SCHOOL OF CIVIL ENGINEERING
M.TECH. PROGRAMME

Specialization: Construction Engineering & Management

Curricula & Syllabi

ACADEMIC CURRICULA – 2024

Kalinga Institute of
Industrial Technology (KIIT)
Deemed to be University
(Established U/S 3 of UGC Act, 1956)
Bhubaneswar, Odisha, India

School of Civil Engineering
M. Tech. Program
Specialization: Construction Engineering and Management

Semester-I

Sl. No	Subject Code	Course Title	Contact Hours per Week			Credit
			L	T	P	
1	CE60003	Computational Methods in Civil Engineering	3	0	0	3
2	EX60001	Research Methods & Documentation	3	0	0	3
3	CE60101	Construction Finance Management	3	0	0	3
4	CE60105	Construction Contract Management & Quantity Surveying	3	0	0	3
5	CE60107	Infrastructure Management	3	0	0	3
6		**Elective-I**	3	0	0	3
7	CE68101	Computational Lab	0	0	3	2
					Total	20

Semester-II

Sl. No	Subject Code	Course Title	Contact Hour per Week			Credit
			L	T	P	
1	CE60004	Soft Computing Techniques in Civil Engineering	3	0	0	3
2	CE60102	Construction Engineering Practices	3	0	0	3
3	CE61104	Advanced construction Materials	3	1	0	4
4	CE60106	Construction Methods and Equipment	3	0	0	3
5		**Elective-II**	3	0	0	3
6	CE68104	Project Management Applications	0	0	2	1
7	CE68106	Advance Material Testing Lab	0	0	2	1
8	CE68108	Comprehensive viva voce	0	0	2	2
					Total	20

Semester-III

Sl. No	Subject Code	Course Title	Contact Hour per Week			Credit
			L	T	P	
1		**Open/ Industry Elective**	3	0	0	3
2	CE67101	Thesis Part-I	0	0	32	16
3	CE68103	Seminar	0	0	2	1
					Total	20

Semester-IV

Sl. No	Subject Code	Course Title	Credit
1	CE67102	Thesis Part-II	20

LIST OF DEPARTMENT ELECTIVES

Elective-I

Sl. No.	Course Code	Course Title	Credit
1	CE60131	Advanced Repairs and Rehabilitation of Structures	3
2	CE60133	Project quality and Safety Management	3
4	CE60137	Building Science	3
5	CE60139	Roads and Highway Project Development	3
6	CE60143	Building Information Modeling	3
7	CE60321	Geo-spatial Engineering	3

Elective-II

Sl. No	Course Code	Course Title	Credit
1	CE60132	Building Services Planning	3
3	CE60136	Quality Control in Construction	3
4	CE60138	Construction Material Management	3
5	CE60140	Management of Underground Construction and Marine Structures	3
6	CE60142	Green Construction Management	3
7	CE60150	Project Formulation and appraisal	3

COMPUTATIONAL METHODS IN CIVIL ENGINEERING

Course Code: CE60003
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OUTCOMES

At the end of the course, the students will be able to
CO 1: Comprehend the measure of central tendency, dispersions and correlation coefficients,
CO 2: Use the Curve Fitting & Least Square Techniques in the experimental methods,
CO 3: Apply the concept of probability and set theory in practical problems,
CO 4: Apply the concept of probability distribution functions,
CO 5: Determine roots of algebraic equation by different methods and obtain interpolating polynomials, and
CO 6: Solve ODE and PDE using numerical techniques.

COURSE DETAILS

Measures of Central Tendency & Dispersions; Covariance; Correlation Coefficients and their Properties in field data;
Curve Fitting & Least Square Techniques and their use in the experimental methods in Civil Engineering; Concept of Regressions; Regression curve in Bi-variate Frequency Distributions;
Introduction to probability and set theory; Probabilistic measures; Conditional probability and Bayes' theorem; Discrete and continuous random variables;
Probability Density Functions; Probability Distributions of Single and Multiple Random Variables; Discrete & continuous distributions; Chi-Square Test; Kolmogorov-Smirnov Test; Analysis of Variance.
Linear equations and eigen value problems, Accuracy of approximate calculations, Nonlinear equations, interpolation, differentiation and evaluation of single and multiple integrals
Initial and boundary value problems by finite difference method, Newton's method, variation and weighted residual methods,

Textbooks

1. Applied Statistics and Probability for Engineers by Douglas C. Montgomery and George C. Runger, Wiley India Pvt. Ltd, 2009.
2. Jay L. Devore, Probability and Statistics for Engineering and the Sciences, Brooke & Cole, 2009.
3. J. B. Scarborough, Numerical Mathematical Analysis, Oxford & IBH Publishing Co. Pvt. Ltd., 2000.
4. K. K. Jain, S. R. K Iyengar and R. K. Jain, Numerical Methods - Problem and Solutions, Wiley India Pvt. Ltd, 2001.

Reference Books

1. W. Mendenhall and T. Sincich, Statistics for Engineering and the Sciences, Prentice-Hall, 2000.
2. Steven Chapra and Raymond Canale, Numerical Methods for Engineers, McGraw-Hill Education; 6th edition 2012.

SOFT COMPUTING TECHNIQUES IN CIVIL ENGINEERING

Course Code: CE60004
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OUTCOMES

At the end of the course, the students will be able to

CO 1: Comprehend the basic concepts of soft computing,
CO 2: Use generic algorithms and Particle swarm intelligence algorithms,
CO 3: Prepare prediction model using neural network,
CO 4: Apply supervised machine learning techniques,
CO 5: Apply the techniques of unsupervised machine learning, and
CO 6: Implement soft computing techniques in Civil Engineering problems.

COURSE DETAILS

Introduction to Soft Computing: Basic concepts, various Soft Computing Techniques, Overview of conventional computing vs. soft computing, Characteristics and advantages of soft computing techniques

Genetic Algorithms (GA):Introduction to genetic algorithms, Representation schemes: binary, real-valued, permutation, Genetic operators: selection, crossover, mutation.

Particle Swarm Optimization (PSO):Introduction to particle swarm optimization, Swarm intelligence principles, PSO algorithm components: particles, velocity update, position update, Ant Colony Optimization (ACO):Basics of ant colony optimization, Ant behavior modeling, ACO algorithm: pheromone trails, ant movement, Pigeon search algorithm.

Artificial Neural Networks (ANN):Fundamentals of neural networks, Single-layer and multi-layer perceptions, Training algorithms: back-propagation, gradient descent, Convolutional Neural Networks (CNN),

Fuzzy Logic Systems: Basics of fuzzy set theory, Fuzzy logic operations and rules, Fuzzy inference systems

Introduction to Machine Learning, Basic Concepts, Supervised learning, unsupervised learning, reinforcement learning, Python libraries

Supervised Learning Techniques: Decision trees and ensemble methods (Random Forests), Support Vector Machines (SVM), , Basic concepts and principles, k-nearest neighbor (kNN)

Unsupervised Learning Techniques: Clustering, K-means clustering, Hierarchical clustering, Dimensionality Reduction, Principal Component Analysis (PCA)

Application of soft computing in Civil Engineering
Application of different algorithms to solve practical problems of Civil Engineering.

Textbooks / Reference Books

1. Pratihar D.K., Soft Computing, Narosa Publishers, and ISBN: 978-81-8487-495-2, 2018.
2. Mangey Ram, J. Paulo Davim, Soft Computing Techniques and Applications in Mechanical Engineering, IGI Global, USA.
3. Simeone O. Machine learning for engineers. Cambridge University Press; 2022.
4. E. Alpaydin, Introduction to Machine Learning, Prentice Hall of India, 2006.

CONSTRUCTION FINANCE MANAGEMENT

Course Code: **CE60101**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OUTCOMES
After successful completion of the course, the students will be able to:
CO 1 Comprehend the construction accounting and engineering economics,
CO 2 Assess the best alternatives for financial investments in construction project,
CO 3 Interpret the cost elements associated with the different phases of construction,
CO 4 Explain the parameters associated with risk and uncertainty,
CO 5 Illustrate the inflation and escalation associated with project,
CO 6 Explain the capital budgeting and working capital management parameters.

COURSE DETAILS
Construction accounting, Profit & Loss, Balance sheet, Income statement, Ratio analysis, Depreciation and amortization, Engineering economics, time value of money, discounted cash flow, NPV, ROR, PI, comparison, incremental rate of return, benefit-cost analysis, replacement analysis, break even analysis, risks and un-certainties, international finance.
Management decision in capital budgeting and inflation,
Work pricing, cost elements of contract bidding and award, revision due to unforeseen causes, escalation,
Turnkey activities, project appraisal and project yield, working capital management finance. International finance,
Budgeting and budgetary control, Performance budgeting appraisal through financial statements,
Practical problems and case studies, project cash flow.

Books

1. Pannerselvam R., Engineering Economics, P.H.I , N.D. 2012,
2. Shrivastava U.K., Construction Planning & Management, Galgotia N.D, 2012,
3. Chandra Prasanna, Project Planning, Analysis, Selection, Implementation & Review ,(Tata McGraw Hill Publishing Co Ltd, ND, 2010,
4. Koontz Harold and Heinz Weihrich, Essentials of Management, Mc. Graw Hill,
5. Verma M. .M. and Agarwal, Principles of Management, Himalaya Publisher, 2008,
6. Singh B.P. and Chhabra J.N, Essentials of Management, South Western College Publishing, 1991,
7. Khanna O.P., Industrial Engg and Management, Khanna Publisher, 2008,
8. Reggs J.L., Engineering Economics, Mc Graw Hill, 1976,
9. Sengupta B. and Guha H., Construction Management and Planning, Tata Mc Graw Hill, ND 1995,
10. Pilcher, Principle of Construction Management, Mc Graw Hill, 1981

CONSTRUCTION CONTRACT MANAGEMENT & QUANTITY SURVEYING

Course Code: **CE60105**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OUTCOMES

After successful completion of the course, the students will be able to:

CO 1 Comprehend the stages of tendering process,
CO 2 List the common documentations of any construction project tender,
CO 3 Execute the estimation and billing for a construction project,
CO 4 State thoroughly about the types of construction contracts,
CO 5 Recognize the origin of claims associated with the construction project,
CO 6 Explain the construction disputes and mechanism of its settlement.

COURSE DETAILS

Tendering (Bidding): Definition, Types of tenders including its advantage and disadvantage, Typical stages of tendering process, Important terms in tendering, Presentation of bid & its evaluation. Registration of vendors of the required goods and services and their pre – qualification criteria, preparing prequalification documents. Preparation of tender documents and invitation to bid.

Quantity Surveying: Measures and mensuration, Types of estimation, Steps in estimation process, Methods of taking off quantities, Standard forms for entering detailed measurements, abstracting and billing, Methods of building estimate, Estimates of RCC works, Methods of measurement of major works in accordance of IS: 1200 and other important components, Analysis of rates, Schedule of rates, Use of cost data in estimation. Fixed & flexible budgets, Effects of inflation on profitability.

