, water quality, lake water, surface water, Ground water, Hilly area, Sources of water, collection of water, Tube well, Hand tube well, dug well, Design of deep tube well. Small scale water treatment, slow sand filter, pressure filter, package water treatment, Chlorination, water reservoir, capacity of reservoir, design of reservoir, distribution system.

MODULE-III **(12 Hours)**

Sewage disposal, cess pool, septic tank principle and design, Biogas plant, Solid waste management, storage collection, composting, vermicomposting, Block level incinerator, Epidemiology, vector transmission, diseases control, Eutriphication of pond and lakes, control.

MODULE-IV **(10 Hours)**

Low cost sanitation, farm house and Cattle shed sanitation-standard recommendation and rules, waste disposal methods, Biogas plant, indoor sanitation-Ventilation, lighting, air conditioning and thermal insulation of buildings, Sanitation of public facilities:- Markets, swimming pools, schools, roads, canteens, hotels, bus stands etc.

Text/Reference Books:

1. Water Supply Engineering, S.K. Garg, Khana Publishers
2. Municipal and Rural Sanitation - V.M Ehlers and E.W Steel, McGraw Hill Publishing Company.
3. Environmental Sanitation - V.M Ehlers and E.W Steel, McGraw Hill Publishing Company
4. Ehler and Steel- A text book of rural water supply and sanitation.
5. Manual of water supply and treatment- CPHEERO.
6. Manual of sewerage and sewage treatment - CPHEERO.
7. Salvato- Environmental Sanitation.
8. Environmental Sanitation-Baljeet S. Kapoor.

Course Outcomes: At the end of the course, students will be able to

1. Design various rural water supply and sanitation structures.
2. Know about landfilling, incineration and vermicomposting.
3. Have knowledge about packaged Treatment unit

ENE106	Environmental Ecology	3-0-0	Credits 3

MODULE-I **(11 Hours)**

Fundamentals of Ecology, Natural eco-systems and their food chains, food webs, bioenergetics, biochemical cycles and ecological succession.

MODULE-II **(09 Hours)**

Biological diversity and its importance, reduction in biological diversity by human activities, classes and general effects of pollutants, biological interactions with pollutants, lethal and sub-lethal effects.

MODULE-III **(12 Hours)**

Ecosystem responses to deoxygenation, nutrient enrichment, pesticides, hydrocarbons, metals and salts, thermal pollution, suspended solids and silt, radio nuclides and atmospheric pollutants.

MODULE-IV **(10 Hours)**

Ecotoxicology of toxic substances and assessment of the hazards, biotic indices, indicator species, ecological indicator species and chemical monitor species, Standards and criteria.

Text/Reference Books:

1. Ecology- Theories and Applications, Stiling, PHI.
2. Essentials of Ecology and Environmental Science, Rana, PHI.
3. Concepts of Ecology, Kormondy, PHI.
4. Environmental Engineering, G Keily, TMH.

Course Outcomes: At the end of the course, students will be able to

1. Comprehend about the Environment, Ecology and Ecosystem.
2. Know about biodiversity and the effect of environmental pollution on biodiversity.
3. Gather knowledge about the response of ecosystem to environmental pollution.
4. Tackle Eco toxicological effects.

ENC103	Environmental Monitoring Lab I	0-0-4	Credits 2

Syllabus: Physical, chemical and biological analysis of water and wastewater

No of Lectures: 28

Text/Reference Books:

1. Standard Methods for Examination of Water and Wastewater, APHA, USEPA

Course Outcomes: At the end of the course, students will be able to

1. Gather Knowledge about various gravimetric and titrimetric methods of environmental Chemical analysis.
2. Design their own laboratory setup and perform their research.

ENC104	Environmental Engineering Design I	0-0-4	Credits 2

Syllabus: Complete design of water treatment unit, determination of storage capacity of reservoirs, analysis and design of water distribution network

No of Lectures: 28

Text/Reference Books:

1. Water Supply Engineering, S.K. Garg, Khana Publishers.
2. Water Supply Engineering, B.C. Punmia, Laxmi Publications.
3. Environmental Engineering: A Design Approach, Sincero&Sincero, PHI.
4. Water and Wastewater Technology, Hammer & Hammer, PHL
5. CPHEEO Manual, "Water Supply and Treatment", GOI Publications.

Course Outcomes: At the end of the course, students will be able to

1. Design various water treatment Units.
2. Analyse and design water distribution network.
3. Determine the capacity of service and distribution reservoirs.

