**Scheme and Syllabi**

**for**

# Post Graduate Program (M. Tech.)

# in

# ENVIRONMENTAL ENGINEERING

**August 2021**

**Department of Civil Engineering**

**Malaviya National Institute of Technology Jaipur**
**JLN Marg, Jaipur**

**Department of Civil Engineering**

## Teaching Scheme for M.Tech. (Environmental Engg.) Full Time
## Academic curriculum

| S. No. | Subject Code | Course Title | Subject Type | Credits | Contact Hours/Week | | |
|---|---|---|---|---|---|---|---|
| | | | | | L | T | P |
| **Semester I** | | | | | | | |
| 1 | 21CET521 | Air and Noise Pollution | Program Core | 3 | 3 | 0 | 0 |
| 2 | 21CET522 | Biological Processes and Environmental Applications | Program Core | 3 | 3 | 0 | 0 |
| 3 | 21CEP523 | Environmental Laboratory | Program Core | 1 | 0 | 0 | 2 |
| 4 | 21CET524 | Physicochemical Principles and Processes | Program Core | 3 | 3 | 0 | 0 |
| 5 | | Program Elective I | Program Elective | 3 | 3 | 0 | 0 |
| 6 | | Program Elective II | Program Elective | 2 | 2 | 0 | 0 |
| 7 | | Program Elective III/ Open Elective I | Program/Institute Elective | 3 | 3/2 | 0/0 | 0/2 |
| **Total Semester Credits** | | | | **18** | | | |
| **Semester II** | | | | | | | |
| 1 | 21CET525 | Environmental Impact Assessment | Program Core | 3 | 3 | 0 | 0 |
| 2 | 21CET526 | Environmental Statistics and Modeling | Program Core | 3 | 3 | 0 | 0 |
| 3 | 21CEP527 | Simulation Laboratory | Program Core | 1 | 0 | 0 | 2 |
| 4 | 21CET528 | Solid and Hazardous Waste Management | Program Core | 3 | 3 | 0 | 0 |
| 5 | 21CETXXX | Program Elective III/IV | Program Elective | 3 | 3 | 0 | 0 |
| 6 | 21CETXXX | Program Elective IV/V | Program Elective | 2 | 2 | 0 | 0 |
| 7 | 21CETXXX | Open Elective I/ Open Elective II | Institute Elective | 3 | 3/2 | 0/0 | 0/2 |
| **Total Semester Credits** | | | | **18** | | | |
| **Semester III** | | | | | | | |
| 1 | 21CED621 | Dissertation | Program Core | 6 | | | |
| 2 | 21CES622 | Seminar/ Minor Research Project | Program Core | 6 | | | |
| **Total Semester Credits** | | | | **12** | | | |
| **Semester IV** | | | | | | | |
| 1 | 21CED623 | Dissertation | Program Core | 12 | | | |
| **Total Semester Credits** | | | | **12** | | | |
| **Total Program Credits** | | | | **60** | | | |

## List of Program Elective Courses

| S. No. | Course Code | Course Title | Credits | Contact Hours/Week | | |
|---|---|---|---|---|---|---|
| | | | | L | T | P |
| 1 | 21CET809 | Advanced Water and Wastewater Treatment | 2 | 2 | 0 | 0 |
| 2 | 21CET810 | Building and Environment | 3 | 3 | 0 | 0 |
| 3 | 21CET811 | Design of Water and Wastewater Systems | 2 | 2 | 0 | 0 |
| 4 | 21CET812 | Environment and Health | 3 | 3 | 0 | 0 |
| 5 | 21CET813 | Environmental Systems Modeling | 2 | 2 | 0 | 0 |
| 6 | 21CET814 | Industrial Pollution Prevention and Treatment | 2 | 2 | 0 | 0 |
| 7 | 21CET815 | Landfill Engineering | 2 | 2 | 0 | 0 |
| 8 | 21CET816 | Life cycle and Circularity Concepts for Engineers | 3 | 2 | 0 | 2 |
| 9 | 21CET817 | Management in WATSAN Sector | 3 | 3 | 0 | 0 |
| 10 | 21CET818 | Operation Research Methods & Project Economics | 3 | 3 | 0 | 0 |

## VISION AND MISSION OF THE INSTITUTE

### Vision Statement:

To create a centre for imparting technical education of international standards and conduct research at the cutting edge of technology to meet the current and future challenges of technological development.

### Mission Statement:

To create technical manpower for meeting the current and future demands of industry: To recognize education and research in close interaction with industry with emphasis on the development of leadership qualities in the young men and women entering the portals of the Institute with sensitivity to social development and eye for opportunities for growth in the international perspective.

## VISION AND MISSION OF THE DEPARTMENT

### Vision of the Department:

To serve the nation by providing high quality engineering education that enables students to get a profession that can improve the civil infrastructure and social welfare.

### Mission of the Department:

To create an environment conducive for excellent teaching, learning and research in order to produce leading entrepreneurs and innovators in the field of civil engineering for sustainable development.

