Babu Banarasi Das University, Lucknow
Department of Civil Engineering
School of Engineering
Master of Technology (Environmental Engineering) – Regular
Evaluation Scheme (w.e.f Session 2021-22)

SEMESTER I									
Course Category	Course Code	Code Title	Contact Hours			Evaluation Scheme			Credits
			L	T	P	CIA	ESE	Course Total	
C	MAS4106	Applied Mathematics	4	0	0	40	60	100	4
C	MEV4101	Environmental Chemistry and Microbiology	4	0	0	40	60	100	4
C	MEV4102	Water Treatment and Distribution	4	0	0	40	60	100	4
C	MEV4103	Wastewater Treatment	4	0	0	40	60	100	4
GE	GE47011/ GE47015	Generic Elective - I	4	0	0	40	60	100	4
C	MEV4151	Water and Waste Water Treatment Lab	0	0	2	100	0	100	1
C	MEV4152	Seminar	0	0	2	100	0	100	1
C	MEV4153	Technical Paper Writing	0	0	2	100	0	100	1
Total			**20**	**0**	**6**	**500**	**300**	**800**	**23**

Legends:

L Number of Lecture Hours per week
T Number of Tutorial Hours per week
P Number of Practical Hours per week
CIA Continuous Internal Assessment
ESE End Semester Examination

Category of Courses:

C Core Course
GE Generic Elective

Babu Banarasi Das University, Lucknow

Department of Civil Engineering

School of Engineering

Master of Technology (Environmental Engineering) – Regular

Evaluation Scheme (w.e.f Session 2021-22)

SEMESTER II									
Course Category	**Course Code**	**Code Title**	**Contact Hours**			**Evaluation Scheme**			**Credits**
			L	**T**	**P**	**CIA**	**ESE**	**Course Total**	
C	MEV4201	Solid Waste Management	4	0	0	40	60	100	4
C	MEV4202	Air and Noise Pollution and Control	4	0	0	40	60	100	4
C	MEV4203	Environmental Quality Management	4	0	0	40	60	100	4
GE	GE47021/ GE47025	Generic Elective - II	4	0	0	40	60	100	4
GE	GE47031/ GE47035	Generic Elective - III	4	0	0	40	60	100	4
C	MEV4251	Air and Noise Pollution Lab	0	0	2	100	0	100	1
C	MEV4252	Seminar	0	0	2	100	0	100	1
C	MEV4253	Technical Paper Presentation	0	0	2	100	0	**100**	**1**
Total			**20**	**0**	**6**	**500**	**300**	**800**	**23**

Legends:

L Number of Lecture Hours per week
T Number of Tutorial Hours per week
P Number of Practical Hours per week
CIA Continuous Internal Assessment
ESE End Semester Examination

Category of Courses:

C Core Course
GE Generic Elective

BabuBanarasi Das University, Lucknow

Department of Civil Engineering

School of Engineering

Master of Technology (Environmental Engineering) - Regular

Evaluation Scheme (w.e.f session 2021-22)

SEMESTER III									
Course Categor	Course Code	Code Title	Contact Hours			Evaluation Scheme			Credits
			L	T	P	CIA	ESE	Course Total	
C	MEV4351	State of the Art Seminar#	-	-	-	200	0	200	4
C	MEV4352	Thesis – I*	-	-	-	400	0	400	16
Total			**-**	**-**	**-**	**600**	**0**	**600**	**20**

\# Student need to perform a literature survey and will give a state-of-the-art presentation and will submit a synopsis clearly mentioning the problem statement. The presentation and synopsis will be evaluated internally within two months of the start of the semester and the result will be intimated to the students so as to proceed for thesis.

* Student will develop the workable model for the problem they have supposed in synopsis.

SEMESTER IV									
Course Category	Course Code	Code Title	Contact Hours			Evaluation Scheme			Credits
			L	T	P	CIA	ESE	Course Total	
C	MEV4451	Thesis – II**	-	-	-	200	800	1000	28
Total			**-**	**-**	**-**	**200**	**800**	**1000**	**28**

** (a) This is in continuation with Thesis -I.

(b) The required experimental / mathematical verification of the proposed model will be done in this semester.

Legends:

L Number of Lecture Hours per week

T Number of Tutorial Hours per week

P Number of Practical Hours per week

CIA Continuous Internal Assessment

ESE End Semester Examination

Category of Courses:

C Core Course

GE Generic Elective

Course Code	Generic Elective-I
GE47011	Earth and Environment
GE47012	Environmental Sanitation and Ecology
GE47013	Renewable Sources of Energy
GE47014	Instrumental Method of Analysis
GE47015	Urban Environmental Utility Design

Course Code	Generic Elective-II
GE47021	Environmental Remote Sensing
GE47022	Water Pollution
GE47023	Rural Environmental Technology
GE47024	Environmental Impact Assessment
GE47025	Ecology and Watershed Management

Course Code	Generic Elective-III
GE47031	Ground Water Management
GE47032	Ground Water Hydrology
GE47033	Design of Water Supply Systems
GE47034	Industrial Wastewater Treatment
GE47035	Design of Water Retaining structures

Credit Summary Chart						
Course Category	**Semester**				**Total Credits**	**%age**
	I	**II**	**III**	**IV**		
C	**19**	**15**	**20**	**28**	**82**	**87.234**
GE	**4**	**8**			**12**	**12.766**
Total	**23**	**23**	**20**	**28**	**94**	**100**

Discipline wise Credit Summary Chart						
Course Category	**Semester**				**Total Credits**	**%age**
	I	**II**	**III**	**IV**		
Engineering Sciences	**4**				**4**	**4.255**
Professional Subject Core	**13**	**13**			**26**	**27.660**
Professional Subject-Generic Elective	**4**	**8**			**12**	**12.766**
Thesis, Seminar	**2**	**2**	**20**	**28**	**52**	**55.319**
Total	**23**	**23**	**20**	**28**	**94**	**100**

Legends:

L Number of Lecture Hours per week

T Number of Tutorial Hours per week

P Number of Practical Hours per week

CIA Continuous Internal Assessment

ESE End Semester Examination

Category of Courses:

C Core Course

GE Generic Elective

MEV4101 ENVIRONMENTAL CHEMISTRY AND MICROBIOLOGY

Course Objective:

1. To familiarize the students with the basics of environmental chemistry.
2. To understand the concept and application of microbial contamination of water.
3. Study about the different –phases of microbial growth.
4. To have knowledge of bio-techniques on environment.

