Guru Nanak Dev Engineering College, Ludhiana

Civil Engineering Department

M.Tech. (Environmental Science & Engineering)

Program Outcomes (PO)

After completion of the program graduates will be able to

1. Develop environmental engineers and sensitize them towards environmental issues.
2. Apply the knowledge of science, mathematics, and engineering principles for developing problem solving attitude.
3. Identify, formulate and solve engineering problems in the domain of Environmental Engineering field.
4. Acquire analytical skills in assessing environmental impacts through a multidisciplinary approach.
5. Demonstrate proficiency in quantitative methods, qualitative analysis, critical thinking, and written and oral communication needed to conduct high-level work.

First Semester									
Course Type	**Course Code**	**Course Name**	**Load Allocations**			**Marks Distribution**			**Credits**
			L	**T**	**P**	**Int**	**Ext**	**Total Marks**	
Core Theory	MEV-101	Physico-Chemical Treatment Methods	3	0	0	50	100	150	3
Core Theory	MEV-102	Solid and Hazardous Waste Management	3	0	0	50	100	150	3
Elective	MEV- AAA	Program Elective I	3	0	0	50	100	150	3
Elective	MEV-BBB	Program Elective II	3	0	0	50	100	150	3
Core Lab I	LMEV-101	Advanced Water and Wastewater Lab	0	0	2	50	50	100	1
Core Lab II	LMEV-102	Environmental Chemistry Lab	0	0	2	50	50	100	1
Core Lab III	LMEV-103	Environmental Design Lab	0	0	2	50	50	100	1
MLC	MRM-101	Research Methodology and IPR	3	0	0	50	100	150	3
Audit 1	MAC-102	Disaster Management	2	0	0	50	-	50	0
		Total	**17**	**0**	**6**	**450**	**650**	**1100**	**18**

Second Semester									
Course Type	**Course Code**	**Course Name**	**Load Allocations**			**Marks Distribution**			**Credits**
			L	**T**	**P**	**Int**	**Ext**	**Total Marks**	
Core	MEV-103	Biological Treatment	3	0	0	50	100	150	3

Theory		Methods							
Core Theory	MEV-104	Air Pollution and Control	3	0	0	50	100	150	3
Elective	MEV- CCC	Program Elective III	3	0	0	50	100	150	3
Elective	MEV- DDD	Program Elective IV	3	0	0	50	100	150	3
Core Lab IV	LMEV-104	Environmental Computation Lab	0	0	4	50	50	100	2
Core Lab V	LMEV-105	Solid waste Analysis Lab	0	0	2	50	50	100	1
Core	LMPEV-101	Project	0	0	4	50	50	100	2
Audit 2	MAC-101	English for research report / paper writing	2	0	0	50	-	50	0
		Total	**14**	**0**	**10**	**400**	**550**	**950**	**17**

Third Semester

Course Type	**Course Code**	**Course Name**	**Load Allocations**			**Marks Distribution**			**Credits**
			L	**T**	**P**	**Int**	**Ext**	**Total Marks**	
Elective	MEV- EEE	Program Elective V	3	0	0	50	100	150	3
Open Elective	MOEV- XXX	Open Elective	3	0	0	50	100	150	3
Pre-thesis	MPTEV-101	Formulation of Research Problem	0	0	2*+ 18**	100	100	200	10
		Total	**6**	**0**	**20**	**200**	**300**	**500**	**16**

Fourth Semester

Course Type	**Course Code**	**Course Name**	**Load Allocations**			**Marks Distribution**			**Credits**
			L	**T**	**P**	**Int**	**Ext**	**Total Marks**	
Thesis	MTEV-101	Thesis	0	0	4*+ 28**	100	200	300	16
		Total	**0**	**0**	**32**	**100**	**200**	**300**	**16**

* Max hours for Teacher

** Independent study hours

List of Electives		
S No	**Course Name**	**Course Code**

1	Environmental Chemistry and Microbiology	MEV – 111
2	Environmental Change and Sustainable Development	MEV – 112
3	Environmental Hydraulics and Hydrology	MEV – 113
4	Environmental Policies and Legislation	MEV – 114
5	Rural Water Supply and Sanitation	MEV – 115
6	Urban Storm water Management	MEV – 116
7	Geo-environmental Engineering	MEV – 117
8	Environmental Impact Assessment and Management	MEV – 118
9	Life Cycle Analysis and Design for Environment	MEV – 119
10	Water Distribution and Sewerage network Design	MEV – 120
11	Watershed Management	MEV – 121
12	Environmental Quality Modelling	MEV – 122
13	Industrial Wastewater Management and Reuse	MEV – 123
14	Analytical Methods for Environmental Monitoring	MEV – 124
15	Groundwater Recharge	MEV – 125
16	Environmental Remote Sensing and GIS	MEV – 126
17	Biodegradation and Bioremediation techniques	MEV – 127
18	Environmental Systems Engineering	MEV – 128
19	Membrane Processes	MEV – 129

MEV-101 Physico-Chemical Treatment Methods

(Credits - 3:0:0 = 3)

Teaching Scheme
Lectures: 3 hrs/week

Course Outcomes:

On completion of the course, the student will have the ability to:

1. Know the sampling and analysis techniques required for the monitoring of water treatment plants and for the characterization of the water.
2. Understand the water quality guidelines, criteria and standards
3. Evaluate various physical and chemical treatment options for treatment of water and wastewater.
4. Explain the mechanism behind the treatment processes and their advantages and disadvantages.

Syllabus Content:

- **Water – Quality, Standards and Criteria**: Physical, chemical and biological water quality parameters; Water quality guidelines, criteria and standards; Wastewater Effluent standards
- **Purification of water**- Natural treatment processes- Physical, chemical and biological processes. Water treatment technologies- overview. Primary, Secondary and tertiary treatment-Unit operations & unitprocesses.
- **Screening & Grit removal:** Screens; grit channels, aerated grit chambers;
- **Settling Tanks, Coagulation and Flocculation**: Theory of settling; Types of settling; Settling Tanks; Coagulation-flocculation; Flash mixing tanks and flocculation tanks; Tube settlers and plate settlers.
- **Aeration**: Diffused and surface and gas transfer processes.
- **Filtration Systems**: Filtration theory and filter hydraulics; Slow sand filters; Rapid gravity filters; Pressure filters; Multimedia filters.
- **Disinfection**: Chlorination; Ozonation; UV radiation
- **Other Water Treatment Technologies**: Ion-exchange process; Adsorption process- Adsorption equilibria- adsorption isotherms; membrane processes (nano-filtration, ultra-filtration and reverse osmosis).

Reference Books:-

1. Metcalf and Eddy, “Wastewater Engineering – Treatment and Reuse”, Tata McGraw Hill.
2. Syed R. Qasim, Edward Motley, Guang Zhu, “Water Works Engineering”- Planning, Design and Operation, PHI
3. Weber W.J., “Physico-chemical Processes for Water Quality Control”, John-Wiley
4. Howard S. Peavy, Donald R. Rowe & George Tchobanoglous, “Environmental Engg.”, McGraw Hill
5. Viessman Jr, Hammer J. M, Perez, E.M, and Chadik, P. A, Water Supply and Pollution Control, PHI Learning
6. Hammer, M.J. and Hammer, M.J. Jr., “Water and Wastewater Technology”, PHI Learning

MEV-102 Solid and Hazardous Waste Management

(Credits - 3:0:0 = 3)

Teaching Scheme
Lectures: 3 hrs/week

Course Outcomes:

On completion of the course, the student will have the ability to:

1. Examine physical and chemical composition of wastes and to analyze activities associated with the management of solid waste.
2. Understand method to recover materials, conserve products, and to generate energy from solid and hazardous wastes.
3. Design and locate waste containment systems as per regulatory standards and to appreciate the increasing importance of waste and resource management in achieving environmental sustainability.
4. Define and explain important concepts in the field of solid waste management and suggest suitable technical solutions for treatment of municipal and industrial waste.
5. Understand the role legislation and policy drivers play in stakeholders' response to the waste and apply the basic scientific principles for solving practical waste management challenges including landfill operations.
6. Define and elucidate the management, treatment and disposal of hazardous wastes and skill to assess and develop physical/chemical/biological treatment techniques for the control of hazardous wastes.

