1. PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

Graduates of the Programme M. E Environmental Engineering will

PEO1 Gain knowledge and skills in environmental engineering which will enable them to have a career and professional accomplishment in the public or private sector organisations.

PEO2 Become consultants on complex real life Environmental Engineering problems related to water supply, sewerage, sewage treatment, solid waste management, air pollution control, environmental impact assessment, industrial pollution control.

PEO3 Become entrepreneurs and develop processes and technologies to meet desired environmental protection needs of society and formulate solutions that are technically sound, economically feasible, and socially acceptable.

PEO4 Perform investigation for solving environmental problems by conducting research using modern equipment and software tools.

PEO5 Function in multi-disciplinary teams and advocate policies, systems, processes and equipment for control and remediation of pollution.

2. PROGRAMME OUTCOMES (POs)

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<tr>
<td>1</td>
<td>Research Aptitude</td>
<td>An ability to independently carry out research/investigation and development work to solve practical problems</td>
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<td>Technical documentation</td>
<td>An ability to write and present a substantial technical report/document</td>
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<td>Technical competence</td>
<td>Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program</td>
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3. PROGRAMME SPECIFIC OUTCOMES (PSOs)

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PEO/PO Mapping:

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(3-High, 2- Medium, 1- Low)
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### Semester I

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* Audit Course is optional

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# LIST OF PROFESSIONAL ELECTIVE COURSES [PEC]

## SEMESTER II, ELECTIVE I

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## SEMESTER II, ELECTIVE III

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## RESEARCH METHODOLOGY AND IPR COURSES (RMC)

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TOTAL CREDITS: 20

## AUDIT COURSES (AC)

Registration for any of these courses is optional to students

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## SUMMARY

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TOTAL CREDIT: 72
OBJECTIVES:

- This course is designed to provide the solid foundation on topics in various statistical methods which form the basis for many other areas in the mathematical sciences including statistics, modern optimization methods and risk modeling. It is framed to address the issues and the principles of estimation theory, testing of hypothesis, correlation and regression, design of experiments and multivariate analysis.

UNIT I  ESTIMATION THEORY  12

UNIT II  TESTING OF HYPOTHESIS  12
Sampling distributions - Small and large samples - Tests based on Normal, t, Chi square, and F distributions for testing of means, variance and proportions – Analysis of r x c tables – Goodness of fit.

UNIT III  CORRELATION AND REGRESSION  12
Multiple and partial correlation – Method of least squares – Plane of regression – Properties of residuals – Coefficient of multiple correlation – Coefficient of partial correlation – Multiple correlation with total and partial correlations – Regression and partial correlations in terms of lower order co-efficient.

UNIT IV  DESIGN OF EXPERIMENTS  12
Analysis of variance – One way and two way classifications – Completely randomized design – Randomized block design – Latin square design - $2^2$ Factorial design.

UNIT V  MULTIVARIATE ANALYSIS  12
Random vectors and matrices – Mean vectors and covariance matrices – Multivariate normal density and its properties – Principal components: Population principal components – Principal components from standardized variables.

OUTCOMES:
After completing this course, students should demonstrate competency in the following topics:

- Consistency, efficiency and unbiasedness of estimators, method of maximum likelihood estimation and Central Limit Theorem.
- Use statistical tests in testing hypotheses on data.
- Concept of linear regression, correlation, and its applications.
- List the guidelines for designing experiments and recognize the key historical figures in Design of Experiments.
- Perform exploratory analysis of multivariate data, such as multivariate normal density, calculating descriptive statistics, testing for multivariate normality.

The students should have the ability to use the appropriate and relevant, fundamental and applied mathematical and statistical knowledge, methodologies and modern computational tools.

REFERENCES:


EV4101 ENVIRONMENTAL CHEMISTRY

OBJECTIVES:
- To educate the students in the area of water, air and soil chemistry
- To explain the theoretical basis and observational methods for study of contaminants and interactions in the environment

UNIT I FUNDAMENTALS
Stoichiometry and mass balance - Chemical equilibria, acid base, solubility product (Ksp), heavy metal precipitation, amphoteric hydroxides, CO₂ solubility in water and species distribution – Ocean acidification, Chemical kinetics, First order - 12 Principles of green chemistry.

UNIT II AQUATIC CHEMISTRY
Water and wastewater quality parameters - environmental significance and determination; Fate of chemicals in aquatic environment, volatilization, partitioning, hydrolysis, photochemical transformation – Degradation of synthetic chemicals - Metals, complex formation, oxidation and reduction, pH diagrams, redox zones – sorption - Colloids, electrical properties, double layer theory, environmental significance of colloids, coagulation.

UNIT III ATMOSPHERIC CHEMISTRY

UNIT IV SOIL CHEMISTRY
Nature and composition of soil - Clays- cation exchange capacity-acid base and ion-exchange reactions in soil – agricultural chemicals in soil-reclamation of contaminated land; salt by leaching-Heavy metals by electrokinetic remediation.

UNIT V EMERGING POLLUTANTS
Heavy metals-chemical speciation – Speciation of Hg & As- endocrine disturbing chemicals-Pesticides, Dioxins & Furan, PCBs, PAHs and Fluro compounds toxicity- Nano materials, CNT, titania, composites, environmental applications.

TOTAL: 45 PERIODS

OUTCOMES:
CO1: Students will gain competency in solving environmental issues of chemicals based pollution
CO2: Ability to determine chemicals mobility in aquatic systems
CO3: Ability to identify contaminating chemicals in air and their fate
CO4: Understand the type of soil contaminants and provide remediation
CO5: Identify emerging environmental contaminants including speciation

REFERENCES:
OBJECTIVES:

- To provide a basic understanding on microbiology relevant to environmental engineering for candidates.
- To gain knowledge on morphology, behaviour and biochemistry of bacteria, fungi, protozoa, viruses, and algae.
- To understand the microbiology of wastewater, sewage sludge and solid waste treatment processes. And to understand the aspects of nutrient removal and the transmission of disease causing organisms.
- To have an exposure to toxicology due to industrial products and byproducts.

UNIT I FUNDAMENTALS OF MICROBIOLOGY
Classification of microorganisms – prokaryotic, eukaryotic, cell structure, characteristics, importance, introduction to water, soil and air borne pathogens and Parasites and their effects on human, animal and plant health, transmission of pathogens, transmissible diseases – bacterial, viral, protozoan, and helminths parasites, concentration and detection of virus. Control of microorganisms preservation of microorganisms, DNA, RNA, replication, recombinant DNA technology, their potential applications and intellectual property rights.

UNIT II MICROBIAL DIVERSITY AND NUTRIENT TURNOVER

UNIT III METABOLISM OF MICROORGANISMS
Nutrition and metabolism in microorganisms, growth phases, carbohydrate, protein, lipid metabolism – respiration, aerobic and anaerobic-fermentation, glycolysis, Kreb’s cycle, hexose monophosphate pathway, electron transport system, oxidative phosphorylation, environmental factors, enzymes, bioenergetics, disruption in metabolism and disease. biodegradation of organic pollutants

UNIT IV MICROBIOLOGY OF WASTEWATER TREATMENT SYSTEMS
Microbiology of biological treatment processes – aerobic and anaerobic, α-oxidation, β-oxidation, nitrification and denitrification, eutrophication. nutrients removal – BOD, nitrogen, phosphate. microbiology of sewage sludge - indicator organisms of water – coliforms - total coliforms, E-coli, streptococcus, clostridium, Bioleaching

UNIT V TOXICOLOGY
Ecotoxicology – toxicants and toxicity, factors influencing toxicity. Effects – acute, chronic, test organisms – toxicity testing-lab and field testing methods, bioconcentration – Bioaccumulation, biomagnification, bioassay, biomonitoring.

TOTAL: 45 PERIODS
OUTCOMES:

- On completion of the course, the student is expected to be able to

  CO1 Explain the basic importance and functional elements of environmental microbiology including the potential applications in the environment and intellectual property rights.

  CO2 Understand and describe the type of microorganisms in the environment, their importance in water supplies and the role of microorganisms in the cycling of nutrients in an ecosystem.

  CO3 Understand the metabolic processes on carbohydrates, protein and lipids, importance of enzymes, production of energy and the various additional metabolic processes.

  CO4 Select and apply appropriate methods for assessing the water, air and soil borne pathogens, their health implications, and importance of microbes in aerobic and anaerobic cycles and deterioration of water bodies.

  CO5 Conduct testing and research on toxicology, understand the importance of test organisms, environmental applications such as biomagnifications, biomonitoring and in developing risk based standards.