Learning Outcome:

1. To learn the basic principles of environmental chemistry.
2. Detailed knowledge of different parameter of water and wastewater.
3. To know the thermodynamics microbial system.
4. Detailed knowledge of concentration of water, aerobic and anaerobic process.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	**Introduction** Chemistry of Water, physical properties, hydrogen bonding in biological systems, changes in water properties by addition of solute, Fundamentals of free radical.	30 Hours	1
II	**Colloidal Chemistry** Enzymes, enzyme metabolism, biosynthesis of DNA and RNA, cloning of DNA, reverse transcription polymerase chain reaction RT-PCR **Hydrocarbon** Chemistry of hydrocarbon decay, environmental effects, effects on macro and micro- organisms.	30 Hours	1
III	**Physio-chemical parameters** Definition and determination of conductivity, pH, COD, BOD, Viscosity, surface tension, estimation of various elements at major, minor trace, concentrations; Choice of a technique; Principle, merits and demerits of the techniques–calorimetry, Atomic Absorption Spectroscopy, Gas chromatography.	30 Hours	1
IV	Thermodynamics of Microbial systems, Mass and Energy Balance, Microbial Process, Aerobic and Anaerobic Microbial growth, Diffusion and Membrane Transport.	30 Hours	1

References:

1. Maier R.M., “Environmental Microbiology”, Academic Press, New York,1999
2. Moore. J. W. and Moore E. A. “Environmental Chemistry” Mc Graw Hill
3. Sawyer C.N., McCarty PL and Parkin G.F, “Chemistry for Environmental Engineers”, 4th Edition, Mc Graw Hill, New Delhi, 1994.

MEV4102 WATER TREATMENT AND DISTRIBUTION

Course Objective:

1. To have a knowledge of water demand, methods of population forecasting and water quality parameters
2. To understand the process of solid removal and settling operations
3. To have a conceptual knowledge of filter media and removal of finer particles through filtration and techniques of water softening.
4. To know about the various miscellaneous treatments imparted to water and understand the Distribution system.

Learning Outcome:

1. It will help to understand the water demand and population forecasting along with the water characteristics.
2. It will give an insight of process of water treatment including solid removal and settling operations.
3. It will help to understand the concept of filtration and water softening techniques.
4. It will impart the knowledge of various miscellaneous treatment imparted to water and the detailed concept of distribution of water.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	**Introduction** Water Demand, Per capita demand, Factors affecting per capita demand, Sources of Water, Design period different methods of Population Forecasting **Water Quality Parameters** Physical, Chemical and Biological Characteristics of water, Water borne disease and their control	30 Hours	1
II	**Purification of water supplies** Screening (Coarse and fine screens) Plain Sedimentation – Theory of sedimentation, Stoke's law, Sedimentation Tanks Sedimentation aided with coagulation –Chemicals used for Coagulation, Constituents of a Coagulation Sedimentation Plant, clariflocculator	30 Hours	1

III	**Purification of water supplies** Filtration - Theory of filtration, filter materials, Slow sand filters, Rapid sand filters, pressure filter Disinfection – Minor methods of disinfection**,** chlorination Water Softening – Methods of removal of temporary and permanent hardness.	30 Hours	1
IV	**Miscellaneous Treatment** Removal of colour, odour and taste from water, Desalination, Defluoridation **Distribution System** Requirements of a good distribution system, Layout of distribution networks, methods of distribution Storage capacity of distribution reservoirs, Analysis of complex pipe networks (hardy cross method)	30 Hours	1

References:

1. Garg S.K., "Water Supply Engineering (Environmental Engineering Vol. – I)", Khanna Publication

2. Peavy, "Environmental Engineering", McGraw Hill

3. Sawyer C.N, McCarty P.L and Parkin G.F, "Chemistry for Environmental Engineering and Science", 5th ed. Tata McGraw-Hill

4. Manual of water supply

MEV4103 WASTE WATER TREATMENT

Course Objective:

1. To know the different terminology used in waste water process
2. Learn about the various parameters of waste water
3. Detailed study about the physico-chemical methods involved in waste water treatment process.
4. To know Industrial waste water and learn its characteristics.

Learning Outcome:

1. To know about the waste water treatment processes.
2. To understand the different physico-chemical parameter of waste water.
3. To develop knowledge about designing of different waste water treatment units.
4. To analyze the industrial waste water and learn its characteristics.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	**Waste Water Characteristics** Constituent of sewage physical & chemical, oxygen demand, BOD, COD, Relative Stability, population equivalent, Biological Characteristics. Wastewater Collection Systems	30 Hours	1
II	**Waste Water Treatment** Flow diagram of conventional sewage, treatment plant, Primary treatment – screens, Grit Chambers, detritus tank, skimming tank, Sedimentation – Plain & Chemical. **Secondary Treatment** Trickling fitters, Biological contactor, Activated sludge process, aerobic pond and ditches, facultative pond, anaerobic ponds- polishing ponds, aerated lagoon.	30 Hours	1
III	**Anaerobic digestion of sludge** Design of low and high rate anaerobic digesters and septic tank, soak pit, soak trench. Basic concept of anaerobic contact process, anaerobic filter	30 Hours	1
IV	**Wastewater Treatment Plant Characteristics** Sequencing of unit operations and processes; Plant	30 Hours	1

	layout; Hydraulic considerations. Anaerobic fixed film reactor, fluidized bed and Expanded bed reactors and up flow anaerobic sludge blanket (UASB) reactor, sludge digestion and sludge disposal.		

References:

1. Arceivala S.J., "Wastewater Treatment for Pollution Control", TMH, New Delhi, Second Edition, 2000.
2. Manual on "Sewerage and Sewage Treatment" CPHEEO, Ministry of Urban Development, Government of India, New Delhi, 1999.
3. Metcalf & Eddy, INC, "Wastewater Engineering – Treatment and Reuse", Fourth Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2003.
4. Sawyer C.N, McCarty P.L and Parkin G.F, "Chemistry for Environmental Engineering and Science", 5th ed. Tata Mc Graw-Hill.