GHM101	Research Methodology & Intellectual Property Rights	2-0-0	Credits 2

MODULE-I **(06 Hours)**

Meaning of research problem, Sources of research problem, Criteria characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem.

Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations.

MODULE-II **(04 Hours)**

Effective literature studies approaches, analysis,

Plagiarism, Research ethics.

MODULE-III **(04 Hours)**

Effective technical writing, how to write report, Paper.

Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee.

MODULE-IV **(06 Hours)**

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

MODULE-V **(04 Hours)**

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

MODULE-VI **(04 Hours)**

New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

Text/Reference Books:

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science& engineering students".
2. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"
3. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners"
4. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd, 2007.

5. Mayall, “Industrial Design”, McGraw Hill, 1992.
6. Niebel, “Product Design”, McGraw Hill, 1974.
7. Asimov, “Introduction to Design”, Prentice Hall, 1962.
8. Robert P. Merges, Peter S. Menell, Mark A. Lemley, “Intellectual Property in New Technological Age”, 2016.
9. T. Ramappa, “Intellectual Property Rights Under WTO”, S. Chand, 2008

Course Outcomes: At the end of the course, students will be able to

1. Understand research problem formulation.
2. Analyze research related information
3. Follow research ethics
4. Understand that today’s world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.
5. Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property.

   Right to be promoted among students in general & engineering in particular.
6. Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.

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2nd Semester

ENC201	Air and Noise pollution	3-0-0	Credits 3

MODULE-I **(11 Hours)**

Air pollutants, Sources, classification, Combustion processes and pollutant emission, Effects on Health, vegetation, materials and atmosphere, Reactions of pollutants in the atmosphere and their effects-Smoke, smog and ozone layer disturbance etc.

MODULE-II **(09 Hours)**

Atmospheric diffusion of pollutants and their analysis, Transport, transformation and deposition of air contaminants on a global scale. Gaussian dispersion model and related computations, Air pollution Meteorology. Plume behaviour, Mixing height, determination of stack height.

MODULE-III **(11 Hours)**

Air sampling and pollutant measurement methods, principles and instruments, ambient air quality and emission standards, control principles, Removal of gaseous pollutants by adsorption, absorption, reaction and other methods. Particulate emission control, settling chambers, cyclone separation, Wet collectors, fabric filters, electrostatic precipitators and other removal methods.

MODULE-IV **(11 Hours)**

Noise Pollution – Definition, Sources, Effects, Mechanisms, SPL, Decibel concepts, Level of pollution, Estimation of equivalent SPl, LD_{eq} Control of noise pollution, Source control, devices, High way and industrial noise estimation, Noise level monitoring techniques

Text/Reference Books:

1. Sewage Disposal and Air Pollution Engineering, S.K. Garg, Khana Publishers.
2. Air pollution M.N Rao& H.V.N. Rao. , TMH
3. Environmental Engineering, Peivy and Rowe.
4. Air pollution Control Engineering, Noel De Nevers, McgrawhillInt Edition.

Course Outcomes: At the end of the course, students will be able to

1. Understand the classification, sources and effects of air pollutants.
2. Understand Regional, global pollution transport mechanisms.
3. Develop pollution control devices: Cyclone, electrostatic precipitator, packed towers, gravitational separator, bag house, scrubbers.
4. Gather knowledge on sources, characteristics and effects of noise pollution.

ENC202	Solid Waste Management	3-0-0	Credits 3

MODULE-I **(11 Hours)**

Solid wastes-Sources, nature and characteristics, Quantities and qualities, Rates of generation and factors affecting them. Potential of diseases, nuisances and other problems due to solid wastes.

MODULE-II **(09 Hours)**

Changing nature of solid wastes and its impact on solid waste management, Solid wastes management-Generation, on-site storage, collection, separation, processing and disposal On-site storage methods-containers, their type, size and location.

MODULE-III **(11 Hours)**

Collection systems-Vehicles, routing, route balancing and transfer stations, Processing methods, recovery and reuse of materials and energy.

MODULE-IV **(11 Hours)**

Disposal methods such as sanitary landfill biological digestion etc. Industrial and Hazardous solid waste management, Urban solid waste management and its modeling.

