MANIPAL UNIVERSITY JAIPUR
Department of Civil Engineering
M Tech (Environmental Engineering)
Batch – 2021-2022

Year	FIRST SEMESTER						SECOND SEMESTER					
	Sub. Code	**Subject Name**	**L**	**T**	**P**	**C**	**Sub. Code**	**Subject Name**	**L**	**T**	**P**	**C**
I	CV6102	Air Pollution Monitoring and Control	3	1	0	4	CV6201	Environmental Impact Assessment	4	0	0	4
	CV6103	Water Treatment and Sanitation Systems	3	1	0	4	CV6202	Wastewater Treatment Systems	3	1	0	4
	CV6107	Energy, Environment and Climate Change	3	1	0	4	CV6203	Solid and Hazardous Waste Management	3	1	0	4
	CV61XX	Program Elective – I	3	0	0	3	CV62XX	Program Elective – II	4	0	0	4
	MA6104	Statistics, Probability and Reliability	3	1	0	4	CV62XX	Program Elective – III	4	0	0	4
	DR6001	Research Methodology	3	0	0	3	------	Open Elective	3	0	0	3
	CV6130	Environmental Engineering Lab - I	0	0	2	1	CV6230	Environmental Engineering Lab - II	0	0	2	1
	CV6180	Minor Project	0	0	2	1	CV6235	Seminar	0	0	2	1
							CV6280	Minor Project	0	0	2	1
			18	4	4	**24**			21	2	6	**26**
	Total Contact Hours (L + T + P)		26				Total Contact Hours (L + T + P) + OE		29			
IV	**THIRD AND FOURTH SEMESTER**											
	CV7080	Dissertation							0	0	0	25
							Total Contact Hours (L + T + P) + OE		0			

Program Elective – I		**Open Elective**	
Sub. Code	**Subject Name**	**Sub. Code**	**Subject Name**
CV6140	Environmental Ecology	CV6280	Environmental Management
CV6141	Urban Environmental Quality Management		
CV6144	Environmental Chemistry and Microbiology		
Program Elective – II			
CV6240	Environmental Economics and Management		
CV6241	Advanced Wastewater Treatment		
CV6242	Environmental Hydrology		
Program Elective – III			
CV6243	Mathematical Modelling in Environmental Engineering		
CV6244	Remote Sensing and GIS Applications		
CV6245	Risk Assessment and Disaster Management		
CV6246	Industrial Waste Management and Disposal		

MANIPAL UNIVERSITY JAIPUR

Syllabus for M.Tech. Environmental Engineering

First Semester

CV6102: AIR POLLUTION MONITORING AND CONTROL [3 1 0 4]

Introduction: Definition of Air Pollution, Global effects of air pollution, Air Pollution Episode, Sources and types of air pollutants, Effect of air pollutants on human beings, plants, animals and economic aspects. Air pollution control acts, ambient air quality standards, sampling and measurement of particular and gaseous pollutants. Air Quality Index. Meteorology: Environmental factors, Elemental properties of the atmosphere, plume dispersion, modelling, maximum mixing depth, stack design. Controlling of Air Pollution and controlling equipments. Gaseous pollutants – absorption, adsorption devices, combustion and condensation devices. Noise Pollution and Control: Sources & Effects, Kinetics of noise, Measurements and control, Noise standards and case studies.

References:

1. Noel de Nevers, *Air Pollution Control Engineering*, McGraw Hill, Inc. New York, 1995.
2. S. P. Mahajan, *Pollution Control in Process industries*, TMH Publishing Co., New Delhi, 2000.
3. A. C. Stern, *Air Pollution*, Academic Press, Inc. New York, 1991.
4. Howard S. Peavy, Donald R. Rowe, George Tchobanoglous, *Environmental Engineering*, McGraw Hill, Singapore, 1986.