REFERENCES:


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EV4103 PHYSICAL AND CHEMICAL TREATMENT SYSTEMS FOR WATER AND WASTEWATER

OBJECTIVE:

- To understand about the various pollutants present in water and wastewater and to choose the respective physico-chemical systems for effective treatment
- To apply the knowledge for municipal, industrial water and wastewater treatment plants and design suitable treatment schemes
- To gain advance knowledge on the emerging environmental issues on treatment systems and conduct research to identify most appropriate treatment schemes

UNIT I INTRODUCTION

Pollutants in water and wastewater—characteristics, standards for performance- significance of physico-chemical treatment—Selection criteria-types of reactor-reactor selection-batch-continuous type-kinetics
UNIT II  TREATMENT PRINCIPLES

UNIT III  DESIGN OF MUNICIPAL WATER TREATMENT PLANTS

UNIT IV  DESIGN OF INDUSTRIAL WATER TREATMENT PLANTS

UNIT V  DESIGN OF WASTEWATER TREATMENT PLANTS

OUTCOME:
• On Completion of the course, the student is expected to be able to

CO1 Explain the significance of various pollutants present in water, wastewater and develop the kinetics for reactor design
CO2 Choose the relevant physico-chemical systems for effective water and wastewater treatment
CO3 Design the treatment scheme for municipal and industrial water, wastewater to meet the specific needs on residue management and up gradation of existing plants
CO4 Identify environmental issues in the society on wastewater treatment and formulate technical solutions that are economically feasible and socially acceptable
CO5 Conduct research to identify and design most appropriate treatment schemes for the emerging environmental issues on treatment systems in collaboration with municipalities, corporation, pollution control boards and industries

REFERENCES:
EV4104 WATER TRANSMISSION, WATER DISTRIBUTION AND SEWERAGE SYSTEMS

OBJECTIVE:
- To educate the students on economic design of water mains, distribution system and sewer networks

UNIT I GENERAL HYDRAULICS
Fluid properties; fluid flow – continuity principle, energy principle and momentum principle; frictional head loss in free and pressure flow, minor head losses, carrying capacity – flow measurement. need for transport of water and wastewater and types

UNIT II WATER TRANSMISSION MAINS
Planning of water system – design of storage reservoirs - water transmission main design - compound gravity and pumping main; selection of pumps and characteristics curve - economics; specials, jointing, laying and maintenance, water hammer analysis;

UNIT III WATER DISTRIBUTION
Service reservoirs-types and design. water distribution pipe networks design, analysis and optimization – appurtenances – corrosion prevention – minimization of water losses – leak detection. plumbing for water supply in high rise buildings. use of computer software in water transmission, water distribution design – EPANET 2.0, LOOP version 4.0, BRANCH,

UNIT IV WASTEWATER COLLECTION AND CONVEYANCE
Planning factors – design of sanitary sewer; partial flow in sewers, economics of sewer design; wastewater pumps and pumping stations- sewer appurtenances; material, construction, inspection and maintenance of sewers; design of sewer outfalls-mixing conditions; conveyance of corrosive wastewaters. plumbing for drains in high rise buildings

UNIT V STORM WATER DRAINAGE
Necessity- combined and separate system; estimation of storm water runoff - formulation of rainfall intensity duration and frequency relationships- rational methods. use of computer software in sewer design–sewer. SewerCAD, SewerGEMS

TOTAL: 45 PERIODS

OUTCOMES:
- On Completion of the Course the student will be able to

CO1 Understand general hydraulics and need for proper collection and conveyance of water and wastewater
CO2 Design economic diameters of gravity and pumping mains and storage reservoirs
CO3 Design and analysis of water distribution networks and apply computer softwares
CO4 Design sewer networks for various flow conditions
CO5 Design storm water drain and apply computer softwares for design of sewers.
REFERENCES:

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RM4151 RESEARCH METHODOLOGY AND IPR

UNIT I RESEARCH DESIGN 6
Overview of research process and design, Use of Secondary and exploratory data to answer the research question, Qualitative research, Observation studies, Experiments and Surveys.

UNIT II DATA COLLECTION AND SOURCES 6
Measurements, Measurement Scales, Questionnaires and Instruments, Sampling and methods. Data - Preparing, Exploring, examining and displaying.

UNIT III DATA ANALYSIS AND REPORTING 6
Overview of Multivariate analysis, Hypotheses testing and Measures of Association. Presenting Insights and findings using written reports and oral presentation.

UNIT IV INTELLECTUAL PROPERTY RIGHTS 6

UNIT V PATENTS 6

REFERENCES

TOTAL : 30 PERIODS
OBJECTIVES:
- To train the students in the analysis of physico-chemical parameters with hands on experience.

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<td>1.</td>
<td>Good Laboratory Practices, Quality control, calibration of Glassware</td>
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<td>2.</td>
<td>Sampling and Analysis of water (pH, alkalinity, hardness, chloride, Sulphate, turbidity EC, TDS,TS, nitrate, fluoride and iron)</td>
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<td>3.</td>
<td>Sampling and Wastewater analysis (BOD, COD, Phosphate, Ammonia, TKN, Oil &amp; Grease, Surfactant and heavy metals)</td>
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<td>4.</td>
<td>Sampling and characterization of soil (Moisture, EC, pH, Na and K)</td>
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TOTAL: 60 PERIODS

OUTCOME:
CO1: Ability to calibrate and standardize the equipments
CO2: Ability to collect proper sample for analysis
CO3: The candidate ability to perform field oriented testing of water, wastewater and soil
CO4: Able to perform soil testing
CO5: Able to perform analysis of water and wastewater

REFERENCES:

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EV4112 ENVIRONMENTAL MICROBIOLOGY LABORATORY

OBJECTIVE:
- To train the students in the analysis of various microbiological techniques, microbiological analysis, enzyme assay, pollutant analysis and operation of bioreactors.

EXPERIMENTS:
1. Preparation of culture media,
2. Isolation and culturing of microorganisms
3. Microscopical identification of Microorganisms (algae, bacteria and fungi)
4. Measurement of growth of microorganisms,
5. Analysis of air borne microorganisms,
7. Effect of pH, temperature on microbial growth
8. Bacteriological analysis of wastewater (Coliforms, *E.coli*, *Streptococcus*) – MPN
9. Bacteriological analysis of wastewater (Coliforms, *Streptococcus*) - MF techniques,
10. Effect of Heavy metals on microbial growth.
11. Detection of Anaerobic bacteria (*Clostridium* sp.)
12. Bioreactors (cultivation of microorganisms)

TOTAL: 60 PERIODS

OUTCOMES:

- On completion of the course, the student is expected to be able to
  
  **CO1** Explain the basic importance and functional elements of environmental microbiology including the types of microorganisms in air, water and soil.
  
  **CO2** Understand and describe the type of microorganisms in the environment, their importance and the method of culturing of microorganisms in the laboratory.
  
  **CO3** Understand the basic biochemical method of identification of microorganisms and to identify them using microscopical tool.
  
  **CO4** Select and apply appropriate methods for detection in the water, air and soil borne pathogens, their health implications, importance of microbes in our daily life.
  
  **CO5** Conduct testing and research on toxicology, the importance of test organisms, environmental applications of such microorganisms in toxicological studies and in developing risk based standards.

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EV4201 BIOLOGICAL TREATMENT PROCESS FOR WASTEWATER  

OBJECTIVES:

- To educate the students on the principles and process designs of various treatment systems for wastewater
- To gain competency in the process employed in design of treatment systems and the components comprising such systems, leading to the selection of specific process.

UNIT I REACTION KINETICS AND BIO REACTORS

UNIT II CONVENTIONAL AEROBIC TREATMENT PROCESSES

UNIT III ADVANCED AEROBIC TREATMENT PROCESSES OF WASTEWATER
Sequencing batch reactors- moving bed biofilm reactors- membrane bioreactor- reclamation and reuse of wastewater-design of tertiary treatment units-application of membrane separation technologies in reuse of sewage -nutrient removal systems-case studies

UNIT IV ANAEROBIC TREATMENT OF WASTEWATER

UNIT V SLUDGE TREATMENT, OPERATION AND MAINTENANCE
Sources and its characteristics-design of sludge management facilities, sludge thickening- sludge digestion - biogas generation- sludge dewatering- mechanical – ultimate residue disposal – recent advances-construction and operational maintenance problems in STPs– trouble shooting – planning, organizing and controlling of plant operations – capacity building - retrofitting case studies

OUTCOMES:
- On completion of the course, the student is expected to be able to
  CO1 Understand the microbial process and its kinetics
  CO2 Design and size the different components of conventional aerobic treatment systems.
  CO3 Design and size the different components of advanced aerobic treatment systems.
  CO4 Understand in detail about the anaerobic treatment of wastewater which includes the design of attached and suspended growth processes.
  CO5 Design the different elements of sludge treatment systems and understand the importance O&M issues pertaining to biological treatment systems

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OBJECTIVE:
- To impart knowledge on types and sources of air pollution, its effects and design of control methods

UNIT I INTRODUCTION 8

UNIT II AIR POLLUTION MONITORING AND MODELLING 8
Ambient and stack sampling and analysis of particulate and gaseous pollutants - effects of meteorology on air pollution - fundamentals, atmospheric stability, inversion, wind profiles and stack plume patterns - transport & dispersion of air pollutants - modelling techniques - Air Pollution climatology.