# Programme Educational Objectives (PEOs) for PG Programme

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| **PEO1** | To empower the students to get employment commensurate Surat interprofessional skills and/or take self-driven initiative in the form of start-up entrepreneurship or to pursue higher education and research in environmental engineering discipline in particular and allied disciplines in general. |
| **PEO2** | To provide a student solid foundation and consolidation knowledge in mathematical, scientific, and engineering fundamentals required to formulate, analyse, and solve environmental engineering related issues. Also, to equip them with experimental expertise to analyse deal life environmental system and develop protocols to create database for the design and installation of new systems. |
| **PEO3** | To prepare the students for acquiring adequate knowledge of environmental laws, regulatory policies, standards, measurement and control methods, and protocols etc. related to the professional practices in India in order to utilise their skills to facilitate environmental compliance of activities related to different engineering projects and to ensure sustainable development of the country. |
| **PEO4** | To inculcate ethical favour among students and to establish understanding of professionalism, safety, and sustainability aspects in performing their duties towards serving the society. |
| **PEO5** | To provide students with encouraging academic environment can make them aware of imbibing excellence and enable them to understand the significance of lifelong learning in competitive global scenarios. |

## Program Outcomes (POs)

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| **PO1** | An ability to in an ability to carry out research investigation and development work to solve practical problems |
| **PO2** | An ability to write and present sustainable technical report document |
| **PO3** | Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program the master should be a level higher than the requirement India appropriate bachelor |
| **PO4** | An ability to design system associated with environmental engineering for sustainable development |
| **PO5** | An ability to apply modern engineering tools in environmental engineering for simulation and data analysis |

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| **UG/PG :** PG | **Department:** Civil Engineering |
| **Course Code: 21CET524** | **Course Name:** Physicochemical Principles and Processes |
| **Credit: 3** | **L-T-P:** 3-0-0 |

**Course Outcome (COs)**

CO1: Gain knowledge related to the fundamental science involved in processes related to water and wastewater treatment

CO2: To be able to select the suitable source of water supply after analysis of water quality and other parameter

CO3: To be able to select the suitable water treatment to be given and design of component of a water treatment plant

CO4: To be able to trouble shoot the operational problems of treatment units based on physico-chemical processes

**Syllabus**

**Water Quality**: Physical, chemical and biological parameters of water, Water quality requirement, Potable water standards, In-stream standards, Wastewater effluent standards

**Water Chemistry:** Chemical reactions and thermodynamic equilibrium, Acid base equilibrium, Alkalinity and buffering in water systems, Solubility equilibrium, Oxidation Reduction equilibrium,

**Aeration and gas transfer**: Gas transfer processes, Rates of gas transfer, Aeration and gas transfer systems, Factors affecting aeration and oxygen transfer rates, Diffusion, Dispersion

**Sedimentation:** Types of settling, Non-ideality in settling

**Coagulation and flocculation**: Coagulation processes, Stability of colloids, Destabilization of colloids, Destabilization in water and wastewater treatment, Transport of colloidal particles

**Filtration**: Filtration processes, Hydraulics of flow through porous media, Rate control patterns and methods

**Disinfection**: Disinfection processes, Non-chemical and chemical methods for disinfection

**Books:**


1. Chemical Processes for Water Quality Control: Walter J. Weber Jr.
2. Water Chemistry for Environmental Engineering and Science: Sawyer, McCarty &Parkin
3. Physico Works Engineering: Planning Design and Operation : Qasim, Motley and Zhu
4. CPHEEO Manual on Water Supply and Treatment
5. Environmental Engineering : Howard Peavy, D Rowe, H S Peavy
6. Chemistry for Water Treatment: Faust, S.D. and Aly, O.M.
7. Standard Methods for Examination of Water and Wastwater: APHA

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|---|---|
| **UG/PG :** PG | **Department:** Civil Engineering |
| **Course Code: 21CET522** | **Course Name:** Biological Processes and Environmental applications |
| **Credit: 3** | **L-T-P:** 3-0-0 |

**Course Outcome (COs)**

CO1: Students understood basic concepts of wastewater generation, collection system, wastewater quality and standards.

CO2: To knowledge regarding wastewater reuse and its challenges.

CO3: To learn about various methods of wastewater treatment.

**Syllabus**

Waste water: Sources, nature and characteristics; Analysis of waste water: Determination of BOD, COD, Nitrogenous species, Phosphates, Solids and volatile solids and their significance; Basics of microbiology and biological oxidation: cells and their classification, reproduction, metabolism and growth kinetics; BOD progression and its formulations; Fundamentals of Process Kinetics: Zero order, First order, Second order Reactions, Enzyme reactions, reactor Analysis, completely mixed batch reactor, continuous flow stirred tank reactor, plug flow reactor, arbitrary flow reactor; Activated Sludge and its process modifications: Process design considerations, evaluation of bio-kinetic parameters, Aeration, Fundamentals of gas transfer, design of aeration systems; Aerated lagoons; Natural engineered systems like oxidation ponds and constructed wetlands; Attached Growth Biological Treatment Systems, Trickling Filters, Rotating Biological Contactors; Centralized versus decentralized systems: SBR, MBR, MBBR and other Micro STPs; Anaerobic processes: Process fundamentals, standard, high rate and hybrid reactors, anaerobic filters, expanded /fluidized bed reactors, Up-flow anaerobic sludge blanket reactors, performance and design aspects, Expanded granular bed reactors, Two stage/phase anaerobic reactors. Sludge Digestion; Introduction to sewage disinfection, biological nutrient removal; Recycle and reuse of treated sewage.