MEV4151 WATER AND WASTE WATER TREATMENT LAB

List of Experiments

1. To estimate the hardness of the given water sample.
2. To estimate the pH and electrical conductivity of the given water sample.
3. To estimate the acidity and alkalinity of the given water sample.
4. To estimate the chloride concentration of the given water sample.
5. To estimate the total solids, total dissolved solids and volatile solids of the given water sample.
6. Turbidity and Optimum Coagulant Dose
7. To determine the BOD, COD of the given sample.
8. Determination of Coagulant Dose by Jar Test.
9. To estimate the fluoride concentration of the given water sample
10. To determine MPN count - total and fecal.
11. To determine Heavy Metals (Cr, As, CN, Cd) in wastewater.

MEV4201 SOLID WASTE MANAGEMENT

Course Objective:

1. To have knowledge of solid waste and management.
2. Study the properties of solid wastes and their different reduction techniques.
3. To study how to handle solid wastes.
4. Discuss the significance of recycling, reuse and reclamation of solid wastes.

Learning Outcome:

1. Illustrate industrial practices in solid waste management.
2. Detailed knowledge on properties of hazardous waste.
3. To know the handling and transportation techniques for solid and hazardous wastes.
4. Students will be able to know processing and handling of solid waste in better way.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	**Sources and Classification of Solid Waste** Types and Sources of solid and hazardous wastes, Need for solid and hazardous waste management, Elements of integrated waste management and roles of stakeholders, Salient features of Indian legislations on management, hazardous wastes, biomedical wastes, lead acid batteries, electronic wastes, plastics and fly ash – Financing waste management	30 Hours	1
II	**Waste Characterization and Source Reduction** Waste generation rates and variation - Composition, physical, chemical and biological properties of solid wastes Hazardous Characteristics, TCLP tests, waste sampling and characterization plan, Source reduction of wastes, Waste exchange, Extended producer responsibility, Recycling and reuse	30 Hours	1

III	**Storage, Collection and Transport of Wastes** Handling and segregation of wastes at source storage and collection of municipal solid wastes, Analysis of Collection systems **Need for transfer and transport** Transfer stations Optimizing waste allocation, compatibility, storage, labeling and handling ofhazardous wastes – hazardous waste manifests and transport **Waste Disposal** Waste disposal options – Disposal in landfills - Landfill Classification, types and methods– site selection - design and operation of sanitary landfills, secure landfills and landfillbioreactors, leachate and landfill gas management, landfill closure	30 Hours	1
IV	**Waste Processing Technologies** Objectives of waste processing, material separation and processing technologies, biological and chemical conversion technologies, methods and controls of Composting- thermal conversion technologies and energy recovery, incineration, Advantages and disadvantages of various technological options.	30 Hours	1

References:

1. T. Hilary and Samuel A, Vigil, “Integrated Solid Waste Management”, Mc-Graw Hill International edition, New York
2. La Grega M., Philip L. Buckingham, “Hazardous waste Management”, Mc-Graw Hill International edition, New York
3. CPHEEO, “Manual on Municipal Solid waste management, Central Public Health and Environmental Engineering Organization, Government of India, New Delhi
4. Vesilind & Worrell, “Solid waste Engineering” Thomsonb Learning Inc., Singapore

MEV4202 AIR AND NOISE POLLUTION AND CONTROL

Course Objective:

1. The scope and scales of air pollution and its effects
2. To understand the concept of meteorology, lapse rate and self-cleansing properties of Environment
3. To understand the methods of control of particulates from stationary sources and gaseous pollutants from industries
4. To understand the effects of noise, calculations of noise levels.

Learning Outcome:

1. It will help in understanding the concept of air pollution and its effect
2. Student will understand the role of meteorology, lapse rate, calculation of effective height of stack
3. They shall be able to understand the methods of control of pollutants from stationary sources and industries.
4. It will help to understand the effects of noise, basic definition, standards and control measures.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	Definition, Scope and Scales of Air Pollution, Natural and man-made air pollution Sources and classification of air pollutants and their effect on human health, vegetation, animals, property, aesthetic value and visibility. Ambient Air Quality and Emission standards, Emission Inventories, Ambient and stacks. Concept of air modeling	30 Hours	1
II	**Meteorology** Effects of meteorology on Air Pollution Lapse rate, Atmospheric stability, Inversion, Dispersion of air pollutants, Dispersion models, Software application, Plume rise, Effective stack height, Emission regulations. Natural self cleansing properties of the Environment	30 Hours	1

III	**Control of Air pollution from Stationary sources** Design and performance equations of Gravity Separators (cyclone), Centrifugal collectors, Wet scrubbers, Fabric filters, Electrostatic Precipitators, Case studies for stationary and mobile sources. Control of Gaseous Pollutants in Industries – Absorption Units, Adsorption Units and Combustion Equipment	30 Hours	1
IV	**Noise Pollution and Control** Effects of noise, Definition of decibel, sound power level, sound intensity level and sound pressure level, Octave bands, Averaging sound pressure levels, Noise rating systems, basic concept of community noise, transportation noise and industrial noise; acceptable outdoor and indoor noise levels; effects of noise and control measures.	30 Hours	1

References:

1. Garg S.K., "Water Supply Engineering (Environmental Engineering Vol. – I)", Khanna Publication

2. Peavy, "Environmental Engineering", McGraw Hill

MEV4203 ENVIRONMENTAL QUALITY MANAGEMENT

Course Objective:

1. To develop an understanding of international environmental standards
2. Conduct Mock Auditing.
3. To develop and apply ISO 14000 for Environmental Management
4. To develop basic knowledge on components of ISO 14000

Learning Outcome:

1. Ability to understand the need and origin of Environmental Management Standards
2. Detailed knowledge of spectroscopic techniques.
3. Ability to identify environmental aspects and impacts.
4. Identify global and national eco labels.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	**Environmental impact assessment** Introduction, Concepts and aims, Impact statement, Methods and Processes, Mitigation processes. Public participation in environment decision making. Evaluation and interpretation of data, geographical and temporal limitations, mitigation of impact and temporal effects. Prediction of impacts on environmental parameters related to air, water, land, noise, flora & fauna	30 Hours	1
II	**Environment education and economics** Environment education and awareness, Environmental economics, Economics of Pollution control, Cost benefit analysis. Prediction and assessment of impacts on the biological, cultural and socio-economic environment, Introduction and basic concepts. Environmental impact assessment of major development projects	30 Hours	1
III	**Environmental audit** Concepts, Objectives of audit. Types of audits, programme, Audit Report, Action Plan & Management of audits. Waste management contractor audits, Life-cycle approach	30 Hours	1

IV	**Introduction to ISO** Principles and Elements of Successful environmental management. ISO Principles, EMS, Creating an environmental management system in line with ISO 14000, general principle of conducting life cycle assessment (LCA), definition, stages and scope of LCA and LCA inventory. Ministry of environmental guidelines, case studies on EIA/EIS and EA.	30 Hours	1

References:

1. Willard Dean.And Settle. „Instrumental methods of analysis Edn. Words Worth, New York, 2004.
2. Paul R, "Environmental Quantitative Analysis: Principles, Techniques, and Applications", Marcel Dekker; 1edition
3. Ewing, "Instrumental Methods of Chemical Analysis", 5th Edition, McGraw Hill, NewYork

MEV4251 AIR AND NOISE POLLUTION LAB

1. Measurement of PM_{10} and $PM_{2.5}$
2. Measurement of $PM_{2.5}$
3. Measurement of CO and HC in exhausts.
4. Measurements of SO_2 in ambient air.
5. Measurement of NO_2 in ambient air.
6. Stack monitoring by BIS/EPA methods by field visit.
7. Detection of levels of noise pollution in residential, commercial, industrial and sensitive areas of Lucknow city.
8. Measurement of H_2S, $O_3$and NH_3 in ambient air
9. Plotting of wind-rose diagram by AERMOD software

GE47011 EARTH AND ENVIRONMENT

Course Objective:

1. Recognize the natural and human-driven systems and processes that produce energy and affect the climate
2. Explain scientific concepts in language non-scientists can understand
3. Use numerical tools and publicly available scientific data to demonstrate important concepts about the Earth, its climate, and resources
4. Demonstrate that greenhouse gases are the most significant factor controlling surface temperature

Learning Outcome:

1. Recall that carbon dioxide has a well-understood and physically unavoidable warming influence on Earth's climate
2. Recall that multiple independent records from different places using different methods all show that both CO_2 and temperature are rising
3. Explain that patterns of global warming in the past century can only be reproduced by considering both natural and human influences on climate
4. Use a model to show that global climate always finds a steady state, but certain factors may influence how long it takes to get there

Course Contents:

Module	Course Topics	Total Hours	Credits
I	Introduction, Structure and composition of Atmosphere, component of environment, Importance of Clean Environment, Ecosystem, Ecological Pyramid.	30 Hours	1
II	Conservation of Environment, Source, Cause and Effect of Thermal Pollution, Radioactive and Non-Radioactive Pollution. Disposal of waste in streams and estuaries	30 Hours	1
III	Source, Cause and Effect Soil and Land Pollution, Impact of Mining and Deforestation, Green House Effect and Global Warming, Depletion of Ozone.	30 Hours	1
IV	Biodiversity, Sustainable Development, e-Waste, Plastic Waste. Land filling, Concept of waste exchange and balanced industrial complexing, Case Studies. Underground water pollution.	30 Hours	1

References:

1. Mukherjee Biswarup, "Environmental Biology", Tata McGraw Hill Publishing Company Limited, New Delhi,1997
2. Manohaan S.E., "Environmental Science and Technology", Lewis Publication, NewYork,1997
3. Sawyer C.N., P.L. Mc Carty and, G.F Parkin,. "Chemistry for Environmental Engineers", 4th Edition, McGraw Hill, New Delhi,1994
4. De A. K, "Environmental Chemistry", New Age International Limited, New Delhi,1995

GE47012 ENVIRONMENTAL SANITATION AND ECOLOGY

Course Objective:

1. To know the different terminology used insanitation.
2. To know about basics of the ecosystem.
3. Gives the knowledge of solid waste management.
4. To know about the biological process.

Learning Outcome:

1. Exposure on the basic concepts of pollution and its effects.
2. Detailed study about solid waste management.
3. To know about the biological process.
4. Awareness of different programme running by government.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	Introduction and terminology, Pollution types and Sources, Air, drinking water and waste water quality standard. Health hazards,	30 Hours	1
II	Water Supply and Sanitary Installations in Buildings, Ecology and Environment, Principles of Ecology, Ecosystems, Energy Flow, Trophic Level, Food chain and Food Web, Eco-cycles of Pollutants and Species	30 Hours	1
III	Waste disposal options – Disposal in landfills - Landfill Classification, types and methods– site selection - design and operation of sanitary landfills, secure landfills and landfill bioreactors – leachate and landfill gas management – landfill closure and environmental monitoring	30 Hours	1
IV	Various problems in implementation of sanitation scheme in lndia. Biogas plants, role of W.H.O. in rural sanitation of India.	30 Hours	1

References:

1. Mukherjee Biswarup, “Environmental Biology”, Tata McGraw Hill Publishing Company Limited, New Delhi,1997
2. Manohaan S.E., “Environmental Science and Technology”, Lewis Publication, New York,1997

3. Sawyer C.N., McCarty P.L. and. Parkin G.F, “Chemistry for Environmental Engineers”, 4th Edition, McGraw Hill, New Delhi,1994
4. De A.K., “Environmental Chemistry”, New Age International Limited, New Delhi,1995

GE47013 RENEWABLE SOURCES OF ENERGY

Course Objective:

1. To learn the basic concept of renewable energy resource.
2. To study the about solar energy, tidal energy, wind energy etc.
3. Detailed study of nuclear energy, hydrogen energy.
4. To develop green technology.