Syllabus Content:

- **Introduction:** Definition of solid wastes and hazardous wastes, Nuisance potential and extent of solid waste problems, Objectives and scope of integrated solid waste management.
- **Characterization and Quantification:** Types, composition, characteristics and quantities of wastes, Methods of quantification and characterization of wastes.
- **Collection, Storage and Transportation of Wastes:** Types of collection systems and their components, Concept of waste segregation at source and recycling and reuse of wastes; Household, street and community level collection bins and storage containers.
- **Solid Waste Processing and Treatment:**Waste processing – processing technologies – biological and chemical conversion technologies – Composting - thermal conversion technologies - energy recovery
- **Hazardous Waste Treatment and Disposal:** Biological and chemical treatment of hazardous wastes; Solidification and stabilization of wastes; Incineration for the treatment and disposal of hazardous wastes; Land farming; Landfill disposal of hazardous waste; Bioremediation of hazardous waste disposal sites.
- **Sanitary Landfills:** Design, development, operation and closure of landfills, Management of leachate and landfill gases, environmental monitoring of landfill sites.
- **Legal Requirements:** Municipal solid waste rules; Hazardous waste rules; Biomedical waste rules; E-waste rules; Rules related to recycled plastics, used batteries, flyash, etc.

Reference Books:

1. Pichtel, J., Waste Management Practices – Municipal, Hazardous and Industrial, CRC Press
2. Vesilind, P.A., Solid Waste Engineering, Thomson Learning Inc.
3. Tchobanoglous, G., Vigil, S.A. and Theisen, H., Integrated Solid Waste Management: Engineering Principles and Management Issues, McGraw Hill
4. Howard S. Peavy, Donald R. Rowe & George Tchobanoglous, “Environmental Engg.”, McGraw Hill
5. CPHEEO, *Manual on Municipal Solid waste management, Central Public Health and Environmental Engineering Organization*, Government of India

MEV-111 Environmental Chemistry and Microbiology

(Credits - 3:0:0 = 3)

Teaching Scheme
Lectures: 3 hrs/week

Course Outcomes:

On completion of the course, the student will have the ability to:

1. Understand the interactions between air, water, soil sediments, equilibrium, acid base reactions and different water quality parameters.
2. Solve redox reactions and to understand various heavy metals in waste water.
3. Identify various sources and effects of indoor and outdoor air pollution.
4. Identify various microorganism and their importance.
5. Analyze the growth kinetics of microorganisms and microbiology of aquatic ecosystem.
6. Know the role of microorganisms in waste water treatment processes.

Syllabus Content:

- **Introduction and Scope:** Air-water, water-sediment/soil and air – water – sediment interactions, physical water quality parameters.
- **Chemistry of Natural Water:** Reaction stoichiometry, basic concepts from equilibrium chemistry, acid-base reactions, solubility of salts (soil chemistry) and related water quality parameters.
- **Nutrients and Organic Impurities in Water:** Oxidation-reduction reactions, water and wastewater quality parameters (ORP, BOD, COD, TOC etc.).
- **Heavy Metals:** Metals in water, complex formation, metal speciation.
- **Atmospheric Chemistry:**Photochemical reactions in atmosphere, Redox reactions, sources of air pollution, Major chemical pollutants and their effects, Indoor air pollutants.
- **Microorganisms:** An introduction to Algae, Fungi, Bacteria, molds, yeast, protozoa, and viruses, including their occurrence, morpohology and importance.
- **The cultivation of bacteria:** Nutritional requirement, nutritional type of bacteria, bacteriological media, choice of media and conditions of incubation, physical conditions required for growth, quantitative measurements of bacterial growth, methods of maintenance and preservation of pure cultures and cultural characteristics.
- **Aquatic microbiology:** Natural waters, the aquatic environment, distribution of microorganisms in the aquatic environment, aquatic microorganisms, the role of aquatic microbial ecosystem, productivity of aquatic ecosystem and biogeochemical transformations (introduction only).
- **Microbiology of domestic water and wastewater:** water purification, determining the sanitary quality, swimming pools, water pollution, wastewater, wastewater treatment and disposal, waste water treatment process, microorganisms and waste water treatment procedure, efficiency of wastewater treatment procedures and the pollution problem.

Reference Books:

1. Sawyer, C.N., McCarty P.L. and Parkin, G.F., “Chemistry for Environmental Engineering and Science”, Tata McGraw Hill.
2. Baird, C., “Environmental Chemistry”, W.H. Freeman.
3. Manahan, S.E., Environmental Chemistry, Lewis
4. Pani, B., Textbook of Environmental Chemistry, IK International
5. “Standard Methods for the Examination of Water and Wastewater”, APHA, AWWA and WEF.
6. Pelczar, M.J., Chan E.C.S. and Krieg, N.R. *Microbiology*, Tata McGraw Hill, New Delhi.
7. Gaudy, A., Microbiology for Environmental Scientists and Engineers, McGraw Hill
8. Maier, R.M., Pepper, I.L. and Gerba, C.P., Environmental Microbiology. Academic Press.

MEV-112 Environmental Change and Sustainable Development

(Credits - 3:0:0 = 3)

Teaching Scheme
Lectures: 3 hrs/week

Course Outcomes:

On completion of the course, the student will have the ability to:

1. Identify factors influencing the global climate systems
2. Understanding of monitoring and modeling of predicting climate change.
3. Assess impacts of climate change on global, regional and local scales
4. Understanding of the climate system and anthropogenic effects.
5. Develop strategies for adaptation and mitigation measures
6. Identify clean technologies for sustainable development

Syllabus Content:

- Earth's Climate System: Introduction-Climate in the spotlight - The Earth's Climate Machine – Climate Classification - Global Wind Systems - Green House Gases and Global Warming – Carbon Cycle
- Observed Changes and Its Causes: Observation of Climate Change – Changes in patterns of temperature, precipitation and sea level rise – Observed effects of Climate Changes –Drivers of Climate Change – Evidences of Changes in Climate and Environment – on a Global Scale and in India – climate change modeling.
- Impacts Of Climate Change: Impacts of climate change on various sectors – Agriculture, Forestry and Ecosystem – Water Resources – Human Health – Industry, Settlement and Society – Methods and Scenarios – Projected Impacts for Different Regions– Uncertainties in the Projected Impacts of Climate Change – Risk of Irreversible Changes.
- Climate Change Adaptation And Mitigation Measures: Adaptation Strategies in various sectors – Water – Agriculture – Human Health – Tourism – Transport – Energy.
- Sustainable Development and Environmental Movements - Sustainable Development Principles - Indicators of Sustainability – Sustainable Development Models - National and International Sustainable Development Scenarios (POP), Sustainable Development Goals (SDGs)- Implementation and monitoring- 2030 agenda for Sustainable Development

Reference Books:

1. Anil Markandya , Climate Change and Sustainable Development: Prospects for Developing Countries, Routledge
2. Heal, G. M., Interpreting Sustainability, in Sustainability: Dynamics and Uncertainty, Kluwer Academic Publication
3. Jepma, C.J., and Munasinghe, M., Climate Change Policy – Facts, Issues and Analysis, Cambridge University Press
4. Munasinghe, M., Sustainable Energy Development: Issues and Policy in Energy, Environment and Economy: Asian Perspective, Kleindorfor P. R. et. al (ed.), Edward Elgar
5. Dash Sushil Kumar, "Climate Change – An Indian Perspective", Cambridge University Press India Pvt. Ltd.
6. www.un.org/sustainabledevelopment

MEV-113 Environmental Hydraulics and Hydrology

(Credits - 3:0:0 = 3)

Teaching Scheme
Lectures: 3 hrs/week

Course Outcomes:

On completion of the course, the student will have the ability to:

1. Facilitate understanding of hydrological aspects of water resources.
2. Understand principles of need based activities such as pumps, mixers related to water.
3. Develop competence to propose effective convergence and design features of water supply projects.
4. Understand the application of pipe flow and open channel flow in water distribution networks and sewers, respectively.

Syllabus Content:

- **Introduction:** Hydrological cycle; Hydrosphere; Water compartments and water fluxes; Water and climate change; Scope for hydrology and water resources
- **Overview of Pipe Flow and Water Distribution System**: Flow through pipes, hydraulic gradient and total energy line; Parallel, compound and equivalent pipes; Design of water distribution networks by Nomograms and Hardy Cross Method.
- **Overview of Open Channel Flow and Sewer Design**: Types of flow in channels, most economical sections, Specific energy diagram; Hydraulic gradelines; Hydraulic jump, hydraulic elements of sewers, and design of sewers
- **Hydraulic design**: Hydraulic design of water and waste water treatment plants; Design of systems for disposal on land and for underground injection
- **Pumps and Pumping stations**: Pumps and their classification, Pump performance curves, system head capacity curves and pump selection, Pumping stations and their design.
- **Aeration and Mixing**: Aeration and mixing equipment, diffused aeration systems, air transfer calculations
- **Surface water hydrology**: Precipitation/rainfall and measurement; Runoff coefficient; Hydrological data analysis and storm water estimation – SCS technique, hydrograph, rational method; Storm sewer design.
- **Groundwater hydrology:** Forms of underground water, ground water movement and governing equations, yield determination of wells, ground water recharging.