**Books:**


1. Wastewater Engineering: Treatment and Reuse by Metcalf & Eddy Inc, Fourth edition, 2003, McGraw Hill.
2. Manual of Sewage treatment by CPHEEO, Ministry of Urban Dev., GOI
3. Introduction to Environmental Engineering by Mackenzie Davis and David Cornwell, 5th Edition, 2013, McGraw Hill.
4. Wastewater treatment for pollution control and reuse by Soli J. Arceivala abd Shyam R. Asolekar, Third edition, McGraw Hill, 2007.
5. Microbiology by Michael J. Pelczar Jr., E.C.S. Chan and Noel R. Krieg, McGraw Hill, 1985.
6. Biological Process Design for Wastewater Treatment, by Clifford W. Randall and Larry W. Benefield, Prentice Hall, 1980.

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| **UG/PG :** PG | **Department:** Civil Engineering |
| **Course Code: 21CET521** | **Course Name:** Air and Noise Pollution |
| **Credit: 3** | **L-T-P:** 3-0-0 |

**Course Outcome (COs)**

CO1: Ability to understand the various sources of air pollution and their classification.

CO2: Knowledge about Emission inventories & Emission factor.

CO3: Ability to understand about Economic Effects of air pollution.

CO4: Ability to understand Control technology for particulate and gaseous pollutants.

**Syllabus**

Definition and scope, Problems and issues, Classification and properties of air pollutants, Measurement of air pollutants, Ambient air quality standards, Air quality indices, Effect of air pollution on environment, Case study of Indian cities;

Meteorological parameters and their effects on urban air pollution, Wind rose, Atmospheric stability, Role of meteorology in dispersion of air pollutants, Gaussian plume model, Air pollution disasters;

Global impacts of air pollution, Global warming and climate change, Ozone layer depletion, Acid rain, Urban heat island, Photochemical smog;

Air pollution due to automobiles and emission control;

Control technologies for particulate and gaseous pollutants;

Noise pollution, Definition, Sources, Effects, Measurement of Noise, Noise level monitoring techniques, Noise mapping, Standards, Introduction to Noise monitoring software; Introduction to indoor air pollution;

Application of GIS techniques;

**Books:**


1. Air Pollution: Its Origin & Control: Wark, Warner & Davis, Harper and Roq, New York
2. Air Pollution Control Engineering: Noel de Nevers, Mc-graw Hill International
3. Noise Pollution and Control: S P. Singhal
4. Air Pollution and Control: KVSG Murali Krishna
5. Air Pollution Engineering Manual: T.D. Wayne, John Wiley & sons

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| **UG/PG :** PG | **Department:** Civil Engineering |
| **Course Code: 21CEP652** | **Course Name:** Environmental and Simulation Laboratory |
| **Credit: 1** | **L-T-P:** 0-0-2 |

**Course Outcome (COs)**

CO1: To understand the difference important water quality parameter their relevance to human health and in treatment processes and their permissible limits as per the standards.

CO2: To be able to analyse physical chemical and biological water quality parameter in laboratory

CO3: To design experiment

CO4: To learn to maintain safety standards in the laboratory

CO5: Develop understanding and application of different numerical methods which can be used for the solution of non-linear problems

CO6: Develop understanding and application of different probability and statistical aspect used in different engineering problems.

CO7: Develop understanding of application of methods, statistical concepts and linear algebra for solving different engineering problems.

**Syllabus**

Air quality: Air for SPM, RSPM, $NO_2$& $SO_2$ using High volume sampler, CO, $NO_x$, $SO_2$ using continuous analyzers;
Water quality: Principles of measurement and testing of water for parameters like pH, TDS, alkalinity, $NO_3$, $PO_4$-P, Hardness, Turbidity, residual chlorine, breakpoint chlorination, DO, Chlorides, Jar test for coagulant dosing;
Wastewater quality: COD, BOD, TOC, SS, VSS, heavy metals using AAS; Color Measurement and its removal using $O_3$;
Microbiology: Microscopy; Staining and detection of microbes; Methods of enumerating microbes; Multiple tube fermentation technique; Membrane filter technique;
Design of water distribution system; Analysis of Hardy Cross Method; Introduction to EPANET software
Design of storm water drainage system using StormCAD
Design of sewerage system using SewerCAD
Introduction to AERMOD modeling system

