

Scheme and Syllabus of  
POSTGRADUATE DEGREE COURSE

**M.Tech. Part time**

**Environmental Engineering**



(Effective from academic session: 2023-24)

Rajasthan Technical University, Kota  
Akelgarh, Rawatbhata Road, Kota-324010

M. Tech. (Part-time) ENVIRONMENTAL ENGINEERING  
Course Scheme Structure Semester – I

S N	Course Type	Course Code	Course Name	Contact Hours per Week			Marks				Credits
				L	T	P	Exam Hrs	IA	ETE	Total	
1	PCC	1MEN1-01	Environmental Chemistry and Microbiology	3	0	0	3	30	70	100	3
2	PCC	1MEN1-02	Air Pollution and Control	3	0	0	3	30	70	100	3
3	MCC	1MCC3-21	Research Methodology and IPR	2	0	0	2	30	70	100	2
4	PCC	1MEN1-07	Air & Noise Quality Lab	0	0	4		60	40	100	2
			<b>TOTAL</b>					<b>150</b>	<b>250</b>	<b>400</b>	<b>10</b>

**M. Tech. (Part-time) ENVIRONMENTAL ENGINEERING**  
**Course Scheme Structure Semester – II**

S N	Course Type	Course Code	Course Name	Contact Hours per Week			Marks				Credits
				L	T	P	Exam Hrs	IA	ETE	Total	
1	PCC	2MEN1-01	Advanced Water Treatment Technology	3	0	0	3	30	70	100	3
2	PCC	2MEN1-02	Advanced Wastewater Treatment Technology	3	0	0	3	30	70	100	3
3	MCC	2MCC3-XX	Audit Course-I	2	0	0					
4	PCC	2MEN1-06	Wastewater Analysis Lab	0	0	4	4	60	40	100	2
			<b>TOTAL</b>					<b>120</b>	<b>180</b>	<b>300</b>	<b>8</b>

**M. Tech. (Part-time) ENVIRONMENTAL ENGINEERING**  
**Course Scheme Structure Semester – III**

S N	Course Type	Course Code	Course Name	Contact Hours per Week			Marks				Credits
				L	T	P	Exam Hrs	IA	ETE	Total	
1	PEC	IMEN2-11	Municipal Solid Waste Management	3	0	0	3	30	70	100	3
		IMEN2-12	Rural Water Supply and Sanitation								
		IMEN2-13	Environment and Health								
2	PEC	IMEN2-14	Environmental Impact Assessment	3	0	0	3	30	70	100	3
		IMEN2-15	Water and Wastewater Treatment								
		IMEN2-16	Solid and Hazardous Waste Management								
3	PCC	1MEN1-06	Water Quality Lab	0	0	4	4	60	40	100	2
			<b>TOTAL</b>					<b>120</b>	<b>180</b>	<b>300</b>	<b>8</b>

**M. Tech. (Part-time) ENVIRONMENTAL ENGINEERING**  
**Course Scheme Structure Semester – IV**

S N	Course Type	Course Code	Course Name	Contact Hours per Week			Marks				Credits
				L	T	P	Exam Hrs	IA	ETE	Total	
1	PEC	2MEN2-11	Groundwater Pollution								
		2MEN2-12	Energy and Environment								
		2MEN2-13	Design of Environmental Structures	3	0	0	3	30	70	100	3
2	PEC	2MEN2-14	Environmental Hydraulics								
		2MEN2-15	Environmental Risk Assessment	3	0	0	3	30	70	100	3
		2MEN2-16	Engineering Economics								
3	PCC	2MEN1-07	Environmental Engineering Design Lab	0	0	4	4	60	40	100	2
4	REW	2MEN4-50	Mini Project with Seminar	0	0	4	4	60	40	100	2
			<b>TOTAL</b>					<b>180</b>	<b>220</b>	<b>400</b>	<b>10</b>

**M. Tech. (Part-time) ENVIRONMENTAL ENGINEERING**  
**Course Scheme Structure Semester – V**

S N	Course Type	Course Code	Course Name	Contact Hours per Week			Marks				Credits
				L	T	P	Exam Hrs	IA	ETE	Total	
1	PEC	3MEN2-11	Industrial Wastewater Treatment Technology	3	0	0	3	30	70	100	3
		3MEN2-12	Remote Sensing and GIS								
		3MEN2-13	Water Quality Modelling								
2	MCC	3MCC3-XX	Open Elective	3	0	0	3	30	70	100	3
3	MCC	3MCC3-XX	Audit Course-II	2	0	0					
4	REW	3MEN4-60	Dissertation-I / IndustrialProject	0	0	20		240	160	400	10
			<b>TOTAL</b>					<b>300</b>	<b>300</b>	<b>600</b>	<b>16</b>

M. Tech. (Part-time) ENVIRONMENTAL ENGINEERING  
Course Scheme Structure Semester – VI

S N	Course Type	Course Code	Course Name	Contact Hours per Week			Marks				Credits
				L	T	P	Exam Hrs	IA	ETE	Total	
1	PCC	4MEN4-70	Dissertation-II	0	0	32		360	240	600	16
			<b>TOTAL</b>					<b>360</b>	<b>240</b>	<b>600</b>	<b>16</b>

## Course Syllabus

### 1MEN1-01: ENVIRONMENTAL CHEMISTRY AND MICROBIOLOGY

S. N.	Course Content	Contact Hours
1	<b>INTRODUCTION: Objective</b> , scope and outcome of the course	1
2	<b>Physical Chemistry:</b> Thermodynamics, Free Energy, osmosis, dialysis, law of mass action, chemical equilibrium and basic concepts of chemical kinetics.	7
3	<b>Biochemistry:</b> Biochemistry of carbohydrates, proteins, fats and oils, Enzymes, buffers, EMP and TCA pathways, electron transport mechanism and oxidation phosphorylation, photosynthesis.	8
4	<b>General Chemistry:</b> Henry's law, activity coefficients, ionization of weak bases, and acids, solubility product, common ion effect, ways of shifting chemical equilibria, Adsorption isotherms.	8
5	<b>Microbiology:</b> Morphology and classification of bacteria, algae, fungi and viruses, elements of microscopy, Microorganisms of various aerobic and anaerobic biological waste treatment units, culture media for microorganisms, sterilization.	8
6	Culture of microorganisms in batch and continuous reactors, energy and kinetics of microbial growth and metabolism and biological fate of pollutants. Microbiology of water, soil and air. Water and air borne diseases and their causative organisms, concept of indicator organisms. Tests for coliforms and streptococci and their significance, MPN and MF techniques, bacteriological standards.	8
	<b>Total</b>	<b>40</b>

#### Recommended Text Books:

1. C.N Sawyer, P.L McCarty and G.F Parkin, Chemistry for Environmental Engineering and Science, 5<sup>th</sup> ed. Tata McGraw-Hill, 2003
2. Pelczar, Jr, M.J., Chan E.C.S., Krieg, R.Noel., and Pelczar Merna Foss, Microbiology, 5<sup>th</sup> Edition, Tata McGraw Hill Publishing Company Limited, New Delhi, 1996.