Construction Contracts Management: Definition, Essential elements of a valid contract, about Indian Contract Act, Classification of contracts, Types of construction contracts, Contract documents, Salient features of the contract, Various important clauses of contracts related to time extension & cost compensation stated in GCC, SCC, ITB, Minutes of pre-bid meeting, addendum etc., Important submittal, Employer's claim, Role & responsibility of Employer, Engineer / Consultant & Contractor, Settlement of disputes including ADR Mechanism, about Indian Arbitration & Conciliation Act, Types of construction claims & its origin.

Textbooks

1. Dutta B.N., "Estimating and Costing in Civil Engineering – Theory and Practical" , UBS Publishers Distributors Pvt. Ltd. , New Delhi, 2002,
2. Kohli D.D. and Kohli R.C., A Text Book of Estimating and Costing, S Chand publisher,
3. Prakash V.A., "Contract Management in Civil Works Projects – A Text Book", NICMAR, 1997,
4. Ashworth, A. , "Civil Engineering Contractual Procedures", Longman, Harlow, 1998,
5. Singhal Ajay Kumar , "Basics of Construction Management" , SEA, 2014,
6. Clough Richard, "Construction Contracting", 5th edition, John Wiley & Sons, New York, 1986,
7. McCaffer R. & Baldwin A.N. , "Estimating & Tendering for Civil Engineering Works", Thomas Telford, London, 1991,
8. Patil, B.S., "Civil Engineering Contracts And Estimates", University Press , 4th Edition 2015,
9. Thomas R., "Construction Contract Claims" , Macmillan, London, 1993.

INFRASTRUCTURE MANAGEMENT

Course Code: **CE60107**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OUTCOMES

After successful completion of the course, the students will be able to:
CO 1: Comprehend the concepts of Project Management for planning of any projects,
CO 2: Annotate the feasibility for identification and selection of Project,
CO 3: Optimize the cost, time and resources of a project using management techniques,
CO 4: Execute various techniques for Project planning, scheduling, execution and control,
CO 5: Identify the risk and propose techniques to reduce the risk of the project,
CO 6: Comprehend the Project Management Software used in construction projects.

COURSE DETAILS

Basics of Project Management: Introduction, Need for Project Management, Project Management Knowledge Areas and Processes, The Project Life Cycle, The Project Manager (PM), Phases of Project Management Life Cycle, Project Management Processes, Impact of Delays in Project Completions,
Project Identification and Selection: Introduction, Project Identification Process, Project Initiation, Pre-Feasibility Study, Feasibility Studies.
Project Planning: Introduction, Project Planning, Need of Project Planning, Roles and Responsibility project leader, Project Planning Process, Work Breakdown Structure (WBS), Concept of Organisational Structure (OBS), LOB.
PERT and CPM: Introduction, Development of Project Network, Time Estimation, Determination of the Critical Path, Floats and types, Time- Cost trade off, Direct and Indirect cost, Cost slope, Crashing of project time, PERT Model, Time estimates, Slack and types, Critical path, Probability of Completion Time for a project.
Project Resource leveling: Introduction, Resource Allocation, Resource Smoothening and Leveling, Project Cost Estimate and Budgets, Cost Forecasts
Project Risk Management: Introduction, Risk, Risk Management, Role of Risk Management in Overall Project Management, Steps in Risk Management, Risk Identification, Risk Analysis, Reducing Risks

Project Performance Measurement and Evaluation: Introduction, Performance Measurement, Productivity, Project Performance Evaluation, Benefits and Challenges of Performance Measurement and Evaluation,
Project Execution and Control: Introduction, Project Execution, Project Control Process, Purpose of Project Execution and Control, Project Close-out, Termination and Follow-up: Introduction, Project Close-out, Steps for Closing the Project.
Project Management Software: Introduction, Advantages of Using Project Management Software, Common Features Available In Most of the Project Management Software

Books:

1. Jha Kumar Neeraj, Construction Project management Theory and Practice, Pearson- 2011,
2. Nagarajan K., Project Management, New Age International Publishers, Sixth Edition 2011,
3. Shrivastava U. K., Construction, Planning and Management, Galgotia Publication, -2012,
4. Sengupta & Guha, Construction, Planning and Management, Tata Mc Graw Hill, ND 1995,
5. Chitkara K.K, Construction Project Management Planning, Scheduling and Control, Tata Mc Graw Hill Publishing Co New Delhi ,1998,
6. Moder. J., Project Management with CPM, PERT and Precedence Diagramming,Van Norstrant Reinhold Co.,
7. Peurifoy R.L., Construction, Planning, Equipments and Methods, McGraw Hill -2010,
8. Gahlot & Dhir, Construction, Planning and Management, New Age Publisher- 2010,
9. Feigenbaum, L, Construction scheduling with PRIMEVERA Project Planner, Prentice Hall Inc 1999,
10. Pilcher, Principle of Construction Management, Mc Graw Hill 1981.

COMPUTATIONAL LAB

Course Code: **CE68101**
Credit: **1.5**
L-T-P: **0-0-3**
Prerequisite: **Nil**

COURSE OUTCOMES

CO 1 Prepare the Plans and Elevation of structures using Auto Cad soft ware,
CO 2 Prepare BOQ of any project using MS-Excel,
CO 3 Prepare rate analysis of various activities of project using MS-Excel,
CO 4 Prepare Bar bending Schedule of RCC structures,
CO 5 Prepare Material Procurement Chart etc,
CO 6 Prepare Material Reconciliation Statement using M. S. Excel.

COURSE DETAILS

Drawing Plans and Elevation by using Auto Cad soft ware,
Estimating A Building, Rate analysis, Depreciation study by using M. S. Excel
Bar bending Schedule, Material Procurement Chart, and Material Reconciliation Statement
by using M. S. Excel.

CONSTRUCTION ENGINEERING PRACTICES

Course Code: CE60102

Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OUTCOMES

After successful completion of the course, the students will be able to:
CO 1 Select the best techniques of concreting in different environments,
CO 2 Comprehend the different process and techniques of formwork and scaffoldings,
CO 3 Explain various construction practices /techniques used for special type structures,
CO 4 Explain the applications of different type of curing methods,
CO 5 Appraise the application of Prefab construction in current scenario,
CO 6 Compare the techniques of construction practices in special constructions.

COURSE DETAILS

Concrete construction methods, Pumping of concrete and grouting, mass concreting (roller compacted concrete), ready mixed concrete. Various methods of placing and handling concrete,
Accelerated curing, hot and cold weather concreting, under water concreting,
Form work design and scaffolding, slip form and other moving forms,
Pre-stressing, Steel and composites construction methods; Fabrication and erection of structures including heavy structures, Special construction methods; Prefab construction, Industrialized construction,
Modular coordination, Construction in Marine environments, high rise construction, Bridge construction including segmental construction, incremental construction and push launching techniques, River valley projects.

Books:

1. Peurifoy Robert L and Oberiender Garold D., Formwork for Concrete Structures, McGraw-Hill,1996,
2. Hurd M.K, Formwork for Concrete, Special Publication No-4, (Fifth Edition)American Concrete Institute, Detroit,1980,
3. Detroit, Guide for Concrete Formwork. American Concrete Institute. Box No 19150, Michigan-48219.

ADVANCED CONSTRUCTION MATERIALS

Course Code: CE61104
Credit: 4
L-T-P: 3-1-0
Prerequisite: Nil

COURSE OUTCOMES

After successful completion of the course, the students will be able to:
CO 1 Comprehend the changes that happen in concrete with age
CO 2 Suggest various techniques to improve durability and prevent corrosion in reinforced concrete
CO 3 Explain the utilization of various industrial wastes in concrete
CO 4 Identify the applications of Ferro-cement concrete materials
CO 5 Suggest sustainable reinforcing materials in construction
CO 6 Compare the suitability of different advanced materials in construction

COURSE DETAILS

Cement and Concrete:
Hydration of cement and products of hydration, Transition zone, Mechanical strength of cement gel, water held in hydrated cement paste and heat of hydration, Factors affecting the strength of concrete, Change in concrete with time.

Durability of concrete:

Effects of the water-cement ratio, Permeability, Acid resistance, Sulphate resistance, Chloride resistance, Fire resistance, Alkali silica reaction and Carbonation of concrete. Corrosion of reinforced concrete with protection and control.

Advanced concretes:

Air-entrained concrete, Fibre reinforced concrete, Lightweight concrete, High-density concrete, Polymer concrete, Concrete made with waste stream materials like fly ash, silica fume and ground granulated blast furnace slag. Geopolymer concrete, Reactive powder concrete, Self-compacting concrete, Self-healing concrete, Light-generating concrete, Flexible concrete, Concrete canvas, Martian concrete, Green concrete

Ferrocement:

Materials and mix proportion, Behaviour in compression, Behaviour in tension, Behaviour in flexure, Modulus of elasticity, Creep and shrinkage, durability and fire resistance. Design criteria, manufacturing process and application of ferrocement

Advanced reinforcing materials:

3D printed graphene, Hemp reinforcement, Bamboo reinforcement, Bio-plastic reinforcement, Strand rods

Material of the future:
Cross-laminated timber, Mycelium, Translucent wood, Transparent aluminum, Liquid graphene, Rammed earth, Sensitiles, Richlite, Hydroceramics,

Books:

1. Shetty M S., Concrete Technology, S.Chand Publisher, 2013
2. Wu CH, Advanced Civil Infrastructure Materials, Woodhead Publishing, CRC Press
3. Shansomayoji, Civil Engineering Materials, Second Edition, Prentice Hall Inc-2001,
4. Derucher, K. Korfiatis. G and Ezeldins, Materials for Civil and Highway Engineers by, Fourth Edition, Prentice Hall Inc,1999,
5. Aitkens, High-Performance Concrete, Mc Graw Hill,1999.

CONSTRUCTION METHODS AND EQUIPMENT

Course Code: CE60106
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OUTCOMESS

After successful completion of the course, the students will be able to:
CO 1 Describe various parameters associated with the selection of construction equipment,
CO 2 Appraise the owning and operating cost of construction equipment,
CO 3 Classify the construction equipments based on their application,
CO 4 Examine the output/ production of construction equipment,
CO 5 Execute the planning of construction equipment for various construction works,
CO 6 Describe the methods of deep foundation constructions.

COURSE DETAILS

Construction Equipment: Factors affecting selection of equipment, Owning and Operating Cost.
Construction Equipment fundamentals: Classification of Construction Equipment, Earth moving Equipments, Hauling, Hoisting, Conveying Equipments, Aggregate and concrete production Equipments, Pile Driven Equipments, Cranes.
Analysis of production output and costs of Excavating Equipments, Characteristics and performances of equipment for Earth moving. Construction equipment planning.
Deep excavation support systems: Diaphragm wall, sheet piling, secant pile, contiguous pile, strutting, ground anchors

Books:

1. Peurifoy R.L., Clofford P.E,J Sehexnayder, P.E., Construction Planning, Equipment and Methods. Tata Mc Graw Hill Publishing ,N.D-2012,
2. Seetharaman S., Construction Engineering and Management, ,4th Edition-2007, Laxmi Publication-2008,
3. Deodhar S.V., Construction Equipment and Job Planning, Khanna Publisher,2008,
4. Sharma S.C., Construction Equipment and Management, Khanna Publishers, New Delhi, 2008,
5. Verma Mahesh, Construction Equipment and its Planning and Application, Metro Politan Book Company, New Delhi,
6. Satyanarayana and Saxena, Construction Planning and Equipment, Standard Publishers- 2008,
7. Vazirani and Chandola, Heavy Constructiony, Khanna Publisher Delhi -2008.