Reference Books:

1. Chow VT, Maidment DR and Mays LW, Applied Hydrology, Tata McGraw Hill
2. McGhee, Water supply and sewerage, McGraw Hill
3. Wurbs RA and James WP, Water resources Engg., PHI
4. Peavy H.S., Rowe D.R. & Tchobanoglous G., Environmental Engineering, McGraw Hill
5. Nathanson, JA, Basic Environmental Technology, PHE
6. Ojha, Berndtsson, Bhuniya, Engineering Hydrology, Oxford
7. Todd D.K. and Mays L.W., Groundwater Hydrology, John Wiley & Sons

MEV-114 Environmental Policies and Legislation

(Credits - 3:0:0 = 3)

Teaching Scheme
Lectures: 3 hrs/week

Course Outcomes:

On completion of the course, the student will have the ability to:

1. Describe national and international policy issues related to environmental media.
2. Understand existing environmental laws and regulation.
3. Assess influence of policy decisions on the environment.
4. Apply knowledge of environmental analysis in planning and policy making.
5. Understand the various international and national treaties, and convention that laid the foundation for environmental awareness and revolution globally.
6. Elucidate and assess the Indian regulations on control and prevention of air pollution, water pollution; protection of forest and wildlife, and public liability insurance.

Syllabus Content:

Common Environmental Laws - Role of Judiciary in Environmental Protection - Criminal Law, Common Law - Criminal Procedure Code - Indian Penal Code - Fundamental Rights and Fundamental Duties - International and National Efforts at Environmental Protection - Green Funding and Taxes - National Environmental Policies - Framework for Environmental Impact Assessment - Pollution Control Acts for Water and Air Pollution - Water Prevention and Control of Pollution) Act, 1974- Water (Prevention and Control of Pollution) Cess Act, 1977 - Air (Prevention & Control of Pollution) Act, 1981 - Other Environmental Protection Acts - Environmental (Protection) Act, 1986 - Forest Conservation Act, 1980 – National Forest Policy 1988 - Wild Life (Protection) Act, 1972 - Public Insurance & Liabilities Act, 1991- Eco- Labelling - EIA Coastal Zone Notification (1991) - International Laws – Stockholm Conference, 1972 - Montreal Protocol, 1987- The Rio Earth Summit, 1992- Kyoto Summit, 1997 - World Summit on Sustainable Development, 2002 – UN conference on Sustainable Development, 2012- UN summit on Sustainable Development, 2015, UN Climate Change Conference, Paris Summit, 2015- Role of UN Authorities in Protection of Global Environment - Global Environmental issues and international Laws: to Control Global Warming, Ozone Depletion, Acid Rains, Hazardous Waste.

Reference Books:

1. S. Divan and A. Roseneranz, Environmental law and policy in India, Oxford University Press
2. R. K. Sapru, Environmental Management in India (Vol. I & II), Ashish Publishing House
3. Gupta, K.R., Environmental Legislation of India, Atlantic Publishers

MEV-115 Rural Water Supply and Sanitation

(Credits - 3:0:0 = 3)

Teaching Scheme
Lectures: 3 hrs/week

Course Outcomes:

On completion of the course, the student will have the ability to:

1. Identify various techniques and problems in rural water supply.
2. Monitor the quality and maintenance of rural water supply.
3. Design low cost water treatment system for rural areas.
4. Understand the rural sanitation and the management of grey and storm water.
5. Recognize different types of waste water treatment systems.
6. Know safe disposal of solid waste and different methods of solid waste management.

Syllabus Content:

- Rural Water Supply: Issues of rural water supply –Various techniques for rural water supply- merits- National rural drinking water program- rural water quality monitoring and surveillance- operation and maintenance of rural water supplies
- Low Cost Water Treatment: Introduction – Epidemiological aspects of water quality- methods for low cost water treatment - Specific contaminant removal systems
- Rural Sanitation: Introduction to rural sanitation- Community and sanitary latrines - Planning of wastewater collection system in rural areas- Ecological sanitation approach – Greywater and stormwater management- Compact and simple wastewater treatment systems in rural areas- catch basins- constructed wetlands- roughing filters- stabilization ponds - septic tanks – anaerobic baffled reactors- soak pits- low cost excreta disposal systems- Village ponds as sustainable wastewater treatment system- Wastewater disposal
- Solid Waste Management: Disposal of Solid Wastes- Composting- land filling- incineration- Biogas plants - Other specific issues and problems encountered in rural sanitation.

Reference Books:

1. Eulers, V.M., and Steel, E.W., Municipal and Rural Sanitation, 6th Ed., McGraw Hill Book Company, .
2. Wright, F.B., Rural Water Supply and Sanitation, E. Robert Krieger Publishing Company, Huntington, New York.
3. Juuti, P., Tapio S. K., and Vuorinen H., Environmental History of Water: Global Views on Community Water Supply and Sanitation, IWA Publishing (Intl Water Assoc).
4. Winbald, U., and Simpson-Hebert, M., Ecological Sanitation, SEI, Stockholm, Sweden.
5. Kadlec R.H. and Wallace S.D., Treatment Wetlands, CRC Press, Boca Raton
6. Wastewater Engineering – Treatment and Reuse, Metcalf and Eddy, Tata McGraw Hill

MEV-116 Urban Stormwater Management

(Credits - 3:0:0 = 3)

Teaching Scheme
Lectures: 3 hrs/week

Course Outcomes:

On completion of the course, the student will have the ability to:

1. Identify factors affecting urban hydrological cycle.
2. Estimate urban water demand and urban stormwater quantity.
3. Investigation of resources for drainage master plan.
4. Plan and design stormwater control and disposal systems.
5. Develop integrated urban water management system.
6. Understand the operation and maintenance of urban drainage system.

Syllabus Content:

- General introduction to urbanisation and its effect on water cycle – urban hydrological cycle – Effect of urbanisation on hydrology.
- Urban Hydrological cycle – time of concentration – importance of short duration of rainfall and runoff data – methods of estimation of time of concentration for design of urban drainage systems.
- Typical contents of an urban drainage master plan – interrelation between water resources investigation and urban planning processes – planning objectives – comprehensive planning – use of models in planning.
- Basic approaches to urban drainage- Storm water Analysis – runoff quantity and quality – peak runoff determination-
- Design of storm water network systems- Elements of drainage systems – open channel – underground drains – appurtenances – pumping – source control.
- Stormwater Best Management Practices – Detention and retention facilities – swales, stormwater wetlands, infiltration trenches, sand filters, filter strip.
- Operation and maintenance of urban drainage system –Watershed models for stormwater management.

Reference Books:

1. Geiger W. F., J Marsalek, W. J. Rawls and F. C. Zuidema, Manual on Drainage in Urbanised area – 2 volumes, UNESCO
2. Hall M J , Urban Hydrology, Elsevier Applied Science Publisher
3. Stahre P and Urbonas B, Stormwater Detention for Drainage, Water Quality and CSO Management, Prentice Hall
4. Urban Hydrology for small Watersheds, TR-55, NRCS, US Deptt. of Agriculture
5. Iowa Stormwater Management Manual, Version-3
6. Hydraulic Design Manual, Texas Department of Transportation
7. McCuen, R.H., Hydrologic Analysis and Design, Pearson Education

LMEV-101 Advanced Water and Wastewater Laboratory

(Credits - 0:0:2 = 1)

Teaching Scheme
Lectures: 2 hrs/week

Course Outcomes:

On completion of the course, the student will have the ability to:

1. Understand the application of analytical equipment in water and wastewater analysis.
2. Develop the methods for the analysis of different pollutants in water and wastewater.
3. Perform the analysis of heavy metals using atomic absorption spectrometer, spectrophotometer.
4. Determine the BOD and ASP kinetic parameters for different types of wastewater.

Syllabus Content:

- Analysis of environmental samples by Spectrophotometer, Flame photometer, AAS, TKN analyzer, ion chromatograph, microbial enumeration by membrane filtration techniques.
- Coagulation and flocculation of water – Optimization of dose/pH/time of flocculation. Color removal from wastewater by adsorption
- Settling column tests for primary and secondary clarifiers, BOD kinetic parameters, ASP kinetic parameters, Determination of MLSS and MLVSS in ASP

Reference Books:

1. Standard methods for the examination of water and wastewater, 21st Edition, Washington: APHA
2. Sawyer, C. N., McCarty, P. L., and Perkin, G.F., Chemistry for Environmental Engineering and Science, McGraw-Hill Inc.
3. B. Kotaiah and Dr. N. Kumara Swamy, Environmental Engineering Laboratory Manual, Charotar Publishing House Pvt. Ltd.