#### Recommended Reference Books:

1. B.S Bhal, GD Tuli and Arun Bhal, Essentials of Physical Chemistry, S. Chand & Co Ltd. New Delhi, 2003
2. Arun Kumar De, Environmental Chemistry, 5<sup>th</sup> ed, New Age International (P) Ltd, New Delhi
3. Stainer, R.Y., Ingraham, J.L., Wheelis, M.C. and Painter, P.R. General Microbiology, MacMillan Edition Limited, London, 1989.
4. Pichai R. and Govindan, V.S., Edition, Biological processes in pollution control Anna University, Madras, 1988.



## 1MEN1-02: AIR POLLUTION AND CONTROL

S. N.	Course Content	Contact Hours
1	<b>INTRODUCTION: Objective</b> , scope and outcome of the course	1
2	<b>Sources and classification:</b> Classification of aerosols, gases vapours, natural air pollutants, properties of air pollutants. <b>Meteorology:</b> Factors influencing air pollution, wind roses, plume behaviour, estimation of plume rise. Air pollution standards and indices.	7
3	<b>Air Quality Monitoring:</b> Objectives, time and space variability in air quality, air sampling design, analysis and interpretation of air pollution data.  <b>Air Pollution Modelling:</b> Dispersion models – Basquill model, ASME model, Gaussian plume model assumptions, limitations.	8
4	<b>Effects of Air Pollutants:</b> Effect on man, material, vegetation, art treasures. Air pollution disasters, Economic effects. Global effects of Air Pollutants: Greenhouse effect, acid rains, ozone hole, heat islands.	8
5	<b>Air pollution due to automobiles:</b> Vehicular emissions, motor fuel combustion, automobile emission control, general concepts of transport planning for prevention of air pollution.	8
6	<b>Particulate control Technology:</b> Dilution, control at source by equipment, setting chambers, cyclones, fabric filters, electrostatic precipitators, scrubbers. Control of Gaseous Pollutants: Adsorption, absorption, combustion, condensation. Indoor air pollution control.	8
<b>Total</b>		<b>40</b>

### Recommended Text Books:

1. Richard W. Boubel et al “Fundamentals of Air pollution”, Academic Press, New York, 1994.
2. Noel de Nevers, Air Pollution Control Engineering, McGraw Hill, New York, 1995.
3. M.N. Rao et al, “Air Pollution” Tata McGraw Hill, 1989.

### Recommended Reference Books:

1. Wark K. & Warner C.F., Air Pollution its origin and Control.
2. Martin Craford (1980), Air Pollution Theory, Tata McGraw Hill Publishers
3. Stern A.C. (1968) Air Pollution, Vol. 1 - 5, Academic Press, New York.
4. Perkins H.C. (1974) Air Pollution, Mc Graw Hill Kogakusha Ltd., Tokyo

## 1MEN2-11: MUNICIPAL SOLID WASTE MANAGEMENT

S. N.	Course Content	Contact Hours
1	<b>INTRODUCTION: Objective</b> , scope and outcome of the course	1
2	<b>General:</b> Problems Associated with Solid Waste Disposal. <b>Generation of Solid Waste:</b> Goals and Objectives of solid Waste Management, Classification of Solid Waste, Factors Influencing Generation of Solid Waste, Characteristics of Solid Waste. Analysis of Solid Waste.	7
3	<b>Onsite Handling, Storage and Processing:</b> Public Health and Aesthetics, Onsite handling, Onsite Storage, Dust bins, Community Containers, Container Locations Onsite Processing methods.	8
4	<b>Solid Waste Collection, Transfer and Transport:</b> Collection Systems, Equipment and Labour Requirement, Collection Routes, Options for Transfer and Transport Systems.	8
5	<b>Processing and Disposal Methods:</b> Processing Techniques and Methods of Disposal, Sanitary Land filling, Composting and Incineration, Bioremediation.	8
6	<b>Recovery of Resources, Conversion Products and Energy:</b> Material Recovery, Energy Generation and Recovery Operation, Reuse in other Industry. <b>Industrial Solid Waste:</b> Nature, Treatment and Disposal methods.	8
	<b>Total</b>	<b>40</b>

### Recommended Text Books:

1. K. Sasikumar, Snoop Gopi Krishna, Solid Waste Management, Prentice Hall India Learning Private Limited, 2009
2. Solid Waste Engineering Principles and Management Issues by G. Technobanoglous, H. Theisen & R. Blssen, Mc Graw Hill Book Co.
3. N. N. Bandela, D. G. Tare, Municipal Solid Waste Management, BR Publishing Corporation, 2009

### Recommended Reference Books:

1. George Tchobanoglous, Frank Krieth, Handbook of Solid Waste Management, 2<sup>nd</sup> edition, McGraw Hill Publication, 2002
2. T. V. Ramachandran, Management of Municipal Solid Waste, Centre for Ecological Sciences, IISc Karnataka Research Foundation, 2009
3. George Techobanoglous et al, "Integrated Solid Waste Management", McGraw-Hill Publication, 1993.

## 1MEN2-12: RURAL WATER SUPPLY AND SANITATION

S. N.	Course Content	Contact Hours
1	<b>INTRODUCTION: Objective</b> , scope and outcome of the course	1
2	<p><b>General:</b> Importance of village community in India, Condition of Indian villages with special regard to economics, social and health aspects.</p> <p><b>Sources of water:</b> Traditional sources of water in rural areas. Different types of wells, sanitary aspects in well construction, pumps used for village wells, Hand pump Technology, its operation and maintenance. Water harvesting techniques.</p>	7
3	<p><b>Quality of water:</b> Estimation of total water requirement including cattle water demand, quality of water needed for village community, water quality surveillance, standards of water quality.</p> <p><b>Communicable Diseases:</b> Diseases and immunity, Source of communicable diseases, Mode of transfer, Control of communicable diseases, Guinea worm Eradication.</p>	8
4	<p><b>Water Treatment:</b> Slow sand filter, horizontal roughing filter and their combination. Disinfection of rural water sources, Fluoride and its removal.</p> <p><b>Schemes of Rural water supply:</b> Different Schemes of Rural water supply in Rajasthan, Their Design and project formulation including the programmes and standards laid by Govt. of India and Govt. of Rajasthan.</p>	8
5	<p><b>Milk and Food sanitation:</b> Essentials of dairy farm and cattle shed sanitation, Tests for milk and dairy products, food epidemics, food poisoning, Botulism.</p> <p><b>Fly and Mosquito control:</b> Life cycle of flies and mosquitoes, various methods of flies and mosquito control.</p>	8
6	<p><b>Rural Sanitation:</b> Village latrines, VIP latrines, pour flush latrines, materials, construction and cost of the latrines, Pollution aspects and pollution travel from latrines. Storm water and sludge problems. Septic tank, soak pit, small bore sewer system; its design and construction. Animal waste, method of composting, Biogas, collection and disposal of wastes. <b>Community Awareness and user participation:</b> Planning of communication support in rural supply and sanitation projects.</p>	8
<b>Total</b>		<b>40</b>