**Books:**


1. Standard Method for the examination of water & wastewater (APHA,AWWA,WEF)
2. APHA (1995): Standard methods for the examination of water and wastewater. 17th edition APHA, Washington DC.
3. Ramp, H.H., and Krist, H., Laboratory Manual for the Examination of Water, Wastewater and Soil, VCH Publishers, Weinheim, 1988.
4. Willard, H.H., Merritt, L.L. Jr., Dean, J.A., and Settle, F.A., Jr., Instrumental Methods of Analysis, 6th Edition, C.B.S. Publishers, New Delhi, 1986.
5. https://www.epa.gov/water-research/epanet
6. https://www.bentley.com/en/products/product-line/hydraulics-and-hydrologysoftware/stormcad
7. https://www.bentley.com/en/products/product-line/hydraulics-and-hydrologysoftware/sewercad
8. https://www.epa.gov/scram/air-quality-dispersion-modeling-preferred-andrecommended-models#aermod

| UG/PG : PG | Department: Civil Engineering |
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| Course Code: 21CET528 | Course Name: Solid and Hazardous Waste Management |
| Credit: 3 | L-T-P: 3-0-0 |

**Course Outcome (COs)**

CO1: Knowledge about characteristics of solid waste and problems associated with solid waste disposal.

CO2: Knowledge about various methods of solid waste treatment

CO3: Knowledge about storage and processing.

CO4: Knowledge about biomedical waste

CO5: Knowledge about electronic waste and its management

**Syllabus**

Problems associated with indiscriminate disposal of solid waste, Sources, composition and properties of municipal solid waste; Engineering principles;

Hierarchy of solid waste management, Source reduction, segregation, collection, recycling and disposal of MSW; Transfer and transport, Odour control, Waste processing, Recovery of resources,

Waste processing technologies, Biological, chemical and thermal technologies;

Composting, Properties of compost, Mechanical composting, Anaerobic digestion, Incineration and pyrolysis;

Planning, siting, design, closure and post-closure monitoring of sanitary landfills,
Regional/Integrated solid waste management related issues.

Municipal Solid Waste rules 2016;

Introduction to e-waste, C&D waste, Sanitary waste, Biomedical waste; Introduction to Hazardous waste

Concept of zero waste homes/town/cities;

Internet of things applications in SWM; Case studies of zero waste;

Definition and properties of hazardous waste, Environmental legislations, Risks associated with hazardous waste, Priorities in hazardous waste management, Hazardous waste treatment, Basel convention;

**Books:**


1. Integrated Solid Waste Management: Tchobanoglous, Theisen and Vigil
2. Hazardous Waste Management: Wentz
3. CPHEEO manual on Municipal Solid Waste Management 2016
4. Not in my Backyard: Solid waste management in Indian cities, Centre for Science and Environment 2016

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| **UG/PG :** PG | **Department:** Civil Engineering |
| **Course Code: 21CET525** | **Course Name:** Environmental Impact Assessment |
| **Credit: 3** | **L-T-P:** 3-0-0 |

**Course Outcome (COs)**

CO1: Ability to understand the concept of sustainable development

CO2: Ability to understand the concept of waste utilization in construction materials

CO3: Ability to understand the introduction to sustainable building design

**Syllabus**

**Introduction to EIA:** Defining EIA, EIA & its evolution, EIA principles, EIA process, Benefits of EIA, Integrating EIA into the planning process, Stakeholders in EIA, Delays in EIA

**Pre activity analysis:** Screening, concept of, requirement of, objectives of, Stakeholders, Scoping, The Process; long list, short list, study list. Terms of Reference, Content of, stakeholders.

**Preliminary Investigations:** Description and Need of the Project, Pertinent Institutional Information, Identification of potential impacts, Description of Affected Environment,

**Impacts:** Definition, characterization of. Impact prediction, Methods of. Uncertainty analysis; Scientific Uncertainty, Data Uncertainty, Policy Uncertainty. Impact assessment; Key elements to establish Impact Significance, Criteria for assessment of Impact Significance, Impact Mitigation; Objectives of, hierarchy for mitigation identification, EIA monitoring and documentation of Environmental impact studies

**Environmental legislation:** EIA process in India, EIA Notification and relevant legal provisions, Effluent standards.

**EIA Methods:** Definition of, Desirable attributes, Ad hoc methods, Checklists, Matrices; simple and stepped, Networks

Environmental indices, definition, type of, utility. Environmental Indicator; concept, development of.

**Books:**


1. Environmental Impact Assessment, Larry Canter, McGraw Hill Series in Water Resources and Environmental Engineering.
2. Introduction to Environmental Impact Assessment, John Glasson, RikiTherivel, Andrew Chadwi. Published by Routledge.
3. Environmental Impact Assessment: A Practical Guide: Betty Bowers Marriott

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| **UG/PG :** PG | **Department:** Civil Engineering |
| **Course Code: 21CET526** | **Course Name:** Environmental Statistics and Modeling |
| **Credit: 3** | **L-T-P:** 3-0-0 |

**Course Outcome (COs)**

CO1: To develop a deeper understanding for probability & statistics concepts.

CO2: To get acquainted with various data analysis techniques.

CO3: To get insights of different mathematical models in the field of environmental engineering.