UNIT III CONTROL OF PARTICULATE POLLUTANTS 10
Factors affecting selection of control equipment; gas particle interaction, – working principle, design and performance equations of gravity separators, cyclones, Fabric filters, particulate scrubbers, electrostatic precipitators – operational considerations - costing of APC equipment – recent advances

UNIT IV CONTROL OF GASEOUS POLLUTANTS 10
Factors affecting selection of control equipment - working principle, design and performance equations of absorption, adsorption, condensation, incineration, bio-scrubbers, bio-filters – control technologies – control technologies-SO₂, NOₓ, CO, H₂S; process control and monitoring - operational considerations - costing of APC equipment – emerging trends,

UNIT V AUTOMOBILE AND NOISE POLLUTION 9
Vehicular Pollution: Automobile emission- types of emissions- prevention and control of vehicular pollution.
Noise Pollution: Sources and effects of noise pollution – measurement – standards – control and preventive measures.
Indoor Air Pollution: Sources and effects – control and preventive measures

TOTAL: 45 PERIODS

OUTCOMES:
After completion of this course, the student is expected to be able to understand:
CO1 Various types and sources of air pollution and its effects
CO2 Methods of source and ambient monitoring and dispersion of pollutants and their modeling
CO3 The principles and design of control of particulate pollutants
CO4 The principles and design of control of gaseous pollutant
CO5 Sources, effects and control of vehicular, indoor air and noise pollution

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EV4203 INDUSTRIAL WASTEWATER POLLUTION - PREVENTION AND CONTROL

OBJECTIVES:
- To understand the principle of various processes applicable to industrial wastewater treatment
- To impart knowledge on the concept and application of Industrial pollution prevention, cleaner technologies, industrial wastewater treatment and residue management.
- To identify the best applicable technologies for wastewater treatment from the perspective of yield production.

UNIT I INTRODUCTION 8

UNIT II INDUSTRIAL POLLUTION PREVENTION & WASTE MINIMISATION 8

UNIT III INDUSTRIAL WASTEWATER TREATMENT 10

UNIT IV WASTEWATER REUSE AND RESIDUAL MANAGEMENT 9

UNIT V CASE STUDIES 10

TOTAL: 45 PERIODS
OUTCOME:

- On Completion of the course, the student is expected to be able to

CO1 Explain the source and types of industrial wastewater and their environmental impacts and choose the regulatory laws pertaining to environmental protection

CO2 Identify industrial wastewater pollution and implement pollution prevention, waste minimization in industries

CO3 Apply knowledge and skills to design industrial wastewater treatment schemes

CO4 Audit and analyze environmental performance of industries to internal, external client, regulatory bodies and design water reuse management techniques

CO5 Conduct research to develop effective management systems for industrial wastewater that are technically sound, economically feasible and socially acceptable

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EV4211 ENVIROMENTAL AND PROCESSES MONITORING LABORATORY

OBJECTIVE:

- To develop the skill for conducting treatability studies of water and wastewater and monitoring of ambient air and noise quality

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<th>Sl. No.</th>
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<td>1.</td>
<td>Coagulation and Flocculation</td>
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<td>Batch studies on settling</td>
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<td>Studies on Filtration- Characteristics of Filter media</td>
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<td>Water softening</td>
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<td>Adsorption studies/Kinetics</td>
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<td>6.</td>
<td>Langelier Saturation Index and Silt Density Index- For Membrane Filtration</td>
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<td>Kinetics of suspended growth process (activated sludge process)-and Sludge volume Index</td>
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<td>8.</td>
<td>Sludge Filterability Test</td>
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<td>9.</td>
<td>Anaerobic Reactor systems / kinetics (Demonstration)</td>
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</table>
10. Advanced Oxidation Processes – (Photo catalysis) 6
11. Disinfection for Drinking water (Chlorination) 6
12. Ambient Air Sampling-Determination of PM10, PM2.5, SO$_2$ and NO$_2$ 12
13. Noise Monitoring-Determination of Equivalent Noise Level 6

TOTAL PERIODS 90

OUTCOME:
After the completion of the course the students will be able

CO1 To conduct treatability studies on water and wastewater treatment

CO2 To determine the removal / degradation of pollutants from water and wastewater and arrive at kinetics

CO3 To design scaled up reactors for treatment of water and wastewater treatment based on laboratory studies

CO4 To determine ambient air quality of given study area in terms of Particulate and Gaseous Pollutants

CO5 To determine Equivalent Noise Level by noise monitoring

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EV4001 SOLID AND HAZARDOUS WASTE MANAGEMENT L T P C 3 0 0 3

OBJECTIVE

- To impart knowledge and skills relevant to minimization, storage, collection, transport, recycling, processing and disposal of solid and hazardous wastes including the related regulations, engineering principles, design criteria, methods and equipment.

UNIT I WASTE CLASSIFICATION AND REGULATORY REQUIREMENTS 9
Sources and types of solid and hazardous wastes - need for solid and hazardous waste management – salient features of latest Indian legislations on management and handling of solid wastes, hazardous wastes, biomedical wastes, electronic wastes, construction and demolition wastes, plastics and discarded lead acid batteries – elements of integrated waste management and roles of stakeholders - seven elements and seven step approach to integrated solid waste management planning.

UNIT II WASTE CHARACTERIZATION, SOURCE REDUCTION AND RECYCLING 9
UNIT III WASTE COLLECTION, TRANSPORT AND MATERIAL RECOVERY

Door to door collection of segregated solid wastes - analysis of hauled container and stationery container collection systems - compatibility, storage, labeling and handling of hazardous wastes — principles and design of transfer and transport facilities - hazardous waste transport and manifests - mechanical processing and material separation technologies – Size reduction – size separation - density separation - magnetic separation – compaction – principles and design of material recovery facilities – physico chemical treatment of hazardous wastes - solidification and stabilization – case studies on waste collection and material recovery

UNIT IV BIOLOGICAL AND THERMAL PROCESSING OF WASTES

Biological and thermo chemical conversion technologies – composting – biomethanation – incineration – pyrolysis- plasma arc gasification –principles and design of biological and thermal treatment facilities - MSW processes to energy with high-value products and specialty BY-Products - operation of facilities and environmental controls - treatment of biomedical wastes – case studies and emerging waste processing technologies.

UNIT V WASTE DISPOSAL

Sanitary and secure landfills - components and configuration— site selection - liner and cover systems - geo synthetic clay liners and geo membranes - design of sanitary landfills and secure landfills- leachate collection, treatment and landfill gas management – landfill construction and operational controls - landfill closure and environmental monitoring – landfill bioreactors – rehabilitation of open dumps and biomining of dumpsites-remediation of contaminated sites- Case studies

OUTCOMES:

- On completion of the course, the student is expected to be able to
- Explain the various functional elements of solid and hazardous waste management including the associated legal, health, safety, and cultural issues as well as responsibilities of different stakeholders
- Apply the knowledge of science and engineering fundamentals to characterize different types of solid and hazardous wastes, assess the factors affecting variation and assess performance of waste treatment and disposal systems
- Design of systems and processes to meet specified needs of waste minimization, storage, collection, transport, recycling, processing and disposal.
- Select appropriate methods for processing and disposal of solid and hazardous wastes, taking into account the impact of the solutions in a sustainability context
- Conduct research pertinent to solid and hazardous waste management and communicate effectively to different stakeholders as well as engage in independent life-long learning

REFERENCES:

7. Cherry P M, Solid and Hazardous Waste Management, CBS publishers and distributors Pvt Ltd, 2018
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EV4002  NATURAL SYSTEMS FOR WASTEWATER TREATMENT  L T P C  3 0 0 3

OBJECTIVE
- To gain knowledge and understanding of wetlands - types of wetland, constructed wetland - application, design, method of treatment of both domestic and industrial wastewaters and case studies.
- To gain knowledge on design, construction and operation of waste stabilization pond and sludge disposal.