PROJECT MANAGEMENT APPLICATIONS

Course Code: CE68104
Credit: 1
L-T-P: 0-1-2
Prerequisite: Nil

COURSE OUTCOMES:

After successful completion of the course, the students will be able to:
CO1 Prepare plan and schedule of any project using MS-Excel,
CO2 Prepare plan and schedule of any project using MS-Project,
CO3 Prepare plan and schedule of any project using PRIMAVER planner-6,

CO4 Prepare the progress of any project using PRIMAVER P6,
CO5 Update and monitor the progress of any project using PRIMAVER P6,
CO6 Update and monitor the progress of any project using MS-Project.

COURSE DETAILS:
Basic exposure to M.S. Project and Primavera Planner-6. Preparation of construction program using MS. Excel, MS Project and PRIMAVER P6. Project updating and progress monitoring.

ADVANCE MATERIAL TESTING LAB

Course Code: CE69106
Credit: 1
L-T-P: 0-0-2
Prerequisite: Nil

COURSE OUTCOMES
CO 1 Comprehend the mix design procedure of cement concrete,
CO 2 Design different grades of mix design of concrete,
CO 3 Design different grades of mix using trial and error techniques,
CO 4 Perform Compressive strength and flexural strength of concrete and RCC beam,
CO 5 Perform the flowability tests of self compacting concrete,
CO 6 Perform different non destructive test of hardened concrete.

COURSE DETAILS
Material Testing, Concrete Mix Design by IS code method and Trial Error method,
Compressive strength, Flexural Strength test. SCC Design and flowability study
NDT Testing, Rebound Hammer Test, Ultrasonic Pulse Velocity Test

SEMINAR

Course Code: CE68103
Credit: 1
L-T-P: 0-0-2
Prerequisite: Nil

COURSE OUTCOMES
After successful completion of the course, the students will be able to:
CO 1 Comprehend the correlation of all subjects,
CO 2 Communicates and defend ones technical knowledge effectively,
CO 3 Appraise the subject proficiency,
CO 4 Communicate the skill acquired during the program effectively,
CO 5 Identify the pros and cons of his performance,
CO 6 locate his expertise after presentation,

COURSE DETAILS:
The topics of the seminar preferably to be related to the subjects.

ADVANCED REPAIRS AND REHABILITATION OF STRUCTURES

Course Code: CE60131
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OUTCOMES:
After successful completion of the course, the students will be able to:

CO 1 Describe different structural strengthening and retrofitting methods of columns, beams, walls, footings and slabs, piers of concrete structures,
CO 2 Explain specialized repair methods of structures,
CO 3 Explain retrofitting by composite materials,
CO 4 State seismic retrofitting of damaged structures,
CO 5 Formulate maintenance schedule for structures,
CO 6 Describe special cares in repair and rehabilitation of heritage structures,

COURSE DETAILS:
Introduction: Need for strengthening due to various reasons such as ageing, natural calamities, increase of load, change of function and design, construction errors.
Structural Strengthening: Strengthening and retrofitting of columns, beams, walls, footings and slabs, piers of concrete structures by jacketing, external post-tensioning, replacing or adding reinforcement, plate bonding, textile reinforced concrete.
Specialized Repairs: Electro chemical repair using re-alkalization and chloride extraction techniques, Specialized repairs for chemical disruption, fire, marine exposure etc, Repair of damaged structures of water retaining structures, hydraulic structures, Pavements and Runways, Tunnels, Bridges, Piers and Flyovers, Parking Garages, Underwater repair, Masonary Repair, Repair and Restoration of Heritage Structures.
Retrofitting by composite materials: Fiber reinforced concrete, Ultra-high performance fibre reinforced concrete (UHPFRC), Fiber reinforced composites, Carbon fibre reinforced polymer (CFRP), Fibre wrapping (Carbon, Aramide, Glass).
Seismic Retrofitting: Seismic strengthening of existing RC structures, Use of FRP for retrofitting of damaged structures.
Post-Repair Maintenance of Structures: Protection & Maintenance schedule against environmental distress to all those structures.
Special cares in repair and rehabilitation of heritage structures

Books:

1. Campbell Denison, Allen and Roper Harold, Concrete Structures: Materials, Maintenance and Repair, Longman Scientific and Technical UK, 1991,
2. Allen R. T. and Edwards S. C., Repair of Concrete Structures, Blakie and Sons, UK,1987,
3. Shetty M. S., Concrete Technology - Theory and Practice, S. Chand and Company, ND- 2013

PROJECT QUALITY AND SAFETY MANAGEMENT

Course Code: CE60133
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OUTCOMES:
After successful completion of the course, the students will be able to:
CO 1 Identify different techniques of quality control and select the appropriate one for given conditions,
CO 2 Explain the quality control and quality assurance during construction of a project,
CO 3 Describe the concept and philosophy of quality management,
CO 4 Explain safety and various parameters associate with safety in construction,
CO 5 Organize the safety standards to avoid accidents and injuries during construction,
CO 6 Explain the safety awareness and implementation training to the site workers.

COURSE DETAILS:
Introduction to quality planning and control of quality during design of structures, Quantitative techniques in quality control, Quality assurance during construction, Inspection of materials and machinery in process inspection and test, Preparation of quality manuals, check list and inspection report, Establishing quality assurance system, Quality standards/ codes in design and construction,
Concept and philosophy of total quality management (TQM), Training in quality and quality management systems (ISO-9000),
Concept of safety, Factors affecting safety, Physiological, Psychological and Technological, Planning for safety provisions, Structural safety, Safety consideration during construction, demolition and during use of equipment, Management of accidents/ injuries and provision of first aid, Provisional aspect of safety, Site management with regard to safety recommendations, Training for safety awareness and implementation, Formulation of safety manuals, safety legislation, standards/ codes with regard to construction, Quality vs Safety. Case studies.

Books:

1. Hinze Jimmy W., Construction Safety, Prentice Hall Inc 1997,
2. Richard J. Coffe, Jimmie Hinze and Theo C. Haud, Construction Safety and Health Management, Prentiee Hall Inc- 2001,
3. Shrivastav U.K., Tamilnadu Factory Act Construction Planning and Management, Golgotia Publication – 2000.

BUILDING SCIENCE

Course Code: CE60137
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OUTCOMES
After successful completion of the course, the students will be able to:
CO 1 Explain urban planning, zoning,
CO 2 Explain physical and functional planning of buildings,
CO 3 Examine fire rating of building construction,
CO 4 Develop the layout plan of lift & escalator in building as per fire safety rules,
CO 5 Design of building components for sound absorption and insulation,
CO 6 Design the fenestration in different buildings.

COURSE DETAILS:
Climatic factors, classification of tropical climates, site climate, microclimate of human settlements, ventilation requirements for health, mechanisms and estimation for natural ventilation, airflow patterns in building.

Thermal comfort factors, comfort indices, thermal quantities, heat exchange in buildings, periodic heat flow, mechanical and structural means of thermal control, Moisture control in buildings, fire safety rules, fire rating systems, lift and escalators.
Propagation of sound, sound insulation, absorption and transmission, reverberation, design of floor, roofing and walling system for sound absorption and insulation, design of auditoria, noise control in buildings,
Day lighting, design of fenestration in buildings for day light of various types, illumination design, luminaries and their characteristics, codal requirements.
Introduction to functional based design for example hospital structures, residential structures, hotels, factories, IT buildings etc.

Books:

1. Koenigsberger O.H., Ingersoll T.G., Mayhew Alan & Szokolay S.V., Manual of Tropical Housing and Buildings (Climatic Design), Orientloagman ,160 Anna Salai,Madras-2,
2. Ailtasimha D., Building Environment, TMH, 12/4 Asafali Road, N.D.11002,
3. Mooref, Environmental Control System, McGraw-Hill Inc,1994,
4. Verghese, Building Construction, PHI EEE New Delhi- 2012,

5. Nathanson, Basic Environmental Technology (Water Supply waste Management, & Pollution Management, PHI India, 2010.

ROADS AND HIGHWAY PROJECT DEVELOPMENT

Course Code: CE60139
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OUTCOMES
After successful completion of the course, the students will be able to:

CO1: Explain road development process.
CO2: Describe the issues related to managing road construction projects,
CO3: Discuss design standards and specification used for road construction,
CO4: Describe financial models used for highway projects,
CO5: Examine the feasibility of the highway projects,
CO6: Explain the road construction process till the handing over.

COURSE DETAILS:
Defining the need and scope for a highway project; Type of highway projects; Design standards based on IRC and MoRT and H guidelines, Highway project development process as per the norms of NHAI, PWD; Various survey and investigations for highway project; Environmental impact assessment, social impact assessment, land acquisition, rehabilitation and resettlement and utility shifting, methods of project procurement, budgeting and funding agencies, preparation of feasibility reports, revenue models, financial closure; Road construction procedure - Contractor's site investigations, Mass haul diagrams, regulatory permits and clearances, work method statements, safety measures during construction, inspection, approval and handing over of works.

Reference books:

1. Chandra, P. (2007). Projects – Planning, analysis, selection, financing, implementation and review. Tata McGraw-Hill,New Delhi.

2. Colm A O'Flaherty (2007). Highways: The location, design, construction and maintenance of road pavements. Elsevier Ltd. Publications.
3. IRC SP: 19. (2001). Manual for survey, investigation and preparation of road projects. The Indian Roads Congress, New Delhi
4. IRC SP: 30 (2009). Manual on economic evaluation of highway projects in India. The Indian Roads Congress, New Delhi
5. IRC: 119 (2015). Guidelines for traffic safety barriers. The Indian Roads Congress, New Delhi
6. IRC: 108 (2015). Guidelines for traffic forecast on highways (First Revision). The Indian Roads Congress, New Delhi
7. IRCSP: 112 (2017). Manual for quality control in road and bridge works. The Indian Roads Congress, New Delhi
8. IRC SP: 87 (2013). Manual of specification and standards for six laning of highways through public private partnership (First Revision).The Indian Roads Congress, New Delhi
9. IRC SP: 99 (2013). Manual of Specifications and Standards for Expressways. The Indian Roads Congress, New Delhi
10. Kumar, R. Srinivasa (2013). Textbook of highway engineering. University Press (P) Ltd.
11. Rajib B. Mallick and Tahar El-Korchi (2013). Pavement engineering-principles and practice. CRC press, Taylor and Francis Group.
12. Saxena, S. C. (2014). Textbook of highway and traffic engineering. CBS Publishers and Distributors Pvt. Ltd.