LMEV-102 Environmental Chemistry Laboratory

(Credits - 0:0:2 = 1)

Teaching Scheme
Lectures: 2 hrs/week

Course Outcomes:

On completion of the course, the student will have the ability to:

1. Conduct experiments as per the standard methods of sampling and analysis.
2. Understanding the importance of laboratory analysis as a controlling factor in the treatment of water and waste water.
3. To interpret the results in comparison with public health considerations and standards.
4. Use the analysis results for making informed decisions about the drinkability of water and disposal of waste water.
5. Determine the concentration of solids, chlorides, hardness, residual chlorine, dissolved oxygen etc. in water and waste water.
6. Evaluate and compare different techniques of experimental analysis.

Syllabus Content:

Analysis of environmental samples by Gravimetric, Titrimetry and Spectrophotometric methods. An indicative list given below.

1. Estimation of Solids (TSS, TDS, VSS, FSS)
2. Determination of Acidity, Alkalinity, Total Hardness, Chlorides
3. Determination of pH and Conductivity
4. Conducting Break Point Chlorination Test
5. Determination of Residual Chlorine
6. Determination of Dissolved Oxygen

Reference Books:

1. Standard methods for the examination of water and wastewater, 21st Edition, Washington: APHA
2. Sawyer, C. N., McCarty, P. L., and Perkin, G.F., Chemistry for Environmental Engineering and Science, McGraw-Hill

LMEV-103 Environmental Design Laboratory

(Credits - 0:0:2 = 1)

Teaching Scheme
Lectures: 2 hrs/week

Syllabus Content:
Design problems of physical and chemical treatment units of water and wastewater treatment and waste management.

Reference Books:

1. Wastewater Engineering – Treatment and Reuse, Metcalf and Eddy, Tata McGraw Hill
2. *Manual on Sewerage and Sewage Treatment*- Central Public Health and Environmental Engg. Organisation, Ministry of Urban Development, Govt. of India.
3. Hammer, M.J. and Hammer, M.J. Jr., “Water and Wastewater Technology”, PHI
4. Environmental Engg.” By Howard S. Peavy, Donald R. Rowe & George Tchobanoglous, McGraw Hill
5. Tchobanoglous, G., Vigil, S.A. and Theisen, H., Integrated Solid Waste Management: Engineering Principles and Management Issues, McGraw Hill

MRM-101 Research Methodology and IPR

(Credits - 3:0:0 = 3)

Teaching Scheme
Lectures: 3 hrs/week

Course Outcomes:

On completion of the course, the student will have the ability to:

1. Understanding and formulation of research problem.
2. Analyze research related information.
3. Understand plagiarism and 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.

Syllabus Content:

Unit 1: 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

Unit 2: Effective literature studies approaches, analysis Plagiarism, Research ethics,

Unit 3: Effective technical writing, how to write report, Paper Developing a Research proposal, Format of research proposal, a presentation and assessment by a review committee

Unit 4: 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.

Unit 5: Patent Rights: Scope of Patent Rights, Licensing and transfer of technology, Patent information and databases. Geographical Indications

Unit 6: 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

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 (Volume –II)
3. Ranjit Kumar, Research Methodology: A Step by Step Guide for beginners
4. Halbert, Resisting Intellectual Property, Taylor & Francis Ltd.
5. Mayall, Industrial Design, McGraw Hill.
6. Niebel, Product Design, McGraw Hill.
7. Asimov, Introduction to Design, Prentice Hall.
8. Robert P. Merges, Peter S. Menell, Mark A. Lemley, Intellectual Property in New Technological Age
9. T. Ramappa, Intellectual Property Rights Under WTO, S. Chand

MAC-102 DISASTER MANAGEMENT

(Credits - 2:0:0 = 0)

Teaching Scheme

Lectures: 2 hrs/week

Course Outcomes:

On completion of the course, the student will have the ability to:

1. Know about the various types of disaster and their components.
2. Know about the measures and precautions at the time of a disaster.
3. Know about various disaster-prone areas and various concepts about disaster preparedness, GIS and remote sensing.
4. Assess risk caused by a disaster and learn about various mitigation measures.

Syllabus Content:

- **Introduction:** Disaster: Definition, Factors And Significance; Difference Between Hazard And Disaster; Natural And Manmade Disasters: Difference, Nature, Types And Magnitude.
- **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.
- **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
- **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.
- **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
- **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

Reference Books:

1. R. Nishith, Singh A.K, Disaster Management in India: Perspectives, issues and strategies, New Royal book Company.
2. Sahni P. et al., Disaster Mitigation Experiences and Reflections, Prentice Hall of India
3. Goel S.L., Disaster Administration and Management Text and Case Studies, Deep & Deep Publication Pvt. Ltd.

M. Tech. (Environmental Science & Engineering)

MEV-103 Biological Treatment Methods

(Credits – 3:0:0 = 3)

Teaching Scheme
Lectures: 3 hours/week

Course Outcomes:

After completing this course, the students will demonstrate the knowledge and ability to:

1. analyse and design the biological processes in wastewater treatment,
2. solve the complex issues in biological wastewater treatment systems,
3. understand and implement process kinetics,
4. develop low cost biological treatment methods for rural areas, and
5. implement the efficient disposal methods of treated wastewater.

Course Content:

Unit I

Wastewater Characteristics and Effluent Standards: Physical, Chemical and Biological Parameters of Water Pollution, Solids (volatile and non-volatile solids, suspended, dissolved and colloidal solids), Biodegradable and Non-Biodegradable organic matter (DO, COD, BOD and BOD kinetics), Nutrients (TKN, total nitrogen, and total and ortho-phosphorus), Sulfides, Phenols, Cyanides, Heavy Metals, Effluent Standards.

Process Kinetics: Fundamentals of Process Kinetics, Zero order, First order, Second order Reactions, Enzyme reactions – Bio reactors- Types-Classification – Design principles.

Unit II

Attached Growth Processes: Trickling Filters (Standard Rate, High Rate), Practices, Features and Design, Operational Difficulties and Remedial Measures, Rotating Biological Contactors. SAF, FAB and MBBR Technologies.

Unit III

Suspended Growth Processes: Activated Sludge Process, Modifications including SBR and Design Equations, Process Design Criteria, Oxygen and Nutrient Requirements.

Waste stabilization Ponds and Lagoons: Aerobic Pond, Facultative Pond, Anaerobic Ponds, Polishing Ponds, Aerated Lagoons. Constructed Wetlands and Duckweed Ponds.

Unit IV

Anaerobic Processes: Process Fundamentals, Standard, High Rate and Hybrid Reactors, Upflow Anaerobic Sludge Blanket Reactors, Design and Operation. Sludge Treatment and Disposal, Sludge Thickening, Sludge Digestion & disposal.

Reference/Text Books:

- Metcalf, Eddy, Tchobanoglous, G., Burton, F.L., Stensel, H.D., "Wastewater Engineering – Treatment, Disposal and Reuse", 4th ed., Tata McGraw Hill (2002).

- Howard S. Peavy, Donald R. Rowe & George Tchobanoglous, "Environmental Engg." International Edition, McGraw Hill (2013).
- Eckenfelder W.W. Jr., "Industrial Water Pollution Control", 3rd ed., McGraw Hill (2003).
- Arceivala, S. J. and Asolekar, S. R., "Wastewater Treatment for Pollution Control", 3rd ed., McGraw-Hill Education (India) Pvt. Ltd., New Delhi (2006).
- Karia G. L. and Christian R. A., "Wastewater Treatment: Concepts and Design Approach", 2nd ed. PHI (2013).
- Manual on Sewerage and Sewage Treatment- Central Public Health and Environmental Engg. Organisation, Ministry of Urban Development, Govt. of India (2013).

MEV-104 Air Pollution and Control

(Credits – 3:0:0 = 3)

Teaching Scheme
Lectures: 3 hours/week

Course Outcomes:

After completing this course, the students will demonstrate the knowledge and ability to:

1. define the various sources of air pollution and their effects on human health and environment,
2. develop the energy balance and plume behaviour for different atmospheric stability conditions,
3. paraphrase the sampling techniques and analyse air quality,
4. interpret various techniques used to control particulate matter and gaseous pollutants, and
5. explain the implementation of biological air pollution control technologies.

Course Content:

Unit I
Sources and classification of pollutants and their effect on human health, vegetation and property, Reactions of pollutants and their effects, smoke, smog and ozone layer disturbance, Greenhouse effect.