### Recommended Text Books:

1. Municipal and Rural Sanitation E.W. Steel, McGraw Hill Book Co.
2. Wastewater Engineering, Treatment and Reuse: Metcalf and Eddy, Tata McGraw Hill Publication, New Delhi

### Recommended Reference Books:

1. Rural Water Supply & Sanitation Manual by Govt. of India
2. Reports of Rajeev Gandhi National Drinking Water Mission, GOI.
3. Environmental Sanitation: J.A. Salvato

1MEN2-13: ENVIRONMENT AND HEALTH

S. N.	Course Content	Contact Hours
1	<b>INTRODUCTION: Objective</b> , scope and outcome of the course	1
2	Contamination of drinking water & the effect on human health. Concept of Indicator organism; Problems of water quality in Rajasthan.	7
3	Water quality standards; Integrated water resource management & health, Concept of Total sanitation campaign & Swachh Bharat Abhiyan, Water supply & Sanitation under emergencies.	8
4	Ambient air Quality & its effect on human health, Sources of air pollution different air pollutants & their impact on respiratory system air quality standards air quality indices indoor air quality & its effect on human health Sources of indoor air pollution WHO guidelines values for indoor air quality. Noise pollution & its impact on human health. Standards for ambient & occupational noise pollution indices.	8
5	Solid waste disposal & its effects on human health. Design of studies to establish cause effect relationship between environmental quality & health. Management of environmental quality to reduce impact on health.	8
6	Environmental Policies: National and international trends, Changes in global perspective, international treaties, Legal provisions for environmental protection, Various Acts, Rules and Regulations, Occupational Safety and Health Act (OSHA), Clean Air Act (CAA), Clean Water Act (CWA), Acts related to hazardous and toxic substances.	8
<b>Total</b>		<b>40</b>

**Recommended Text Books:**

1. A Textbook of Environmental Health by S. K. Adhikari
2. Environment, Health & Sustainable development: Megan Landon

**Recommended Reference Books:**

1. Man & Environment: Health Perspective: Anne Nadakavukaren
2. Environmental Health and Science by Frank R. Spellman & Revonna M. Bieber
3. Environmental Health from Global to Local by Howard Frumkin

## 1MEN2-14: ENVIRONMENTAL IMPACT ASSESSMENT

S. No.	Contents	Hours
1	<b>Introduction: Objective</b> , scope and outcome of the course	1
2	<b>Introduction &amp; Concepts of EIA:</b> effect of human activity on environment, concept of ecosystem imbalances, definition of E.I.A, E.I.S, E.M.P, industrial policy of the Govt. of India. <b>International Protocols, Treaties and Conventions:</b> Stockholm and Basal convention, Copenhagen conference, Rio-Earth summit, <b>Indian Scenario:</b> Guidelines of MoEF and CPCB.	7
3	<b>Methodologies for EIA:</b> preliminary assessment, quantification, comparison of alternatives and comprehensive E.I.As using Ad hoc, Overlays, Checklist, Matrix and Network methods.	8
4	<b>Prediction and assessment of impacts</b> on air, water, biota, noise, land, cultural and socio-economic environment. <b>Water quality impact:</b> Water quality criteria, standards and indices, Impacts on water quality of development projects.	8
5	<b>Air quality impact:</b> Air quality criteria, standards and indices, air quality impact of industry transport systems <b>Noise:</b> Effects of noise on people, noise scales and rating methods, Noise barriers, estimating transportation noise impacts. <b>Land Pollution</b> due to construction activities. <b>Biota:</b> Impact on fauna and flora, mitigation measures, alternatives.	8
6	<b>Cultural and socio-economic impacts:</b> effect of developmental projects on cultural and social settings and economic profile of the community. <b>Energy impact:</b> EIA of hydro, thermal and nuclearpower plants Public Participation in environmental decision making, Some Case Studies of EIA.	8
<b>Total</b>		<b>40</b>

### Recommended Text Books:

1. Anji Reddy Mareddy, Environmental Impact Assessment Theory and Practice, Elsevier Publication, 1<sup>st</sup> Edition, 2017
2. Introduction to Environmental Impact Assessment, A Guide to Principles and Practice, Oxford Publication, 3<sup>rd</sup> Edition, 2015
3. Canter L. W. Environmental Impact Assessment, 2nd Ed., McGraw-Hill, 1997.

### Recommended Reference Books:

1. Burke,G., Singh, B.R., and Theodore, L. Handbook of Environmental Management and Technology, 2nd Ed., John Wiley & Sons, 2000.
2. Kulkarni, V. and Ramachandra, T.V., “Environment Management”, TERI Press. 2009.
3. MoEF Guidelines and amendments as updated on <http://moef.gov.in>

## 1MEN2-15: WATER AND WASTEWATER TREATMENT

S. No.	Contents	Contact Hours
1	<b>Introduction:</b> Objective, scope and outcome of the course	1
2	<b>Water Quality:</b> Physical, chemical and biological parameters of water- Water Quality requirement - Potable water standards - Wastewater Effluent standards -Water quality indices.	5
3	<b>Water purification systems in natural systems:</b> Physical processes-chemical processes and biological processes-Primary,Secondary and Tertiary Treatment-Unit operations-unit processes.	6
4	<b>Sedimentation:</b> Types, Aeration and gas transfer, Coagulation and flocculation, coagulation processes - stability of colloids - destabilization of colloids transport of colloidal particles, Clari-flocculation.	8
5	<b>Filtration:</b> theory of granular media filtration; Classification of filters; slow sand filter and rapid sand filter; mechanism of filtration; modes of operation and operational problems; <b>Disinfection:</b> Factors affecting disinfection, Disinfection - chlorine dioxide; chloramines; ozonation; UV radiation.	12
6	<b>Miscellaneous Methods:</b> Ion Exchange-processes, Application of Membrane Processes, Reverse Osmosis, Micro-filtration, Nano-filtration, Ultra-filtration and Electro-dialysis. <b>Wastewater Treatment Technologies:</b> Introduction, Detailed Design Criteria, Advantages and disadvantages.	8
	<b>Total</b>	<b>40</b>

### Recommended Text Books:

1. Metcalf and Eddy, Wastewater Engineering, Treatment and Reuse, Tata McGraw Hill Publication, New Delhi, 2003
2. Water & Waste Water Engineering by Fair and Gayer.