BUILDING INFORMATION MODELING

Course Code: CE60143
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OUTCOMES:
After successful completion of the course, the students will be able to:

CO1 Identify the fundamentals of BIM and its benefits
CO2 Explain the various BIM dimensions.
CO3 Explain the different aspects of collaborative modeling, BIM based scheduling and estimating.
CO4 Explain the basics of drafting like creating a drawing, dimensioning, annotating
CO5 Integrate the personal and group knowledge to achieve positive results in complex engineering and construction tasks.
CO6 Explain the application of BIM like clash detection, timeline simulation, quantity take-offs.

COURSE DETAILS:
Fundamentals of BIM and its benefits; BIM as a collaborative construction process; Use of BIM by all project stakeholders, introduction and use of a federal model concept; BIM dimensions, introduction to basics of drafting like creating a drawing, dimensioning, annotating, etc.; Information modeling of buildings using in-built families; 3D clash detection and resolution; 4D timeline simulation; 5D quantity take-offs, application of shared virtual platform for project information management.
Reference books:

1. Crotty, R. (2012). The impact of building information modelling : Transforming construction. Spon Press.

2. Eastman, C., Teicholz, P., Sacks, R. and Liston, K. (2008). BIM Handbook, a guide to building information modeling for owners, managers, designers, engineers, contractors. John Wiley and Sons, New Jersey.
3. Fox, L.C., Balding, J.J. (2011). Introducing and ACM C A20: BUILDING INFORMATION
4. MODELING implementing revit architecture 2009, Delmar/Cengage Learning.
5. Hardin, B., Mccool, D. (2015). BIM and construction management proven tools, methods and workflows. John Wiley and Sons.
6. Kymell, W. (2008). Building information modelling: Planning and managing construction projects with 4D CAD and simulations. The Mcgraw-Hill Companies, Inc.

GEO-SPATIAL ENGINEERING

Course Code: CE60321
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OUTCOMES

After successful completion of the course, the students will be able to:

CO1: Explain the principle of remote sensing,
CO2: Interpret and analyze the digital images,
CO3: Explain the fundamental operations of GIS,
CO4: Manage GIS data files and also analyze the spatial and attribute data,
CO5: Describe different applications of remote sensing & GIS, and
CO6:Interpret the application of remote sensing and GIS in various water resources applications.

COURSE DETAILS

Principle of Remote Sensing: Introduction, Historical development of remote sensing, Passive and active remote sensing, Electromagnetic radiation, Energy interactions in the atmosphere and earth surface features, Spectral reflectance curves, Remote sensing system: Satellites and orbits, types of satellites, multispectral, thermal and hyperspectral sensing, remote sensing satellites and their features Digital image interpretation and analysis: Geometric corrections, Image enhancement techniques, Image classification, Image transformations, vegetation indices, Digital image processing software, Passive and active microwave remote sensing, Geographic Information Systems (GIS): Introduction, different components of GIS, maps and map scale, Geo referencing and projections, Spatial data modelling, GIS data management, Spatial interpolation techniques, Digital elevation models, Demonstration through GIS software, Limitations of GIS, Integration of Remote sensing and GIS Global positioning system (GPS): Introduction, principle and errors in GPS measurement, Differential global positioning system (DGPS).

Textbooks/ Reference Books:

1. T.M. Lilles, R.W. Kiefer and J.W. Chipman, Remote sensing and Image Interpretation, 2015, 7th Edition, John Wiley & Sons Ltd., England.
2. C.P.L.O. Albert, K.W. Yong, Concept and Techniques of GIS, Prentice Hall Publishers.
3. P.A. Burrough and R. A. McDonnell, Principles of geographical information systems by, 1998, Oxford University Press.

4. M.A. Reddy, Remote Sensing and Geographical Information Systems, 2008, 3rd Edition, BS Publications, India.
5. P.J. Gibson, Introductory Remote Sensing- Principles and Concepts by, 2000, Routledge, London.
6. M.F. Goodchild, P.A. Longley, D.J. Maguire and D.W. Rhind, U.K. Geographic information systems and science by, 2001, John Wiley & Sons Ltd., England.

BUILDING SERVICES PLANNING

Course Code: CE60132
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OUTCOMES:

After successful completion of the course, the students will be able to:
CO 1 Explain various factors associated with building planning,
CO 2 Explain neighbourhood planning of buildings,
CO 3 Explain the functional planning of the building,
CO 4 Formulate the linear and non-linear optimization problems,
CO 5 Determine various services of building like: fire rating, escape system, cold and hot water systems, waster water systems, and electrical systems,
CO 6 Develop the layout plan of lift & escalator in building as per fire safety rules.

COURSE DETAILS:

Components of urban forms and their planning,
Concepts of neighborhood unit, Street system and layout in a neighborhood,
Functional planning of buildings, optimization of space; Spatial Synthesis graphical techniques, heuristic procedures, formulation of linear and non-linear optimization problem.
Space requirements and relationships for typical buildings, like residential offices, hospitals
Standard fire, fire resistance, classification of buildings, means of escape, alarms,
Engineering services in a building as a systems, Lifts, escalators, cold and hot water systems, waster water systems, and electrical systems

Books:

1. Mooref, Environmental Control Systems, McGraw Hill,Inc 1994,
2. Peter R.Smith and Warren G.Jullian, Building Services by, Applied Science, Publisher ltd, London,
3. Elder A.J. and Martix Vinder Bary, Hand book of Buildings and Enclosure, McGraw Hill Book Co, 1982
4. Janetaylor and Gordin Coone, The fire Precautions Act in Practices 1987, Architectural Press.

QUALITY CONTROL IN CONSTRUCTION

Course Code: CE60136
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OUTCOMES:
After successful completion of the course, the students will be able to:

CO 1 Comprehend the quality management system for a construction project,
CO 2 Describe a quality inspection procedure,
CO 3 Explain the objectives and methods of quality policy in construction industry,
CO 4 Interpret quality assurance and control of different types of construction,
CO 5 Appraise the different aspects of quality influencing construction,
CO 6 Explain the value engineering and value analysis of construction project.

COURSE DETAILS:
Construction Organization
Types of Organization-Inspection, Control and enforcement, Quality Management Systems and Method, Responsibilities and authorities in Quality assurance and Quality control-Architects, Engineers, Contractors, and Consultants, Quality circle
Quality Planning
Quality policy, Objectives and methods in construction industry-Consumer satisfaction- Ergonomics -Time of Completion-Statistical Tolerance-Taguchi's concept of quality- Codes and standards-Documents-Contract and construction programming -Inspection procedures - Processes and products-Total QA / QC Program and cost implication.
Quality Assurance and Control
Objectives-Regularity agent- Owner, design, contract and construction oriented objectives, methods-Techniques and needs of QA/QC- Different aspects of quality- Appraisals, Factors influencing construction quality-Critical, major failure aspects and failure mode analysis,-Stability methods and tools, Optimum design-Reliability testing, reliability coefficient and reliability prediction-Selection of new materials-Influence of drawings, detailing, specification, Standardization-Bid preparation-Construction activity, Environmental safety, Social and environmental factors-Natural causes and speed of construction-Life cycle costing Value Engineering and value analysis.

Books:

1. Brien O', James J., Construction Inspection Handbook by Quality Assurance and Quality Control, Van Nostrand Reinhold Compan, New York, 1989.
2. Kwaku A., Tenah and Jose M Guevera, Fundamental of Construction Management and Organization, Prentice Hall of India, 1995,
3. Quality planning and Analysis, by Juran Frank, J.M. and Gryna, F.M. Tata McGraw Hill, 1982.
4. Hutchins. G., ISO 9000, Viva Books, New Delhi, 1993,
5. Clarkson H. Oglesby, Productivity Improvement in Construction, McGraw Hill 1989,
6. John L. Ashford, The Management of Quality in Construction, E & F.N Spon, New York, 1989.

Steven McCabe, Quality Improvement Techniques in Construction, Addisson Wesley Longman Ltd., England, 1998.

CONSTRUCTION MATERIAL MANAGEMENT

Course Code: CE60138
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OUTCOMES:
After successful completion of the course, the students will be able to:
CO 1: Identify the skills necessary for the efficient management of Materials,
CO 2: Explain the planning and procurement procedure of materials,
CO 3: Explain the store handling and book keeping of store,
CO 4: Differentiate the importance of materials used in construction using various techniques,
CO 5: Explain the ordering and reordering procedure of materials,
CO 6: Appraise the Material Reconciliation statement.

COURSE DETAILS:
Material Management: Importance, Scope, Objective and function of material management.
Integrated approach to materials management.
Classification, Estimation, Planning, Procurement, Identification of sources, Vendor development and analysis negotiation, Purchase procedure, Legal aspects of purchasing.
Stores Management: Stores organization, Stores layout receipt and inspection, Materials codification. Standardization, Variety reduction, care and safety in handling store records and store accounting.
Inventory / Stock Control: Importance, Classification, Models & Techniques, ABC, . EOO its drawback ascertaining the EOQ & Various costs safety stock, Recorder level, Lead-time service level & other statistical application, Material Reconciliation

Books:

1. Ahuja, K.K. Material Management, 1st ed., CBS Publishers and Distribution reprint 1999,
2. Gopalkrishnan P. , "Handbook of material management", Prentice Hall of India Pvt. Ltd. New Delhi , 2001,
3. Jhamb, L.C., "Modernization of materials Management", Everest Publishing House, Pune, 2002,
4. Zeng, Gray j., "Purchasing and the management of materials", 7th ed., John Wiley and Sons, New York, 1994,
5. Singh, Jagman, Heavy Construction Planning, Equipment and Methods, published by Oxford and IBH publishing Company Pvt. Ltd. , New Delhi, Second Edition,
6. Jha Kumar Neeraj, Construction Project management Theory and Practice, Pearson- 2011,
7. Nagarajan K., Project Management, New Age International Publishers, Sixth Edition 2011,
8. Shrivastava U. K., Construction, Planning and Management, Galgotia Publication, N.D. New Edition-2012.

MANAGEMENT OF UNDERGROUND CONSTRUCTION AND MARINE STRUCTURES

Course Code: CE60140
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OUTCOMES:
After successful completion of the course, the students will be able to:

CO 1: State the geological details before we start the construction,
CO 2: Comprehend about the ease of work using latest technology for tunneling,
CO 3: Identify the importance of marine structure,
CO 4: Explain the design specification and guidelines for concrete marine structures,

CO 5: Explain the Sea water–retaining structures,
CO 6: Comprehend the design and specification of marine concrete structures.