Unit II
Dynamics of atmosphere, Energy balance of atmosphere, Meteorological aspects, Wind and wind roses, Environmental and adiabatic lapse rates, Derivations of DALR, WALR and ELR, Atmospheric stability, Factors influencing stability, Temperature inversions, Mixing height.

Unit III
Transport, transformation and deposition of air contaminants, Air sampling (Ambient and stack sampling) & pollution measurement methods, Ambient air quality and emission standards, Modelling- Gaussian model and equation, Air quality index, Indoor air quality.

Unit IV
Settling chambers, cyclone separation, Wet collectors, fabric filters, electrostatic precipitators, Removal of gaseous pollutants by adsorption, absorption, reaction and other methods, Bio-scrubbers, bio-filters.

Reference/Text Books:

- Griffin R D, “Principles of Air Quality Management”, 2nd Edition, CRC Press, Boca Raton, USA (2007).
- Howard S. Peavy, Donald R. Rowe & George Tchobanoglous, “Environmental Engg.”, International Edition, McGraw Hill (2013).
- Perkins, H.C., “Air Pollution”, McGraw-Hill (2004).
- Khare M, “Air Pollution - Monitoring; Modelling; Health and Control”, In Tech Publishers (2012).
- Rao M.N. and Rao H.V.N., “Air Pollution”, Tata McGraw Hill (2006).

LMEV-104 Environmental Computation Lab

(Credits – 0:0:4 = 2)

Teaching Scheme
Lectures: 4 hours/week

Course Outcomes:

After completing this course, the students will demonstrate the knowledge and ability to:

1. understand different software used in environmental science and engineering,
2. compare that how software reduces the work load of design,
3. design a model of water supply network,
4. develop a model to transport and discharge the wastewater to treatment unit, and
5. design a model for rain water harvesting.

Course Content:

Hands-on practice on standard software in environmental science and engineering field and use them in solving various environmental problems, the different softwares are:

- EPAnet
- Water Gem
- Sewer CAD
- Storm CAD
- Civil Storm

Reference/Text Book:

- Manuals of concerned softwares.

LMEV-105 Solid Waste Analysis Lab

(Credits – 0:0:2 = 1)

Teaching Scheme
Lectures: 2 hours/week

Course Outcomes:

After completing this course, the students will demonstrate the knowledge and ability to:

1. identify the type of solid waste through physical and chemical evaluation,
2. analyze the environmental impacts of waste,
3. ascertain the economical value of different streams of solid waste,
4. implement waste to energy strategies, and
5. understand the optimum disposal method of solid waste.

Course Content:

Experiment 1: To quantify and segregate the commingled MSW.

Experiment 2: To find the moisture content, energy content and ash content in the solid waste.

Experiment 3: To determine the Ultimate analysis of solid waste and to derive chemical formula.

Experiment 4: To determine the heavy metals in solid waste samples.

Experiment 5: To find the organic and inorganic constituents in solid waste samples.

Reference/Text Books:

1. Tchobanoglous, G., Vigil, S.A. and Theisen, H., "Integrated Solid Waste Management: Engineering Principles and Management Issues", McGraw Hill (1993).
2. CPHEEO, Manual on Municipal Solid waste management, Central Public Health and Environmental Engineering Organization, Government of India (2016).
3. Test methods for evaluating solid waste, EPA, (1986).

LMPEV-101 Project

(Credits – 0:0:4 = 2)

Teaching Scheme
Lectures: 4 hours/week

Course Outcomes:

After completing this course, the students will demonstrate the knowledge and ability to:

1. identify environmental engineering problems by reviewing available literature,
2. decide the methodology for collecting relevant data to solve the problem,
3. analyse multiple possible solutions to present a solution that suits best for the given conditions,
4. analyse the effects of various parameters as applicable to the given solution, and
5. present a report that completely defines the problem and its solution.

Course Content:

The purpose of this subject (Project) is to introduce, familiarise and prepare the student for research work to be carried out during thesis. Thus, there is no fixed syllabus as such (although general guidelines are given below), and the student can choose any topic considering that the work to be carried out must result in certain deliverables (conclusions). Since the report outline of this subject is similar to 'Thesis Work', it would provide an opportunity to learn and present the work in a systematic fashion.

Following broad areas (or part thereof) can be considered to be taken up as 'Project':

1. Characterization of water, wastewater and solid waste samples.
2. Evaluation of an existing water, air and soil condition for environmental safety using established procedures and techniques.
3. Design and evaluation of water/wastewater treatment facilities.
4. Design and evaluation of material recovery facilities.
5. Optimization of various parameters impacting an environmental matrix
6. Use of software for efficient management and conveyance of water and wastewater.

MEV-117 Geo-environmental Engineering

(Credits – 3:0:0 = 3)

Teaching Scheme
Lectures: 3 hours/week

Course Outcomes:

After completing this course, the students will demonstrate the knowledge and ability to:

1. identify the causes and effects of subsurface contamination,
2. define contaminant transport mechanisms in soils and its detection and control,
3. plan a site for the landfill by monitoring the environmental conditions,
4. design landfill and liners for contaminants, and
5. categorize the reuse of solid waste materials.

Course Content:

Unit I
Subsurface Contamination and Contaminant Transport, Causes and effects of subsurface contamination, Detection, control and remediation of subsurface contamination.

Unit II
Characteristics of solid wastes, Waste Containment Principles, Waste disposal on Land and containment, Types of landfills, planning of landfills, Design of liners and covers for landfills, Environmental Monitoring around landfills.

Unit III
Geotechnical re-use of solid waste materials, Slurry ponds, Monitoring of subsurface contamination, Control and Remediation.

Unit IV
Engineering Properties of waste and geotechnical reuse, erosion control, sustainability, energy geotechnics.

Reference/Text Books:

- Reddy, L.N. and Inyang. H. I., "Geoenvironmental Engineering - Principles and Applications", Marcel Dekker (2000).
- Mohamed, A.M.O. and Antia, H.E., "Geoenvironmental Engineering", Elsevier (1998).
- Hsai Yang Fang and Daniels, J.L., "Introductory Geotechnical Engineering, an Environmental Perspective", Taylor & Francis (2006).
- Yong, R. N., "Geoenvironmental Engineering: Contaminated Soils, Pollutant Fate and Mitigation", CRC press LLC, Florida (2001).
- Fang, H.Y, "Introduction to Environmental Geotechnology", CRC Press (1997).

MEV-118 Environmental Impact Assessment and Management

(Credits – 3:0:0 = 3)

Teaching Scheme
Lectures: 3 hours/week

Course Outcomes:

After completing this course, the students will demonstrate the knowledge and ability to:

1. summarize the importance of environmental impact assessment in various engineering projects,
2. identify various key issues in the impact assessment of various projects,
3. predict the magnitude of an impact using mathematical tools and prepare methodology to prepare EIA reports,
4. apply proper mitigation measures to avoid environmental impacts, and
5. generate EIA report with suitable environmental management plan.

Course Content:

Unit I
The Need for EIA, Indian Policies Requiring EIA, The EIA Cycle and Procedures, Screening, Scoping, Baseline Data, Impact Prediction, Assessment of Alternatives, Delineation of Mitigation Measure and EIA Report, Public Hearing, Decision Making, Monitoring the Clearance Conditions, Components of EIA, Roles in the EIA Process. Government of India Ministry of Environment and Forest Notification (2000), List of projects requiring Environmental clearance.

Unit II
Key Elements of an Initial Project Description and Scoping, Project Location(s), Risks to Environment and Human Health, Socio-Economic Impacts, Ecological Impacts, Global Environmental Issues.

Unit III
Criteria for the selection of EIA methodology, impact identification, impact measurement, impact interpretation & Evaluation, Methods - Adhoc methods, Checklists methods, Matrices methods, Networks methods, Overlays methods, Environmental index using factor analysis, Cost/benefit analysis, Predictive or Simulation methods

Unit IV
Environmental Management Plan, Identification of Significant or Unacceptable Impacts Requiring Mitigation, Mitigation Plans and Relief & Rehabilitation, Stipulating the Conditions, Monitoring Methods, Pre-Appraisal and Appraisal. Preparation of EIA for developmental projects- Factors to be considered in making assessment decisions, Water Resources Project, thermal plant, Highway project, Sewage treatment plant, Municipal Solid waste processing plant, Tannery industry.

Reference/Text Books:

- Sadler, B. and McCabe M., “Environmental Impact Assessment: Training Resource Manual”, UNEP (2002).

- Wathern.P., “Environmental Impact Assessment - Theory and Practice”, Routledge Publishers, London (2004).
- Rau J. G. and Wooten D. C., “Environmental Impact Analysis Handbook”, Tata McGraw Hill (1980).
- Canter R. L., “Environmental Impact Assessment”, Tata McGraw-Hill (1981).
- ISO 14001 (2004), ISO 14004 (2004), ISO 19011 (2002).
- EIA manual, Ministry of Environment and Forests, Government of India (http://www.envfor.nic.in/legis/eia/so195.pdf).