CV6103: WATER TREATMENT AND SANITATION SYSTEMS [3 1 0 4]

Water Quality: Definitions and Concepts, Water sources, characteristics and water quality standards, Estimation of water quantity. Water Treatment: Theory and design of Conventional Unit Operations used in Water Treatment, Advanced Water Treatment: Theory and Design of Advanced Unit Operations used in Water Treatment: Membrane processes, Ion Exchange, Aeration/stripping, Precipitation, Adsorption, Oxidation-reduction and advanced oxidation processes; Methods of Low Cost Water Treatment, Water supply concept during emergencies. Water Quality Index (WQI), Basics of distribution system design. Sanitation Systems: Introduction, City wide sanitation planning, Types of Compendium. Sanitation products, functional group, Single and double pit technologies, Anaerobic sanitation technologies, Emerging sanitation technologies, Collection and Conveyance: Container and sewer based sanitation systems.

References:

1. L. D. Benefield, J. F. Judkins, B. L. Weand, *Process Chemistry for Water and Wastewater Treatment*, End ed., Prentice-Hall, Inc. New Jersey, USA, 1982.
2. V.M. Ehlers, E.W. Steel, *Municipal and Rural Sanitation*. New York: McGraw Hill Book Company, 1927.
3. C. Sawyer, P, McCarty and G. Parkin, *Chemistry for Environmental Engineering and Science*, 5/e, McGraw Hill, New Delhi, 2003.
4. Howard S. Peavy, Donald R. Rowe, George Tchobanoglous, *Environmental Engineering*, McGraw Hill, Singapore, 1986.

CV6107: ENERGY, ENVIRONMENT AND CLIMATE CHANGE [3 1 0 4]

Overview on the Earth's energy requirement vis-à-vis Climate Change. Origins of the terrestrial atmosphere. Earth's early atmosphere. Introduction to Climate. Layers of atmosphere. Composition of atmosphere. Atmospheric chemistry, greenhouse gases and O_3 depletion problem. Energy Balance: Earth –Atmosphere System. Solar and Terrestrial Radiation. Solar variability and the Earth's Energy Balance. Atmospheric Chemistry and Climate Change. Atmospheric Aerosol and Cloud Effects on Climate. Environmental Variability: Natural and Anthropogenic. Effects of urbanization, Landscape changes, Desertification and Deforestation. International Forums: Safeguarding Future Climate. The role of International Bodies. Kyoto and Montreal Protocol. Intergovernmental Panel on Climate Change (IPCC 2007). The Stern Report. Carbon Credits. Indian Context. Alternative Energy Sources: Solar, Wind, Hydro Power and Nuclear Energy. Predicting Future Climate Change: Global Climate Models.

References:

1. J. Jaeger, *Climate and Energy Systems - A review of their interactions*, John Wiley, 1983.
2. R. Wolfson, *Energy, Environment and Climate*, W. W. Norton & Co., Inc., New York, 2008.
3. W. R. Cotton, R. A. Pielke, *Human Impacts on Weather and Climate*, Cambridge University Press, 2007.
4. R.B. Stull, *Introduction to Boundary Layer Meteorology*, Reidel Publishing Co., Dordrecht, 1988.

MA6104: STATISTICS, PROBABILITY AND RELIABILITY [3 1 0 4]

Basics of Statistics: Random Variables and its Properties. Applications of Mean, Median, Mode, Standard Deviation, Correlation Coefficient in Analyzing Quality Related Data, Preliminary Analysis of

Data by Graphical Representation, Measure of Central Tendency Dispersion, Peakedness in Context with Construction Industry and Quality Control Problems, Dependent Variables, Co-Relation, Co-Relation Coefficient and It's Significance; Basic Probability: Probability of Discrete and Continuous Variables, Probability Mass Function, Probability Density Function, Cumulative Density Function, Discrete and Continuous Standard Probability Distributors and their Properties, Central Limit Theorem, Equivalent Normal Distribution for Non-Normal Distributions, Utilization of Random Events, Measures of Probability Concepts for Quality Control Related Issues, Applications of Frequency Distribution and Probability, Probability Distributors, Continuous And Discrete Distributions in Analyzing Data Related to Process and Quality Control, Goodness of Fit Tests, Chi-Square Test, Kolmogorov-Smirnov Goodness of Fit Test and Two Sample Test, Monte-Carlo Simulation; Reliability Analysis: Concept of Reliability, Risk and Safety Factors. Safety Margin Function, Reliability Index, FOSM Method of Reliability Analysis, Application of FOSM to Linear and Non Linear Safety Margin Functions-Hasofer-Lynd Method.