COURSE DETAILS:
Site investigation; Ground and rock characterization, rock composition and ground types, rock mass classification, geological studies; Drilling and blasting - pneumatic breakers, explosives, safety precautions, drilling patterns, explosive load charging and blasting;
Tunneling technology – Heading and benching method, shield, micro, special methods; Hazards and safety Introduction, Importance of marine concrete structures and durability design, Characteristics of the marine environment, Fundamental requirements for marine concrete structures, Standards and guidelines for design and construction of marine concrete structure, Design, specification and construction of marine concrete structures, Types of marine concrete structures, Port structures, Coastal structures, Sea water–retaining structures, Summary Sources of further information, Design and specification of marine concrete structures, Introduction to marine concrete structure design. Case study

Reference book:

1. Agerschou, Hans, et al. (2004). Planning and design of ports and marine terminals. Thomas Telford, London,
2. Beer, G. (2010). Technology innovation in underground construction. CRC Press, The Netherlands,
3. Gerwick, B. (2007). Construction of marine and offshore structures. CRC Press, Boca Raton,
4. Indian Road Congress. (1996). Corrosion and corrosion protection of pre-stressed concrete bridges in marine environment. IRC, New Delhi,
5. Narasimhan S., Kathiroli S. and Kumar B. N. (2002). Harbour and coastal engineering. (Indian Scenario), Vol. I and II, NIOT, Chennai, India.

GREEN CONSTRUCTION MANAGEMENT

Course Code: CE60142
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OUTCOMES:
After successful completion of the course, the students will be able to:

CO1 Describe the climate change issue due to construction,
CO2 Explain the concept of energy efficient buildings,
CO3 Select appropriate material for sustainable green building,
CO4 Identify the concepts of green construction like zero energy building, zero water etc,
CO5 Explain the water and waste management systems,
CO6 Examine the green rating certifications for worldwide buildings.

COURSE DETAILS:
Climate change impacts and mitigation; Energy efficient buildings – meaning, design details and methods, passive solar design, renewable energy systems; Green buildings, green architecture, green building materials (product selection criteria and sustainable materials); Green procurement and subcontracting, green building commissioning, future of green building; Zero energy buildings and high performance buildings – their design and development; Concept of zero water building, water management and waste

management, water conservation strategies in buildings; Construction and demolition waste management; Green building movement in India (IGBC, TERI, GRIHA, ECBC), global green building movement and introduction to green rating systems worldwide; Latest techniques and technologies in green rating certifications.

Reference books:

1. Ching, F. D. K., Shapiro I. M. (2014). Green building illustrated. John Wiley and Sons.
2. Glavinich, T. E. (2008). Contractor's guide to green building construction: Management, project delivery, documentation, and risk reduction. John Wiley and Sons.
3. Heywood, D. I., Cornelius, S. C. and Carver, S. J. (2011). An introduction to geographical information systems. 4th Edition, Pearson Prentice Hall, London.
4. Kubba, S. (2016). Handbook of green building design and construction: LEED, BREEAM, and green globes. 2nd Edition, Butterworth-Heinemann.
5. Means, R. S. (2011). Green building: Project planning and cost estimating. 3rd Edition, John Wiley and Sons, New Jersey.

PROJECT FORMULATION AND APPRAISAL

Course Code: CE60150
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OUTCOMES:
After successful completion of the course, the students will be able to:

CO 1: Describe the steps of detailed project report of any project,
CO 2: Explain the projects Economic, EIA, Risk, Cash flow etc,
CO 3: Comprehend the project cash flows analysis,
CO 4: Explain the behavior in different project life-cycle phases,
CO 5 Compare financial parameter like, NPV, B/C ratio, IRR etc,
CO 6: Define the issues in appraisal process & challenges.

COURSE DETAILS
Project Formulation Overview, Strategy and Resource allocation, Idea generation Techniques, Market Analysis and Demand Forecasting, Technical analysis including Value Engineering, Economic Analysis, Environmental Analysis including brief discussion on Environmental Impact Assessment (EIA), Project risk analysis, Project cash Flow Estimation from Contractors view and Clients View, PPP projects and life cycle perspective from developers view; Preparation of Detailed Project Report (DPR) from various stakeholders perspective i.e. client, contractor, sponsors; Preparation of DPRs for different types of projects; Project Cash Flows Analysis of project cash flows & their behavior in different project life-cycle phases; Project Appraisal-Overview, Criteria for project Appraisal- Non-discounted and discounted cash flow methods incl. Pay Back period, Accounting Rate of Return, Net Present Value, Internal rate of return, Benefit Cost Ratio, Modified IRR, Adjusted Present value, Merits and Demerits of different appraisal methods; Special Decision Situations-Choice between Mutually Exclusive Projects of Unequal Life, Effect of Inflation; Contemporary issues in Project Appraisal- Social Cost benefit Analysis, Appraisal of green buildings, Appraisal of international Projects; Project Appraisal by Financial Institutes, Process of Application.

Reference books:

1. Chandra, P. (2014). Projects -Planning, analysis, financing, implementation and review. 8th Edition, Tata McGraw-Hill, New Delhi,
2. Tiffin, R. (2007). Practical techniques of effective project investment appraisal. Viva Books, New Delhi,
3. Sarda, D. (2007). Project finance – Appraisal and follow up. ADB Publishers, Jaipur,
4. Khatua, S. (2011). Project management and appraisal. Oxford University Press, New Delhi,
5. Benjamin C. Esty (2004). Modern Project Finance: A Casebook. Wiley.

RESEARCH METHODS AND DOCUMENTATION

Course Code: EX60001
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE

Post-graduate engineering students carry out a year-long research-intensive thesis or project that requires them to have the full knowledge of general principles of defining and scoping a problem, deciding the approach to research design, implementing the design, making the analysis, drawing inferences, and communicating their research findings. This subject covers the essential features of research methods and research communications.

COURSE OUTCOMES

After successfully completing the course, the student will be able to

CO1: Define and scope a problem,
CO2: Make a review of literature,
CO3: Decide on an appropriate research design and develop an experimental setup and/or an appropriate model,
CO4: Generate and/or collect the necessary data, make the required data analysis, and draw inferences,
CO5: Initialize the art and science of scientific and technical writing, and
CO6: Write a project report following the principles of scientific writing.

COURSE CONTENT

A. Research Methods

A.1 Introduction to Research

Research Definition; Elements of Research: Novelty, Originality, Creativity, and Critical Thinking; Deductive, Inductive, and Abductive Approaches.

A.2 Selecting a Research Problem

Research Topics, Problems, Objectives and Scope, Questions, and Research Contribution.

A.3 Measurement, Data, and Data Analytics

Measurement Scales and Data Visualization; Revisiting Basic Statistics, Probability, and Probability Density Functions; Sampling and Sampling Distributions, Tests of Hypotheses, and Simple and Multivariate Regression Analysis

A.4 Models and Modelling

Characteristics and Types of Models, Discrete-Event Simulation, and Neural Networks Models.

A.5 Research Design

Qualitative Research: Survey, Case Study, Action Research, and Citizen Science; Experimental Research: Factors, Factor Levels, Replication, ANOVA, and Factorial Designs.

B. Research Documentation

B.1 Language Issues

Paragraphing, Unity of Ideas, Topic Sentences, Link Words, Transitions; Common English Errors; Use of Hyphen, Dashes, and Ampersand; Responsible Use of Generative AI Tools.

B.2 Organization of a Research Document

Front Matters, Body, and End Matters; Guidelines on Titles, Abstracts, Keywords, Symbols and Abbreviations, and Capitalization; Narrative and Systematic Literature Review, Referencing Systems, Reference Management Software; Guidelines on Tables, Figures, Mathematical Operations and Equations, SI Units, Scientific and Engineering Notations of Numbers, and Significant Digits.

B.3 Elements of Research and Publication Ethics

Research Misconduct: Types and Research Code of Conduct; Plagiarism and Copyright.

Reference Books

1. Dunn, P. K. (2021), Scientific Research and Methodology: An Introduction to Quantitative Research and Statistics in Science, Engineering, and Health, Available free at https://bookdown.org/pkaldunn/Book/. [***Covers most of the topics***]
2. Durdella, N. (2019), Qualitative Dissertation Methodology: A Guide for Research Design and Methods, California: SAGE Publications. [***For topics related to qualitative methods***]

3. Montegomery, D. C. (2019), Design and Analysis of Experiments, 10th Edition, John Wiley & Sons, Inc. [***For topics related to design of experiments, model and modelling***]
4. Perelman, L. C., J. Paradis, and E. Barrett, Eds. (1998), The Mayfield Handbook of Technical and Scientific Writing, Mayfield Publishing, Available free at http://www.mhhe.com/mayfieldpub/tsw/toc.htm. [***For topics related to research documentation***]
5. Kothari, C. R. (2004), Research Methodology: Methods and Techniques, 2nd Revised Edition, Hyderabad: New Age International.
6. Marder, M. C. (2011), Research Methods for Science, Cambridge University Press.

SCHOOL OF CIVIL ENGINEERING

M.TECH. PROGRAMME

Specialization: Structural Engineering

Curricula & Syllabi

ACADEMIC CURRICULA – 2024

Kalinga Institute of
Industrial Technology (KIIT)
Deemed to be University
(Established U/S 3 of UGC Act, 1956)
Bhubaneswar, Odisha, India

SCHOOL OF CIVIL ENGINEERING
M. TECH. PROGRAM
SPECIALIZATION: STRUCTURAL ENGINEERING

Semester-I

Sl. No	Course Code	Course Title	Contact Hours per Week			Credit
			L	T	P	
1	CE60003	Computational Methods in Civil Engineering	3	0	0	3
2	EX60001	Research Methods & Documentation	3	0	0	3
3	CE60201	Advanced Structural Analysis	3	0	0	3
4	CE61205	Advanced Design of Concrete and Steel Structures	3	1	0	4
5		**Elective – I**	3	0	0	3
6	CE69201	Structural Laboratory	0	0	4	2
7	CE69203	Computational Lab	0	0	4	2
					Total	20

Semester-II

Sl. No	Course Code	Course Title	Contact Hour per Week			Credit
			L	T	P	
1	CE60004	Soft Computing Techniques in Civil Engineering	3	0	0	3
2	CE60202	Earthquake Engineering	3	0	0	3
3	CE60206	Theory of Elasticity & Plasticity	3	0	0	3
4	CE60203	Finite Element Method	3	0	0	3
5		**Elective – II**	3	0	0	3
6		**Elective – III**	3	0	0	3
7	CE68204	Comprehensive Viva Voce	-	-	-	2
					Total	20

Semester-III

Sl. No	Course Code	Course Title	Contact Hour per Week			Credit
			L	T	P	
1		**Open Elective / Industry Elective**	3	0	0	**03**
2	CE67203	Thesis Part-I	-	-	-	16
3	CE68205	Seminar	0	0	2	01
					Total	20

Semester-IV

Sl. No	Course Code	Course Title	Contact Hour per Week			Credit
			L	T	P	
1	CE67204	Thesis Part-II	-	-	-	20
					Total	20

LIST OF DEPARTMENT ELECTIVES

Elective – I, II & III

Sl. No	Subject Code	Subject Name	Credit
1	CE60224	Pre-stressed Concrete	3
2	CE60223	Theory of Plates & Shells	3
3	CE60440	Advanced Foundation Engineering	3
4	CE60131	Advanced Repairs and Rehabilitation of Structures	3
5	CE60204	Stability of Structures	3
6	CE60221	Bridge Engineering	3
7	CE60222	Design of Industrial Structures	3
8	CE60226	Design of Offshore Structure	3
9	CE60228	Soil-Structure Interaction	3
10	CE60230	Composite Materials	3

SCHOOL OF CIVIL ENGINEERING

M. TECH. PROGRAM

SPECIALIZATION: STRUCTURAL ENGINEERING

SYLLABUS

COMPUTATIONAL METHODS IN CIVIL ENGINEERING

Course Code: CE60003
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OUTCOMES

At the end of the course, the students will be able to
CO 1: Comprehend the measure of central tendency, dispersions and correlation coefficients,
CO 2: Use the Curve Fitting & Least Square Techniques in the experimental methods,
CO 3: Apply the concept of probability and set theory in practical problems,
CO 4: Apply the concept of probability distribution functions,
CO 5: Determine roots of algebraic equation by different methods and obtain interpolating polynomials, and
CO 6: Solve ODE and PDE using numerical techniques.