Learning Outcome:

1. Learn conventional and nonconventional type of energy resource.
2. To enhance knowledge about different renewable resources like solar energy, tidal energy etc.
3. To study about lithium cell.
4. To analyze characteristics of LNG and CNG.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	**Introduction** Introduction to Renewable Sources of Energy, Wind energy, Ocean and tidal energy, Geo-Thermal energy, etc.	30 Hours	1
II	**Solar Radiation** Measurements of solar Radiation and sunshine, Solar Thermal Collectors – Flat Plate and Concentrating Collectors – Solar Applications – fundamentals of photo Voltaic Conversion – solar Cells – PV Systems – PV Applications.	30 Hours	1
III	**Wind Data and Energy Estimation** Wind Energy Conversion Systems – Wind Energy generators and its performance – Wind Energy Storage it's Applications, Hybrid systems, Process of Wind mill installations	30 Hours	1
IV	Hydrogen, generation, storage, transport and utilization, Applications : power generation, transport – Fuel cells – technologies, types – economics and the power generation LPG/ CNG, Bio-Diesel. LNG Ships	30 Hours	1

References:

1. Boyle G., “Renewable Energy, Power for a Sustainable Future”, Oxford University Press, U.K.,1996
2. Twidell, J.W. & Weir, “Renewable Energy Sources”, EFN Spon Ltd., UK, 1986
3. Tiwari G.N., “Solar Energy–Fundamentals Design, Modelling and applications”, Narosa Publishing House, New Delhi,2002
4. Freris L.L., “Wind Energy Conversion systems”, Prentice Hall, UK,1990
5. Sukhatme S.P., “Solar Energy”, Tata McGraw Hill Publishing Company Ltd., New Delhi,1997

GE47014 INSTRUMENTAL METHOD OF ANALYSIS

Course Objective:

1. To learn the basic concept of quantitative chemistry.
2. To study the about photometry, chromatography.
3. To develop green technology.
4. To study about Colorimetry.

Learning Outcome:

1. To learn the basic concept of X-Ray Fluorescence.
2. To study the about Chromatography.
3. To develop green technology.
4. To learn NMR technique.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	**Introduction** Concepts of Quantitative Chemistry, Electron Paramagnetic Resonance, X-Ray Fluorescence.	30 Hours	1
II	**Spectroscopy** Infrared Spectroscopy, Emission Spectroscopy, Flame Photometry, UV-Visible spectroscopy, Atomic Absorption Spectroscopy, Nephelometry and Turbidimetry.	30 Hours	1
III	Gas-Solid Chromatography, Gas-Liquid Chromatography, High Pressure Liquid Chromatography, Polarography, Voltametry and Chronopotentiometry, Fluorimetry, Laser Techniques.	30 Hours	1
IV	Electron Microscopy, Ion Chromatography, Nuclear Magnetic Resonance, TOC analyzer.	30 Hours	1

References:

1. Willard H.H, Merit L.L, Dean J.A. and Settle F.A., "Instrumental Methods of Analysis", 7th Ed. CBP Publishers and Distributors, New Delhi1986
2. Skoog D.A.,West D.M. and Nieman T.A, "Principles of Instrumental Analysis", 5th Ed.Thomson Asion (P) Ltd. Singapore,2004
3. Mendham J., Denney R.C, Barnes J.D and Thomas M., "Vogel"s Textbook of Quantitative Chemical analysis", 6th Ed. Pearson Education Ltd New Delhi 2002.
4. Sawyer C.N., Mc Carty P.L and Parkin G.F., "Chemistry for Environmental Engineers", 4th Edition, McGraw Hill, New Delhi 1994.

GE47015 URBAN ENVIRONMENTAL UTILITY DESIGN

Course Objective:

1. Disseminate knowledge and skill for proper design of design of gas recovery system and related to land fill site.
2. To enhancement of knowledge and skill for proper design of water supply.
3. To inculcate the understanding on quantification and variation for municipal sewerage system.
4. To understanding the principles, practices and design parameters of RWH.

Learning Outcome:

1. Skilled Engineer who can select and design engineering land fill site.
2. Trained and skilled environmental engineer having sufficient knowledge to plan and design water supply, sewerage, drainage, rainwater utilitysystem.
3. Trained and skilled environmental engineer having sufficient knowledge to sewerage, drainage and rainwater utility system.
4. To study quality aspect of rain water harvesting system.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	Site selection criteria for secured land fill sites, estimation of area required for land fill sites, design of engineering land fill site, design of natural and artificial lining system, geo-liner, design of leachate collection system, design of gas recovery system.	30 Hours	1
II	Municipal water requirements, water supply appurtenances distribution systems, optimum design of water main, design of water distribution network, computer applications in water supply design.	30 Hours	1
III	Quantification of rain water- runoff, sewer appurtenances quantification and variation of municipal sewage, design of open and closed sewerage systems, computer application in design of sewerage system.	30 Hours	1
IV	Water conservation – principles and practices, rainwater harvesting system, different types of rainwater harvesting system (RWH), characteristics of good rainwater harvesting system, design parameters and design of RWH units.	30 Hours	1

References:

1. Peavy & Rowe "Environmental Engineering" Mc Graw Hill
2. Introduction to Environmental Engineering, Davis and Cornwell, McGraw Hill Series
3. Manual of Water Supply, CPHEEO, MoUD, Govt. of India
4. Manual of Sewerage System, CPHEEO, MoUD, Govt. of India
5. Manual of Solid Waste Management, CPHEEO, MoUD, Govt. of India

GE47021 ENVIRONMENTAL REMOTE SENSING

Course Objective:

1. To know the thermodynamics microbial system.
2. Learn about the technique.
3. How to examine microbial contamination of water.
4. Study about the different –phases of microbial growth.