References:

1. L.T. Blank, *Statistical Procedures for Engineering, Management, and Science*, Mc-Graw Hill Series in Industrial Engineering and Management Science, 1982.
2. A.H.S. Ang, W.H. Tang, *Probability Concepts in Engineering: Emphasis on Applications to Civil and Environmental Engineering*, John Wiley & Sons; 2nd edition (2006)
3. N.T. Kottegoda, Rosso Renzo, Statistics, Probability and Reliability Methods for Civil and Environmental Engineers, McGraw-Hill College (1997).
4. W. Mendenhall, D. D. Wackerly, R. L. Scheaffer, *Mathematical Statistics with Applications*, 7th Edition, Thomson Brooks/Cole, 2008.
5. K. M. Ramachandran, C. P. Tsokos, *Mathematical Statistics with Applications*, Academic Press, 2009.

DR6001: RESEARCH METHODOLOGY [2 0 0 2]

Meaning of research, type of research, Qualitative and quantitative research, defining research problem, review of literature, formulation of theory & hypothesis, data collection, data analysis: hypothesis testing, ANOVA, regression analysis, reporting research findings. Design of experiments, Full and fractional factorial experiments, randomized block design, latin square design, robust design, taguchi method.

References:

1. C. R. Kothari, *Research methodology: methods and techniques*, New Age International Publication Ltd, 2018.
2. J. W. Creswell, *Research Design*, Sage South Asia Edition, 2009
3. D.G. Montgomery, *Design and Analysis of Experiments*, John Willy India Edition, 2016

CV6130: ENVIRONMENTAL ENGINEERING LABORATORY- I [0 0 2 1]

Analysis of water/wastewater for physicochemical parameters: Total solids, total dissolved solids, and volatile solids, Turbidity, alkalinity, pH, hardness, chlorides, sulphates, ammonical nitrogen, nitrates, sulphate, oil and grease, available chlorine, dissolve oxygen, biochemical oxygen demand, chemical oxygen demand. Residual chlorine and chlorine demand, determination of available chlorine in Bleaching powder, Determination of Calcium, Potassium, Sodium and Lithium. Determination of heavy metals in aqueous solution – Chromium, Lead and Zinc. Coagulation and flocculation of water – optimization of dose / pH / time of flocculation. Characteristics of Industrial wastewater. Analysis of solid wastes: characterisation of wastes from different industries.

References:

1. Standard Methods for the Examination of Water and Waste Water - ALPHA - AWWA – WPCF.
2. C. Sawyer, P. McCarty, G. Parkin, *Chemistry for Environmental Engineering,* McGraw Hill, New York. 1994.
3. IS: 3025 - 1964 - *Methods of Sampling and Test (Physical and Chemical) for Water Used in Industry*, IIT New Delhi.
4. Drinking water Standards IS: 10500-1991.

CV6180: MINOR PROJECT [0 0 2 1]

Students will undertake a project in the domains pertaining to relevant specialization

PROGRAM ELECTIVES – I

CV6140: ENVIRONMENTAL ECOLOGY [4 0 0 4]

Concepts & Fundamentals of ecology, Natural ecosystems and their food chains, food webs, bioenergetics, biochemical cycles and ecological succession. Ecological engineering principles, Biological diversity and its importance, reduction in biological diversity, Ecosystem Responses: Ecosystems responses to de-oxygenation nutrient enrichment, pesticides, hydrocarbons, metal and salts, thermal pollution, suspended solids and silt. Community Ecology: Principles of population and

community ecology, concepts of systems and models, building and analysis of models, environmental systems, structures and interaction between coastal aeolian, glacial, fluvial, weathering, soil and detrital systems. Integration Ecological Principles: Integration of classical, agro and restoration ecological principles and methods, Biomonitoring and its role in the evaluation of aquatic ecosystem, rehabilitation of ecosystem, Introductory models of ecosystems.