COURSE DETAILS

Measures of Central Tendency & Dispersions; Covariance; Correlation Coefficients and their Properties in field data;
Curve Fitting & Least Square Techniques and their use in the experimental methods in Civil Engineering; Concept of Regressions; Regression curve in Bivariate Frequency Distributions; Introduction to probability and set theory; Probabilistic measures; Conditional probability and Bayes' theorem; Discrete and continuous random variables;
Probability Density Functions; Probability Distributions of Single and Multiple Random Variables; Discrete & continuous distributions; Chi-Square Test; Kolmogorov-Smirnov Test; Analysis of Variance.
Linear equations and eigenvalue problems, Accuracy of approximate calculations, Nonlinear equations, interpolation, differentiation and evaluation of single and multiple integrals
Initial and boundary value problems by finite difference method, Newton's method, variation and weighted residual methods,

Textbooks

1. Applied Statistics and Probability for Engineers by Douglas C. Montgomery and George
   C. Runger, Wiley India Pvt. Ltd, 2009.
2. Jay L. Devore, Probability and Statistics for Engineering and the Sciences, Brooke & Cole, 2009.

3. J. B. Scarborough, Numerical Mathematical Analysis, Oxford & IBH Publishing Co. Pvt. Ltd., 2000.
4. K. K. Jain, S. R. K Iyengar and R. K. Jain, Numerical Methods - Problem and Solutions, Wiley India Pvt. Ltd, 2001.

Reference Books

1. W. Mendenhall and T. Sincich, Statistics for Engineering and the Sciences, Prentice-Hall, 2000.
2. Steven Chapra and Raymond Canale, Numerical Methods for Engineers, McGraw-Hill Education; 6th edition 2012.

SOFT COMPUTING TECHNIQUES IN CIVIL ENGINEERING

Course Code: CE60004
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OUTCOMES

At the end of the course, the students will be able to

CO 1: Comprehend the basic concepts of soft computing,
CO 2: Use generic algorithms and Particle swarm intelligence algorithms,
CO 3: Prepare prediction model using neural network,
CO 4: Apply supervised machine learning techniques,
CO 5: Apply the techniques of unsupervised machine learning, and
CO 6: Implement soft computing techniques in Civil Engineering problems.

COURSE DETAILS

Introduction to Soft Computing: Basic concepts, various Soft Computing Techniques, Overview of conventional computing vs. soft computing, Characteristics and advantages of soft computing techniques

Genetic Algorithms (GA):Introduction to genetic algorithms, Representation schemes: binary, real-valued, permutation, Genetic operators: selection, crossover, mutation.

Particle Swarm Optimization (PSO):Introduction to particle swarm optimization, Swarm intelligence principles, PSO algorithm components: particles, velocity update, position update, Ant Colony Optimization (ACO):Basics of ant colony optimization, Ant behavior modeling, ACO algorithm: pheromone trails, ant movement, Pigeon search algorithm.

Artificial Neural Networks (ANN):Fundamentals of neural networks, Single-layer and multi-layer perceptrons, Training algorithms: back-propagation, gradient descent, Convolutional Neural Networks (CNN),

Fuzzy Logic Systems:Basics of fuzzy set theory, Fuzzy logic operations and rules, Fuzzy inference systems

Introduction to Machine Learning, Basic Concepts, Supervised learning, unsupervised learning, reinforcement learning, Python libraries

Supervised Learning Techniques: Decision trees and ensemble methods (Random Forests), Support Vector Machines (SVM), , Basic concepts and principles, k-nearest neighbor (kNN)

Unsupervised Learning Techniques: Clustering, K-means clustering, Hierarchical clustering, Dimensionality Reduction, Principal Component Analysis (PCA)

Application of soft computing in Civil Engineering
Application of different algorithms to solve practical problems of Civil Engineering.

Textbooks / Reference Books

1. Pratihar D.K., Soft Computing, Narosa Publishers, and ISBN: 978-81-8487-495-2, 2018.
2. Mangey Ram, J. Paulo Davim, Soft Computing Techniques and Applications in Mechanical Engineering, IGI Global, USA.
3. Simeone O. Machine learning for engineers. Cambridge University Press; 2022.
4. E. Alpaydin, Introduction to Machine Learning, Prentice Hall of India, 2006.

ADVANCED STRUCTURAL ANALYSIS

Course Code: **CE60201**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OUTCOMES

At the end of the course, the students will be able to

CO 1: Apply different energy theorems to analyze structures
CO 2: Draw influence line diagrams for indeterminate structures
CO 3: Analyze beams, trusses and frames using flexibility Matrix methods
CO 4: Analyze beams, trusses and frames using stiffness Matrix methods
CO 5: Determine shape factors for different member cross sections, and
CO 6: Perform plastic analysis of beams and frames

COURSE DETAILS

Energy Theorems

Total potential energy, Complementary Energy, Simple Examples

Influence line for Redundant Structures

Muller-Breslau Principle, Influence lines for reaction components, shear force and bending moment for single redundancy

Matrix Method of Analysis

Introduction to Matrix Methods, Direct Flexibility and Stiffness Methods, Element Flexibility and Stiffness Methods, Problem to be solved for Beams, Pin and Rigid jointed structures, Influence coefficients, Substitute technique, Plane Grids

Plastic Analysis

Introduction to plastic analysis, Factor of safety: stress factor, shape factor, factor of safety due to redundancy.Upper and Lower bound Theorems, simple examples of beams and frames

Textbooks

1. Pandit and Gupta, Matrix Analysis, TMH Company Limited
2. Subramanian N, Design of Steel Structure,2nd edition, Oxford publication.

Reference books

1. Mukhopadhyay M and Sheikh Abdul Hamid S A, Matrix and Finite Element Analyses of Structures, ANE Books

2.Kinney J. S., Indeterminate Structures, Addition Wesley Publication Co.

3. Manick Selvam, Fundamental of Limit Analysis of Structures, Dhanpat Rai Publication.

4. Weaver W, and Gere J M, Matrix Analysis of Framed Structures, CBS Publishers

EARTHQUAKE ENGINEERING

Course Code: **CE60202**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OUTCOMES

At the end of the course, the students will be able to

CO 1: Explain fundamentals of Seismology

CO 2: Estimate seismic hazard of structures

CO 3: Perform dynamic Analysis of structure using fundamental of Vibrations

CO 4: Analyze framed structure using response spectrum method

CO 5: Determine Seismic forces on reinforced concrete framed building as per IS 1893 (Part-1) and

CO 6: Design Earthquake Resistant detailing of Reinforced concrete frames and shear wall as per IS 13920

COURSE DETAILS

Fundamental of Seismology
Earth and its interior, Plate Tectonics, Convection Currents, The Earthquake, Inter Plate Earthquake (Convergent Boundaries, Divergent Boundaries and Transform Boundaries), Intra Plate Earthquake (Faults and Types of Faults), Seismic Waves, Basic Terminology, Measuring Units and Instruments, Intensity and magnitude of earthquake

Strong motion and estimation of seismic hazard
Earthquake ground motion, Errors in strong motion records, ground motion characteristics, amplitude parameters, frequency content of motion, earthquake site effects, seismic hazard analysis

Fundamental of Vibrations of Structures
Equation of Motion for SDOF System, response analysis of SDOF system (Free and forced vibration for dampled and undamped system), Numerical methods for seismic analysis of SDOF system (time

stepping, central difference, Newmark's Beta and Runge-Kutta methods), response analysis of MDOF system

Response Spectrum Method
Response spectra (formulation, factors influencing, errors), Response Spectra methods for MDOF system (analysis, modal combination rules), dynamic analysis of structure using response spectrum method

Seismic analysis of reinforced concrete framed building as per IS 1893 (Part-1)
Mathematical modeling of multistoried RC buildings, Seismic weight, fundamental natural period, design base shear, distribution of base shear

Earthquake Resistant design (ERD) of Reinforced concrete Buildings
Ductility considerations (requirement, assessment, factors affecting), ERD of frame, shear wall based on IS 13920,

Textbooks

1. "Earthquake Resistant Design of Structures" by Pankaj Agarwal & Manish Shrikhande, PHI Publications.
2. "Dynamics of Structures" by A. K. Chopra, Pearson, New Delhi.
3. IS: 1893 (Part-I) 2016, Criteria for Earthquake Resistant Design General Provision to Building
4. IS: 13920 (1993), Code of Practice for Ductile Detailing of RC Structures

Reference books

1. "Earthquake Resistance Design of Structures", by S. K. Duggal, Oxford University Press, New Delhi.
2. Structural Dynamics for Structural Engineers by Gary C Hart and Kevin Wong, John Willey & Sons, Singapore.

FINITE ELEMENT METHOD

Course Code: **CE60203**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OUTCOMES

At the end of the course, the students will be able to

CO 1: Comprehend the fundamentals of finite element method

CO 2: Develop the governing finite element equations

CO 3: Derive various types of finite elements (1D, 2D, 3D and axisymmetric elements) and its application

CO 4: Formulate isoparametric elements problem and its uses

CO 5: Apply numerical integration technique for integration of stiffness matrix calculation, and

CO 6: Solve civil engineering problems using FEM

COURSE DETAILS

Fundamentals of finite element
Equations of equilibrium, Compatibility equations, Nodes, Elements, Degrees of freedom, Finite Element modeling, Shape functions and types, Boundary Conditions, Loading type, Stiffness matrices, Solution technique, Different steps involved in finite element analysis, Strain displacement relations, Stress strain relations, Convergence criteria, C0 and C1 type elements, higher order elements

Finite Element Formulation
Governing differential equations, Variation methods, Gelerkin method, Weighted residual methods

One Dimensional Finite Element
Shape functions and stiffness matrices for one dimensional element, bar element, beam element and Truss element

Two dimensional Elements
Application of two dimensional elements, Pascal triangle, Shape functions using Lagrange and Hermite polynomials, Shape functions and stiffness matrices for two dimensional elements, Constant strain triangular (CST) element, rectangular element, Isoparametric elements

Three dimensional Elements
Shape functions three dimensional elements, Tetrahedral element and its application

Axisymmetric Elements
Analysis of 3D structures using axisymmetric elements, Three noded axisymmetric element formulation

Isoparametric Elements
Natural coordinates ,Isoparametric Eight node element, Numerical integration,Gauss Quadrature Integration, Advantages and application of isoparametric elements compared to other elements.