UNIT I  INTRODUCTION TO WETLAND TREATMENT SYSTEM  9
Definition and concept of wetland - types of wetland. Wetland - ecology, flora and fauna, ecological aspects, human health and wetland, onsite applications. Introduction to constructed wetland - types of wetland, free water surface, subsurface wetland - horizontal and vertical flow, wastewaters and their application in wetland - constructed wetland plants - media – in constructed wetland.

UNIT II  CONSTRUCTED WETLAND AND REMOVAL MECHANISMS  9
Site identification - construction and design of constructed wetland, startup, operation and maintenance of wetland system - wetland hydrology - hydraulics. Treatment of domestic wastewater and its performance, mechanisms of pollutant removal - suspended solids, organic matter, nitrogen, phosphorus, pathogen and other contaminants. Reuse of treated wastewater and its applications - limitation of constructed wetland system.

UNIT III  CASE STUDIES ON CONSTRUCTED WETLAND SYSTEM  8

UNIT IV  DESIGN OF WASTEWATER POND SYSTEMS.  10

UNIT V  SLUDGE MANAGEMENT AND TREATMENT  9
Sludge quantity and characteristics - stabilization and dewatering - sludge freezing - reed beds - vermi stabilization - comparison of bed type operations - composting land application and surface disposal of bio solids onsite wastewater systems - effluent disposal and reuse. Sludge quantity and characteristics - stabilization and dewatering - sludge freezing reed beds - vermi stabilization - Comparison of bed-type operations - composting land application and surface disposal of biosolids - on-site wastewater systems - effluent disposal and reuse.

TOTAL : 45 PERIODS
OUTCOMES:

- On completion of the course, the student is expected to be able to

CO1 Explain the various aspects of wetland system, its function and its application in the treatment of wastewaters

CO2 Apply the knowledge of science and engineering fundamentals to know the types of wetlands, construction and operation of wetlands, wetland hydraulics and design of wetland and its performance Understand the process of treatment of domestic waste in the removal of solids, organic matter, phosphate, nitrogen, pathogens and its reuse

CO3 Understand the process of treatment of industrial wastewater in the removal of solids, organic matter, phosphate, nitrogen, heavy metals, phenolics and feasibility for reuse

CO4 Understand the various pond system available for wastewater treatment. design of pond system -removal mechanism

CO5 Manage and dispose the sludge naturally and economically.

REFERENCES:

1. EPA- Design Manual on constructed wetland and aquatic plant system for municipal wastewater treatment system
5. Constructed wetlands for industrial wastewater treatment system by Alexandros I.Stefanakis (editor), Wiley black well.2018

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EV4003 ENVIRONMENTAL SYSTEM ANALYSIS L T P C 3 0 0 3

OBJECTIVES:

- To introduce the modelling concept in various environmental field like ecological modelling, CSTR modelling and the kinetics of reaction
- To gain knowledge on river and stream water modelling and soft computing techniques.

UNIT I ECOLOGICAL SYSTEM


UNIT II REACTOR MODELLING

UNIT III WATER QUALITY MODELLING

UNIT IV MICROBIAL DYNAMICS AND ENERGETICS

UNIT V COMPUTER BASED SOLUTIONS

TOTAL: 45 PERIODS

OUTCOMES:
• On completion of the course, the students are able to

CO1 Apply the principle of system modeling
CO2 Do reactor modeling
CO3 Develop water quality models.
CO4 Model microbial dynamics
CO5 Apply the knowledge of numerical techniques to environmental system modeling

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EV4004 ENVIRONMENTAL IMPACT ASSESSMENT

OBJECTIVES:
• To make the students to understand environmental clearance, its legal requirements and to provide knowledge on overall methodology of EIA, prediction tools and models, environmental management plan and case studies.

UNIT I INTRODUCTION
UNIT II

IMPACT IDENTIFICATION AND PREDICTION


UNIT III

SOCIO-ECONOMIC IMPACT ASSESSMENT

Socio-economic impact assessment - relationship between social impacts and change in community and institutional arrangements. Factors and methodologies- individual and family level impacts. Communities in transition-rehabilitation

UNIT IV

EIA DOCUMENTATION AND ENVIRONMENTAL MANAGEMENT PLAN

Environmental management plan - preparation, implementation and review – mitigation and rehabilitation plans – policy and guidelines for planning and monitoring programmes – post project audit – documentation of EIA findings – ethical and quality aspects of environmental impact assessment

UNIT V

CASE STUDIES

Mining, power plants, cement plants, highways, petroleum refining industry, storage & handling of hazardous chemicals, common hazardous waste facilities, CETPs, CMSWMF, building and construction projects

OUTCOMES:

- On completion of the course, the student is expected to be able to

CO1 Understand need for environmental clearance, its legal procedure, need of EIA, its types, stakeholders and their roles

CO2 Understand various impact identification methodologies, prediction techniques and model of impacts on various environments

CO3 Understand relationship between social impacts and change in community due to development activities and rehabilitation methods

CO4 Document the EIA findings and prepare environmental management and monitoring plan

CO5 Identify, predict and assess impacts of similar projects based on case studies

REFERENCES:

1. EIA Notification 2006 including recent amendments, by Ministry of Environment, Forest and Climate Change, Government of India
2. Sectoral Guidelines under EIA Notification by Ministry of Environment, Forest and Climate Change, Government of India

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OBJECTIVE:
- To understand on the principles and process designs aspects of onsite sanitation and decentralized wastewater management systems.
- To gain competency in the process employed in sludge and septage management systems and the components comprising such systems, leading to the selection of specific process.

UNIT I URBANIZATION AND SANITATION

UNIT II DESLUDGING AND CONVEYANCE OF SEPTAGE
Planning for Emptying Services - Current Status of Emptying Services - Need for Periodic Cleaning of Septic Tanks - Prohibition of Employment as Manual Scavengers and their Rehabilitation Act- Technologies for Desludging - Parameters for Assessing Conveyance Options - Demand Based Desludging - Schedule Based Desludging - Private Sector Participation.

UNIT III SEWAGE TREATMENT

UNIT IV SLUDGE STABILIZATION
Objectives-Aerobic and Anaerobic Sludge digestion processes — Types of anaerobic digesters — design of Low rate and High rate digesters — Two stage digester-Aerobic digestion - Pure oxygen and thermopilic aerobic digestion - Chemical and Thermal stabilization process

UNIT V REUSE AND LAND APPLICATION OF SEWAGE SLUDGE
Introduction- beneficial use-requirements and associated risks-handling and management-storage- operation aspects of transport and application of biosolids application land - Lagooning - Landfilling-land farming-Composting-windrow composting -Vermicomposting -Laws and regulations on sludge management

OUTCOMES:
CO1 Understand the sanitation value chain with challenges and need for addressing septage
CO2 Know about desludging and conveyance of septage
CO3 Plan and implement decentralized sewage treatment scheme
CO4 Understand technology options for sludge stabilization
CO5 Know about the requirements and associated risk while reusing sewage sludge

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EV4006 SUSTAINABILITY ENGINEERING

OBJECTIVES
- To learn about the principles, indicators and general concept of sustainability.
- To apprehend the local, regional and global impacts of unsustainable designs, products and processes.
- To apply the sustainability concepts in engineering.

UNIT I SUSTAINABILITY
Introduction to sustainability concepts, the magnitude of the pressures on resources and ecosystems, Roles of engineers in developing sustainable society, Energy, Materials use, Environmental emissions –ozone depletion, global warming, air quality, water quality, wastes in the India – water, air, solid.

UNIT II RISK AND LIFE CYCLE BASED FRAME WORKS FOR SUSTAINABILITY

UNIT III SUSTAINABLE MATERIALS
Environmental and natural resource use footprints – material extraction and production, material flows in engineered systems, Environmental releases- chemical and physical properties, estimate environmental partitioning, persistence and measures of exposure.

UNIT IV DESIGN FOR SUSTAINABILITY
Sustainable engineering design principles, economic performance indicators, environmental performance indicators, social performance indicators, environmental cost analysis

UNIT V CASE STUDIES
Sustainable built environments, Biofuels for transportation, electric vehicles, bioplastics,

TOTAL: 45 PERIODS

OUTCOMES
1. Students would be able to quantify sustainability, and resource availability.
2. rationalize the sustainability based on scientific merits
3. Understand and apply sustainability concepts in designs, product developments and processes across various engineering disciplines.
4. To make a decision in applying green engineering concepts.
5. Lifelong advocate of sustainability in society.
REFERENCES
1. Sustainable Engineering concepts, design and case studies, David T. Allen and David R. Shonnard, Prentice hall.
2. Engineering applications in sustainable design and development, Bradley Striebig, Adebayao A. Ogundipe and Maria Papadakis, Cengage Learning; 001 edition (January 1, 2015).