Learning Outcome:

1. Introduction to the basic principles of environmental chemistry.
2. Detailed knowledge of different parameter of water and wastewater.
3. Overview of remote sensing.
4. Know the aerobic and anaerobic process involved in the water and waste-water.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	Historical Perspective, Principles of remote sensing, components of Remote Sensing, Energy source and electromagnetic radiation, Energy interaction, Spectral response pattern of earth surface features. Applications of remote sensing	30 Hours	1
II	Classification of Remote Sensing Systems, Energy recording technology, Aerial Photographs, Photographic systems – Across track and along track scanning, Multispectral remote sensing, Thermal remote sensing, Microwave remote sensing – Active and passive sensors, RADAR, LIDAR, Satellites and their sensors, Indian space programme - Research and development resolution.	30 Hours	1
III	Characteristics of Remote Sensing data, Photogrammetry – Satellite data analysis– Visual image interpretation, Digital image processing– Image rectification, enhancement, transformation, Classification, Data merging, RS – GIS Integration, Image processing software. Remote sensing data products and their procurement	30 Hours	1

IV	GIS Concepts – Spatial and non spatial data, Vector and raster data structures, Data analysis, Database management – GIS software, Conservation of resources, Sustainable and use, Coastal zone Management – Limitations. Ground truth collection – spectral signatures	30 Hours	1

References:

1. Kiefer R.W, "Remote sensing and image interpretation", John Wiley and sons, New York,2004.
2. Konechy G., "Geoinformation & Remote sensing, Photogrammetry and Geographical Information Systems", CRC press, 1st Edition,2002.
3. Burrough P.A, Mc Donnell R.A, "Principles of Geographic Information Systems" Oxford University Press, New York,2001.
4. Lintz. J, "Remote sensing of Environment", Addison Wesley Publishing Company, New Jersey,1998

GE47022 WATER POLLUTION

Course Objective:

1. Clean, safe & adequate freshwater is vital to the survival of all living organisms
2. Learn about the various parameters of wastewater
3. Detailed study about the physico-chemical methods involved in waste water treatment process.
4. To know about the biological treatment process.

Learning Outcome:

1. To know about the waste water treatment processes.
2. To understand the different physico-chemical parameter of waste water.
3. To develop knowledge about designing of different waste water treatment units.
4. To analyze the industrial waste water and learn its characteristics.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	Beneficial uses of water and quality requirements, standards. Concepts of water and wastewater quality: physical, chemical and bacteriological examination of water and wastewater. Water borne diseases and their control. **Wastewater characteristics** Waste Water Composition Temperature, pH, colour and odour, solids, nitrogen and phosphorus, chlorides, toxic metals and compounds, etc. Objectives of treatment: Water and wastewater treatment, unit operations and processes and flow sheets, latest codal limits.	30 Hours	1
II	Determination of settling velocity, efficiency of ideal sedimentation tank, short circuiting; different classes of settling; design of primary and secondary settling tanks; removal efficiency for discrete and flocculent settling.	30 Hours	1

	Coagulation Mechanisms of coagulation, coagulants and their reactions, coagulant aids; design of flocculators and clariflocculators.		
III	**Treatment Processes** Preliminary, primary, secondary and tertiary treatment processes. Primary Treatment: Screens, grit chamber and their design, sedimentation and chemical treatment to be given. Secondary Treatment: Theory of organic matter removal; activated sludge process, design of different units and modifications, extended aeration systems; trickling filters; aerated lagoons, waste stabilization ponds, oxidation ditches, R.B. C. etc. Sludge Treatment Stages: Sludge thickening, Sludge Stabilization, Sludge Dewatering, sludge disinfection, disposal. Removal of Pathogenic bacteria	30 Hours	1
IV	Design of low and high-rate anaerobic digesters and septic tank. Basic concept of anaerobic contact process, anaerobic filter, anaerobic fixed film reactor, fluidized bed and expanded bed reactors and Disposal of wastewater on land and in water bodies. Introduction to Duck weed pond, vermiculture and root zone technologies and other emerging technologies for wastewater treatment. **Eutrophication of Lakes & Reservoirs**	30 Hours	1

References:

1. Metcalf and Eddy Inc.: "Wastewater Engineering", TMH

2. Garg S.K., "Water Supply Engineering (Environmental Engineering vol. – I)", Khanna Publication

3. Garg S.K.: "Sewage Disposal and Air Pollution Engineering Environmental Engineering Vol. – II)", Khanna Publication

GE47023 RURAL ENVIRONMENTAL TECHNOLOGY

Course Objective:

1. Study about water, its characteristics and its constituent minerals.
2. Learn about the sedimentation principles of wastes in water.
3. How to treat waste water: primary, secondary, tertiary treatment.
4. Study about digestion of sludge.

Learning Outcome:

1. Introduction to the water quality and assessment.
2. Detailed knowledge of settling laws of particulate contamination.
3. To know the details of water treatment process.
4. Know the anaerobic process to stabilize sludge.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	**General** Concept of environment and scope of sanitation in rural areas. Magnitude of problems of rural water supply and sanitation. Population to be covered, difficulties. National policy.	30 Hours	1
II	Various approaches of planning of water supply schemes in rural areas. Development of proffered sources of water springs. Wells, infiltration wells, radial wells and infiltration galleries, collection of raw water from surface source. Specific problems in rural water supply and treatment.	30 Hours	1
III	Improved methods and compact systems of treatment of surface and ground waters for rural water supply, slow sand filter, chlorine diffusion cartridges. Pumps, pipes materials, appurtenances and improved devices for use in rural water.	30 Hours	1
IV	Planning of distribution system in rural areas. Treatment and Disposal of waste water. Various methods of collection and disposal of night soil. Simple waste water treatment units and systems in rural areas such as stabilization ponds, latest developments in treatment of water.	30 Hours	1

References:

1. Metcalf and Eddy Inc.: “Wastewater Engineering” TMH

2. Garg S.K., “Water Supply Engineering (Environmental Engineering Vol. – I)”, Khanna Publication

3. Garg S.K.: “Sewage Disposal and Air Pollution Engineering (Environmental Engineering Vol. – II)”, Khanna Publication

GE47024 ENVIRONMENTAL IMPACT ASSESSMENT

Course Objective:

1. To learn the importance of environmental impact assessment in various engineering projects
2. To brief the various methodologies involved in environmental impact assessment
3. To identify the prediction tools for the assessment of different environmental impacts
4. To describe the concepts of environmental management system

Learning Outcome:

1. To analyze the environmental impacts of proposed projects
2. To predict the magnitude of an impact using mathematical tools
3. To propose proper mitigation measures to avoid environmental impacts
4. To summarize the EIA report with suitable environmental management plan

Course Contents:

Module	Course Topics	Total Hours	Credits
I	Definition of environmental impact assessment and environmental auditing, objectives of EIA. Types of environmental impacts, various steps in EIA. Environmental legislations, NEPA, environmental protection act 1986, other acts, organizational setup and analysis, preparation of Environmental Base map, Classification of environmental parameters **EIA Methodologies** Introduction, Criteria for the selection of EIA Methodology, E I A methods, Ad-hoc methods, matrix methods, Network method Environmental Media Quality Index method, overlay methods, cost/Benefit Analysis.	30 Hours	1
II	**Impact of Developmental Activities and Land Use** Introduction, Methodology for the assessment of soil and ground water, Delineation of study area, Identification of activities. Assessment of Impact of development Activities on Vegetation and wildlife, environmental Impact of Deforestation – Causes and effects of deforestation.	30 Hours	1

III	**Prediction and Assessment of Impact** Quality, Impact prediction, Assessment of Impact significance, Identification and Incorporation of mitigation measures. EIA in surface water, Air and Biological environment: Methodology for the assessment of Impacts on surface water environment, Air pollution sources, generalized approach for assessment of Air pollution Impact.	30 Hours	1
IV	**Environmental Audit & Environmental legislation** Objectives of Environmental Audit, Types of environmental Audit, Audit protocol, stages of Environmental Audit, on-site activities, evaluation of Audit data and preparation of Audit report. Case studies on EIA/EIS and EA.	30 Hours	1

References:

1. Environmental Impact Assessment Methodologies, by Y. Anjaneyulu, B.S. Publication, Sultan Bazar, Hyderabad.
2. Environmental Science and Engineering, by J. Glynn and Gary W. Hein Ke – Prentice Hall Publishers
3. Environmental Science and Engineering, by Suresh K. Dhaneja – S.K. Katania & Sons Publication., New Delhi
4. Environmental Pollution and Control, by Dr. H.S. Bhatia – Galgotia Publication (P) Ltd, Delhi

GE47025 ECOLOGY AND WATERSHED MANAGEMENT

Course Objective:

1. Provide basic knowledge of ecological principles and ecosystem
2. Impart basic knowledge of ecological principles and ecosystem for sustainable environmental development
3. To introduce students with the concept of a watershed and its quantitative characteristics.
4. To discuss various aspects of watershed development and management – in terms of technological, social. Ecological and environmental issues.

Learning Outcome:

1. Environmental Engineers having knowledge of ecological principles and ecosystem for sustainable environmental development.
2. The fully aware of principles and practices of water management approaches.
3. Student will be able to understand the basic concept of watershed development in context to its morphometric characteristics
4. To know the different source of basin.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	Ecology – meaning and scope, ecosystem and its attributes, concepts of ecosystem, structure and function of ecosystem; Energy flow in ecosystem, Ecological succession.	30 Hours	1
II	Ecological systems – Freshwater environment, marine system, terrestrial ecosystems; Equatorial, hot deserts, taiga, tundra and mountains ecosystems; Disruption of ecological systems, impact of man on environment, global environmental challenges and ecological policies	30 Hours	1
III	Watershed classifications, based on the size and land use pattern, soil and water conservation, soil erosion, measures for erosion control, types of soil surveys	30 Hours	1
IV	Introduction: area of the basin, stream order, drainage density, stream density, length of the basin, shape of the basin, relief of the basin, slope of the basin.	30 Hours	1

References:

1. Environmental Engineering, Grady, Tata McGraw Hill Pvt. Ltd. New Delhi India
2. Ecology and Environment, S.D. Sharma, Chand Publications, Meerut,India
3. Watershed Management by Murthy J. V. S., New Age International, New Delhi – 1998
4. Watershed Hydrology, by Black Peter E., Prentice Hall, London -1991
5. Watershed Management and Sustainable Management by GopalIyer K. and Roy U. N., Kanishka Publishers, New Delhi2005

GE47031 GROUND WATER MANAGEMENT

Course Objective:

1. To know source of water
2. Learn about the various parameters of water
3. Ground water modeling.
4. To understand the mechanism of ground water recharge.

Learning Outcome:

1. To study about the different source of water and their availability.
2. To analyze the different parameter of water in lab.
3. To study quality aspect of ground water and surface water
4. To understand ground water management technique.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	**Introduction** Occurrence of ground water, Hydrological Cycle, Ground water contamination Sources and Mechanisms of Groundwater Pollution from Landfills and Waste Dumps. Precipitation, its types & forms	30 Hours	1
II	Physical, Chemical and Biological Characteristics of Water. Standard methods of determination of important physical and chemical parameters of water quality, eg.pH, turbidity, total Solids, alkalinity, hardness etc.	30 Hours	1
III	**Ground permeability & its determination,** Well Hydraulics and Water Wells, Ground Water quality, Ground Water Modeling Techniques, Surface and Subsurface Investigations of Ground water.	30 Hours	1
IV	Artificial discharge and Recharge of Ground Water, Ground Water Management Techniques. Rainwater harvesting & and other similar methods.	30 Hours	1

References:

1. Sawyer C.N., Mac Carty P.L. and Parkin G.F., "Chemistry for Environmental Engineering and Science", Tata McGraw – Hill, Fifth edition, New Delhi
2. "Manual on water supply and Treatment", CPHEEO, Ministry of Urban Development, Government of India, New Delhi.
3. G.M.; Masters Introduction to Environmental Engineering and Science, Prentice Hall of India.

GE47032 GROUND WATER HYDROLOGY

Course Objective:

1. Hydrological cycle of water
2. Study the working and types of well
3. Study on ground water pollution.
4. Design of rain water harvesting.