Application of finite element method
Structural static and dynamic problems,Commercial softwares, FEA programming techniques

Textbook

1. Concepts and Applications of Finite Element Analysis, by R. D. Cook, 4th Edition, John Wiley & Sons.

Reference books

1. The Finite Element Method: Its Basics and Fundamentals, by O. C. Zienkiewicz, Elsevier.
2. Fundamentals of Finite Element Analysis, D.V. Hutton, McGraw Hill.
3. Finite Element Procedures, by K. J. Bathe, Prentice Hall, Second edition.
4. Introduction to Finite Elements in Engineering, by T. R. Chandrupatla and A. D. Belegundu, Pearson.

STABILITY OF STRUCTURES

Course Code: **CE60204**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OUTCOMES

At the end of the course, the students will be able to

CO 1: Analyze torsion of thin walled open sections
CO 2: Determine Warping constants for rolled steel section
CO 3: Analyze lateral buckling of beams under pure bending
CO 4: Analyze Beam-columns on rigid supports
CO 5: Perform approximate calculation of critical loads for bar structures by energy method, and
CO 6: Analyze the effects of shearing force on the critical load

COURSE DETAILS

Torsion of thin walled open sectionsand Warping constants
Torsion of thin walled open sections, warping displacements under pure torsion,-Warping constants for rolled steel section. Strain energy in bending and torsion of members of thin walled open section including the effects of warping. Torsional buckling including the effects of Wagner's effect, flexural torsional buckling (with centroid and shear centres coincident)

Lateral buckling of beams under pure bending
Lateral buckling of beams under pure bending central point load through centre of gravity of the section. Cantilever beams with point load at the free end, Application of Rayleigh-Ritz method.

Beam-columns
Beam-columns on rigid supports-concentrated and continuous lateral loads with simply supported and built in-ends. Continuous beam with as axial loads. Application of trigonometric series. In-plane buckling of bars.

Approximate calculation of critical loads
Approximate calculation of critical loads for bar structures by energy method- a bar on elastic foundation, a bar with intermediate compressive forces, bar under distributed axial loads, a bar with changes in cross section.

Effects of shearing force on the critical load
Effects of shearing force on the critical load. Buckling of built-up columns. In-elastic in-plane buckling of columns. Tangent and reduced modulus concept, Shanley's contribution, elastic critical loads for rigid frames and triangulated structures, stability functions. Bending of thin plate. Buckling of thin rectangular plates in compression, shear and bending

Textbooks / Reference Books

1. Theory of Elastic Stability by S.P.Timosheko& Gere, McGraw-Hill, 1961

2. Structural Members and Frames by T.V Galambos Prentice-Hall INC, 1968.
3. The stability of Frames by M.R.Horns and W.Merchang Pergamon press, 1965.
4. Elastic Instability by M.Gregory, Spon's Civil Engineering series,1967.
5. Buckling Strength of Metal structures by F. Bleich, McGraw Hill Book co.,1952
6. Structural Stability (Theory and implementation) by W.F. Chen and EM Lui Elsevier NY

ADVANCED DESIGN OF CONCRETE AND STEEL STRUCTURES

Course Code: **CE61205**
Credit: **4**
L-T-P: **3-1-0**
Prerequisite: **Nil**

COURSE OUTCOMES

At the end of the course, the students will be able to

CO 1: Design deep beams

CO 2: Design RCC beam with redistribution of moments.

CO 3: Design RCC beam with redistribution of moments.

CO 4: Design different types of bolted and welded moment and shear connections in steel beams and columns

CO 5: Design plate girders for long span bridges and buildings, and

CO 6: Design Gentry girders

COURSE DETAILS

Design of deep beam, Design of deep beams for flexure and shear for both simple supported and continuous
Re distribution of moment in RCC beams
Design of shear walls: Concept, Requirment, types and design of shear walls
Design of shear and moment resisting connections in steel structures. Bracket connections both by bolt and weld.
Design of Gentry girder
Design of plate girder for long span bridges and buildings

Text Book

1-Advanced Reinforced concrete design .By P.C .Varghese, PHI publisher
2-Design of steel structure By S.K.Duggal. Mc Graw Hill Publisher

Reference Book

1. Reinforced Concrete Design by S U Pillai and D-Menon, Tata Mc Graw Hill, NR 1998 Benner
2. Design of Steel Structure, by N.Subramanian, S2nd edition, Oxford publication.

THEORY OF ELASTICITY & PLASTICITY

Course Code: CE60206
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OUTCOMES

At the end of the course, the students will be able to

CO 1: Solve plane stress problems

CO 2: Solve plane strain problems

CO 3: Develop equations in polar coordinate for curved member

CO 4: Analyze stress and strain in three dimensions

CO 5: Analyze torsion of non–circular prismatic bars, and

CO 6: Explain different theories of plasticity

COURSE DETAILS

Plane stress and plane strain problems
General stress and strain equations (Equilibrium and compatibility equations). Two dimensional problems in rectangular coordinates. Stress and strain components, differential equation, equilibrium equations and compatibility.

Equations in polar coordinate
Stress distribution for axi-symmetric problems. Pure bending of curved bars, thick walled cylinder. Concentrated force at a point of straight boundary. Force acting on the end of a wedge. Concentrated force acting on a beam.Effect of circular holes on stress distributions in plates

Stress and strain in three dimensions
Principles stresses, maximum shearing stress, principal axes of strain. Stretching of prismatic bar by its own axis, Elementary problems of elasticity in three dimensions.

Torsion of non–circular prismatic bars
Saint Venant's Theory. Various Analogies. Torsion of hollow and thin sections.

Introduction to the theory of plasticity:
The yield criteria of metals, stress space representation of yield criteria. Stress strain relations, plastic potential, flow rules and maximum work hypothesis.

Textbooks / Reference Books

1. Theory of Elasticity by S.P. Timoshenko and J.N. Goodier, Mc Graw- Hill
2. Theory of Plasticity by Hoffman and Sachs, McGraw-Hill, 1953
3. Plasticity of Mechanical Engineers by W. Johnson and P.B. Meller, North-Holland Publishing Company- 1973
4. Theory of Flow and Fracture of Solids by A. Nadai Mc Graw-Hill, NY- 1985.

BRIDGE ENGINEERING

Course Code: CE60221
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OUTCOMES

At the end of the course, the students will be able to

CO 1: Identify suitable site for a new bridge considering type of bridge, loads on bridge and the I.R.C. specifications for road bridges,

CO2: Design a R. C. Slab Culvert,

CO 3: Design deck slab of a R. C. C. T-Beam type bridge,

CO 4: Design longitudinal Girder of a R. C. C. T-Beam type bridge,

CO 5: Design pier and abutment for a R. C. C. T-Beam type bridge, and

CO 6: Design elastomeric pad bearing for a bridge

COURSE DETAILS

Introduction
Different types of bridges, criteria for site selection, different types of load acting on bridges, I.R.C. specifications for road bridges.

Design of R.C Slab Culvert
Loads considered for design, IRC load specifications.Design of a R.C. slab culvert.

Design of T – Beam Bridge
Pigeaud's method for computation of slab moments; design of slab, courbon's method for computation of moments in girders; Design of simply supported T-beam for bridge.

Design of Sub-Structure for Bridges
Pier and abutment caps; Materials for piers and abutments', Design of pier; Design of abutment.

Foundations for Bridges
Types of foundations; Details of well and pile foundation.

Design of Bearings for Bridges
Importance of bearings; bearings for slab bridge; bearings for girder bridges; Expansion bearings; Fixed bearings; Design of elastomeric pad bearing.

Textbooks

1. Essentials of Bridge Engineering, D. J. Victor, Oxford and IBH.
2. Design of Bridge Structures, by T. R. Jagadeesh & M. A. Jayaram, 2nd Edition, PHI Learning Pvt. Ltd.

Reference Books

1. Design of Bridges, N. Krishna Raju, Oxford and IBH.
2. Concrete bridge Practice: Analysis, Design and Economics‖, V. K. Raina, Tata McGraw Hill.
3. Dynamics of Railway Bridges, L. Fryba, Thomas Telford Ltd, April 1996.
4. Concrete Bridges by P.E. Mondorf, Taylor & Francis.

5. Bridge Engineering by S. Ponnuswamy, Tata Mc-Graw Hill.

DESIGN OF INDUSTRIAL STRUCTURES

Course Code: CE60222
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OUTCOMES

At the end of the course, the students will be able to

CO 1: Prepare plan of industrial structures
CO 2: Design single and multi-bay industrial structure in steel.
CO 3: Design Bunkers and Silos
CO 4: Design Pressure vessels,
CO 5: Design Chimneys and Cooling towers, and
CO 6: Analyze Large span Roof Structures, Suspension Roof Structures

COURSE DETAILS

Planning of industrial structures
Design of single and multibay industrial structure in steel.
Bunkers and silos.
Pressure vessels
Chimneys and Cooling towers,
Large span Roof Structures, Suspension Roof Structures.

Textbooks / Reference Books

1. Design of Steel Structures by A.S. Arya and J.L. Ajmani, Publisher: Nemchand& Bros. Roorkee-2010.
2. Design of Steel Structure by P. Dayaratnam, A.M, Wheeler & Co Allahabad- 2010
3. Design of Steel Structures by B. Bresler, T.Y. Lin & J.B. Scalzi, Publisher: John Wiley, NewYork-1968
4. Design of Steel Structures by E.H. Gaylord and Gaylord, C.N. Charles, International Students Edn., McGraw Hill Book Co., Inc./Kogakusha Co. Ltd. 1975
5. Steel Designer's Manual CrossbyLockwoud, London 1972

THEORY OF PLATES AND SHELLS

Course Code: **CE60223**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OUTCOMES

At the end of the course, the students will be able to

CO 1: Explain pure bending of plates
CO 2: Analyze circular plates for different support conditions
CO 3: Analyze rectangular plates for different support conditions
CO 4: Comprehend membrane theory of shell
CO 5: Analyze shells for different shapes and support conditions, and
CO 6: Design spherical dome

COURSE DETAILS

Theory of Plates
Pure bending of plates, Slope and curvature of slightly bent plates, relationship between moment and curvature, strain energy in bending of plates.

Circular Plates
Differential equations for symmetrical bending of circular plates under lateral loads. Uniformly loaded, concentrically loaded and loaded at the center of simply supported and fixed circular plates.

Rectangular Plates
Differential equation of the deflection surface and boundary conditions of laterally loaded rectangular plates by classical theory. Solutions of simply supported rectangular plates due to sinusoidal loads, uniformly distributed loads and concentrated load by Navier's Solution, Levy approach.

Theory of Shells
Membrane theory of symmetrical loaded shells of revolution, Spherical shells, conical shells, Membrane theory of cylindrical shells and shells of Double curvature such as Hyperbolic paraboloids and elliptic paraboloids, conoids. Circular cylindrical shells loaded symmetrically with respect to its axis, particular cases of symmetrical deformation of circular cylindrical shells, cylindrical tanks of uniform wall thickness.