CO4: To apply various concepts of statistics & data analysis in the field of environmental engineering to help prepare students for their research career in both academic & industrial fields.

**Syllabus**

**Statistics and Probability:** Probability theor, Baye's theorem, Binomial, Poisson and normal distributions, Correlation and regression, Coefficient of correlation, Rank correlation, Lines of regression, Student T-test, Chi-square test and their applications in environmental engineering

**Statistics and Probability:** Probability theory; Bayes'theorem; Binomial, Poisson, Uniform and Normal distributions; Hypothesis testing for equality of mean and standard deviation: t-test, chisquare test and F-test; Confidence intervals; Errors in hypothesis testing; Applications of statistics for environmental engineering

**Fundamentals of Data Analysis:** Regression &correlation analysis; Pearson correlation coefficient; Autocorrelation in data; Linear versus non-linear regression models; Coefficient of determination; Inherent limitations; Outliers and robustness; Basics of simulations; Random number generation; Calibration and sensitivity analysis of data

**Environmental Modeling& its Applications:** Introduction to mass balance-based models; Applications of air pollution models; Indoor air quality modeling; Applications of water pollution models; The Streeter-Phelps equation

**Introduction to SPSS software**

**Books:**


1. Berthouex, P.M. and Brown, L.C., Statistics for Environmental Engineers, Lewis Publishers, CRC Press, Boca Raton, 1994.
2. Mendenhall, W. and Beaver, R.J., Introduction to Probability and Statistics, 8th Ed., PWS-Kent Publishing Co, Boston, 1991.
3. Ott, W.R. Environmental Statistics and Data Analysis, Lewis Publishers, New Jersey, 1995.
4. Seinfeld, J.H., and Pandis, S.N., Atmospheric Chemistry and Physics, John Wiley and Sons, Inc., New York, 1998.
5. Schnoor J.L., Environmental Modelling, Inter Sc. Publ., 1996.
6. Boubel, R.W., Fox, D. L., Turner, D. B., and. Stern, A.C., Fundamentals of Air Pollution, Academic Press, New York, 1994.

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| **UG/PG :** PG | **Department:** Civil Engineering |
| **Course Code: 21CET810** | **Course Name:** Building and Environment |
| **Credit: 3** | **L-T-P:** 3-0-0 |

**Course Outcome (COs)**

CO1: Ability to understand the concept of sustainable development

CO2: Ability to understand the concept of waste utilization in construction materials

CO3: Ability to understand the introduction to sustainable building design

**Syllabus**

Sustainable building, concept of. Building rating system, Building rating agencies in India,

Site Efficiency, Site selection, Site analysis, Statutory Requirements, Inappropriate sites, sustainable site planning, impervious surface management, reasons and methods of. Heat island effect, control strategies. Storm water management; grades and slopes, natural drainage.

Water Efficiency: The Concept, Water Efficiency: Options; Management option; dual plumbing, water budgeting, decentralized sewage treatment. Technology options, Water Efficiency: Opportunities; in buildings, in landscape, in HVAC process, in construction.

Material Efficiency, Issues and Concern vis-à-vis building material, Selection Criteria for new building materials, Material Resource Efficiency.

Energy Efficiency, Overview of energy efficiency (EE) in buildings and its benefits, Approach to EE in Buildings, Different opportunities and measures for improving EE of Buildings. Key aspects of suitable design for Energy Efficient Buildings, building form, Orientation, and Building envelope for energy efficient building design,

Environmental Quality, Environmental Risks due to construction & Demolition activities, Issues to be addressed/ Mitigation option: During Operation (to be finalized at Planning Stage), During Construction/ Demolition activities

**Books:**


1. Energy Efficient Buildings: Architecture, Engineering, and Environment: D. Hawkes and W. Forster
2. Sustainable Buildings: Design Manual, Vol I and II, TERI Press
3. Manual on norms and standards for environment clearance of large construction projects, Ministry of Environment & Forest, Govt. of India.

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| **UG/PG :** PG | **Department:** Civil Engineering |
| **Course Code: 21CET817** | **Course Name:** Management in WATSAN sector |
| **Credit: 3** | **L-T-P:** 3-0-0 |

**Course Outcome (COs)**

CO1: To understanding the planning of water supply system

CO2: To understanding the basics of water supply and planning management

CO3: To understand various financial ratio regarding water supply

**Syllabus**

Introduction: Overview of Indian WATSAN sector and its problems, Risks, Engineers vs. Managers, Global water policy dialogues, Health aspects of WATSAN Sector,

Institutional perspective: Institution, Indicators for Typical Water Supply Institutions, tools/techniques for appraisal of Water supply Institutions with case study, Institutional development in water sector with case study, Change Management

Financial Perspective: overview of finances in water sector, Financial Management in water sector, Capital Budgeting, techniques for budgeting Financial accounting, ratios, Tariff,
Marketing

Sustainability of water supply sector: water supply reforms for sustainability, water conservation, waste water treatment, water management in high water table areas, Applications of GIS and Remote sensing for water sector