Course Outcomes: At the end of the course, students will be able to

1. Get a comprehensive overview of source, classification, characterization of solid, waste.
2. Know about collection and transportation of solid waste.
3. Design transfer stations, sanitary landfills, Composting plants and incinerators.
4. Expertise on recycle, recover and reuse of solid waste.
5. Take up solid waste management projects

ENE201	Hazardous Waste Management	3-0-0	Credits 3

MODULE-I **(11 Hours)**

Sources of hazardous waste: types and sources hazardous wastes - need for hazardous waste management - elements of integrated hazardous waste management and roles of stakeholders and NGOs- salient features of Indian legislations on management and handling of hazardous wastes, biomedical wastes, lead acid batteries, e-waste.

MODULE-II (9 Hours)

Characterization of hazardous waste :hazardous waste generation rates and variation - composition, physical, chemical and biological properties of hazardous wastes - hazardous characteristics – tclp tests - waste sampling and characterization plan - source reduction of wastes -recycling and reuse.

MODULE-III (11 Hours)

Handling of hazardous waste: handling and segregation of wastes at source - storage and collection of hazardous. Wastes -need for transfer and transport - transfer stations optimizing waste. Allocation - compatibility, storage, labelling and handling of hazardous wastes.

MODULE-IV (11 Hours)

Processing of hazardous waste: objectives of waste processing - material separation and processing

Technologies- biological and chemical conversion technologies - thermal conversion technologies and energy recovery - incineration - solidification and stabilization of hazardous wastes – treatment of biomedical wastes and e-waste. Disposal of hazardous waste: waste disposal options - disposal in landfills - landfill classification-construction and operation of secured landfills -bioreactors – ocean dumping - land disposal – soil remediation.

Books for reference:

1. Hazardous Waste Management: Charles A. Wentz, TMH
2. Introduction to Environmental Engineering, Master, TMH.
3. Environmental Engineering, G Keily, TMH.
4. Principles of Environmental Engineering and Science, Davis, Masten,TMH.

Course Outcomes: At the end of the course, students will be able to

1. Get a comprehensive overview of source, classification, characterization of hazardous waste.
2. Know about collection and transportation of hazardous waste.
3. Design transfer stations, sanitary landfills, Composting plants and incinerators for hazardous waste
4. Take up hazardous waste management projects.

ENE202	Industrial Pollution Control	3-0-0	Credits 3

MODULE-I **(11 Hours)**

Industrial waters-Sources, nature and characteristics, quantity and quality of industrial wastes and their impact on the environment, Industrial waste survey, estimating organic content. Industrial Waste survey - Process flow charts, condition of waste stream. Sampling – Grab, Composite and integrated samples. Continuous monitoring – pH, Conductivity, Biomonitoring. Pre and primary treatment- equalization, neutralization,

MODULE-II **(9 Hours)**

sedimentation, oil separation, flotation, Coagulation and precipitation, heavy metal removal, principles of biological oxidation, biological wastewater treatment processes- lagoons and stabilization basins, aerated lagoons, activated sludge process, Trickling filter, RBC, Anaerobic decomposition, Adsorption, ion exchange, chemical oxidation.

MODULE-III **(11 Hours)**

Sources, Characteristics, waste water treatment flow sheets for selected industries such as Textile, Tannery, Pharmaceutical, Dairy, Sugar, Pulp and Paper, Distillery, Steel plants, Oil refineries, fertilizer

MODULE-IV **(11 Hours)**

Air Pollution Laws, Air pollutants monitoring equipment and method of analysis, Air pollution control methods in industries, sludge treatment and disposal.

Books for reference:

1. Industrial Pollution Control, W.W. Eckenfelder, McGraw Hill International Edition.
2. Industrial Wastewater Treatment, Patwardhan, PHI.
3. Industrial Pollution Control, Nancy J Sell, Wiley eastern limited
4. Mahajan S.P., Pollution Control in Process Industries, Tata Mcgraw Hill
5. Air pollution Control Engineering, Noel De Nevers, Mcgrawhill Int Edition.

Course Outcomes: At the end of the course, students will be able to

1. Understand various terms used in industrial wastewater treatment and to acquaint with different steps involved in treatment of industrial wastewater.
2. Learn physical/chemical/biological characteristics of and the evaluation technique for various industrial wastewaters.
3. Understand the theory, engineering application, and design technique for the industrial wastewater treatment unit processes.
4. Design various air pollution control equipments.