MEV-119 Life Cycle Analysis and Design for Environment

(Credits – 3:0:0 = 3)

Teaching Scheme
Lectures: 3 hours/week

Course Outcomes:

After completing this course, the students will demonstrate the knowledge and ability to:

1. perform life cycle inventory analysis of products,
2. develop strategies to bring energy efficiency in all stages of the product development cycle,
3. formulate plans for comprehensive environmental protection, in order to comply with environmental laws,
4. resolve issues in the lifecycle analysis from raw material to disposal/reuse stage, and
5. develop waste management strategies of the disposed products.

Course Content:

Unit I
Introduction: Life Cycle Assessment concepts, A brief history of Life-cycle Inventory analysis, overview of methodology, three components, identifying and setting boundaries for life-cycle stages, issues that apply to all stages, Applications of inventory analysis.

Unit II
Procedural framework of Life-cycle inventory: Introduction, define the purpose and scope of inventory.

Unit III
General issues in Inventory analysis: Introduction, Using Templates, Data issues, special case boundary issues.

Product design evaluation and analysis using LCA

Unit IV
Issues Applicable to specific life cycle stages: Introduction, Raw Material acquisition stage, Manufacturing stage, Use/Reuse/Maintenance stage, Recycle/Waste Management stage.

Reference/Text Books:

- Ciambrone D.F., “Environmental Life Cycle Analysis”, CRC Press (1997).
- Ralph E Horne, Tim Grant, Verghese K, “Life Cycle Assessment: Principles, Practice and Prospects”, CSIRO Publishers (2009).
- Curran, M.A., “Life Cycle Assessment Handbook: A Guide for Environmentally Sustainable Products”, Wiley (2012).
- Handbook on Life Cycle Assessment: Operational guide to the ISO standards, Kluwer Academic Publishers (2004).

MEV-120 Water Distribution and Sewerage Network Design

(Credits – 3:0:0 = 3)

Teaching Scheme
Lectures: 3 hours/week

Course Outcomes:

After completing this course, the students will demonstrate the knowledge and ability to:

1. estimate water demand and analyze water quality,
2. design conventional water treatment systems,
3. design treatment systems for removal of dissolved solids,
4. analyze and design water distribution systems, and
5. assess methods employed for water reuse, wastewater reclamation and storm water control.

Course Content:

Unit I

General hydraulics and flow measurement: Fluid properties; fluid flow, continuity principle, energy principle and momentum principle; frictional head loss in free and pressure flow, minor heads losses, Carrying Capacity, Flow measurement.

Unit II

Water transmission and distribution: Need for transport of water and wastewater, Planning of Water System, Selection of pipe materials, Water transmission main design, gravity and pumping main; Selection of Pumps and its characteristics and economics, Specials, Jointing, laying and maintenance, water hammer analysis; water distribution pipe networks design, analysis and optimization, appurtenances, corrosion prevention, minimization of water losses, leak detection storage reservoirs.

Unit III

Wastewater collection and conveyance: Planning factors, Design of sanitary sewer; partial flow in sewers, economics of sewer design, Wastewater pumps and pumping stations- sewer appurtenances, material, construction, inspection and maintenance of sewers, Design of sewer outfalls-mixing conditions, conveyance of corrosive wastewaters.

Unit IV

Storm water drainage: Necessity, combined and separate system, Estimation of storm water run-off, Formulation of rainfall intensity duration and frequency relationships, Rational methods.

Reference/Text Books:

- Metcalf, Eddy, Tchobanoglous, G., Burton, F.L., Stensel, H.D., “Wastewater Engineering – Treatment, Disposal and Reuse”, 4th ed., Tata McGraw Hill (2002).
- Chanson H., Butterworth-Heinemann, “Environmental Hydraulics of Open Channel Flows”, 2nd ed., Oxford, UK: Elsevier (2004).

- Chow, V.T., Maidment, D.R. and Mays, L.W., "Applied Hydrology", McGraw Hill Inc. (2010).
- "Manual on water supply and Treatment", CPHEEO, Ministry of Urban Development, Government of India, New Delhi (1999).
- "Manual on Sewerage and Sewage Treatment", CPHEEO, Ministry of Urban Development, Government of India, New Delhi (1993).

MEV-121 Watershed Management

(Credits – 3:0:0 = 3)

Teaching Scheme
Lectures: 3 hours/week

Course Outcomes:

After completing this course, the students will demonstrate the knowledge and ability to:

1. demarcate and characterize watersheds,
2. analyze the watersheds and identify the issues and concerns associated with them,
3. frame the watershed management objectives,
4. comprehend and analyze the hydrological and remote sensing data, and
5. define the best management practices for the sustainable management of watershed.

Course Content:

Unit I

Introduction: Concept of watershed development, Objectives, need, integrated and multidisciplinary approach.

Characteristics of Watershed: Size, Shape; Physiography; Slope, Climate, Drainage, Land Use; Vegetation; Geology and Soils, Soils, Hydrology and Hydrogeology, Socio-Economic Characteristics, Basic Data on Watersheds.

Unit II

Water Harvesting: Rainwater harvesting, catchment harvesting, Harvesting structures, Soil moisture conservation, Check dams, Artificial recharge, Farm ponds, Percolation tanks.

Land Management: Land use and land capability, Classification, Management of forest, Agricultural, grass land and wild land; Reclamation of saline and alkaline soils.

Unit III

Ecosystem Management: Role of ecosystem, Crop husbandry, Soil enrichment; inter-mixed and strip cropping, Cropping pattern, Sustainable agriculture, Biomass management, Dry land agriculture, Silvipasture; Horticulture, Social forestry and afforestation.

Water Bodies and Aquatic Ecosystems: Influence of ponding on water quality, Thermal stratification and mixing, Eutrophication and water weeds, Sediment-water interactions, Effects of waste disposal and pollution, Fate of pollutants discharged into water bodies Self cleansing capacities of water bodies.

Unit IV

Human Interventions for Water Quality Management**:** People participation, Preparation of action plans, administrative requirements, Management of catchments/watersheds and prevention of pollution, Flood control, Wetlands and constructed wetlands, Control of weeds and nutrient removal, River basin management system, Satluj river action plan, Ganga action plan.

Reference/Text Books:

1. Nathanson J.A., “Basic Environmental Technology”, Prentice-Hall (2002).
2. Heathcote, I.W., “Integrated Watershed Management: Principles and Practice”, Wiley (2009).
3. De Barry, P.A., “Watersheds: Process, Assessment and Management”, Wiley (2004).
4. Murthy J.V.S, “Watershed Management”, New Age International (1998).
5. Awurbs R and James W.P., “Water Resources Engineering”, Prentice Hall (2001).
6. Murthy V.V.N., “Land and Water Management”, Kalyani Publications (2009).
7. Majumdar D.K., “Irrigation and Water Management”, Prentice Hall (2000).

MEV-122 Environmental Quality Modelling

(Credits – 3:0:0 = 3)

Teaching Scheme
Lectures: 3 hours/week

Course Outcomes:

After completing this course, the students will demonstrate the knowledge and ability to:

1. develop and evaluate model,
2. define various drinking water quality parameters,
3. classify and validate water quality models,
4. identify air quality models, and
5. exemplify the various components and types of air quality models.

Course Content:

Unit I
Model, Development of Model, Importance of Models, Uses of Model, Evaluation of Model, Application of Model.

Unit II
Water Quality Modelling, Modelling of Lakes and reservoirs, Rivers and streams, Groundwater modelling; Modelling for common Water Quality Parameters: DO, Temperature, Suspended Solids, Algae, Nutrients, Coliforms and Toxics, Calibration.

Unit III
Validation and use of water quality models (DO-BOD Models, Solute Transport Models, Nutrients and Eutrophication Models, and Toxic Substances and Sediments models), Conventional water quality models: QUAL2E – QUAL2K; BASINS and WASP7.

Unit IV
Basic Components of an Air Quality Simulation Model, Parameters of Air Pollution Meteorology, Steady-state, Non-Steady-state and Grid Meteorological Modelling, Dispersion and Receptor Modelling Techniques, Gaussian Plume Model, Pasquilli's stability classification, Uses and Validation of Air Quality Models, Air Pollution Forecast Models.