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EV4007 PROJECT FORMULATION AND IMPLEMENTATION

OBJECTIVES:
- To examine the techniques and procedures relevant for project planning and implementation in developing countries, especially infrastructure projects pertaining to environmental sector
- To enable the students to understand about project identification, feasibility analysis, design, financing, implementation, monitoring and evaluation

UNIT I INTRODUCTION TO PROJECT FORMULATION
Overview of the project cycle – planning process and project planning – search for project ideas – strategies in capital allocation – key elements in project formulation – methods and tools for project formulation – project identification and selection – preparation of feasibility reports as per government policies (AMRUT / JnNURM)

UNIT II PROJECT ANALYSIS

UNIT III PROJECT APPRAISAL
Time and value of money – investment criteria – internal rate of return – net present value, cost benefit analysis, and social cost benefit analysis – project risk analysis – appraisal of marketing strategy – pricing and credit worthiness and management capabilities

UNIT IV PROJECT FINANCING AND IMPLEMENTATION
Funding options for urban and rural development projects – tender procedure – transparency in government tender rules – organizational aspects in project management – network techniques for project management – resource management - risk management

UNIT V PROJECT MONITORING AND EVALUATION
Need and techniques for monitoring – service Level benchmark performance and process monitoring – monitoring Schedules – Penalty and Bonus points

TOTAL: 45 PERIODS
OUTCOMES:
On completion of the course, the student is expected to be able to

CO1 Understand the project cycle, key elements in project formulation, methods and tools for project formulation

CO2 Understand capital cost estimation, market and demand analysis, technical, environmental, financial and economic analysis

CO3 Understand time and value of money, investment criteria, internal rate of return, cost benefit analysis, project risk analysis and appraisal of marketing strategy

CO4 Have knowledge on funding options for urban and rural development projects, tender procedure, transparency, resource management & risk management

CO5 Understand need and techniques for monitoring project performance

REFERENCES:
3. John M Nicholas “Project Management for Business and Technology” Prentice Hall Of India Pvt Ltd
5. Detailed Project Report: Preparation Toolkit (Sub-mission for Urban Infrastructure and Governance), Government of India
6. www.india.gov.in national portal for India

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OBJECTIVES:
- To identify the most critical issues and challenges that limit the use of conventional treatment processes in planning, design and operation of modern water and wastewater treatment facilities
- To understand the fundamentals of advanced oxidation processes (AOPs), photochemistry, ozone chemistry, and its application to AOPs for the detoxification of contaminated water
- To develop in-depth knowledge that can be used to devise and design effective AOP treatment systems to meet not only current but also anticipated regulatory requirements, and to enhance independent learning and critical thinking skills.

UNIT I  INTRODUCTION TO AOPs  8
UNIT II HOMOGENOUS AOPs
Ozone, electro-chemical oxidation, ultrasonication, UV – photolysis, hydrogen peroxide and ultraviolet radiation (H₂O₂/UV), Fenton and Photo Fenton's oxidation, chemical and non-chemical AOPs, advantages and disadvantages of homogeneous processes.

UNIT III HETEROGENEOUS PROCESS

UNIT IV AOP ENHANCEMENT TECHNIQUES
Non-thermal plasma-electron hydraulic cavitation and sonolysis- super water oxidation – γ rays-electron beams, Quantum yield improvement by additional oxidants – hydrogen peroxide persulphate– catalyst modification. case studies and applications semiconductor photolysis. process fundamentals, applications and commercial process.

UNIT V INDUSTRIAL APPLICATIONS AND ECONOMIC ASSESSMENT OF AOPs

TOTAL: 45 PERIODS

OUTCOME:
On Completion of the course, the student is expected to be able to

CO1 Comprehend the basic principles of advanced water treatment processes, capabilities / constraints of their application in water and wastewater treatment

CO2 Apply technical knowledge and skills on the design and operation of AOPs for the water and wastewater treatment

CO3 Design suitable pre-treatment and post treatment schemes, and cleaning protocols for AOPs

CO4 Conduct economic assessment on AOs for water and wastewater treatment

CO5 Select appropriate AOPs to solve emerging environmental wastewater issues in the society, that are technically sound, economically feasible and socially acceptable

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EV4009 COMPUTING TECHNIQUES IN ENVIRONMENTAL ENGINEERING L T P C 3 0 0 3

OBJECTIVES:
- To educate the students to know about the computing techniques used in environmental engineering, and explain the artificial intelligence like ANN, Fuzzy logic and genetic algorithm applications in environmental engineering.

UNIT I SOFT COMPUTING PRINCIPLES
Introduction to computing techniques – algorithms and flowcharts, numerical methods - solution to ordinary and partial differential equation using finite difference, finite element and finite volume methods, numerical integration and differentiation.

UNIT II ARTIFICIAL INTELLIGENCE
Knowledge based expert system concepts - principle of Artificial Neural Network (ANN) – perceptron learning rule, neural network structure – neural network operations – ANN Algorithm - Application of ANN Model to environmental field – genetic algorithms

UNIT III FUZZY LOGIC
Fuzzy logic principles - fuzzy logic and the theory of uncertainty - fuzzy set theory- fuzzy membership function, fuzzy relations, fuzzy rule, and applications of the fuzzy set theory to inference and control, clustering, and image processing.

UNIT IV DIGITAL DATA MANAGEMENT

UNIT V ENVIRONMENTAL MODELING SOFTWARE
Introduction to MATLAB Software – MATLAB applications in environmental – pollutants transport, decay and degradation modeling using MIKE 21 – MODFLOW - case studies.

TOTAL: 45 PERIODS

OUTCOMES:
- On completion of the course, the students are able to
  - CO1 Understand the various computing techniques available for environmental engineering.
  - CO2 Apply the principles of ANN and GA for solving environmental problems
  - CO3 Apply the principles of Fuzzy logic and for solving environmental problems.
  - CO4 Work in the statistical analysis software SYSTAT.
  - CO5 Employ modern advanced computing tool MATLAB software in environmental studies

REFERENCES:
OBJECTIVES

- To acquire knowledge on the Geotechnical engineering problems associated with soil contamination.
- To safe disposal of waste and remediate the contaminated soils by different techniques.
- To remediate the contaminated ground water thereby protecting environment.

UNIT I INTRODUCTION

Emergence of Geo-Environmental engineering, Types of Geo-Environmental problems, inorganic and organic toxic chemicals, composition of soils, soil properties, inorganic and organic geochemistry.

UNIT II CONTAMINANT TRANSPORT AND FATE

Transport processes, chemical mass transfer processes, biological processes, contaminant transport and fate modeling, landfill and surface impoundments, in-situ barriers, ground water contamination.

UNIT III SUBSURFACE CONTAMINATION AND WASTE CONTAINMENT

Sources and types of contamination, remediation approach, contaminated site characterization, risk assessment and remedial strategy. Vertical and bottom barriers, surface caps, ground water pumping systems, subsurface drains, liner systems.

UNIT IV SOIL REMEDIATION

Soil vapour extraction, soil washing, stabilization and solidification, electrokinetic remediation, thermal desorption, vitrification, bioremediation, phytoremediation, soil fracturing.

UNIT V GROUND WATER REMEDIATION

Pump and treat, In-situ flushing, permeable reactive barriers, in-situ air sparing monitored natural attenuation, bioremediation.

TOTAL: 45 PERIODS

OUTCOMES

1. Assess the contamination in the soil
2. Understand the current practice of waste disposal
3. To prepare the suitable disposal system for particular waste.
4. Stabilize the waste and utilization of solid waste for soil improvement.
5. Select suitable remediation methods based on contamination.
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EV4011 ENVIRONMENTAL MONITORING INSTRUMENTS  

OBJECTIVES:
- To educate the students on various instrumental methods of monitoring the quality of air, water and soil.

UNIT I FUNDAMENTALS  
Wet chemistry methods and their limitations-instrumental methods, selection of method- precision and accuracy, error in measuring signals- quality control & assurance- sample preservation, sample preparation and analyte isolation.

UNIT II SPECTROSCOPIC METHODS  
Principles, techniques and applications of spectrophotometry, fluorimetry, nephelometry and turbidimetry, Atomic Absorption Spectrometry (Flame, graphite furnace, cold vapour and hydride generation), Atomic Emission Spectrometry (AES), flame photometry and Inducted Coupled Plasma (ICP) – TOC Analyzer

UNIT III CHROMATOGRAPHIC METHODS  
Principles, techniques and applications of GC, GC-MS, high performance liquid chromatography (HPLC) and Ion Chromatography (IC)-hyphenated techniques for environmental contaminant (trace organics) analysis, ICP-MS

UNIT IV ELECTRO AND RADIO ANALYTICAL METHODS  
Principles, techniques and applications of conductometry, potentiometry, coulometry, AOX Analyzer, amperometry, polarography, electro-capillary analysis, Neutron Activation Analysis (NAA), X-ray Fluorescence (XRF) and X-ray Diffraction (XRD) methods.