### Recommended Reference Books:

1. Weber, W.J., Physicochemical processes for water quality control, John Wiley and sons, Newyork, 1983.
2. Peavy, H.S., Rowe, D.R. and Tchobanoglous, G. Environmental Engineering, McGraw Hills, New York 1985.
3. C.A.Sastry, Water Treatment Plants, Narosa Publishing House, Bombay, 1996.

## 1MEN2-16: SOLID AND HAZARDOUS WASTE MANAGEMENT

S. No.	Contents	Contact Hours
1	<b>INTRODUCTION: Objective</b> , scope and outcome of the course	1
2	<b>Introduction to SWM:</b> Definition of waste and solid waste, classification solid waste, sources of solid waste, its composition, factors affecting waste generation, traditional methods of waste collection and disposal.	7
3	<b>Waste Collection:</b> Components of waste collection, waste collection containers, their characteristics, types, waste collection vehicles, collection frequency, collection route, transfer stations.	8
4	<b>Solid Waste Characterization:</b> Physical characteristics, chemical characteristics and biological characteristics of solid wastes.  <b>Waste Processing:</b> Size reduction, factors affecting size reduction, size reducing equipments, volume reduction, equipments for volume reduction, waste minimization, waste hierarchy, 3 R principle.	8
5	<b>Hazardous Waste:</b> Definition, sources, classification, collection, segregation, treatment and disposal methods. <b>Radioactive Waste, E-Waste, Biomedical Waste:</b> Definition, sources, classification, segregation, management and disposal methods.	8
6	<b>Treatment and Disposal of Solid Waste:</b> Composting, vermicomposting, biogas production, thermal treatment, incineration, pyrolysis, gasification, biological treatment, Sanitary land filling, land fill leachate and gas management <b>Latest Advances and Rules</b> related to SWM, Hazardous Waste, Plastic Waste and E-Waste Management.	8
<b>Total</b>		<b>40</b>

### Recommended Text Books:

1. K. Sasikumar, Snoop Gopi Krishna, Solid Waste Management, Prentice Hall India Learning Private Limited, 2009
2. Bandela, D. G. Tare, Municipal Solid Waste Management, BR Publishing Corporation, 2009

### Recommended Reference Books:

1. Kumar, Sunil, Effective Waste Management in India, INTECH, CROATIA, 2010
2. George Techobanoglous et al, Integrated Solid Waste Management, McGraw-Hill Publication, 1993.
3. Charles A. Wentz, Hazardous Waste Management, McGraw Hill Publication, 1995.

1MCC3-21: RESEARCH METHODOLOGY & IPR

S. No.	Contents	Contact Hours
1	<b>INTRODUCTION: Objective</b> , scope and outcome of the course	1
2	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	7
3	Effective literature studies approaches, analysis, Plagiarism, Research ethics	3
4	Effective technical writing, how to write report and paper, Developing a Research Proposal, Format of research proposal, apresentation and assessment by a review committee	5
5	<b>Nature of Intellectual Property:</b> 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.	6
6	<b>Patent Rights:</b> Scope of Patent Rights, Licensing and transfer of technology, Patent information and databases, Geographical Indications. <b>New Developments in IPR:</b> Administration of Patent System, New developments in IPR, IPR of Biological Systems, Computer Software etc. Traditional knowledge, Case Studies.	8
	<b>Total</b>	<b>30</b>

**Recommended Text Books:**

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students".
2. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"
3. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners"

**Recommended Reference Books:**

1. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd, 2007.
2. Mayall, "Industrial Design", McGraw Hill, 1992.
3. Niebel, "Product Design", McGraw Hill, 1974.
4. Asimov, "Introduction to Design", Prentice Hall, 1962.
5. Robert P. Merges, Peter S. Menell, Mark A. Lemley, "Intellectual Property in New Technological Age", 2016.
6. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008



1MEN1-06: WATER QUALITY LAB  
**Measurement of Water Quality Parameters**

S. N	Experiment
1	Introduction to Standards, Sampling, Collection & Preservation of Samples
2	Determination of pH, Colour and Odour for a water sample
3	Determination of Acidity and Alkalinity for a water sample
4	Determination of Conductivity for a water sample
5	Determination of Calcium, Magnesium and Total Hardness for a water sample
6	Determination of Turbidity for a water sample
7	Determination of Chlorides for a water sample
8	Determination of Nitrates for a water sample
9	Determination of Optimum Dosage of Alum using Jar test apparatus.
10	Determination of available chlorine in bleaching powder and Residual Chlorine for a water sample

**Recommended Text / Reference Books / Manuals:**

1. Lab Manual, ISO 14001 Environmental Management, Regulatory Standards for Drinking Water and Sewage disposal.
2. Clair Sawyer and Perry McCarty and Gene Parkin, "Chemistry for Environmental Engineering and Science", McGraw-Hill Series in Civil and Environmental Engineering.
3. Guide manual: Water & wastewater analysis, Central Pollution Control Board, Govt. of India.
4. APHA standard methods for the examination of water and wastewater – 20th edition.
5. Water supply engineering by S.K. Garg- 30th Edition, Khanna Publications, New Delhi
6. Environmental Engg. Laboratory Manual by R.P. Mathur

## 1MEN1-07: AIR AND NOISE QUALITY LAB

### Measurement of Air Quality Parameters and Noise Levels

S. N.	Experiment
1	Introduction and Demonstration of Equipments related to Air Sampling and Noise measurement
2	Introduction to Air Quality and Noise Standards as per CPCB
3	Determination of SPM in air sample
4	Determination of PM <sub>10</sub> in air sample
5	Determination of PM <sub>2.5</sub> in air sample
6	Determination of SO <sub>2</sub> in air sample
7	Determination of NO <sub>2</sub> in air sample
8	Determination of CO in air sample
9	Introduction and Understanding of Air Quality Index (AQI)
10	Determination of Sound by SLM at different locations