Reference/Text Boks:

- Smith J. and Smith P., "Environmental Modeling an Introduction", Oxford University Press (2011).
- Chapra SC, "Surface water quality modelling", Waveland Press (2008).
- Palmer MD, "Water quality modelling: A guide to effective practice", World Bank Publications (2001).
- Brebbia CA, Power H and Tirabassi T, "Air Pollution V: Modelling; Monitoring and Management", In Tech. (1997).
- Khare M, "Air Pollution – Monitoring; Modelling; Health and Control", In Tech Publishers (2012).
- Manivanan R, "Water Quality Modelling: Rivers, Streams and Estuaries", New India Publishing Agency (2008).

MEV-123 Industrial Wastewater Management and Reuse

(Credits – 3:0:0 = 3)

Teaching Scheme
Lectures: 3 hours/week

Course Outcomes:

After completing this course, the students will demonstrate the knowledge and ability to:

1. sample and analyze the characteristics of industrial wastewaters,
2. analyze the effects of disposal of industrial wastes,
3. identify and design treatment options for handling industrial wastewater,
4. implement the effective reuse of treated industrial wastewater, and
5. suggest waste minimising techniques to industries.

Course Content:

Unit I
Sources of Pollution: Physical, Chemical, Organic & Biological properties of Industrial Wastes, Difference between industrial & municipal waste waters, Effects of industrial effluents on sewers and Natural water Bodies.

Pre & Primary Treatment: Equalization, Proportioning, Neutralization, Oil separation by Floating, Waste Reduction, Volume Reduction, Strength Reduction.

Unit II
Waste Treatment Methods: Nitrification and De-nitrification, Phosphorous removal, Heavy metal removal, Membrane Separation Process, Air Stripping and Absorption Processes, Special Treatment Methods, Disposal of Treated Waste Water.

Unit III
Characteristics and Composition of wastewater and Manufacturing Processes of Industries like Sugar, Characteristics and Composition of Industries like Food processing Industries, Steel, and Petroleum Refineries.

Unit IV
Characteristics and Composition of Industries like Textiles, Tanneries, Atomic Energy Plants and other Mineral Processing Industries, Joint Treatment of Raw Industries waste water and Domestic Sewage, Common Effluent Treatment Plants (CETP): Location, Design, Operation and Maintenance Problems, Economical aspects.

Reference/Text Books:

- Metcalf, Eddy, Tchobanoglous, G., Burton, F.L., Stensel, H.D., “Wastewater Engineering – Treatment, Disposal and Reuse”, 4th ed., Tata McGraw Hill (2002).
- Eckenfelder W.W. Jr., “Industrial Water Pollution Control”, 3rd ed., McGraw Hill (2003).
- M.N. Rao and Dutta, “Waste Water Treatment”, 3rd Edition, Oxford and IBH Publishers (2018).

- Mark J. Hammer, Mark J. Hammer, Jr., “Water & Wastewater Technology”, Prentice Hall of India (2008).
- Patwardhan, “Industrial Waste water Treatment”, Prentice Hall of India, New Delhi (2008).
- Nemerrow N.L., “Theories and practices of Industrial Waste Engineering”, Addison-Wesley Publishing Company (1955).
- C.G. Gurnham, “Principles of Industrial Waste Engineering”, Public Health Service Publications (1955).

MEV-124 Analytical Methods for Environmental Monitoring

(Credits – 3:0:0 = 3)

Teaching Scheme
Lectures: 3 hours/week

Course Outcomes:

After completing this course, the students will demonstrate the knowledge and ability to:

1. analyze the principles of volumetric and instrumental analytical methods in environmental monitoring,
2. study the principle of chromatography, spectrophotometry and their applications,
3. apply statistical methods for evaluating and interpreting data of environmental interest,
4. categorize various electrochemical methods, and
5. summarize various material characterization techniques and its principles.

Course Content:

Unit I
Classification of Instrumental Methods, Performance Characteristics of Instruments (Static And Dynamic), Errors and Uncertainties in Performance Parameters, Noise Reduction, Sensitivity and Detection Limit, Errors, Types, Expression of Errors, Precision and Accuracy, Calibration of Instrumental Methods, Spectrophotometry, Electromagnetic Radiation, Atomic Absorption and Emission Spectrometry, Ultraviolet-Visible Spectrophotometry

Unit II
Principle and Instrumentation: Atomic Absorption Spectroscopy, Flame Photometer, Fluorimetry, Nephelometry and Turbidimetry, Chromatography, Principle and Classification, Column Efficiency and Resolution, Quantitative Determination,

Unit III
Column Chromatography, Thin Layer Chromatography, Principle and Application of Ion chromatography, Application Gas Chromatography (GC), Principle and Application of High Precision Liquid Chromatography (HPLC), Ion Chromatography, Mass Spectroscopy, Gas Chromatography Mass Spectroscopy (GCMS)

Unit IV
Electro Chemical Methods, Electrochemical Cell - Reference Electrodes, Cyclic Voltammetry, Polarograph, Oscilloscope Polarography, Ion Selective Electrodes, Conductometry, Electrolytic Conductivity, Specific Equivalent and Molar Conductance, Working Principles of pH, EC, TDS Meters, Material Characterization Techniques, SEM, TEM, XRD, FTIR, Thermal Analysis, Working Principles and Applications.

Reference/Text Books:

- Skoog D. A., West D.M. and Nieman T.A., “Principles of Instrumental Analysis”, 5th Ed. Thomson Asion (P) Ltd. Singapore (2004).
- Willard, Merritt, Dean and Settle, “Instrumental Methods of Analysis”, Wadsworth Pub. Co., USA. (1989).

- Sawyer C.N., McCarty P.L. and Parkin, G.F., “Chemistry for Environmental Engineering and Science”, Tata McGraw Hill, New Delhi (2017).

MEV-125 Ground Water Recharge

(Credits – 3:0:0 = 3)

Teaching Scheme
Lectures: 3 hours/week

Course Outcomes:

After completing this course, the students will demonstrate the knowledge and ability to:

1. infer the importance of ground water hydraulics in interpreting the groundwater processes,
2. determine the effect of different natural and anthropogenic activities on ground water,
3. articulate different techniques to recharge ground water,
4. design and develop ground water recharge facilities and reuse of wastewater for the same, and
5. analyze the effect of chemical, microbiological activities in aquifer transport.

Course Content:

Module I
Introduction: Role of groundwater in the hydrologic cycle, problems and perspectives. Occurrence and movement of groundwater, hydrogeology of aquifers, Darcy's law, general flow equations. Groundwater Hydraulics: steady and unsteady radial flows in aquifers.

Unit II
Groundwater Levels and Environmental Influences: Time variations of levels, Fluctuations due to evapotranspiration, meteorological phenomenon, urbanization, earthquakes, global climate change. Management of Groundwater: concepts of basin management, conjunctive use, mathematical modeling for groundwater management.

Unit III
Artificial Recharging of Groundwater: concepts, recharge techniques, recharge rates, design, operation and maintenance of surface recharge systems and recharge well systems, groundwater mounding, stormwater infiltration basin mound development, clogging, recharge and groundwater models, induced recharge.

Unit IV
Wastewater recharge for reuse, soil aquifer treatment systems, transport and degradation of organic compounds, chemical reactions and particle transport during aquifer transport, microorganisms and microbiology, public health issues, aquifer storage and recovery wells, Case studies of artificial recharge.

Reference/Text Books:

- Todd D.K., Mays L.W., “Groundwater Hydrology”, Wiley (2004).
- Raghunath H.M., “Ground Water”, New Age International Publishers (2007).
- Schwarz F., Zhang H., “Fundamentals of Ground Water”, Wiley (2002).
- Fitts C., “Groundwater Science”, Academic Press (2012).
- Bear J., “Hydraulics of Groundwater”, Dover Publications (2007).

- Mays L. W., “Hydraulic Design Handbook”, McGraw Hill (2004).
- Artificial Recharge of groundwater, European Commission, EC project ENV4-CT95-0071 (2001).

MEV-126 Environmental Remote Sensing and GIS

(Credits – 3:0:0 = 3)

Teaching Scheme
Lectures: 3 hours/week

Course Outcomes:

After completing this course, the students will demonstrate the knowledge and ability to:

1. apply basic principles of remote sensing for resource mapping and evaluation,
2. understand and operate GIS softwares,
3. develop geospatial database of water resources and environmental engineering systems,
4. implement GIS models for hydrological simulation, and
5. enact GIS models for planning environmental engineering systems.

Course Content:

Unit I

Introduction: Concepts of Remote Sensing, Energy sources and radiation principles, Energy interactions in the atmosphere, Spectral reflectance of earth surface features, GIS concepts, Data analysis, GIS software.