References:

1. E. P. Odum, G.W. Barrett, *Fundamentals of Ecology*, Thomson, 2002.
2. I. D. White, D. N. Mottershead, S. J. Harrison, *Environmental Systems: An Introductory Text*, Chapman and Hall, London, 1992.
3. P. A. Colinvaux, *Introduction to Ecology*, John Wiley & Sons, New York, 1973.

CV6141: URBAN ENVIRONMENTAL QUALITY MANAGEMENT [4 0 0 4]

Urbanisation & Pollution: Consequences of urbanization, Sources of pollution to the urban environment: Status of pollution levels in major cities, Air & Noise Pollution in Urban Environment: Sources, nature and effect of air pollution on Urban Environment. Air pollution Indices, Sources of noise pollution, Status and effect of noise pollution in major cities. Water and Land pollution in Urban Environment: Water demands and pollution in urban areas, Sources of land pollution in urban areas: Impact of urban soil pollution on quality of living system. Management of Urban Environment Quality: Land use planning – traffic management. Safe municipal water supply and planning of safe municipal water supply and drainage system, solid waste management including disposal, abatement of noise pollution, regulation of settlements. Natural Conservation: Planning of urbanization on ecological basis, preservation and development of green recovery areas. Urban Disaster Management: Management of Industrial explosions, landslides, earthquakes, Floods and Management of epidemics.

References:

1. C. K. Varshney, *Water Pollution and Management*, Wiley Eastern Ltd., New Delhi, 1998.
2. S. Plowden, *The Cost of Noise*, London, Metra, 1996.
3. A.B. Gallion, S. Eisner, *The Urban Pattern: City Planning and Design*, Van Nostrand, 1963.
4. M. J. Suess, S. R. Craxford, *Manual on urban air quality management*, WHO, Copenhagen, 1976

CV6144: ENVIRONMENTAL CHEMISTRY AND MICROBIOLOGY [3 1 0 4]

Importance of Environmental Chemistry, Types of reactions, Redox reactions, Reaction kinetics, Electrochemistry and its applications. Physical and equilibrium chemistry: fundamentals and applications. Trace Contaminants and their analyses, Buffers and Buffer index, Colloidal Chemistry: Properties of colloids, colloidal dispersions, stability of colloids and applications. Colourimetry: Principles and applications. Applications of Analytical Chemistry: emission and absorption techniques. Microbiology: Microorganisms in air, water and soil environment. Principle and applications of microscopy, microscopic flora and fauna, Metabolism and metabolic pathways, Bio-concentration, Bio-magnification and Bio-accumulation. Bacteria: Morphology, typical growth curve and generation time. Measurement Techniques: APC, MPN (Probability and Thomas methods), Enzymes classification, kinetics - Michaelis-Menten equation, factors influencing enzyme reaction.

References:

1. R. E. McKinney, *Microbiology for Sanitary Engineers*, New York McGraw Hill, 1962.
2. C. Sawyer, P, McCarty and G. Parkin, *Chemistry for Environmental Engineering and Science*, 5/e, McGraw Hill, New Delhi, 2003.
3. M. J. Pelczar, ECS Chan, N. R. Krieg, *Textbook of Microbiology,* 5e, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 1998.
4. A. F. Gaudy, *Microbiology for Environmental Scientists and Engineers*, McGraw Hill, 1980.