ENE203	Occupational Health and Safety	3-0-0	Credits 3

MODULE-I **(11 Hours)**

Occupational Health and Safety concern and problems. National and international protocols and concerns, policies and legislation. Ergonomics; Stress-strain concept;

MODULE-II **(9 Hours)**

Assessment of human capabilities and limitations; Human Physiological Work Capacity and its evaluation. Sources of work stress (a) intrinsic to the jobs, (b) work environmental stressors like heat & Humidity , noise & vibration, dust, illumination, etc

MODULE-III **(11 Hours)**

Methodologies for evaluating different types of stresses. Human Error and Accidents: Different Classification of Human Error, Theories of Accident Causation, Human Error Audit. Accident analysis.

MODULE-IV **(11 Hours)**

Education and Training in Occupational Hygiene. Need to evolve an integrated Occupational Health and Safety Programme for specific industries. Occupational Health & Safety Management Systems (OHSAS - 18001): Legal and other Requirements ; Overview; Planning, hazard identification and risk assessment; Occupation Health and Safety Policy; OH & SMS Documentation; Emergency Preparedness and Response.

Books and Reference

1. Dan Petersen, “Techniques of Safety Management”, McGraw-Hill Company, Tokyo, 1981.
2. Relevant India Acts and Rules, Government of India.
3. Relevant Indian Standards and Specifications, BIS, New Delhi.
4. Blake R.B., “Industrial Safety” Prentice Hall, Inc., New Jersey, 1973.
5. Safety and Good House Keeping”, N.P.C., New Delhi, 1985.
6. Accident Prevention Manual for Industrial Operations”, N.S.C.Chicago, 1982.

Course Outcomes: At the end of the course, students will be able to

1. Gather knowledge about occupational health problems for workers.
2. Apply Industrial safety measures in case of an work related accident.
3. Know about the level of exposure of worker during industrial operations.

ENE204	Environmental Hydraulics	3-0-0	Credits 3

MODULE-I **(11 Hours)**

Ground water and well hydraulics: steady and unsteady radial flows in aquifers (confined, unconfined), effect of well bore storage, multiple well systems, partially penetrating wells, bounded aquifers, characteristic well losses, and estimation of aquifer parameters.

MODULE-II **(9 Hours)**

Fluid flow - continuity principle, energy principle and momentum principle; frictional head loss in free and

pressure flow Flow through Pipes: Major and minor losses of energy in pipes , Hydraulic gradient and total energy line,

Flow through pipes in series, in parallel, equivalent pipe, Flow through branch pipe. Water Distribution network analysis – Hardy cross and Equivalent pipe method.

MODULE-III **(11 Hours)**

Open channel hydraulics: open channel flow and its classifications, and properties, energy and momentum principles, Critical flow computation and its applications, transitions with sub critical and super critical flows uniform flow, gradually varied flow, Most efficient channel section.

MODULE-IV **(11 Hours)**

Water Distribution network analysis – Hardy cross and Equivalent pipe method. Hydraulic design of sewers and sewerage network.

Books for reference:

1. Fluid Mechanics, A.K. Jain, Khana Publishers.
2. Hydraulics and Fluid Mechanics, Modi and Seth, Standard Book House.
3. Open Channel Flow, Subramanya, Mcgraw-Hill Publishing Co.
4. Ground Water Hydrology, Raghunath, Wiley Eastern limited.

Course Outcomes: At the end of the course, students will be able to

1. Use transport models for contaminant transport for ground water and surface water.
2. Apply basic fluid mechanics principles in the analysis and design of pipe flow.
3. Analyse and design pipe networks.
4. Solve well hydraulics problems.
5. Gather knowledge on open Channel flow

ENE205	Engineering Hydrology	3-0-0	Credits 3

MODULE-I **(11 Hours)**

Hydrological cycle, Rainfall –Runoff data analysis, Precipitation, Evaporation, Evapotransporation, Measurement of Evaporation, Infiltration, Stream flow measurement.

MODULE-II **(9 Hours)**

The ground water environment, Aquifer, Aquitard, Darcy's law, Permeability, Development of Lap lace's basic ground water flow equation, Aquifer parameter, Well hydraulics – steady and unsteady flow equation, Jacob's Thies equation, Well functions, Ground water flow between water bodies.

MODULE-III **(11 Hours)**

Unit hydrograph, S-Hydrograph, Application of Hydrographical data for flood estimation, Gumbel's approach, Meskingham's equation, salt water intrusion and modeling

MODULE-IV **(11 Hours)**

Ground water pollution, Transport of contaminates, advection, diffusion, Adsorption model, Numerical modeling and solution, Artificial recharge and rainwater harvesting.