Unit II

Water Resources: Rainwater harvesting systems, performance evaluation of irrigation systems, agricultural drought monitoring and impact assessment, watershed development & sustainable planning using RS & GIS, Water quality monitoring and modelling.
Land Resources: Soil survey and land evaluation, land use/land cover mapping and planning, case studies on mapping of wastelands and waterlogged areas of India using RS & GIS.

Unit III

Ecology and Forestry: Ecosystem analysis, monitoring of forest fires, Forest evapo-transpiration assessment, mapping of forest cover, RS based forest management plans, focus on Mangrove forests and wetlands.

Unit IV

Geological Applications: RS and GIS in ground water studies, mineral/oil exploration, air borne geophysical surveys.
Urban Studies: Spatial analysis of urban sprawl, impact of urbanization on vegetation and water bodies, urban heat islands condition assessment, urban road infrastructure development assessment, GIS based urban land use change detection.

Reference/Text Books:

- Barrett, “Introduction of Environmental Remote Sensing”, Chapman and Hall, New York, USA (1992).
- Engman, “Remote Sensing in Hydrology”, Chapman and Hall, New York, USA (1991).
- Siegel, “Remote Sensing in Geology” John Wiley, Inc, New York, USA (1980).
- Burrough P.A., “Principles of GIS for Land Resources Assessment”, Oxford Science Publications (1998).

- Kang Tsung Chang, “Introduction to Geographic Information Systems”, Tata McGraw Hill, New Delhi (2001).

MEV-127 Biodegradation and Bioremediation Techniques

(Credits – 3:0:0 = 3)

Teaching Scheme
Lectures: 3 hours/week

Course Outcomes:

After completing this course, the students will demonstrate the knowledge and ability to:

1. identify the benefit of microorganisms in degrading the contaminants,
2. summarize the fate and transport of contaminants in soil and water bodies and principle of biodegradation,
3. determine suitable microorganism for biodegradation of selected compound,
4. analyze the role of strains and protein in the enhancement of biodegradation, and
5. carryout suitable assessment methods for bioremediation.

Course Content:

Unit I
Historical Perspectives of Biodegradation and Bioremediation, Contaminant Bioavailability, Microbial Catabolism of Organic Pollutant, Catabolic Enzymes and their properties,

Unit II
Biodegradation Measurement Potential, Impediments to Microbial Biodegradation, Biodegradation Detoxication Reactions, Principles of Biodegradation, Biodegradation Kinetics, Effect of Pollutant Chemical Structure on Biodegradation, Fate and Transport of Contaminants in Soils and Water Bodies, Requirements of Biodegradation, Nutritional Factors, Cell Structure, Environmental Factors, Biological Factors, and Aging.

Unit III
Biodegradation of Organic Compounds, Anaerobic Biodegradation of Benzene and Ethyl Benzene, Polyaromatic Transformation and Degradation, Co-Metabolic Process for Polychlorinated Biphenyl Degradation, Aerobic Hexachloro cyclohexane Biodegradation, Co-Posting of Contaminated Soil, Bio adsorbents, Metal Precipitation, Enzymatic Transformation of Metals, Strains for Enhanced Biodegradation, Improved Biodegradation by Protein.

Unit IV
Improved Bioremediation by Engineering Microbes, Bioremediation Monitoring and Assessment Methods, Conventional Plating and Microbial Enumeration, Biochemical and Physiological Methods, BIOLOG, Soil Enzyme Assay Immunochemical Methods, Phospholipids Fatty Acid Analysis, Molecular Biology Based Methods, Bacterial Biosensors - Molecular Techniques - Toxicological Risk Assessments.

Reference/Text Books:

- Singh and Ward O.P., “Biodegradation and bioremediation”, Springer-Verlag Berlin Heidelberg New York (2004).
- Baker K.H. and Herson D.S., “Bioremediation”, McGraw-Hill, Inc., New York (1994).
- M. Alexander, “Biodegradation and Bioremediation”, 2nd Edition, Academic Press, (1999).

- Eweis, J.B., Ergas, S.J., Chang D.P.Y., and Schroeder E.D., “Bioremediation Principles”, McGraw-Hill Publishing Company, Singapore (1998).
- Young, L.Y., and Cerniglia, C.E., “Microbial Transformation and Degradation of Toxic Organic Chemicals”, Wiley–liss Publishers, New York, USA (1995).

MEV-128 Environmental System Engineering

(Credits – 3:0:0 = 3)

Teaching Scheme
Lectures: 3 hours/week

Course Outcomes:

After completing this course, the students will demonstrate the knowledge and ability to:

1. analyze the system performance using simulation models,
2. optimize environmental engineering systems using optimization models,
3. employ model-based environmental analysis,
4. choose a suitable environmental systems analysis method and tool for a given decision situation, and
5. identify the contemporary issues, design, formulate and solve the problem.

Course Content:

Unit I
System approach: concept and analysis, Problem formulation, model construction and deriving solution from models, Linear Programming Problem (LPP): Primal and Dual Simplex Method, Limitations of LPP, Sensitivity analysis.

Unit II
Application of linear programming to wastewater management systems, pesticide management problems, planning of municipal wastewater treatment, air quality management, and agricultural non-point source pollution.

Unit III
Lagrange's multipliers: Unconstrained and constrained optimization, Limitations of Lagrange's multipliers, Sequential search algorithms, Box algorithm.

Unit IV
Separable and integer programming: Application to multi-objective planning, Application of integer programming to municipal solid waste management, Transportation models.

Reference/Text Books:

- Hamdy A. Taha, "Operations Research: An Introduction", Prentice Hall Pub. (2006).
- Henry R. Bungay, "Environmental Systems Engineering", Kluwer Academic Pub. (1997).
- Haith D.A., "Environmental Systems Optimization", Wiley Sons, (1982).
- Charles S. Revelle, Earl Whitlatch, Jeff Wright, "Civil and Environmental Systems Engineering", Pearson Publishers (2003).
- Jorgensen S.E., Halling Sorensen B, and Nielsen S.N., "Handbook of Environmental and Ecological Modelling", CRC Press (1995).
- Sharma J.K., "Operation Research: Theory & applications", Macmillan India Ltd. (2009).

MEV-129 Membrane Processes

(Credits – 3:0:0 = 3)

Teaching Scheme
Lectures: 3 hours/week

Course Outcomes:

After completing this course, the students will demonstrate the knowledge and ability to:

1. classify types of membrane filtrations techniques and the selection of particular type according to requirement,
2. explain the principle and applications of common membrane processes,
3. analyze the principle and design of MBR,
4. interpret membrane fouling and techniques to control it, and
5. summarize and monitor pretreatment methods and strategies.

Course Content:

Unit I

Membrane filtration processes: Solid Liquid separation systems, Theory of Membrane separation, Mass Transport Characteristics, Cross Flow filtration, Membrane Filtration, Flux and Pressure drop, Types and choice of membranes, porous, nonporous, symmetric and asymmetric, Plate and Frame, spiral wound and hollow fibre membranes, Liquid Membranes.

Unit II

Membrane systems: Microfiltration principles and applications, Ultrafiltration principles and applications, Nano Filtration principles and applications, Reverse Osmosis: Theory and design of modules, assembly, plant process control and applications, Electro dialysis, Ion exchange membranes, process design, Pervaporation, Liquid membrane, Liquid Per traction, Supported Liquid Membrane and Emulsion, Membrane manufactures, Membrane Module/Element designs, Membrane System components, Design of Membrane systems, pump types and Pump selection, Plant operations, Economics of Membrane systems.

Unit III

Membrane bioreactors: Introduction and Historical Perspective of MBRs, Biotreatment Fundamentals, Biomass Separation MBR Principles, MBR Design Principles, Alternative MBR Configurations, Commercial Technologies.

Unit IV

Membrane Fouling, Control of Fouling and Concentration Polarization, Pretreatment systems, Pretreatment methods and strategies, Monitoring of Pretreatment, Langlier Index, Silt Density Index, Chemical cleaning, Bio flocculant control.

Case studies: Case studies on the applications of membrane-based water and wastewater treatment systems, zero liquid effluent discharge Plants, Desalination of brackish water.

Reference/Text Books:

- Symon Jud, "Principles and application of MBR in water and wastewater treatment", Elsevier (2006).
- Jorgen Wagner, "Membrane Filtration handbook, Practical Tips and Hints", 2nd Edition, Revision 2, Osmonics Inc. (2001).
- Baker R.W., "Membrane technology and applications", 2nd Edition, John Wiley, (2004).
- Noble R.D. and Stern S.A., "Membrane Separations Technology: Principles and Applications", Elsevier, Netherlands (1995).
- Stephenson T., Brindle K., Judd S., Jefferson B. "Membrane Bioreactors for Wastewater Treatment", IWA Publishing, London (2000).