#### Recommended Text / Reference Books / Manuals:

1. CPCB (2011), Guidelines for the Measurement of Ambient Air Pollutants, Volume-1, Delhi.
2. IS 5182 (part 23), 2006, Indian standards – Methods for measurement of air pollution, Part-23 – Respirable suspended particulate matter (PM10), cyclonic technique.
3. IS 5182 (Part 14)-2000 (reaffirmed 2005): Indian standards, Method of measurement of air pollution: Guidelines for planning the sampling for atmosphere.
4. IS 5182 Part 2 Method of measurement of air pollution: Sulphur dioxide
5. IS 5182 (Part 6)-2006: Indian standards, Method of measurement of air pollution: Nitrogen dioxide.
6. Rao, M. N. and Rao, H. V. N., Air Pollution, TMGH Co. Ltd. New Delhi 1989

## 2MEN1-01: ADVANCED WATER TREATMENT TECHNOLOGY

S. No.	Contents	Contact Hours
1	<b>INTRODUCTION: Objective</b> , scope and outcome of the course	1
2	<b>Water Quality Parameters:</b> Significant water quality parameters for Municipal Water Supplies. Standards and Guidelines of Water for drinking purposes.	7
3	<b>Water Treatment:</b> Settling types, Discrete particle settling, Flocculent Settling, Theory of Tube Settlers, Plate Settlers, Choice of Clarifiers, Ideal sedimentation Tank Concept.	8
4	<b>Coagulation:</b> Theory, Chemistry and Mechanism of Coagulants, Coagulant Aids, Flocculation, Orthokinetic, Perikinetic, Mean Velocity Gradient, Long Rectangular Basin, Circular Basin Design of Clariflocculators.	8
5	<b>Filtration:</b> Theory, Carman Kozeny equation, Filter Arrangement, Filter operation. <b>Disinfection:</b> Types, Mechanisms of, Factors Influencing Efficiency of Disinfectants, Chlorine Chemistry, Chlorinator.	8
6	<b>Miscellaneous Methods:</b> Process and Application of Ion Exchange, Adsorption, Reverse Osmosis, Electro-dialysis.	8
	<b>Total</b>	<b>40</b>

### Recommended Text Books:

1. Water Supply and Sanitary Engineering G.S. Bridie & J.S. Brides, Dhanpat Rai & Sons.
2. A Treatise on Rural, Municipal, and industrial water management, KVSG Murali Krishna.
3. Weber W.J., (1975) "Physico - Chemical Processes for Water Quality Control".

### Recommended Reference Books:

1. AWWA, (1971), "Water Quality and Treatment" McGraw Hill.
2. CPHEEO Manual, (1991), "Water Supply and Treatment", GO Publications.
3. Peavy, H.S., Rowe and Tchobonoglous, G., (1985), "Environmental Engineering", McGraw Hill

## 2MEN1-02: ADVANCED WASTEWATER TREATMENT TECHNOLOGY

S. No.	Contents	Contact Hours
1	<b>INTRODUCTION: Objective</b> , scope and outcome of the course	1
2	<b>Wastewater Characteristics</b> and their significance. B.O.D., Methods of Determination of K and Lo, Nitrification, Comparison of various methods of Determination of Organics.	7
3	<b>Screens, Grit Chamber, Floatation, Sedimentation</b> , Zone Settling, Classification of biological Wastewater Treatment Process, Design of PST and SST.	8
4	<b>Aeration of Wastewater, Oxygen Transfer:</b> Process, Kinetic Relationship of Bio-Kinetic Parameters, Design Procedure, Modifications of A.S.P., Extended Aeration, Contact Stabilization, Step aeration, Tapered aeration, <b>Trickling Filters:</b> Theory, Physical Arrangements, Design of ponds and Lagoons. Theory & Design of Rotating Biological Contactors, Concepts of Sequencing Batch Reactors Anaerobic & Filter UASB Sewage Farming.	12
5	<b>Sludge:</b> Sources, Characteristics, Volume- Mass relationship, Sludge Stabilization, Conventional and High-Rate Digesters, Gas Production, Collection, Disposal of Sludge.	8
6	<b>Tertiary treatment:</b> Nitrogen removal, Phosphorus Removal.	4
	<b>Total</b>	<b>40</b>

### Recommended Text Books:

1. "Wastewater Engineering - Treatment and Reuse", Metcalf and Eddy Inc., (2003), 4th Edition, Tata McGraw Hill Publishing Co. Ltd., New Delhi.
2. Sewage Waste Disposal and Air Pollution Engineering by S.K. Garg, Khanna Publications, New Delhi
3. "Wastewater Treatment Concepts and Design Approach", Karia G.L., and Christian R.A., (2001), Prentice Hall of India Pvt. Ltd., New Delhi.

### Recommended Reference Books:

1. "Water-wastewater engineering", Fair G.M., Geyer J.G and Okun
2. Water Supply and Sanitary Engineering G.S. Bridie & J.S. Bridie, Dhanpat Rai & Sons, New Delhi

## 2MEN2-11: GROUNDWATER POLLUTION

S. No.	Contents	Contact Hours
1	<b>INTRODUCTION: Objective</b> , scope and outcome of the course	1
2	<b>WATER QUALITY:</b> Natural occurrence of common solutes in water, Suspended & dissolved constituents, Principle chemical constituents in ground water, water quality criteria for drinking, Agricultural and Industrial uses, Quality of ground water resources.	7
3	<b>SOURCES OF POLLUTION:</b> Various sources & causes of ground water pollution. Activities generating contaminants, Types of contaminants & Mechanism of ground water pollution	8
4	<b>MOVEMENT OF POLLUTANTS:</b> Principles of Pollutant movement (Darcy's law, Hydraulic Conductivity, Anisotropic Aquifer), Attenuation of pollution in the ground, Pollution dispersion in the ground. Ground water movement in saturated zone. Factors affecting Pathogen movement & Survival, Transportation equation, ground water remediation.	8
5	<b>PROBLEMS OF TOTAL DISSOLVED SOLIDS:</b> Fluoride & Nitrate Pollution of ground water, Natural occurrence of Nitrates & sources related to man's activities. Groundwater Legislation in India and Case histories, Salt water intrusion and related artificial recharge studies.	8
6	<b>MONITORING GROUNDWATER QUALITY:</b> General principles, Monitoring Management of Ground Water Quality, Section of Parameters for Monitoring. Economic considerations in ground water quality management.	8
<b>Total</b>		<b>40</b>

### Recommended Text Books:

1. Todd D. K. Groundwater Hydrology, John Wiley publishers, 2004
2. Jacob and Bear, Hydraulics of Groundwater, McGraw Hill, 1997

### Recommended Reference Books:

1. Raghunath, Groundwater & Well Hydraulics, Wiley Eastern Ltd, New Delhi, 1992
2. Groundwater Pollution, Volume 41st Edition by J.J. Fried.