Second Semester

CV6201: ENVIRONMENTAL IMPACT ASSESSMENT [4 0 0 4]

Concepts of EIA: Effect of human activity on environment, concept of eco-system imbalances, definition of EIA, EIS, EMP, industrial policy of the Govt. of India. Prediction and assessment of impacts on air, water, biota, noise, cultural and socio-economic environment, Air quality indices, air quality impact of industry transport systems, human settlements. Methods of assessment, litigation of impact. Water quality impact: Water quality criteria, standards and indices, Impacts on water quality of development projects. Biota: Impact on fauna and flora, mitigation measures, alternatives. Noise: Effects of noise on people, noise scales and rating methods. Estimating transportation noise impacts. Cultural and socio economic impacts: Effect of developmental projects on cultural and social settings and economic profile of the community. Energy impact: EIA of hydro, thermal and nuclear power plants. Methodologies for EIA: Preliminary assessment, quantification, comparison of alternatives and comprehensive EIAs

References:

1. L. W. Canter, *Environmental Impact Assessment*, (2e), McGraw-Hill, 1997.
2. Y. Anjaneyulu, V. Manickam, *Environmental Impact Assessment Methodologies*, CRC Press, 2011.
3. J. Petts, G. Eduljee, *Environmental Impact Assessment for Waste Treatment and Disposal Facilities*, John Wiley & Sons, 1994.
4. G. Burke, B. R. Singh, L. Theodore*, Handbook of Environmental Management and Technology*, (2e), John Wiley & Sons, 2004.

CV6202: WASTEWATER TREATMENT SYSTEMS [3 1 0 4]

Introduction: Objectives of treatment, wastewater characteristics, flow variations and hydraulic profile, types of reactors, CSTR and PFR reactors analysis. Wastewater Treatment: Types and basics working principles of treatment unit, Theoretical principles and design: Suspended growth and attached growth system, Designing and related kinetics of various wastewater treatment unit, Sludge Processing: Separation - sludge thickeners, volume reduction, conditioning and digestion – aerobic and anaerobic. Advanced Wastewater Treatment: Need and technologies used. Nitrification and Denitrification Processes, Phosphorous removal. Wastewater disinfection. Treatment and Disposal of wastewater: Compact, simple and low cost wastewater treatment units in rural areas; Effluent disposal. Integrated water resource management & health, Concept of Total sanitation, Sanitation under emergencies.

References:

1. A. R. N. Sankar, *Environmental Management*, Oxford University Press, New Delhi, 2015.
2. M. M. Sulphey, *Introduction to Environmental Management*, PHI Learning, New Delhi, 2013.
3. C. C. Lee, S.D. Lin, *Handbook of Environmental Engineering Calculations*, McGraw Hill, New York, 1999.
4. C. Sawyer, P, McCarty and G. Parkin, *Chemistry for Environmental Engineering and Science*, 5/e, McGraw Hill, New Delhi, 2003.

CV6203: SOLID AND HAZARDOUS WASTE MANAGEMENT [3 1 0 4]

Municipal Solid Waste Management: Legal and Organizational foundation: Definition, sources and types of solid waste, major legislation, monitoring responsibilities, sampling and characterization, storage and handling of solid waste. Collection and transport of solid waste: types of collection systems, analysis of collection system. Transport means and methods, transfer station types and design requirements. Process of Solid Waste and Energy recovery, Geo-environmental investigations, engineered sites, leachate control and treatment, gas recovery and control, including utilization of recovered gas (energy), and landfill monitoring and reclamation, Integrated waste management facilities. Economics of the on-site v/s off-site waste management options. Natural attenuation process and its mechanisms. Household Hazardous Waste Management: Definition and identification of hazardous wastes-sources and characteristics, Design practices. Hazardous waste regulations, handling, storage, collection and transport of hazardous waste..

References:

1. G. Tchobanoglous, F. Kreith, *Handbook of Solid Waste Management*, McGraw-Hill Education, 2002.
2. A. Bagchi, *Design, Construction, and Monitoring of Landfills*, Wiley Interscience, 1994.
3. G. Tchobanoglous,H. Theisen, S.A. Vigil, *Integrated Solid Waste Management: Engineering Principles and Management Issues*, McGraw- Hill Publication, 1993.
4. C. A. Wentz, *Hazardous Waste Management*, McGraw-Hill Publication, 1995.