Learning Outcome:

1. To study about the different source of water
2. Study about well hydraulics.
3. Design of water treatment process
4. Application of GIS in ground water study.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	Darcy"s law, General hydro-dynamic equations, flow- nets in isotropic medium, confined and unconfined aquifers, Geological Formations: Aquifer, aquiclude, aquitard, aquifuge	30 Hours	1
II	Schwartz-Christoffel Transformation and its application for groundwater flow and Seepage problems. Failure due to seepage: piping failure, etc. Multiple well system, partially wells, Image wells, Mutual interference of wells. Contamination of groundwater, control of Ground water	30 Hours	1
III	Control of ground water pollution. Storage and exploration of groundwater, drainage, construction and maintenance of wells, groundwater recharge and runoff, water quality, budgeting. Well development	30 Hours	1
IV	Stimulation of groundwater basin application of GIS and remote sensing for groundwater. Roof-top Rainwater Harvesting and Recharge. Artificial method of Recharge of ground water	30 Hours	1

References:

1. C.N Sawyer, P.L. Mac Carty, and G.F Parkin, Chemistry for Environmental Engineering and Science, Tata McGraw – Hill, Fifth edition, New Delhi
2. "Manual on water supply and Treatment", CPHEEO, Ministry of Urban Development, Government of India, New Delhi.

GE47033 DESIGN OF WATER SUPPLY SYSTEMS

Course Objective:

1. To know the requirements, layout, methods of distribution and functions, storage capacity of distribution reservoirs

2. To have the knowledge of water plumbing systems

3. To have an insight to water supplies in a rural area

4. To know the details of preparing and planning of water supply projects

Learning Outcome:

1. To have the knowledge of distribution system and distribution reservoirs.

2. Understanding the details of water supply plumbing systems in buildings and house and design considerations for water piping systems

3. It will help to understand the concept of supplying water to small rural areas

4. It will help in understanding the preparing and planning of water supply projects.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	Distribution System - Requirements, Layouts of distribution networks, methods of distribution. Distribution Reservoirs – functions, storage capacity, detection of leakage in the distribution pipe, analysis of pipe networks	30 Hours	1
II	Water supply plumbing systems in buildings and houses. Plumbing systems, house water connections, pipe fittings, water piping in buildings, design consideration for water piping systems in buildings	30 Hours	1
III	Water supplies in small rural areas. Sources of water for small rural areas, selection of suitable sources, Assessment of the requirement of water and required water treatment, treatment methods for high fluorine water, removal of Iron, Chlorination	30 Hours	1
IV	Planning and preparing water supply projects - General introduction, data to be collected, analysis of data, Project drawings, estimates, reports	30 Hours	1

References:

1. Garg S.K., “Water Supply Engineering (Environmental Engineering Vol. – I)”, Khanna Publication

2. Peavy, “Environmental Engineering”, Mc Graw Hill

3. Sawyer C.N, Mc Carty P.L and Parkin G.F, “Chemistry for Environmental Engineering and Science”, 5th ed. Tata Mc Graw-Hill

4. Manual of water supply

GE47034 INDUSTRIAL WASTEWATER TREATMENT

Course Objective:

1. To know general characteristic and sources of industrial wastewater
2. Learn about the various parameters of industrial wastewater
3. To study about the methods involved in industrial water treatment process.
4. Which type of disposal adopted in industrial wastewater treatment process?

Learning Outcome:

1. To know about the waste water treatment processes.
2. To understand the different physico-chemical parameter of waste water.
3. To develop knowledge about designing of different waste water treatment units.
4. To analyze the industrial waste water and learn its characteristics

Course Contents:

Module	Course Topics	Total Hours	Credits
I	**Industrial scenario in India** Industrial activity and Environment - Uses of Water by industry – Sources and types of industrial wastewater – Nature and Origin of Pollutants -. General methods of treatment of industrial effluent. Nutrient and its role in the treatment	30 Hours	1
II	Industrial wastewater monitoring and sampling, generation rates, characterization and variables, Toxicity of industrial effluents, Typical Industrial Wastes Characteristics and Treatment Planning of Sugar Industry, Distillery, Tannery, Electroplating Industry, Petroleum Industry.	30 Hours	1
III	Pesticide and Fertilizer Industry, Pharmaceutical Industry Textile Industry, Pulp and Paper Industry, Chlor- Alkali Industry, Soap and Detergent Industry, Atomic Power Plants, Dairy, Steel, Thermal Power Plants.	30 Hours	1
IV	Pre-Treatment of effluent waste volume and strength reduction, equalization and proportioning of wastes. Neutralization of wastes, oil removal and floatation. General Standards for Disposal of Effluents, Concept of Common Effluent Treatment Plant. Common Effluent Treatment Plants – Joint treatment of industrial and domestic wastewater - Zero effluent discharge systems	30 Hours	1

References:

1. Metcalf and Eddy, “Wastewater Engineering, Treatment and Reuse”, Tata Mc Graw Hill, New Delhi,2003
2. Jaya P., Reddy R., “hydrology” Laxmi Publication
3. Sawyer C.N, McCarty P.L and Parkin G.F, “Chemistry for Environmental Engineering and Science”, 5th ed. Tata Mc Graw-Hill
4. Garg S. K,.” Water Supply EngineeringVol.1”, Khanna Publishers, New Delhi.

GE47035 DESIGN OF WATER RETAINING STRUCTURES

Course Objective:

1. Providing basic knowledge of and skill for different types of reinforced cement concrete structures commonly used in water supply and sewerage system.
2. To disseminate knowledge to students for design of water retaining structures.
3. To design of flat slab and different concrete structures.
4. Learn about the various parameters of pipes and conduits.

Learning Outcome:

1. Providing sufficient knowledge on application of various fundamental principles to design the water retaining structures
2. Environmental Engineers should be able to understand about basics of reinforced cement concrete.
3. Environmental Engineers should be able to understand about basics of designing the structures involved in water and wastewater.
4. To analyze the various parameters of underground structures used in water and waste water.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	Design and constructional aspects, durability requirement, provision of Indian standards and their applications	30 Hours	1
II	Design of different water retaining structures, design of cantilever walls to retain liquids, IS:2911-1965	30 Hours	1
III	Design of flat slab, roofs, cantilever beam and columns for reservoirs, Circular and rectangular tanks, overhead tanks	30 Hours	1
IV	Underground and on-ground, pipes and conduits, IS: 1893-2002. Planning and layout of sewerage systems.	30 Hours	1

References:

1. Design of Reinforced Concrete, A.K. Jain, Khanna Publishers, India Water Retaining Structure, K.K.
2. Reinforced Concrete Construction Meghashyam Jain Book Depot India.