UNIT V CONTINUOUS MONITORING INSTRUMENTS  
Principles, techniques and applications of NDIR analyzer for CO, chemiluminescent analyzer for NOX, fluorescent analyzer for SO2- particulates analysis- auto analyzer for water quality using flow injection analysis. LIMS.

TOTAL: 45 PERIODS
OUTCOMES:
CO1: Able to select appropriate instrumental method for chemical analysis
CO2: Understand spectroscopic methods of analysis of pollutants
CO3: Select correct method for toxic organics estimation using chromatography methods
CO4: Understand electro and nondestructive methods of analysis
CO5: Familiar with online analyzers

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EV4012 WATER QUALITY MODELLING

OBJECTIVES:
- To understand the fundamentals of mathematical models and their importance in water quality modelling, and to impart the skills to use water quality modelling software for surface and groundwater quality modelling.

UNIT I MODELLING INSIGHTS
Engineers and Mathematical models-Water quality models – historical development - different types of models-- steps in model development - importance of model building.- calibration and verification of models- finite element, finite difference and finite volume methods.

UNIT II POLLUTANT TRANSPORT
Transport phenomena – advection, diffusion, dispersion- contamination transport in surface and subsurface water - Simple transport models –steady state and time variable solutions- conservation of mass, momentum and energy balance, governing equation for contaminant fate and transport

UNIT III SURFACE WATER QUALITY MODELLING
UNIT IV  GROUNDWATER QUALITY MODELLING

UNIT V  WATER QUALITY MODELLING SOFTWARE
Exposure to surface water and groundwater quality modelling software’s – MIKE 21, WASP, QUAL2E and MODFLOW – demonstration - case studies.

OUTCOMES:
- On completion of the course, the students are able to
CO1 Know about the principles of water quality modelling.
CO2 Understand the pollutant transport phenomena in surface and groundwater.
CO3 Apply the knowledge of surface water quality modelling to predict the water quality of rivers, lakes and estuary.
CO4 Predict the groundwater contamination transport.
CO5 Predict water quality of surface and sub surface water using numerical solution.

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EV4013  MARINE POLLUTION AND CONTROL

OBJECTIVES:
- To impart the knowledge about marine and coastal environment, oceanography, and sources, effects and monitoring of marine pollutants.

UNIT I  MARINE AND COASTAL ENVIRONMENT
Seas and oceans, continental area, coastal zone, properties of sea water, principles of marine geology, coastal features – beaches, estuaries, lagoons, salt marshes, mangroves and sand dunes– the oceans and climate, coastal zone regulation in india- national and international treaties.
UNIT II OCEAN HYDRODYNAMICS
Wave theory, waves in shallow waters – refraction, diffraction and shoaling, approximations for deep and shallow water conditions – tidal classification - general circulation of ocean waters - ocean currents - coastal sediment transport - onshore offshore sediment transport - beach formation and coastal processes - Tsunamis, storm surge, El Nino effect.

UNIT III MARINE POLLUTION
Sources of marine pollution – point and non-point sources, pollution caused by effluent discharge, oil exploration, dredging, offshore mining, port and harbour activities, power plants, agriculture runoff, plastic waste, marine debris and marine litter - effects of marine pollution on marine water quality and coastal ecosystems.

UNIT IV MARINE POLLUTION MONITORING
Basic measurements - sounding boat, echo sounders – current meters - tide gauge - use of GPS – measurement of coastal water characteristics – sea bed sampling – modelling of pollutant transport and dispersion - oil spill models - ocean monitoring satellites – applications of remote sensing and GIS in monitoring marine pollution – online marine pollution monitoring,

UNIT V MARINE POLLUTION CONTROL MEASURES
Marine discharges and effluent standards, pollution control strategies – marine outfall design-selection of optimal marine outfall locations - Total Maximum Daily Load (TMDL) applications – protocols in marine pollution control– Integrated Coastal Zone Management (ICZM) and sustainable development.

OUTCOMES:
- On completion of the course, the students are able to
  CO1 Know about the different components of marine environment.
  CO2 Understand physical concepts lying behind the tides, waves, and oceanic currents and natural processes of various activities happening over the marine environment
  CO3 Identify and measure the marine pollution levels and effects
  CO4 Apply the knowledge of remote sensing and GIS for monitoring marine environment water quality,
  CO5 Develop marine pollution control measures.

TOTAL: 45 PERIODS

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OBJECTIVES:
- To introduce the emerging concepts of climate modelling and projecting future climate change, understand data analysis and application.

UNIT I CLIMATE CHANGE AND CLIMATE VARIABILITY 9
Introduction- atmosphere - weather and climate - climate parameters (Temperature, Rainfall, Humidity, Wind etc.,) Equations governing the atmosphere - numerical weather prediction models - introduction to GCMs - applications in climate change projections

UNIT II IPCC CLIMATE SCENARIOS 9
Intergovernmental PANEL on Climate Change (IPCC) - an overview - key assumptions – Representative Concentration Pathways (RCP 2.6, 4.5, 6.0, 8.5)

UNIT III GLOBAL CLIMATE MODEL AND REGIONAL CLIMATE MODEL 9
Climate model – types of model- General Circulation Models (GCM) - Issues with GCMs - Introduction to RCMs and LAMs - RCMs modellers -advantages and disadvantages of GCMs and RCMs

UNIT IV DOWNSCALING GLOBAL CLIMATE MODEL - AN OVERVIEW 9
Need for downscaling - selection of GCMs for regional climate change studies - ensemble theory selection of ensembles, model domain (Spatial domain and temporal domain), Resolution and climate variables - lateral boundary conditions - methods of downscaling (Statistical and Dynamical) - examples from each and their limitations.

UNIT V ANALYSIS AND POST PROCESSING 9
Model validation and calibration- evaluating model performance- post processing - introduction to analysis tools - Ferret, R, Grads, IDL, SPSS, ArcGIS - climate change impact - vulnerability assessment-case studies-Adaptation strategies

TOTAL: 45 PERIODS

OUTCOMES
- On completion of the course, the student is expected to be able to
  CO1: Understand the basics of climate change and variability
  CO2: Comprehend the latest IPCC climate scenarios
  CO3: Gain in-depth knowledge on climate models
  CO4: Downscale of climate scenarios through different modelling techniques, and validate climate models
  CO5: Post process the model outputs for climate impact assessment, know about adaptation strategies

REFERENCES:

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OBJECTIVE:
- To educate the student on the various operation & maintenance aspects of water treatment systems, sewer systems, sewage treatment plants and effluent treatment plants.

UNIT I ELEMENTS OF OPERATION AND MAINTENANCE
9
Strategy for good operation and maintenance - preventive and corrective maintenance scheduling - operation and maintenance Plan - proper and adequate tools, spare units and parts - training requirements- laboratory control- records and reports- housekeeping –sampling procedure- analytical techniques- code of practice for analytical laboratories- measurement of flows, pressures and Levels -safety in O&M operations - management information system - measures for conservation of energy

UNIT II OPERATION AND MAINTENANCE OF WATER SUPPLY SYSTEMS
9
Operational problems, O&M practices and records of operation of reservoir and intakes - causes of failure of wells- rehabilitation of tube wells & bore wells- prevention of incrustation and corrosion - problems in transmission mains- maintenance of pipelines and leakage control- repair method for different types of pipes- preventive and corrective maintenance of water pumps - problems in the water distribution system and remedies- water quality monitoring and surveillance

UNIT III OPERATION AND MAINTENANCE OF SEWERAGE SYSTEMS
9

UNIT IV OPERATION AND MAINTENANCE OF PHYSICO-CHEMICAL TREATMENT UNITS
9
Operation and maintenance in screen chamber, grit chamber and clarifiers- operation issues, trouble shooting guidelines and record keeping requirements for clarifier, equalization basins, neutralization unit - chemical storage and mixing equipment - chemical metering equipment - flash mixer –filters, thickeners and centrifuges- filter press - start-up and maintenance inspection - motors and pumps - hazards in chemical handling – jar test - chlorination equipment - membrane process systems- SDI and LSI determination- process chemistry and chemical dosage calculations- SOP-case studies

UNIT V OPERATION AND MAINTENANCE OF BIOLOGICAL TREATMENT UNITS
9
Construction, operation and maintenance aspects of activated sludge process, trickling filters, anaerobic digester, SBR, UASBR, MBRs- startup and shutdown procedures-DO, MLSS and SVI monitoring- trouble shooting guidelines –planning, organizing and controlling of plant operations – capacity building, case studies of retrofitting- SOP-case studies