CV6230: ENVIRONMENTAL ENGINEERING LABORATORY-II [0 0 2 1]

Determination of phenol compounds and total/ kjeldhal nitrogen in wastewater, Determination of total phosphate, sulphate of the given sample, Settling-column analysis, Microscopic examination of micro-organisms, Plate count test, MPN count-total and faecal, Sampling and analysis of inorganic and organic substances. Ambient air quality monitoring: Determination of PM10, PM2.5, SO_x, NO_x, CO. Demonstration of stack monitoring. Measurement of noise pollution. Use of analytical instrument such as AAS, Gas Chromatography, LC for gas and micro-pollutant analysis

References:

1. Standard Methods for the Examination of Water and Waste Water - ALPHA - AWWA – WPCF.
2. C. Sawyer, P. McCarty, G. Parkin, *Chemistry for Environmental Engineering,* McGraw Hill, New York. 1994.
3. IS: 3025, *Methods of Sampling and Test (Physical and Chemical) for Water Used in Industry*, IIT New Delhi, 1964.

CV6235: SEMINAR [0 0 2 1]

Students will present a seminar on topic related to relevant specialization.

CV6280: MINOR PROJECT [0 0 2 1]

Students will undertake a project in the domains pertaining to relevant specialization.

PROGRAM ELECTIVES – II

CV6240: ENVIRONMENTAL ECONOMICS AND MANAGEMENT [4 0 0 4]

Sustainable Development: Introduction to sustainable development, Economy-Environment inter-linkages, Environmental Kuznets curve, Economics of energy, scarcity, optimal resources, backstop technology. Economic significance, causes and analysis of environmental degradation, Concepts of policy failure, Equi-marginal principle. Economics of Pollution, regulation, monitoring and enforcement, managing pollution using existing markets: Bargaining solutions, Cost-benefit analysis, Concept of Total Economic Value, Alternative approaches. Economics of biodiversity, Policy responses at national and international levels. Economics of Climate Change.

References:

1. D. W. Pearce, A. Markandya, E. B. Barbier, *Blueprint for a Green Economy*, Earthscan, London, 1989.
2. D. W. Pearce, R. K. Turner, I. Bateman, *Environmental Economics: An Elementary Introduction*, Harvester Wheatsheaft, London, 1994.
3. D.W. Pearce, R. K. Turner, *Economics of Natural Resources and the Environment*, Harvester Wheatsheaf, London, 1990.
4. Michael S. Common, Michael Stuart, *Environmental and Resource Economics: An Introduction*, 2nd Edition, Harlow: Longman, 1996.

CV6241: ADVANCED WASTEWATER TREATMENT [4 0 0 4]

Importance of Advanced Wastewater Treatment, Basis of process selection and development of treatment flow sheets. Biological nutrient removal process, conventional biological nitrification/ denitrification processes and its process fundamentals. Sequencing Batch Reactor (SBR) and Simultaneous Nitrification – Denitrification (SND) processes. Membrane Bio-Reactor for removal of organic pollutants and suspended solids, Other new treatment technologies Physical and chemical treatment methods, Removal of phosphorus by chemical addition. Refractory Organics and Dissolved Inorganic Substances Removal: Advanced Oxidation Processes (AOP)/ Adsorption / Chemical precipitation / Ion Exchange / Membrane Processes. Wastewater Reclamation/Reuse/Disposal: Direct and indirect reuse of wastewater- Municipal reuse/industrial reuse/agricultural reuse/ recreational reuse/ground water recharge. Criteria and disposal of effluent in to lakes, rivers and ocean.

References:

1. A. R. N. Sankar, *Environmental Management*, Oxford University Press, New Delhi, 2015.
2. M. M. Sulphey, *Introduction to Environmental Management*, PHI Learning, New Delhi, 2013.
3. C. C. Lee, S.D. Lin, *Handbook of Environmental Engineering Calculations*, McGraw Hill, New York, 1999.
4. C. Sawyer, P, McCarty and G. Parkin, *Chemistry for Environmental Engineering and Science*, 5/e, McGraw Hill, New Delhi, 2003.