Books for reference:

1. Subramanyam - Engineering Hydrology
2. K.C. Patra – Hydrology
3. Sing. V.P – Elementary Hydrology
4. D.K.Todd – Ground Water Hydrology
5. Bear & Gaeob – Hydrology of Ground Water.
6. K.S. Reddy – Geo-Environmental Engineering
7. Raghunath - Ground Water Hydrology
8. Viesmann – Hydrology – Prentice Hall
9. Beers and Rowe- Ground water flow modeling

Course Outcomes: At the end of the course, students will be able to

1. Understand theories and concepts in surface and subsurface hydrology, the physical, chemical and biological interactions between the hydrosphere, the lithosphere, the biosphere and the atmosphere.
2. Evaluate and analyze hydrological systems and processes at a wide range of scales in both space and time for the purpose of water resources assessment, natural hazard assessment and mitigation, and environmental planning and management.

ENE206	Application of Remote Sensing and GIS for Environmental Studies	3-0-0	Credits 3

MODULE-I **(11 Hours)**

Introduction to Remote Sensing: Principles of Remote sensing, Types of Remote Sensing, Advantages of Remote Sensing, Physical basis of Remote Sensing,

Applications of Remote Sensing: History of Remote Sensing; The Electromagnetic spectrum; The nature and generation of Electromagnetic radiation (EMR) Spectral Reflectance Curves. Interaction of EMR with the atmosphere and earth's surface features. Spectral signatures and characteristics, spectral reflectance curves for rocks, soil, vegetation and water features within near and near Infrared. Spectral signatures, Resolution.

MODULE-II **(9 Hours)**

Remote Sensing observations and platforms: Ground, airborne and satellite based platforms; Some important Remote Sensing Satellites. Aerial Stereo coverage and Remote Sensing Satellites.

Sensors: Passive and Active Sensors; Major Remote Sensing Sensors; single and multi-band scanners Satellite band designations and principal applications; Colour / False Colour; Aerial Photography/ Aerial Photo Interpretation. USS sensor and other type of sensors. Details of sensors on board latest Earth resources Satellites viz.; LANDSAT 6/7/8, SPOT, IKONOS, IRS and ERS.

MODULE-III **(11 Hours)**

Digital Image Processing: Pixels and Digital Number; Digital Image Structure; Format of Remote Sensing Data; Image Processing functions: Image Restoration, Image Enhancement, Image Transformation, Image Classification and Analysis; Image interpretation strategies. Visual Photo- Interpretation Techniques based on 'Photo elements' and 'Terrain elements'.

MODULE-IV **(11 Hours)**

Geographic Information System: Introduction, Definition, Preparation of thematic map from remote sensing data, Map Projection and Co-ordinate system, GIS components: Hardware, software and infrastructures, GIS data types, Data acquisition, Data Input and Data Processing, and management including topology DEM/ DTM generation.

Integration of Remote Sensing and GIS techniques and its applications in Environmental Impact Assessment and Management including some case studies.

Books and Reference:

1. Remote Sensing and GIS - Anji Reddy M., The Book Syndicate, Hyderabad, 2000.
2. Principles of Geographical Information Systems - P A Burrough and R. A. McDonnell, OUP, Oxford, 1998.
3. Remote Sensing for Earth Resource- Rao, L.P., AEG Publication, Hyderabad, 1987.
4. Geographic Information System- Kang Tsung Chang, Tata Mc Graw Hill, Publication Edition, 2002.

5. Remote Sensing And Image Interpretation Thomas M. Lillesand, Ralph W. Kiefer, Jonathan W. Chipman, Wiley,2003
6. Journal by Insurance Company.

Course Outcomes: At the end of the course, students will be able to

1. Apply remote sensing in solving environmental problems.
2. Use GIS software to locate and design environmental pollution control units.
3. Apply remote sensing and GIS data in environmental remediation and EIA studies.

ENC203	Environmental Monitoring Lab II	0-0-4	Credits 2

Syllabus

Physical, chemical and biological analysis of water and wastewater (instrumental methods).

Measurement of particulate and gaseous air pollutants.

No of Lectures:28 Hours

Books for reference:

1. Standard Methods for Examination of Water and Wastewater, APHA, USEPA

Course Outcomes: At the end of the course, students will be able to

1. Gather Knowledge about various instrumental methods of environmental Chemical analysis.
2. Design their own laboratory setup and perform their research.
3. Set up air pollution monitoring stations.

ENC204	Environmental Engineering Design II	0-0-4	Credits 2

Syllabus

Complete design of wastewater treatment unit, analysis and design of sewerage network.

