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.