CV6242: ENVIRONMENTAL HYDROLOGY [4 0 0 4]

Concepts of Hydrology: definition, scope and role of environmental hydrology. Types of data, sources, River hydrology, catchment, waterways, water-shed, Surface water characteristics, Ground water occurrence, types of aquifers, Environmental Influences, fluctuation due to evapotranspiration, meteorological effect of tides, recharge. Ground Water Pollution: Quality analysis, sources of pollution monitoring quality, sea water intrusion, and preventive measures. Ground Water Modelling: contamination modelling, flow modelling, transport modelling, Accuracy of models, Application of Numerical methods, Modelling of subsurface transport of microorganisms, Hydrological Consequences: Eco-hydrological consequences of Environmental degradation water conservation, planning and impact process, mitigation of impact processes.

References:

1. P. V. Singh, *Environmental Hydrology*, Kluver Academic Publishers, London, 1997.
2. D. K. Todd, *Ground water Hydrology*, John Willy Sons, New York, 2004.
3. H. Nash, G. J. H. McCall, *Ground water Quality*, Chapman & Hall Publishers, London, 1995.
4. H. M. Raghunath, *Ground water*, Willy and Eastern publication, New York, 1987.
5. Ray K. Linsley, Joseph B. Franzini, *Water Resource Engineering*, Mc Graw Publications, New York, 1987.

PROGRAM ELECTIVES – III

CV6243: MATHEMATICAL MODELLING IN ENVIRONMENTAL ENGINEERING [4 0 0 4]

Basics and Necessity of Modelling, Earth's atmosphere, Lapse Rate Quantification, stability states, Quantification of wind circulation and geo-strophic winds. Material Mass-Energy flows balances, Air Pollution Modelling, Boundary Layer: mixing length and eddy diffusion, Gaussian Plume Model. Plume Rise estimation. Simple noise quality models: Models for Roadway Noise, Modelling the mass transport of Sulphur Dioxide into falling rain drops. Reaction Pathways. Mass and Charge Balance. Normalization of the Convective Diffusion Equation. Modelling the Homogeneous and Heterogeneous Pathways for Ozone depletion. Global Warming and Climate Change Modelling: Solar and Terrestrial Radiation. Quantifying the Green House Effect. A model for estimating the Equilibrium temperature of the Earth. Aerosol and cloud processes. The Basic tenets of Global Circulation Models for Weather Forecasting, Water Quality Modelling, Solid waste modelling, Modelling the methane potential of discards.

References:

1. J. Smith, P. Smith, *Introduction to Environmental Modelling*, OUP, 2009.
2. G. M., Master, *Introduction to Environmental Engineering and Science*' Prentice-Hall of India, New Delhi, 3rd Edition, 2007.
3. H.S. Peavy, D.R. Rowe, G. Tchobanoglous, *Environmental Engineering*, McGraw-Hill Book Company, New York. 1985.
4. R.B. Stull, *Introduction to Boundary Layer Meteorology*, Reidel Publishing Co., Dordrecht, 1988.

CV6244: REMOTE SENSING AND GIS APPLICTIONS [4 0 0 4]

Basics of Remote Sensing: Introduction to remote sensing, Electromagnetic radiation, Characteristic of real remote sensing systems, Satellite - Indian remote sensing satellite Sensors and Retrievals. Image interpretation & Processing: Elements and concept of image interpretation, Basics of GIS: Introduction to GIS, History of development of GIS, Elements of GIS, Computer hardware and software, GIS Analysis: Map overlay, Vector and raster data model, Mapping concept, Data storage and database management, Development of map overlay, Overlay operation, Applications of GIS and remote sensing in Energy & Environmental Engineering.

References:

1. A. N. Patel, S. Singh, *Remote Sensing Principles and Applications*, Scientific Publisher, Jodpur, 1999.
2. P. A. Burrough, *Principle of Geographical Information Systems for Land Resources Assessment*, Clarendon Press, Oxford, 2000.
3. T. M. Lilles, R. W. Kiefer, *Remote Sensing and Image Interpretation*, John Wiley & Sons, New York, 1999.
4. K.C. Clarke, B.O. Parks, M.P. Crane, *Geographic Information Systems and Environmental Modeling*, Prentice-Hall of India, 2005.