Design of air pollution control devices

No of Lectures:28 Hours

Books for reference:

1. Sewage Disposal and Air Pollution Engineering, S.K. Garg, Khana Publishers.
2. Wastewater Engineering, B.C. Punmia, Laxmi Publications.
3. Wastewater, Treatment, Disposal and Reuse, Mtcalf & Eddy

4. Water and Wastewater Technology, Hammer & Hammer, PHI

Course Outcomes: At the end of the course, students will be able to

1. Design various wastewater treatment Units.
2. Analyse and design sewerage network.
3. Design air pollution control devices

M.Tech

Audit Courses

List of Audit courses

1. AHM101 English for Research Paper Writing
2. ACE101 Disaster Management
3. AHM102 Sanskrit for Technical Knowledge
4. AHM103 Value Education
5. AHM104 Constitution of India
6. AHM105 Pedagogy Studies
7. AHM106 Stress Management by Yoga
8. AHM107 Personality Development through Life Enlightenment Skills

AHM101	English for Research Paper Writing	2-0-0	Credits 0

Course Objectives: Students will be able to:

1. Understand that how to improve your writing skills and level of readability
2. Learn about what to write in each section
3. Understand the skills needed when writing a Title

   Ensure the good quality of paper at very first-time submission

MODULE-I **(4 Hours)**

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness.

MODULE-II **(4 Hours)**

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticising, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction.

MODULE-III **(4 Hours)**

Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.

MODULE-IV **(4 Hours)**

key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature.

MODULE- V **(4 Hours)**

Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions.

MODULE-VI **(4 Hours)**

Useful phrases, how to ensure paper is as good as it could possibly be the first- time submission.

Suggested Studies:

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)
2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press
3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book.
4. Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011.

ACE101	Disaster Management	2-0-0	Credits 0

Course Objectives: Students will be able to:

1. Learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.
2. Critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
3. Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
4. Critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in.

MODULE-I **(4 Hours)**

Introduction

Disaster: Definition, Factors and Significance; Difference between Hazard and Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

MODULE-II **(4 Hours)**

Repercussions of Disasters and Hazards:

Economic Damage, Loss of Human and Animal Life, Destruction of Ecosystem.

Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts and Famines, Landslides and Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks and Spills,

Outbreaks of Disease and Epidemics, War and Conflicts.

MODULE-III **(4 Hours)**

Disaster Prone Areas In India

Study of Seismic Zones; Areas Prone To Floods And Droughts, Landslides and Avalanches; Areas Prone to Cyclonic and Coastal Hazards with Special Reference to Tsunami; Post-Disaster Diseases and Epidemics

MODULE-IV **(4 Hours)**

Disaster Preparedness and Management

Preparedness: Monitoring of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data From Meteorological and Other Agencies, Media Reports: Governmental and Community Preparedness.

MODULE-V **(4 Hours)**

Risk Assessment

Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival.

MODULE-VI **(4 Hours)**

Disaster Mitigation

Meaning, Concept and Strategies of Disaster Mitigation, Emerging Trends in Mitigation. Structural Mitigation and Non-Structural Mitigation, Programs of Disaster Mitigation In India.

Text / Reference Books:

1. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies, New Royal book Company.
2. Sahni, Pardeep Et.Al. (Eds.), "Disaster Mitigation Experiences and Reflections", Prentice Hall Of India, New Delhi.
3. Goel S. L, Disaster Administration And Management Text And Case Studies" ,Deep &Deep Publication Pvt. Ltd., New Delhi.

AHM102	Sanskrit for Technical Knowledge	2-0-0	Credits 0

Course Objectives:

1. To get a working knowledge in illustrious Sanskrit, the scientific language in the world

2. Learning of Sanskrit to improve brain functioning
3. Learning of Sanskrit to develop the logic in mathematics, science & other subjects enhancing the memory power
4. The engineering scholars equipped with Sanskrit will be able to explore the huge knowledge from ancient literature

MODULE-I **(8 Hours)**

- Alphabets in Sanskrit
- Past/Present/Future Tense
- Simple Sentences

MODULE-II **(8 Hours)**

- Order
- Introduction of roots
- Technical information about Sanskrit Literature

MODULE-III **(8 Hours)**

- Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics

Suggested reading:

1. "Abhyaspustakam" – Dr.Vishwas, Samskrita-Bharti Publication, New Delhi
2. "Teach Yourself Sanskrit" Prathama Deeksha-Vempati Kutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication
3. "India's Glorious Scientific Tradition" Suresh Soni, Ocean books (P) Ltd., New Delhi.