**Books:**


1. Agarwal M.D. and Agarwal N.P. , Financial Management
2. Chandra prasanna , Projects, Planning, Analysis, Financing, Implementation
3. CPHEEO, Manual on Water Supply and treatment
4. Saleth R. Marla,Dinar(1999) Evaluating water Institutions and water sector performance
5. DFID : Guidance Manual on Water & Sanitation Programme
6. Thomas and Callan: Environmental Economics

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| **UG/PG :** PG | **Department:** Civil Engineering |
| **Course Code: 21CET818** | **Course Name:** Operation Research Methods & Project Economics |
| **Credit: 3** | **L-T-P:** 3-0-0 |

**Course Outcome (COs)**

CO1: Converting a physical problem to mathematical model

CO2: Applying linear problem to get optimal solution of mathematical model

CO3: Understanding non linearity in optimization and solving

CO4: Applying transportation and assignment problem to get the optimal solution of mathematical model

**Syllabus**

Linear Programming, Problem Formulation, Graphical Method, Simplex Tableau, Big M and Two Phase Method, Transportation Problem, Assignment Problem, Introduction to Non Linear Programming, Algorithm for Shortest routes etc., Interest and Equivalence, Cash Flow Diagrams, Single Payment Compound Amount Factor, Single Payment Present Worth Factor, Uniform Series Sinking Fund Factor, Uniform Series Compound Amount Factor, Uniform Series Capital Recovery Factor, Uniform Series Present Worth Factor, Present Worth Analysis, Annual Cash Flow Analysis, Rate of Return Analysis, CPM & PERT Analysis.

**Books:**


1. Engineering Optimization: S. S. Rao
2. Operation Research: Wagner
3. Operation Research: Hillier & Lieberman
4. Engineering Economics: James L. Riggs, David D. Bedworth, Sabah U. Randhawa
5. Engineering Economic Analysis: Donald G. Newnan, Ted G. Eschenbach, Jerome P. Lavelle

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| **UG/PG :** PG | **Department:** Civil Engineering |
| **Course Code: 21CET811** | **Course Name:** Design of Water and Wastewater Systems |
| **Credit: 2** | **L-T-P:** 2-0-0 |

**Course Outcome (COs)**

CO1: To learn the method of design of sewerage system and components

CO2: To design water in waste treatment facilities

CO3: To analyse design deep water supply distribution system and networks

CO4: To plan and design strong drainage system

CO5: To simulate the urban watershed behaviour using different modelling tools

CO6: To understand and analyse the urban hydrological cycle in its component

**Syllabus**

Water supply: estimation of water quantity, design of water distribution networks
Design of conventional unit operations used in water treatment: sedimentation, flotation, coagulation, flocculation, filtration, and disinfection processes
Design of advanced unit operations used in water treatment: membrane processes, ion-exchange, aeration/stripping, precipitation, adsorption, oxidation-reduction and advanced oxidation processes
Water treatment plant design: selection of raw water source, planning of water treatment plant, hydraulics of water treatment plant, chemical requirement and residuals management
Wastewater collection systems: estimation of wastewater quantity, wastewater collection, design of sewers and sewerage systems
Wastewater treatment:
*Primary treatment*: bar-rack, screens, grit chamber, equalization tank, primary sedimentation
*Secondary treatment*: aerobic processes, anaerobic processes
*Tertiary treatment*: nutrient removal
Wastewater Treatment Plant Design: planning of wastewater treatment plant, hydraulics of wastewater treatment plant, chemical requirements and residual management
Wastewater disposal: disposal to inland waters such as lakes, reservoirs, rivers and streams, disposal to sea, disposal on land

**Books:**


1. Water Works Engineering: Planning Design and Operation by Qasim, Motley and Zhu
2. CPHEEO Manual on Water Supply and Treatment
3. Wastewater Engineering: Treatment and Reuse: Metcalf &. Eddy
4. Waste water Treatment Plant: Design and Operation: Qasim
5. Wastewater Treatment for Pollution Control: Arceiwala

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| **UG/PG :** PG | **Department:** Civil Engineering |
| **Course Code: 21CET812** | **Course Name:** Environment and Health |
| **Credit: 3** | **L-T-P:** 3-0-0 |

**Course Outcome (COs)**

CO1 - Students understand basic concepts of a mathematical approach to bring out cause-effect relationships between environmental contamination and human health that gas become highly relevant in NGT initiated proceedings.

CO2 -To gain knowledge about environmental (water, air, noise) pollution and its effect on human health.

CO3 -Implementation of mathematical approach by Case studies for causal relations between air quality and health. such studies are important for environmental risk assessment and estimating compensations for violations.

**Syllabus**

Mathematical approach to bring out cause-effect relationships between environmental contamination and human health: design of field studies, data requirements and collection, data manipulation to bring out meaningful inferences for establishing linkages through significance testing and regression analysis. Management of environmental quality to reduce impact on health.