## 2MEN2-12: ENERGY AND ENVIRONMENT

S. No.	Contents	Contact Hours
1	<b>INTRODUCTION: Objective</b> , scope and outcome of the course	1
2	<b>Introduction:</b> Human Development, Socio-Economic Activities and Energy Needs; Introduction to Primary and Secondary Energy Resources; Introduction to Energy Conservation Technologies. Energy Needs (fuel types) of Domestic /Commercial Transport and Industrial Sectors; National and Global Energy Demand and Supply.	7
3	<b>Environmental Implications of Energy Use:</b> Laws of Thermodynamics, Degradation of Energy; Fuel chain, Environmental Impacts at Different Stages of the Fuel Chain; Local, Regional and global Impacts; Waste Recycling and its impacts on Energy and Environment. Air pollution from cooking Appliances, Vehicle and Power Plants, long term Emission Standards for Indian Industries and Transport Sector.	8
4	<b>Pollution Control Technologies in Energy Sector:</b> Clean Fuels and Environmentally Friendly Cooking and Heating Appliances, Emission Control from Diesel & Petrol Engines, New and Efficient Engines: Clean Combustion Technologies for Coal; Flue Gas Desulphurization & Recirculation; Advanced Burner Technology& Staged Firing; Selective Catalytic reduction.	8
5	<b>Energy Environment Models:</b> Analysis and design of Environmental Policies; Decision Analysis, System Dynamics and Linear Programming Models for Designing Environmental Policies, Current Research on Energy environment Interactions.	8
6	<b>Environmental Economics:</b> Environmental Benefits and cost of the use of various options including Fossil Fuels, Bio Gas, Solar and Wind Energy.	8
<b>Total</b>		<b>40</b>

### Recommended Text Books:

1. De, B. K., Energy Management audit & Conservation, 2nd Edition, Vrinda Publication, 2010.
2. Murphy, W. R., Energy Management, Elsevier, 2007.
3. Smith, C. B., Energy Management Principles, Pergamum, 2007

### Recommended Reference Books:

1. Turner, W. C., Doty, S. and Truner, W. C., Energy Management Hand book, 7th edition, Fairmont Press, 2009.
2. Environment pollution control Engineering by C S Rao, New Age International, 2006, reprint 2015, 2nd edition.
3. Environmental studies, by Benny Joseph, Tata McGraw Hill, 2008, 2nd edition.

## 2MEN2-13: DESIGN OF ENVIRONMENTAL STRUCTURES

S. No.	Contents	Contact Hours
1	<b>INTRODUCTION: Objective</b> , scope and outcome of the course	1
2	<b>Conduit:</b> Stresses in pipes, Strength of Conduits, Design of concrete and steel pipes for internal and external loads. Anchor Blocks.	7
3	<b>Tanks:</b> Underground Tanks, Retaining Wall and floor Junctions, Rectangular and Circular Tanks in R.C.C. and Steel, Intz Tanks, Steel and Concrete Staging.	8
4	<b>Treatment Units:</b> Clarifiers, Flocculators, Filter House, Hopper Bottom Tanks, Digesters.	8
5	<b>Design of Special Purpose Structures:</b> Underground reservoirs and swimming pools, Intake towers, structural design including foundation of water retaining structures	8
6	<b>Repair and Rehabilitation of Structures:</b> Diagnosing the cause and damage, identification of different types of structural and non-structural cracks – repair and rehabilitation methods for Masonry, Concrete and Steel Structures.	8
<b>Total</b>		<b>40</b>

### Recommended Text Books:

1. Reinforced Concrete by P. Dayaratnam.
2. Prestressed Concrete by Krishna Raju, Tata McGraw Hill Publishing Co. 2nd Edition 1988.
3. Reinforced Concrete by N.C.Sinha&S.K.Roy - S.Chand and Co. 1985.

### Recommended Reference Books:

1. Hulse R., and Mosley, W.H., “Reinforced Concrete Design by Computer”, Macmillan Education Ltd., 1986.
2. Ramaswamy, G.S., “Design and Construction of Concrete shell roofs”, CBS Publishers, India, 1986.
3. Green, J.K. and Perkins, P.H., “Concrete liquid retaining structures “, Applied Science Publishers, 1981.

## 2MEN2-14: ENVIRONMENTAL HYDRAULICS

S. No.	Contents	Contact Hours
1	<b>INTRODUCTION: Objective</b> , scope and outcome of the course	1
2	<b>Evaporation and infiltration:</b> measurement and estimation of evaporation from land and water surfaces. Infiltration, factors affecting infiltration. <b>Hydrograph analyses:</b> Surface runoff, overland flow, factors affecting runoff. Rational formula. Hydrograph analyses, Unit hydrograph, channel and storage routing.	7
3	<b>Groundwater Development:</b> Well development, Artificial recharge, Salinity of Ground water, Ground water pollution, Infiltration Galleries.	8
4	<b>Water Distribution System:</b> General design requirements, Methods of analyses, control of water hammer in long distance transmission. Introduction to optimization of water distribution system.	8
5	<b>Sewerage system design:</b> General design principles of sewers, Recent development in sewerage system design. <b>Urban Storm Drainage:</b> Introduction to drainage problems in difficult climates. Planning concepts, Rainfall intensity-duration-frequency curves. Design of drainage system elements, control of storm waterpollution.	8
6	<b>Water and wastewater pumping:</b> Classification, selection, installation, operation and maintenance of pumps for water and wastewater pumping, electrical motors, choice and installation, starters and other accessories.	8
<b>Total</b>		<b>40</b>

### Recommended Text Books:

1. Chow VT, Maidment DR and Mays LW, Applied hydrology, Tata McGraw Hill, New Delhi (2010).
2. "Ground Water", H.M. Raghunath, Wiley Eastern Limited, New Delhi, 2007.
3. "Ground Water Hydrology", David Keith Todd, Wiley India Pvt. Ltd., 2005.