Course Output: Students will be able to

1. Understanding basic Sanskrit language
2. Ancient Sanskrit literature about science & technology can be understood
3. Being a logical language will help to develop logic in students

AHM103	Value Education	2-0-0	Credits 0

Course Objectives: Students will be able to

1. Understand value of education and self- development
2. Imbibe good values in students
3. Know about the importance of character

MODULE-I **(6 Hours)**

- Values and self-development –Social values and individual attitudes. Work ethics, Indian vision of humanism.
- Moral and non- moral valuation. Standards and principles.
- Value judgements

MODULE-II **(6 Hours)**

- Importance of cultivation of values.
- Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness.
- Honesty, Humanity. Power of faith, National Unity.
- Patriotism. Love for nature, Discipline

MODULE-III **(6 Hours)**

- Personality and Behaviour Development - Soul and Scientific attitude.
- Positive Thinking. Integrity and discipline.
- Punctuality, Love and Kindness.
- Avoid fault Thinking.
- Free from anger, Dignity of labour.
- Universal brotherhood and religious tolerance.
- True friendship.
- Happiness Vs suffering, love for truth.
- Aware of self-destructive habits.
- Association and Cooperation.
- Doing best for saving nature

MODULE-IV **(6 Hours)**

- Character and Competence –Holy books vs Blind faith.
- Self-management and Good health.
- Science of reincarnation.
- Equality, Nonviolence, Humility, Role of Women.

- All religions and same message.
- Mind your Mind, Self-control.
- Honesty, Studying effectively

Text / Reference Books

1. Chakroborty, S.K. "Values and Ethics for organizations Theory and practice", Oxford University Press, New Delhi

Course outcomes: Students will be able to

1. Knowledge of self-development
2. Learn the importance of Human values
3. Developing the overall personality

AHM104	Constitution of India	2-0-0	Credits 0

Course Objectives: Students will be able to:

1. Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
2. To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.
3. To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.

MODULE-I **(4 Hours)**

- **History of Making of the Indian Constitution:**

  History

  Drafting Committee, (Composition& Working)

MODULE-II **(4 Hours)**

- **Philosophy of the Indian Constitution:**

  Preamble

  Salient Features

MODULE-III **(4 Hours)**

- **Contours of Constitutional Rights & Duties:**

  Fundamental Rights

  Right to Equality

  Right to Freedom

  Right against Exploitation

  Right to Freedom of Religion

  Cultural and Educational Rights

  Right to Constitutional Remedies

  Directive Principles of State Policy

  Fundamental Duties.

MODULE-IV **(4 Hours)**

- **Organs of Governance:**

  Parliament

  Composition

  Qualifications and Disqualifications

  Powers and Functions

  Executive

  President

  Governor

  Council of Ministers

  Judiciary, Appointment and Transfer of Judges, Qualifications

  Powers and Functions

MODULE-V **(4 Hours)**

- **Local Administration:**

  District's Administration head: Role and Importance,

  Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation.

  Pachayati raj: Introduction, PRI: Zila Pachayat.

  Elected officials and their roles, CEO Zila Pachayat: Position and role.

  Block level: Organizational Hierarchy (Different departments),

  Village level: Role of Elected and Appointed officials,

  Importance of grass root democracy

  Model Curriculum of Engineering & Technology PG Courses [Volume -II]

MODULE-VI **(4 Hours)**

- **Election Commission:**

  Election Commission: Role and Functioning.

  Chief Election Commissioner and Election Commissioners.

  State Election Commission: Role and Functioning.

  Institute and Bodies for the welfare of SC/ST/OBC and women.

Text / Reference Books:

1. The Constitution of India, 1950 (Bare Act), Government Publication.
2. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.
3. M. P. Jain, Indian Constitution Law, 7th Edn, Lexis Nexis, 2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

Course Outcomes: Students will be able to:

1. Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
2. Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
3. Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
4. Discuss the passage of the Hindu Code Bill of 1956.

AHM105	Pedagogy Studies	2-0-0	Credits 0

Course Objectives: Students will be able to:

1. Review existing evidence on the review topic to inform programme design and policymaking undertaken by the DfID, other agencies and researchers.
2. Identify critical evidence gaps to guide the development.