Contamination of drinking water and its effect on human health. Biological contamination of water and the emerging issues. Issues of chemical quality of drinking water in Rajasthan and their impact on human health through case studies. Emerging issues of water quality and health and the national approach for their management in urban and rural environs. Water supply and sanitation under emergencies. Ambient air quality and its effect on human health, different air pollutants and their impact on respiratory system and other parts of human body, Air quality standards and indices. Indoor air quality and its effect on human health, Sources of indoor air pollution, WHO guideline values for indoor air quality. Case studies for casal relations between air quality and health. Noise pollution and its impact on human health, Standards and indices for ambient and occupational noise. Solid waste disposal and its effects on human health.

**Books:**


1. Environment, Health and Sustainable Development: Megan Landon
2. Man and Environment: Health Perspective: Anne Nadakavukaren
3. Water quality and its control, James C. Lamb, John Wiley.
4. Preventive and social Medicine, K. Park Banarsidas Bhanot Pub,
5. Guidelines for drinking water quality, Vol I,II and III, WHO- CBS publication.

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| **UG/PG :** PG | **Department:** Civil Engineering |
| **Course Code: 21CET814** | **Course Name:** Industrial Pollution Prevention and Treatment |
| **Credit: 2** | **L-T-P:** 2-0-0 |

**Course Outcome (COs)**

CO1: Ability to understand source and characteristics; effects of discharges of industrial waste on recieving bodies of water;

CO2: Ability to understand the specific industrial processes

CO3: Ability to understand the methods of treatment of industrial wastewater

CO4: Ability to understand the potential for industrial wastewater recycle & reuse in Industries

**Syllabus**

Nature and characteristics of industrial wastes; Principles and techniques for industrial pollution prevention and waste minimization; Prevention versus control of industrial pollution; Source reduction tools and techniques: raw material substitution, toxic use reduction and elimination, process modification and procedural changes; Recycling and reuse.

Problems of industrial wastewater in India; Effects of discharges of industrial waste on receiving bodies of water, land and sewer; Effluent and stream standards; Environmental legislation and standards related to industrial waste; Industrial treatment Processes; Concept of common effluent treatment plants.

Waste audits, emission inventories and waste management hierarchy for process industries;Emission sources; Estimation of fugitive emissions; Environmental impact of VOCs; Energy and resource (material and water) audits for efficient usage and conservation.

Case studies on pollution prevention applications from textile (cotton and synthetic), tannery, pulp and paper, dairy, metal plating (chromium and cyanide problem), slaughterhouse, distillery, dyeing and printing, fertilizer, copper & cement, coal-based thermal power plants and other industries.

Comprehensive Environmental Pollution Index (CEPI)

**Books:**


1. Industrial Water Pollution Control, W. Wesley Eckenfelder
2. Industrial Wastewater Treatment: Nemarow
3. Bishop, P.E., Pollution Prevention : Fundamentals And Practice, McGraw Hill, 2000.
4. Freeman, H. M., Industrial Pollution Prevention Handbook, McGraw Hill, 1995.
5. Allen, D.T., and Rosselot, K.S., Pollution Prevention for Chemical Processes, John Wiley, 1997.

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| **UG/PG :** PG | **Department:** Civil Engineering |
| **Course Code: 21CET815** | **Course Name:** Landfill Engineering |
| **Credit:2** | **L-T-P:** 2-0-0 |

**Syllabus**

Concepts of Integrated SWM & Geoenvironmental Engineering.

Soil- Water- Environment Interaction, Soil- contaminant Interaction, Contaminant transport and Fate of contaminants.

Landfills: MSW and hazardous waste landfills, Planning, Generation and Control of Leachate and Gas from Landfills, Landfill covers and liners,

Control, Remediation and Rehabilitation of sites; Rehabilitation of old waste dumps; Waste reutilization.

Methods for Soil and groundwater Remediation: In-situ and ex-situ remediation techniques.

**Books:**


1. Sharma, H. D., & Reddy, K. R. (2004). Geoenvironmental engineering: site remediation, waste containment, and emerging waste management technologies. John Wiley & Sons.
2. CPHEEO. (2016). Manual on Solid Waste Management.
3. Environmental Engineering : Howard Peavy, D Rowe, H S Peavy

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| **UG/PG :** PG | **Department:** Civil Engineering |
| **Course Code: 21CET809** | **Course Name:** Advanced Treatment Processes for Water and Wastewater |
| **Credit:2** | **L-T-P:** 2-0-0 |

**Syllabus**

**Separation processes:** Adsorption and ion exchange. Introduction to adsorption on mineral surfaces and isotherm models and rates considerations, Sorption on organic matrices, Surface complexation and reactions, Sorption in engineered systems for water and wastewater treatment

**Advance Oxidation Processes**: Fundamentals and applications for targeting recalcitrant and emerging pollutants, Fenton and Photo- Fenton reactions, catalysis,

**Membrane processes**: Reverse Osmosis, Nanofiltration, Ultrafiltration, Process design and operation, Municipal and industrial applications, Fouling and pretreatment,