OUTCOMES:
On completion of the course, the student is expected to be able to
CO1 Understand the O&M issues pertaining to STP and WTP
CO2 Understand operation and maintenance of water intakes and supply systems
CO3 Recognize the O&M issues relevant to sewerage system
CO4 Understand operation and maintenance of physico-chemical treatment units
CO5 Understand operation and maintenance of biological treatment units

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EV4016 AIR QUALITY MODELLING L T P C 3 0 0 3

OBJECTIVES:
- To introduce the theory of dispersion of air pollution in the atmosphere and major approaches for air pollution modelling and to demonstrate the features of most widely used commercial and freely available air quality models

UNIT I MODELLING AND MODELS
Overview of different types of models-deterministic and stochastic approach- steps in model development- numerical and simulations models- calibration and validation of models- limitations- transport phenomena- mass balance analysis-model development and decision making. Types of air quality models-classification

UNIT II METEOROLOGY AND DISPERSION

UNIT III EMISSION AND SOURCE DISPERSION MODELS
modeling for reactive and nonreactive pollutants, point source-single and multiple sources- area sources, line source models, fixed box models- diffusion models- Gaussian plume derivation-modifications of Gaussian plume equation- Gaussian puff model- emission models-emission factors-long term average-multiple cell model-accuracy and utilization-limitations-air quality mapping

UNIT IV RECEPTOR MODELS AND INDOOR AIR QUALITY MODELS
UNIT V SOFTWARE PACKAGE APPLICATIONS
Commercial air quality models - ADMS, AERMOD, CALINE, CALPUFF, DEGADIS, HYROAD, INDUSTRIAL SOURCE COMPLEX, SCREEN, HYSLIP, INDEX

TOTAL: 45 PERIODS

OUTCOMES:
- At the end of the course the student will be to
CO1 Concepts and types of models, model development, their applicability and limitations.
CO2 Understand the physicochemical transformation of air pollutants in the atmosphere along with the meteorological influence in dispersion of pollutants.
CO3 Identifies emission source and applies suitable modeling tools to estimate the impact of the pollutants.
CO4 Fetch knowledge on source inventories, model prediction efficiency and potential risk assessment.
CO5 Understand the application of models to predicts the air quality scenarios for different conditions and find suitable mitigation measures.

REFERENCES:
3. Lawrence K. Wang, Norman C. Parela, Yung Tse Hung, "Air Pollution Control Engineering", Tokyo, 2004

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EV4017 FATE AND REMEDIATION OF EMERGING CONTAMINANTS

OBJECTIVE:
- To impart knowledge on the priority list of emerging contaminants and improve understanding of their sources, occurrence, distribution, existing regulations/policies, analysis and screening techniques, environmental fate, transport, underlying mechanisms, modelling frameworks, ecotoxicity, risk assessment tools and remediation technologies.

UNIT I SOURCES, OCCURRENCE AND REGULATORY REQUIREMENTS
Definition - Priority vs. emerging contaminants - recent concerns - major groups - examples - properties - sources - occurrence - distribution in soils, groundwater, industrial and municipal wastewaters, aquaculture effluents, freshwater and marine ecosystems, air, food, plants, animals and human blood - existing global regulatory frameworks and policies.
UNIT II  CHARACTERIZATION AND INSTRUMENTATION
Sampling – sample preparation methods – analytical protocols for detection of pharmaceuticals, personal care products, antimicrobials and antibiotics, hormones, phthalate plasticizers and degradation products, surfactants, brominated fire retardants, pesticides and nanoparticles – analytical instruments

UNIT III  ENVIRONMENTAL FATE AND TRANSPORT

UNIT IV  REMEDIATION TECHNOLOGIES
Incineration - sonolysis - multi-phase extraction - permeable reactive barrier - advanced oxidation processes - membrane based separation - nanofiltration - Reverse osmosis - biosorption - bioaugmentation - combined treatment options - remediation endpoints - challenges - opportunities

UNIT V  CASE STUDIES
Occurrence in different environmental compartments - environmental fate and transport - potential and known risks to human health and the environment - effective technological and policy approaches to prevent, control and remove emerging pollutants in the environment

TOTAL: 45 PERIODS

OUTCOMES:
- On completion of the course, the student is expected to be able to:
  CO1 Explain about the different kinds of emerging contaminants, their sources, occurrence, distribution in different environmental compartments and existing regulations/policies
  CO2 Explain about the analytical techniques for the detection of emerging contaminants in environment
  CO3 Explain about the environmental fate, behaviour, underlying mechanisms, human health and ecological risks of emerging contaminants, and will be able to monitor and assess the degree of environmental contamination by emerging pollutants
  CO4 Select an appropriate single and/or integrated physical, chemical and/or biological clean-up option for environments contaminated with different classes of emerging pollutants in order to achieve the target remedial endpoints
  CO5 Conduct independent research in the future pertinent to emerging contaminant pollution and remediation

REFERENCES:
OBJECTIVES:
- To gain an understanding of the fundamentals of chemical reaction engineering with a focus on chemical reaction rates and reaction mechanisms. The course will cover mole balances, rate laws, chemical kinetics, and reactor design. These principles can be applied to any environmental system where chemical transformations must be described.

UNIT I PRINCIPLES OF REACTION ENGINEERING 9
Classification of reactions, reaction rate, variables affecting reaction rate, speed of chemical reactions. Reaction engineering principles of chemical treatment – chemical reactions in major treatment technologies, incineration, selective catalytic reduction. Wet-gas scrubbing - H₂S

UNIT II KINETICS OF HOMOGENOUS REACTIONS 9
Simple reactor types, the rate equation, concentration dependent term of rate equation. Molecularity and order of reaction. Rate constant k, representation of an elementary and nonelementary reaction. Kinetic models for nonelementary reactions. Testing kinetic models. Temperature dependent term of rate equations from Arrhenius theory and comparison with collision and transition state theory. Activation energy and temperature dependency.

UNIT III REACTOR ANALYSIS 8
Reactor concepts, ideal reactors, reaction rate measurements, sequencing batch reactor, reactors in series and reactors in recycle. Non-ideal reactor behaviour, RTD analysis

UNIT IV MASS TRANSFER AND ITS APPLICATIONS 8
Principles of diffusion and mass transfer between phases, gas absorption, humidification operations, leaching and extraction, drying of solids, fixed-bed separation, membrane separation process-adsorption.

UNIT V BIOLOGICAL REACTION ENGINEERING 10

OUTCOMES:
- On completion of the course, the student is expected to be able to

CO1 Successfully apply advanced concepts of reaction engineering to identify, formulate, and solve complex environmental engineering problems
CO2 Understand interaction of pollutants in environment
CO3 Understand reactor behavior and transformation of contaminants
CO4 Conceptualize mass transport phenomena
CO5 Apply reaction engineering concept in biological treatment system
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EV4019 MEMBRANE SEPARATION FOR WATER AND WASTEWATER TREATMENT

OBJECTIVE
- To introduce the principles and design of different membrane separation technologies including microfiltration, ultrafiltration, nanofiltration, reverse osmosis, electrodialysis and membrane bioreactor processes for water and wastewater treatment.

UNIT I MEMBRANE FILTRATION PROCESSES

UNIT II MEMBRANE SYSTEMS
Membrane module/element designs – membrane system components – design of membrane systems - design of modules, assembly, plant process control and applications - design and applications of low pressure membrane technology systems-microfiltration and ultrafiltration- design and applications of diffusive membrane technologies- nanofiltration and reverse osmosis - electro dialysis : Ion exchange membranes, process design- design of membrane systems - pump types and pump selection – plant operations – economics of membrane systems

UNIT III MEMBRANE BIOREACTORS
Historical perspective of MBRs- biotreatment fundamentals- MBR principles and fundamentals- MBR design principles, design assignment, alternative MBR configurations - commercial technologies- fouling and fouling control- case studies

UNIT IV PRETREATMENT AND POST TREATMENT SYSTEMS
UNIT V  CASE STUDIES

Case studies on the design of membrane based water and wastewater treatment systems – zero liquid effluent discharge plants – desalination of brackish water and seawater – project implementation and project economics – environmental issues – reject management -energy recovery systems

TOTAL: 45 PERIODS

OUTCOMES:

• On completion of the course, the student is expected to be able to

CO1 Explain the various main membrane processes, principles, separation mechanisms, and applications

CO2 Apply the knowledge of science and engineering fundamentals to analyse the mechanisms of membrane filtration

CO3 Design of membrane systems involving microfiltration, ultrafiltration, nanofiltration, reverse osmosis, electrodialysis and membrane bioreactor processes