### Recommended Reference Books:

1. McGhee, Water supply and sewerage, McGraw Hill, New Delhi (1991).
2. Wurbs RA and James WP, Water resources engineering, PHI New Delhi (2002).
3. Nathanson, JA, Basic environmental technology, PHE, New Delhi (2003).
4. A. Vermjit, "Theory of Groundwater Flow" - MacMillan, 1970
5. H. Boluwer, "Groundwater Hydrology" - McGraw Hill, Kogakusha, 1979



## 2MEN2-15: ENVIRONMENTAL RISK ASSESSMENT

S. No.	Contents	Contact Hours
1	<b>INTRODUCTION: Objective</b> , scope and outcome of the course	1
2	<b>Sources of Environmental hazards:</b> Environmental and ecological risks, Environmental risk assessment framework, Regulatory perspectives and requirements, Risk Analysis and Management and historical perspective; Social benefit v/s technological risks; Path to risk analysis; Perception of risk, risk assessment in different disciplines	7
3	<b>Elements of Environmental Risk Assessment:</b> Hazard identification and accounting, Fate and behaviour of toxics and persistent substances in the environment, Properties, processes and parameters that control fate and transport of contaminants, Receptor exposure to Environmental Contaminants, Dose Response Evaluation, Risk Characterization and consequence determination, Vulnerability assessment, Uncertainty analysis.	8
4	<b>Tools and Methods for Risk Assessment:</b> HAZOP and FEMA methods, Cause failure analysis, Event tree and fault tree modelling and Analysis, Multimedia and multipath way exposure modelling of contaminant migration for estimation of contaminant concentrations in air, water, soils, vegetation and animal products, Estimation of carcinogenic and non-carcinogenic risks to human health, Methods in Ecological risk assessment, Probabilistic risk assessments, radiation risk assessment, Data sources and evaluation.	8
5	<b>Risk Management:</b> Risk communication and Risk Perception, comparative risks, Risk based decision making, Risk based environmental standard setting, Risk Cost Benefit optimization and tradeoffs, Emergency Preparedness Plans, Emergency planning for chemical agent release, Design of risk management programs, risk-based remediation; Risk communication, adaptive management, precaution and stake holder involvement	8
6	<b>Applications:</b> Case studies on risk assessment and management for hazardous chemical storage, Chemical industries, Tanneries, Textile industries, Mineral processing and Petrochemical plants, Hazardous waste disposal facilities, nuclear power plants, contaminated site remediation, Case histories on Bhopal, Chernobyl, Seveso, Three Mile Island.	8
	<b>Total</b>	<b>40</b>

**Recommended Text Books:**

1. Cutter, S.L., Environmental Risk and Hazards, Prentice-Hall of India Pvt. Ltd., New Delhi, 1999.
2. Kolluru Rao, Bartell Steven, Pitblado R and Stricoff, "Risk Assessment and Management Handbook", McGraw Hill Inc., New York, 1996.
3. Kofi Asante Duah, "Risk Assessment in Environmental management", John Wiley and sons, Singapore, 1998.

**Recommended Reference Books:**

1. Kasperson, J.X. and Kasperson, R.E. and Kasperson,R.E., Global Environmental Risks, V.N.University Press, New York, 2003.
2. Risks and Decisions for Conservation and environmental management, Mark Burman, Cambridge University Press.
3. Susan L Cutter, "Environmental Risks and Hazards" Prentice Hall of India, New Delhi, 1999.

## 2MEN2-16: ENGINEERING ECONOMICS

S. No.	Contents	Contact Hours
1	<b>INTRODUCTION: Objective</b> , scope and outcome of the course	1
2	<b>Financial Evaluation of Projects and Project Planning:</b> Capital investment proposals, criterions to judge the worthwhileness of capital projects viz. net present value, benefit cost ratio, internal rate of return, Risk cost management, main causes of project failure.	7
3	<b>Categories of construction projects:</b> objectives, project development process, Functions of project management, Project management organization and staffing, Stages and steps involved in project planning, Plan development process, objectives of construction project management.	8
4	<b>Project Economics:</b> Project network analysis using CPM & PERT Techniques	8
5	<b>Management:</b> Principles of management, functions, planning, organization, staffing, directing, controlling, coordination, decision making.	8
6	<b>Project Evaluation:</b> Meaning, Capital and OMR cost, Project life, Stages, Methods of Evaluations with their limitations.	8
<b>Total</b>		<b>40</b>

### Recommended Text Books:

1. Engineering Economics, R. Paneerselvam, PHI
2. Engineering Economics and Management, Vikas Kulkarni, Hardik Bavishi, Vikas Publishing

### Recommended Reference Books:

1. Engineering Economic Analysis, Newnan, Eschenbach, Lavelle. Oxford
2. Principles of Engineering Economic Analysis, White, Case, and Pratt. Wiley & Sons

2MEN1-06: WASTEWATER ANALYSIS LAB  
**Measurement of Wastewater / Sewage Parameters**

S. N.	Experiment
1	Determination of Total Solids in sewage sample
2	Determination of Dissolved and Suspended Solids in sewage sample
3	Determination of Volatile and Fixed Solids in sewage sample
4	Determination of Settleable Solids in sewage sample
5	Determination of Dissolved Oxygen in wastewater sample
6	Determination of BOD in wastewater sample
7	Determination of COD in wastewater sample
8	Determination of Heavy Metals in wastewater sample
9	Introduction to Microscope, its types & applications
10	Introduction to MPN and MF techniques

**Recommended Text / Reference Books / Manuals:**

1. Lab Manual, ISO 14001 Environmental Management, Regulatory Standards for Drinking Water and Sewage disposal.
2. Clair Sawyer and Perry McCarty and Gene Parkin, "Chemistry for Environmental Engineering and Science", McGraw-Hill Series in Civil and Environmental Engineering.
3. Guide manual: Water & wastewater analysis, Central Pollution Control Board, Govt. of India.
4. APHA standard methods for the examination of water and wastewater – 20th edition.
5. Environmental Engg. Laboratory Manual by R.P. Mathur

## 2MEN1-07: ENVIRONMENTAL ENGINEERING DESIGN LAB

Design of Environmental Engineering structures as per Theory Courses on Water and Wastewater Treatment Technologies including:

1. Introduction to various design criteria and formula / methods as per Indian Standards
2. Population Forecasting Methods
3. Design of Pipes: Water Mains and Distribution network
4. Design of Sedimentation Tanks
5. Design of Slow Sand and Rapid Sand Filters
6. Design of Sewers
7. Design of Activated Sludge Process
8. Design of Trickling Filters
9. Design of Oxidation Ponds and Septic Tanks
10. Introduction and Application of Softwares for design of above structures

### Recommended Text / Reference Books / Manuals:

1. Manual on Water Supply and Treatment, CPHEEO, Ministry of Urban Development, GOI, 1999.
2. Manual on Sewerage and Sewage Treatment Systems, CPHEEO, Ministry of Urban Development, GOI, 2013
3. Water Supply and Sanitary Engineering G.S. Bridie & J.S. Bridie, Dhanpat Rai & Sons
4. Water Supply Engineering by S.K. Garg, Khanna Publications, New Delhi
5. Sewage Waste Disposal and Air Pollution Engineering by S.K. Garg, Khanna Publications, New Delhi
6. "Wastewater Engineering - Treatment and Reuse", Metcalf and Eddy Inc., (2003), 4th Edition, Tata McGraw Hill Publishing Co. Ltd., New Delhi.
7. "Wastewater Treatment Concepts and Design Approach", Karia G.L., and Christian R.A., (2001), Prentice Hall of India Pvt. Ltd., New Delhi.
8. "Water-wastewater engineering", Fair G.M., Geyer J.G and Okun

## 2MEN4-50: MINI PROJECT WITH SEMINAR

The student shall be required to choose a relevant topic for mini project related to latest technology / development in the concerned field, current environmental problem/issue or any other suitable topic and shall carry out experimental / analytical research suggesting solution with sufficient literature survey and shall prepare seminar report and present the same under the supervision of the nominated guide.