**Fundamentals of Electro dialysis**

**Books:**


1. Hillis, P., Membrane technology in water and wastewater treatment edited by Royal Society of Chemistry, Cambridge, 2000.
2. Weber, W. J. Jr., Environmental Systems and Processes: Principles, Modeling and Design, John Wiley and Sons Inc., New York, 2001
3. Weber, W. J. Jr., Physicochemical Processes for Water Quality Control, John Wiley and Sons Inc., New York, 1972

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| **UG/PG :** PG | **Department:** Civil Engineering |
| **Course Code: 21CET816** | **Course Name:** Life Cycle and Circularity Concepts For Engineers |
| **Credit: 2** | **L-T-P:** 2-0-0 |

**COs**

**Syllabus**

Sustainable development goals, Introduction to ISO 14040 series and its applications, Sustainability concept and life cycle thinking, Life cycle assessment, Cradle-to-grave analysis of new products, LCA application in engineering, sustainability indicators, low carbon products, Sustainability assessment methods for products and technology, concept of sustainable products, Eco labeling

Circularity and Resource efficiency concepts, Circular economy, waste to resource/wealth concept with case studies, Eco-friendly startups/entrepreneurship concept, circular designs, circularity assessment methods for product and technology, Eco friendly product, case studies from Civil and Environmental Engineering

1. Life Cycle Assessment Lab - 1
2. Life Cycle Assessment Lab - 2
3. Life Cycle Assessment Lab - 3
4. Waste to resource lab - 1
5. Waste to resource lab - 2
6. Eco-friendly product lab - 1
7. Eco-friendly product lab - 2
8. Circular Design Lab - 1
9. Circular Design Lab - 2
10. Sustainability assessment lab
11. Circularity assessment lab
12. Green product/Entrepreneurship case lab

**Books:**


1. Environmental Life-cycle Assessment: Book by M. A. Curran
2. Life Cycle Assessment in the Built Environment: Book by Robert Crawford
3. Life Cycle Assessment (LCA): A Guide to Best Practice Book by Walter Klöpffer
4. Designing for the Circular Economy: Book by Martin Charter
5. Waste to Wealth: The Circular Economy Advantage: Book by Jakob Rutqvist and Peter Lacy
6. Sustainable Entrepreneurship and Investments in the Green Economy: Book by Andrei Jean-Vasile, Domenico Nicolò
7. Green Engineering: Innovation, Entrepreneurship and Design: Book by Riadh Habash

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| **UG/PG :** PG | **Department:** Civil Engineering |
| **Course Code: 21CET814** | **Course Name:** Industrial Pollution Prevention and Treatment |
| **Credit: 2** | **L-T-P:** 2-0-0 |

**COs**

CO1: Ability to understand source and characteristics; effects of discharges of industrial waste on recieving bodies of water;

CO2: Ability to understand the specific industrial processes

CO3: Ability to understand the methods of treatment of industrial wastewater

CO4: Ability to understand the potential for industrial wastewater recycle & reuse in Industries

**Syllabus**

Nature and characteristics of industrial wastes; Principles and techniques for industrial pollution prevention and waste minimization; Prevention versus control of industrial pollution; Source reduction tools and techniques: raw material substitution, toxic use reduction and elimination, process modification and procedural changes; Recycling and reuse.

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| **UG/PG :** PG | **Department:** Civil Engineering |
| **Course Code: 21CET813** | **Course Name:** Environmental Systems Modeling |
| **Credit: 2** | **L-T-P:** 2-0-0 |

**Syllabus**

Definition; Classification; Examples of models for environmental systems.

Introduction to air quality models; Mass balance models; Indoor air pollution models for rural and urban homes, especially for kitchens; Applications of CFD software for indoor air quality modeling; Human health risk assessment models; Urban diffusion models; Global radiation balance and climatic changes; Calibration and sensitivity analysis.

Transport and fate of pollutant in aquatic systems; Introduction to river, estuarine and lake hydrodynamics; Stratification and eutrophication of lakes; Dissolved oxygen model for streams; Temperature models.

Computational methods in environmental modelling; Basics of Monte Carlo simulations; Uncertainty analysis and Python programming.

**Books:**


1. Seinfeld, J.H., and Pandis, S.N., Atmospheric Chemistry and Physics, John Wiley and Sons, Inc., New York, 1998.
2. Schnoor J.L., Environmental Modelling, Inter Sc. Publ., 1996.
3. Boubel, R.W., Fox, D. L., Turner, D. B., and. Stern, A.C., Fundamentals of Air Pollution, Academic Press, New York, 1994.
4. Thomann, R.V., and Muller, J.A., Principles of Surface Water Quality Modelling and Control, Harper International Edition, N.D., 1987.
5. Tchobanoglous, G., Schroeder, E.D., Water Quality, Addison – Wesley Publishing Company, Reading, Massachusetts, 1987.
6. https://www.epa.gov/risk/human-health-risk-assessment
7. https://docs.python.org/3/tutorial/
8. https://www.ansys.com/products/fluids/ansys-fluent
9. https://en.m.wikipedia.org/wiki/Monte_Carlo_method