CO4 Select appropriate membrane technologies for water and wastewater treatment taking into account the impact of the solutions in a sustainability context

CO5 Conduct research pertinent to membrane technology applications to water and wastewater treatment and communicate effectively to different stakeholders as well as engage in independent life-long learning

REFERENCES:

1. Mihir K. Purkait, Randeep Singh, Membrane Technology in Separation Science, CRC Press, 2018


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AUDIT COURSES

AX4091 ENGLISH FOR RESEARCH PAPER WRITING L T P C 2 0 0 0

OBJECTIVES
• Teach how to improve writing skills and level of readability
• Tell about what to write in each section
• Summarize the skills needed when writing a Title
• Infer the skills needed when writing the Conclusion
• Ensure the quality of paper at very first-time submission

UNIT I INTRODUCTION TO RESEARCH PAPER WRITING 6
Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

UNIT II PRESENTATION SKILLS 6

UNIT III TITLE WRITING SKILLS 6
Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check

UNIT IV RESULT WRITING SKILLS 6
Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions

UNIT V VERIFICATION SKILLS 6
Useful phrases, checking Plagiarism, how to ensure paper is as good as it could possibly be the first-time submission

TOTAL: 30 PERIODS

OUTCOMES
CO1 – Understand that how to improve your writing skills and level of readability
CO2 – Learn about what to write in each section
CO3 – Understand the skills needed when writing a Title
CO4 – Understand the skills needed when writing the Conclusion
CO5 – Ensure the good quality of paper at very first-time submission

REFERENCES

AX4092 DISASTER MANAGEMENT L T P C 2 0 0 0

OBJECTIVES
• Summarize basics of disaster
• Explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
• Illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
• Describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
• Develop the strengths and weaknesses of disaster management approaches

UNIT I : INTRODUCTION
Disaster: Definition, Factors and Significance; Difference between Hazard And Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

UNIT II : REPERCUSSIONS OF DISASTERS AND HAZARDS

UNIT III : DISASTER PRONE AREAS IN INDIA
Study of Seismic Zones; Areas Prone To Floods and Droughts, Landslides And Avalanches; Areas Prone To Cyclonic and Coastal Hazards with Special Reference To Tsunami; Post-Disaster Diseases and Epidemics

UNIT IV : DISASTER PREPAREDNESS AND MANAGEMENT
Preparedness: Monitoring Of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological And Other Agencies, Media Reports: Governmental and Community Preparedness.

UNIT V : RISK ASSESSMENT

TOTAL : 30 PERIODS

OUTCOMES
CO1: Ability to summarize basics of disaster
CO2: Ability to explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
CO3: Ability to illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
CO4: Ability to describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
CO5: Ability to develop the strengths and weaknesses of disaster management approaches

REFERENCES

AX4093
CONSTITUTION OF INDIA

OBJECTIVES
Students will be able to:
• Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
• To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional Role and entitlement to civil and economic rights as well as the emergence nation hood in the early years of Indian nationalism.
• To address the role of socialism in India after the commencement of the Bolshevik Revolutionin1917and its impact on the initial drafting of the Indian Constitution.
UNIT I   HISTORY OF MAKING OF THE INDIAN CONSTITUTION
History, Drafting Committee, (Composition & Working)

UNIT II   PHILOSOPHY OF THE INDIAN CONSTITUTION
Preamble, Salient Features

UNIT III   CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES
Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to
Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive
Principles of State Policy, Fundamental Duties.

UNIT IV   ORGANS OF GOVERNANCE
Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive,
President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges,
Qualifications, Powers and Functions.

UNIT V   LOCAL ADMINISTRATION
District’s Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of
Elected officials and their roles, CEO Zila Pachayat: Position and role. Block level: Organizational
Hierarchy(Different departments), Village level:Role of Elected and Appointed officials, Importance
of grass root democracy.

UNIT VI   ELECTION COMMISSION
Election Commission: Role and Functioning. Chief Election Commissioner and Election
Commissioners - Institute and Bodies for the welfare of SC/ST/OBC and women.

OUTCOMES
Students will be able to:
• Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival
  of Gandhi in Indian politics.
• Discuss the intellectual origins of the framework of argument that informed the conceptualization
  of social reforms leading to revolution in India.
• Discuss the circumstances surrounding the foundation of the Congress Socialist Party(CSP) under
  the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections
  through adult suffrage in the Indian Constitution.
• Discuss the passage of the Hindu Code Bill of 1956.

SUGGESTED READING
• The Constitution of India,1950(Bare Act),Government Publication.
UNIT II
அறநநறித் தமிழ் 6
1. அறநநறி வகுத்ததிருவள்ளுவர்
   - அறநநறி வலியுறுத்தல், அன்புகடகம், ஒப்புரவறிதல், ஈகக், புகழ்
2. பிற அறநூல்கள்
   - இலக்கியமருந்து - ஏலொதி, சிறுபஞ் மூலம், திரிகடுகம்,
     ஆன்கார்பகொகவ (தூய்கமகய வலியுறுத்தும் நூல்)

UNIT III
இரட்டடக் காப்பியங்கள் 6
1. கணக்கியின் புரட்சி
   - சிலப்பதிகொர வழக்குகரமூகம்
     - இலக்கியமணிப்பககல்
   - சிகறக்பகொட்டம் அறக்பகொட்டமொகியமூகம்
2. மறைநல்
   - அண்டகார்குரியபுன்கன்
3. திருமந்திரம் (617, 618)
   - இயமம் விதிகள்
4. தர்மாகலகயுநிறுவியவள்ளலொர்
5. புறாகனூறு
   - சிறுவபனவள்ளலொன்
6. அகநூறு (4)
   - மூக்குகொற்றொட்டானூறு (11)
     - பப்பர்
   - கொரிகொநூறு (11)
     - பப்பர், பப்பர்
8. துநாகசுல்லோ (50 (27)
   - பப்பர்
   - அமையாம் புனிதசு வண்டுறு

UNIT IV
அருள்நநறித் தமிழ் 6
1. கணக்கியின் புரட்சி
   - பரி (மலரைகளூறு விளகள், பல்கம முருக்கொருணானூறு
     பஞ்சு விளக்குவருத்து, அமையாம் துநாக பெண்கில்கொர மிகுன்கொர, ஆன்கார் வாச்சுப்பககல்
2. மறைநல்
   - அண்டகார்குரியபுன்கன்
3. திருமந்திரம் (617, 618)
   - இயமம் விதிகள்
4. தர்மாகலகயுநிறுவியவள்ளலொர்
5. புறாகனூறு
   - சிறுவபனவள்ளலொன்
6. அகநூறு (4)
   - மூக்குகொற்றுகொநூறு (11)
     - பப்பர்
   - கொரிகொநூறு (11)
     - பப்பர், பப்பர்
8. துநாகசுல்லோ (50 (27)
   - பப்பர்
   - அமையாம் புனிதசு வண்டுறு

UNIT V
சுற்றுசூழல் தமிழில் 6
1. சுற்றுசூழல் காற்று
   - குறிப்பிட்டுசு பிள்ளையம்,
   - குறிப்பிட்டுசு வெளிப்பொருள்,
   - குறிப்பிட்டுசு தூங்கசு தமிழில்
   - பவள்ளவுனகம்
   - வறுகம்.
2. சுற்றுசூழல் குறிப்பிட்டுசு புறாகனூறு குறிப்பிட்டுசு தமிழில்
3. சுற்றுசூழல் குறிப்பிட்டுசு புறாகனூறு தமிழில்
4. சுற்றுசூழல் குறிப்பிட்டுசு விளக்குப் தூங்கசு தமிழில்
5. சுற்றுசூழல் குறிப்பிட்டுசு
6. சுற்றுசூழல் குறிப்பிட்டுசு
7. சுற்றுசூழல் தூங்கசு தமிழில்

TOTAL: 30 PERIODS
தமிழ் துறைமுக வலிப்பிள்ளைகள் / புத்தகக் கலைகள்

1. தமிழ் துறைமுக தொழில்முறைக் கல்விகழகம் (Tamil Virtual University) - www.tamilvu.org
2. தமிழ் விக்கிப்பீடியொ (Tamil Wikipedia) - https://ta.wikipedia.org
3. திருச்சிராப்பள்ளி பேராசிரியர்
4. வழக்குடல் கல்விகளம் - தமிழ் பேரரசு கல்வி துறைமுகம்
5. தமிழ் கல்விகளம் - தமிழ் விளக்கக் கல்வி (thamilvalarchithurai.com)
6. அறிவியல் கல்விகளம் - தமிழ் பேரரசு கல்வி துறைமுகம், திருச்சி