MODULE-I **(4 Hours)**

- **Introduction and Methodology:**
- Aims and rationale, Policy background, Conceptual framework and terminology
- Theories of learning, Curriculum, Teacher education.
- Conceptual framework, Research questions**.**
- Overview of methodology and Searching.

MODULE-II (2 Hours)

- Thematic overview: Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries.
- Curriculum, Teacher education.

MODULE-III (4 Hours)

- Evidence on the effectiveness of pedagogical practices
- Methodology for the in depth stage: quality assessment of included studies.
- How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?
- Theory of change.
- Strength and nature of the body of evidence for effective pedagogical practices.
- Pedagogic theory and pedagogical approaches.
- Teachers' attitudes and beliefs and Pedagogic strategies.

MODULE-IV (4 Hours)

- Professional development: alignment with classroom practices and follow up support
- Peer support
- Support from the head teacher and the community.
- Curriculum and assessment
- Barriers to learning: limited resources and large class sizes

MODULE- V (2 Hours)

- **Research gaps and future directions**
- Research design
- Contexts
- Pedagogy
- Teacher education
- Curriculum and assessment

- Dissemination and research impact.

Text / Reference Books:

1. Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2):245-261.
2. Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361-379.
3. Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. London: DFID.
4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33 (3): 272–282.
5. Alexander RJ (2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.
6. Chavan M (2003) Read India: A mass scale, rapid, 'learning to read' campaign.
7. www.pratham.org/images/resource%20working%20paper%202.pdf.

Course outcomes: Students will be able to understand:

1. What pedagogical practices are being used by teachers in formal and informal classrooms in developing countries?
2. What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?
3. How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?

AHM106	Stress Management by Yoga	2-0-0	Credits 0

Course Objectives:

1. To achieve overall health of body and mind
2. To overcome stress

MODULE-I **(8 Hours)**

- Definitions of Eight parts of yoga. (Ashtanga)

MODULE-II **(8 Hours)**

- Yam and Niyam.

  Do`s and Don't's in life.

  i) Ahinsa, satya, astheya, bramhacharya and aparigraha

  ii) Shaucha, santosh, tapa, swadhyay, ishwarpranidhan

MODULE-III **(8 Hours)**

- Asan and Pranayam

  i) Various yog poses and their benefits for mind & body

  ii) Regularization of breathing techniques and its effects-Types of pranayam

Text / Reference Books:

1. 'Yogic Asanas for Group Tarining-Part-I" :Janardan Swami Yogabhyasi Mandal, Nagpur
2. "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, AdvaitaAshrama (Publication Department), Kolkata

Course outcomes: Students will be able to:

1. Develop healthy mind in a healthy body thus improving social health also
2. Improve efficiency

AHM107	Personality Development through Life Enlightenment Skills	2-0-0	Credits 0

Course Objectives:

1. To learn to achieve the highest goal happily
2. To become a person with stable mind, pleasing personality and determination
3. To awaken wisdom in students

MODULE-I **(8 Hours)**

Neetisatakam-Holistic development of personality

- Verses- 19,20,21,22 (wisdom)
- Verses- 29,31,32 (pride & heroism)
- Verses- 26,28,63,65 (virtue)
- Verses- 52,53,59 (dont's)

- Verses- 71,73,75,78 (do's)

MODULE-II **(8 Hours)**

Approach to day to day work and duties.

- Shrimad Bhagwad Geeta: Chapter 2-Verses 41, 47,48,
- Chapter 3-Verses 13, 21, 27, 35, Chapter 6-Verses 5,13,17, 23, 35,
- Chapter 18-Verses 45, 46, 48.

MODULE-III **(8 Hours)**

Statements of basic knowledge.

- Shrimad Bhagwad Geeta: Chapter 2-Verses 56, 62, 68
- Chapter 12 -Verses 13, 14, 15, 16,17, 18
- Personality of Role model. Shrimad Bhagwad Geeta: Chapter 2-Verses 17, Chapter 3-Verses 36,37,42,
- Chapter 4-Verses 18, 38,39
- Chapter18 – Verses 37,38,63

Text / Reference Books:

1. "Srimad Bhagavad Gita" by Swami Swarupananda Advaita Ashram (Publication Department), Kolkata
2. Bhartrihari's Three Satakam (Niti-sringar-vairagya) by P.Gopinath, Rashtriya Sanskrit Sansthanam, New Delhi.

Course outcomes: Students will be able to:

1. Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achieve the highest goal in life
2. The person who has studied Geeta will lead the nation and mankind to peace and prosperity
3. Study of Neetishatakam will help in developing versatile personality of students.