CV6245: RISK MANAGEMENT AND DISASTER MANAGEMENT [4 0 0 4]

Risk Assessment: Methodologies and Guidelines: Principles, Code of practice, Emergency plans, Occupational Health and Safety, Risk analysis survey and health evaluation, behavioural studies, epidemiological approach, Risk assessment techniques, Risk Assessment and Disaster Response, Quantification Techniques, NGO Management, SWOT Analysis based on Design & Formulation Strategies, Insurance & Risk Management. Disaster Management: Introduction & Dimensions of Natural & Anthropogenic Disasters, Principles/Components of Disaster Management, Role of Union/States, Armed Forces/Other Agencies in Disasters, Role of Financial Institutions in Mitigation Effort, Concept of Team Building, Motivation Theories and Applications, School Awareness and Safety Programs, Psychological and Social Dimensions in Disasters, Trauma and Stress, Emotional Intelligence, Electronic Warning Systems. Use of Information systems, Experiences and case studies.

References:

1. V. K. Rao, *Environmental Strategics Hand book*, Mc-graw Hill Inc., New York, 1994.
2. W. B. Neely, G. E. Blan, *Environmental Exposure from chemicals*, Volume II, CHC Press Inc., Florida, 1989.
3. W. E. Woodsen, *Human factors design handbook – information and guidelines for design to systems, facilities, equipment and product for human use*, Mc Graw Hill, New York, 1981.

CV6246: INDUSTRIAL WASTE MANAGEMENT AND DISPOSAL [4 0 0 4]

Introduction: Industrial scenario in India, Sources, types and disposal of Industrial wastewater, Regulatory requirements, generation rates, characterization and variables, Individual and Common Effluent Treatment Plant, Cleaner production: Waste management approach, Waste audit, Material and process modifications, Zero discharge processes- case studies. Treatment and Disposal of industrial effluents, Treatment and disposal of solid wastes: Sources and quantities of solid waste from industrial processes, Waste classification, Residuals of industrial wastewater treatment, Case studies.

References:

1. W. W. Eckenfelder, *Industrial Water Pollution Control*, Mc-Graw Hill, 1999.
2. L. N. Nelson, *Liquid waste of Industry, Theories, Practice and Treatment,* Addison-Wesley Publishing Company, London, 2000.

3. World Bank Group, *Pollution Prevention and Abatement Handbook – Towards Cleaner Production*, World Bank and UNEP, Washington D.C., 1998.
4. R. L Stephenson, J. B. Blackburn, *Industrial Wastewater Systems Handbook*, Lewis Publishers, New York, 1998.

OPEN ELECTIVE

CV6280: Environmental Management [3 0 0 3]

Environmental Economics: Introduction, Economic Tools for Evaluation, Cleaner Development Mechanisms (CDM) and their Applications; Environmental Laws and Policies: Water Act, Air Act, Environment Protection Acts, Solid Waste Management Rules, Hazardous and Biomedical Waste Rules; Environmental Audit: Methods, Procedure, Reporting and Case Studies; Environmental Management System and Techniques: Environmental Safety and ISO 14000 Standards, ISO 14001 Standards, Environmental Management Systems, (EMS) Total Quality Management (TQM) and Total Safety Management (TSM), ISO 9000 and ISO 18000 Standards.

References:

1. A. R. N. Sankar, *Environmental Management*, Oxford University Press, New Delhi, 2015.
2. M. M. Sulphey, *Introduction to Environmental Management*, PHI Learning, New Delhi, 2013.
3. MOEF, Government of India, "*Carrying Capacity Based Developmental Planning Studies for the National Capital Region"*, 1995-96.
4. *Environmental Laws* - MOEF, Government of India.

Third and Fourth Semester

CV7080: DISSERATION [0 0 0 25]

Students will undertake a project in the domains pertaining to relevant specialization.