### 3MEN2-11: INDUSTRIAL WASTEWATER TREATMENT TECHNOLOGY

S. No.	Contents	Contact Hours
1	<b>INTRODUCTION: Objective</b> , scope and outcome of the course	1
2	<b>General:</b> Comparative study of industrial waste water with municipal wastewater, <b>Industrial wastewater problems in India:</b> Effects of discharges of Industrial Waste of Receiving Bodies of Water, Land and Sewer. Effluent and Stream Standards. Historical Development of law related to environmental Protection, Salient feature of Water Act- 1974, Air Act-1981 and Environmental (Protection) Act -1986	7
3	<b>Specific Industrial Treatment Processes:</b> Neutralization, Equalization and Proportioning, Volume and strength reduction	8
4	Raw materials, Water requirements, Process Characteristics, Composition, effects and treatment, flow sheet of Industrial Wastewaters generated from: Textile (Cotton and Synthetic), tannery, Pulp and Paper, Dairy, Metal Plating (Chromium and Cyanide problem), Slaughter house	12
5	Distillery, Dyeing and printing, Fertilizer, Copper & Cement Industry. Provision of various Indian Standards for above Industries	8
6	Potential of Wastewater Recycle and Reuse in Industries, Concept of Common Effluent Treatment Plants	4
	<b>Total</b>	<b>40</b>

**Recommended Text / Reference Books:**

1. Wastewater Treatment by M. N. Rao and A. K. Datta–Oxford I. B. H publishers
2. Metcalf & Eddy, “Wastewater engineering Treatment disposal reuse”, Tata McGraw Hill.
3. Eckenfelder, W.W., “Industrial Water Pollution Control”, McGraw-Hill
4. M.N. Rao and Dutta – Industrial Waste.

**Recommended Text / Reference Books:**

1. Mark J. Hammer, Mark J. Hammer, Jr., “Water & Wastewater Technology”, Prentice Hall of India.
2. N.L. Nemerrow –Theories and practices of Industrial Waste Engineering.
3. C.G. Gurnham –Principles of Industrial Waste Engineering.

### 3MEN2-12: REMOTE SENSING AND GIS

S. No.	Contents	Contact Hours
1	<b>INTRODUCTION: Objective</b> , scope and outcome of the course	1
2	Introduction: Energy-electromagnetic radiation, radiation principles, electromagnetic spectrum, ideal remote sensing system, energy interaction with atmosphere, atmospheric windows, Energy interaction with earth surface feature, spectral signature, Multi concept of remote sensing.	7
3	Sensor System: Various types of platforms, different types of sensors, Indian remote sensing systems, data acquisition, spatial, spectral & radiometric resolution, thermal sensors, fundamentals of microwave remote sensing.	8
4	Digital Image Processing: Operations involved in Digital Image Processing, source of image acquisition, data pre-processing – atmospheric, radiometric, geometric. Histograms, density slicing, grey level mapping, contrast stretching, filtering, principal component analysis, basic pattern recognition concepts, and discrimination functions. Data Products and Interpretation: Various data products, characteristics, principles of interpretation, ground control points, ground truth.	8
5	Geographic Information Systems: Definition, functions of GIS, types of data – spatial, non-spatial, point, line, polygon, vector and raster. Database, digitizer, scanner, spatial analysis, overlay, query. Sample analysis, modelling in GIS, DEM, DTM, path analysis. Introduction to GIS packages.	8
6	Application of Remote Sensing and GIS to Water Resources Land Use Land Cover mapping, determination of crop characteristics, ground water, pollutant mapping, rainfall measurement, weather monitoring, soil erosion, soil classification, and water shed prioritization, solid wastecollection, and water supply. GPS and KML: introduction to global positioning system and KML format.	8
<b>Total</b>		<b>40</b>

#### Recommended Text Books:

1. Agarwal C S and P K Garg (2000), “Textbook on Remote Sensing in Natural Resources Monitoring and Management”, Wheeler Publishing, Allahabad.
2. Meijerink M J, HAM de Brouwer, C M Mannaerts, C R Velenzuela, (1994), “Introduction to the Use of Geographical Information Systems for Practical Hydrology”, ITC publication no. 23, UNESCO, Paris

#### Recommended Reference Books:

1. Lillesand T M and R W Keifer (1994), “Remote Sensing and Image Interpretation”, John Wiley & Sons, N York
2. Swain P H and S M Davis (1987), “Remote Sensing–The Quantitative Approach”, McGraw Hill Pub. Co. N York



### 3MEN2-13: WATER QUALITY MODELLING

S. No.	Contents	Contact Hours
1	<b>INTRODUCTION: Objective</b> , scope and outcome of the course	1
2	Introduction: concepts of scale in natural systems, brief review of the fate processes in the environment, examples of natural systems, principles of model formulation, calibration, validation, error estimation and sensitivity analysis	7
3	Derivation of generalized mass balance equation for contaminants in incompressible fluid(water) in the non-inertial frame of reference	8
4	River Modelling: one dimensional advection-dispersion-reaction model, river properties and estimation of parameters, different forcing situations (point, non-point, aerial sources and sinks), sediment water interaction	8
5	Estuary Modelling: types and properties, flow characterization, advection-dispersion models, salt gradient box models; Lake Modelling: box models, generalized models, special considerations for large lakes, sediment mixing and interaction with water column	8
6	Wetlands: box models for flow, equilibrium and kinetic geochemical models for red-ox reactions, transport of heavy metals	8
	<b>Total</b>	<b>40</b>

**Recommended Text Books:**

1. 1. Surface Water Quality Modeling by Steven C. Chapra

**Recommended Reference Books:**

2. Water Quality Modeling for Rivers and Streams by Benedini, Marcello & Tsakiris, George
3. Water Quality Modelling for Rivers, Streams and Estuaries by Dr. R. Manivanan