Structural Design of Dome
Design of spherical dome.

Textbooks / Reference Books

1. Theory of Plates and Shells- by S P Timoshenko and S. W. Krieger, Mc Graw Hill, NY-1984
2. Thin Shell Concrete Structures – by O P Billington, Mc Graw Hill, NY

3. Design and Construction of Concrete Shell Roofs by G.S.Ramaswam Mc Graw Hill, NY-1984
4. Stress in Shells by W. Flugge, Springer Verlag, NY- 1973

PRE-STRESSED CONCRETE

Course Code: **CE60224**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OUTCOMES

At the end of the course, the students will be able to

CO 1: Analyze different systems of prestressing
CO 2: Analyze and design prestressed concrete beam
CO 3: Design end block for a post tensioned beam
CO 4: Determine deflection of prestressed structures
CO 5: Describe principles of design of indeterminate prestresed concrete structures, and
CO 6: Design prestresed concrete Circular tanks, Pipes, Mast, and Railway sleepers

COURSE DETAILS

Systems of prestressing
Different systems of prestressing, Characteristics of concrete and steel, Other suitable materials, Losses in prestress.

Design of Prestressed concrete Beam
Analysis and design of section for flexure, shear and torsion. Design of compressive member. Limit state design as per IS code. Introduction to Partial prestressing.

End Block Design
Stress distribution in end-block of post tensioned section: Magnel's method, Guyen's method, Rowe's method and IS code method.

Deflection of prestressed structures
short term as well as long term deflections of uncracked and cracked members.
Indeterminate structures- Principles of design of prismatic continuous beams of two and three equal, unequal spans with variable moments of inertia, Composite construction of prestressed and in-situ concrete.

Design of special structures
Circular tanks, Pipes, Mast, and Railway sleepers.

Textbooks / Reference Books

1. Prestressed concrete Vol-I & Vol.-II by Y. Guyen- John Willey & Sons, New York-1960.
2. Prestressed concrete theory & design by E. W. Bennet- Chapman & Hall, London-1962.
3. Design of prestressed concrete structures by T. Y. Lin & H. Burns Ned, Johnwilley& Sons, New York-1982.
4. Prestressed concrete by N. Krishnaraju- Tata McGraw-Hill, New Delhi-2004.
5. Prestressed concrete by S. K. Mallik & A. P. Gupta- Oxford & IBH, New Delhi-1982.

DESIGN OF OFFSHORE STRUCTURE

Course Code: **CE60226**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OUTCOMES

At the end of the course, the students will be able to

CO 1: Comprehend oil exploration and production
CO 2: Describe fluid-structure phenomena
CO 3: Analyze different types of offshore structural systems
CO 4: Explain concept of stochastic process and nondeterministic evaluation
CO 5: Describe techniques of offshore piling for various structures, and
CO 6: Explain soil structure interaction of both jacket and gravity type platforms

COURSE DETAILS

Oil exploration and production
Engineering problems in offshore exploration and production, seabed survey and soil engineering.

Fluid-structure phenomena
Brief introduction to fluid-structure phenomena, Dynamics of progressive waves, diffraction of waves, wave forces on structural system, Morison's equation, Formulation of governing equations of motion for multi-degree freedom systems,

Offshore structural systems
Different types of offshore structural systems including submarine pipe lines, review of linear deterministic analysis by superposition and numerical integration procedure.

Stochastic process and nondeterministic evaluation
Introduction to stochastic process and nondeterministic evaluation of the linear nondeterministic response where there is no interaction.

Offshore piling for various structures

Techniques of offshore piling for various structures, dynamic stresses in pile driving, soil structure interaction of both jacket and gravity type platforms. Behaviour of a single pile under cyclic lateral loads. Various load situations for jackets as well as piles.

Textbooks / Reference Books

1. Dynamic Analysis of offshore structures by C.A. Brebbia and S. Walker - Newnes-Butterwortgs
2. An introduction to Ocean Science and Technology by A.K. Malhotra– National book trust India
3. Estuary and Coastline Hydrodynamics by A.T. Ippen– Tata McGrawHill Book Company

SOIL-STRUCTURE INTERACTION

Course Code: **CE60228**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OUTCOMES

At the end of the course, the students will be able to

CO 1: Comprehend fundamentals of Soil-Foundation Interaction
CO 2: Explain Scope of soil foundation interaction analysis
CO 3: Analyze Beam on Elastic Foundation
CO 4: Explain Plate on Elastic Medium
CO 5: Perform Elastic Analysis of Pile, and
CO 6: Perform Load deflection prediction for laterally loaded piles

COURSE DETAILS

Soil-Foundation Interaction
Introduction to soil-foundation interaction problems, Soil behaviour, Foundation behaviour, Interface behaviour, Scope of soil foundation interaction analysis, soil response models, Winkler, Elastic continuum, Two parameter elastic models, Elastic plastic behaviour, Time dependent behaviour.

Beam on Elastic Foundation
Soil Models: Infinite beam, Two parameters, Isotropic elastic half space, Analysis of beams of finite length, Classification of finite beams in relation to their stiffness. Plate on Elastic Medium: Thin and thick plates, Analysis of finite plates, Numerical analysis of finite plates, simple solutions.

Elastic Analysis of Pile
Elastic analysis of single pile, Theoretical solutions for settlement and load distributions, Analysis of pile group, Interaction analysis, Load distribution in groups with rigid cap.
Load deflection prediction
Load deflection prediction for laterally loaded piles, Subgrade reaction and elastic analysis

Textbooks / Reference Books

1. Foundation Analysis and Design by J E Bowles- Tata-McGraw Hill
2. Elastic Analysis of Soil-Foundation Interaction by Selvadurai, A. P. S Elsevier
3. Pile Foundation Analysis and Design by Poulos H. G. and Davis E. H.- John Wiley,1980.
4. Design Analysis of Beams, Circular Plates and Cylindrical Tanks on Elastic Foundation by E.S.Melersk.
5. Beams of Elastic Foundation by M.Hetenyi, University Michigan Press 1946

COMPOSITE MATERIALS

Course Code: **CE60230**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OUTCOMES

At the end of the course, the students will be able to

CO 1: Comprehend fundamentals of composite materials

CO 2: Analyze Macro-mechanical behaviour of lamina

CO 3: Analyze Micromechanical behaviour of lamina

CO 4: Analyze Macro-mechanical behavior of laminate

CO 5: Determine Strength criterion for an orthotropic lamina, and

CO 6: Explain design requirements, material selection and Configuration selection of composite structures

COURSE DETAILS

Introduction to composite materials
Isotropy, Orthotropy and Anisotropy, Lamina, Laminate, Advantages and limitations, Classification and characteristics of Composite materials, Mechanical behaviour of composite material, Manufacture of laminated fiber reinforced composite material

Macromechanicalbehaviour of lamina
Stress strain relations for anisotropic materials, Stress strain relations for a lamina of arbitrary orientation, Inter laminar stresses

Micromechanical behaviour of lamina
Volume and mass fraction, Density and void content, Evaluation of elastic moduli

Macromechanical behavior of laminate
Classical lamination theory: Lamina stress-strain behavior, Stress and strain variation in laminate, Resultant laminate forces and moments, Special cases of laminate stiffnesses

Strength criterion for an orthotropic lamina
Maximum stress failure criterion, Maximum strain failure criterion, Tsai-Hill failure criterion, Tsai-Wu failure criterion, Hoffman failure criterion

Bending of laminated plate
Assumptions, Equilibrium equation, Solution technique

Introduction to the design of composite structures
Design requirements, Material selection and Configuration selection

Textbooks / Reference Books

1. "Mechanics of Composite Materials", by Robert M. Jones, CRC Press, Second edition, 2015
2. Engineering mechanics of Composite materials by I M Daniel and O. Ishai- Oxford university press- 2005
3. Fiber-reinforced Composites by P.K. Mallick- Marcel Dekker inc- 1993
4. An introduction to composite materials by D. Hull and T W Clyne- Cambridge university press- 1996
5. "Mechanics of Composite Materials", by A.K. Kaw, Taylor& Francis-India, Second edition, 2006

STRUCTURAL LABORATORY

Course Code: **CE69201**
Credit: **2**
L-T-P: **0-0-4**
Prerequisite: **Nil**

COURSE OUTCOMES

At the end of the course, the students will be able to

CO 1: Explain functions of different types of equipment for structural analysis

CO 2: Perform concrete Mix Design

CO 3: Determine the splitting tensile strength of cylindrical concrete specimen

CO 4: Determine the flexural tensile strength of prismatic concrete specimens

CO 5:Perform the flexural test of reinforced concrete beam, and

CO 6: DetermineTensile strength of steel bar

COURSE DETAILS

- Study of different types of equipment e.g. CTM, UTM,Plate Vibrator,Table vibrator etc.
- Concrete Mix Design and Cube testing
- Splitting tensile strength
- Flexural tensile strength of prismatic concrete specimens
- Flexural test of reinforced concrete beam
- Tensile strength of steel bar

Textbooks / Reference Books

1. IS 10262-2019 Guidelines to Concrete mix design
2. Design of Concrete Mixes By- N Krishna Raju CBS Publishers and Distributors PVT LTD, (5^{th} Edition),
3. Concrete and Structure Laboratory Manual by School of Civil Engineering,KIIT DU

COMPUTATIONAL LAB

Course Code: CE69203
Credit: 2
L-T-P: 0-0-4
Prerequisite: Nil

COURSE OUTCOMES

At the end of the course, the students will be able to

CO 1: Idealize a building frame to satisfy the functional requirement.

CO 2: Model of the building frame structure in MS-Excel

CO 3: Analyze the building frame in MS-Excel using stiffness Matrix Method

CO 4:Learn MATLAB commands for different types of mathematical problems,

CO 5: Analyze the building frame in MATLAB using stiffness Matrix Method

CO 6: Learn basic commands and perform static analysis of structure in FEAST Software

COURSE DETAILS

- Finalization of column and beam plan from a architectural plan
- Modeling of the building frame in MS-Excel
- Calculation of Dead load, live load, wind load and seismic load on the frame in MS-Excel
- Analysis of the building frame in MS-Excel using stiffness Matrix Method
- Introduction to MATLAB
- Analyze the building frame in MATLAB using stiffness Matrix Method
    - CO 1: Learn basic commands required for modeling in FEAST Software
    - CO 2: Perform static analysis of structure in FEAST Software
-

Textbooks / Reference Books

1. Getting Started with MATLAB: A Quick Introduction for Scientists & Engineer by Rudra Pratap, Oxford; Edition (1 January 2010)
2. IS: 875 - 1987 (Part 1), Dead Loads — Unit Weights Of Building Materials And Stored Materials, Bureau of Indian Standards, New Delhi.
3. IS: 875 - 1987 (Part 2), Imposed Loads, Bureau of Indian Standards, New Delhi.
4. IS: 875 - 2015 (Part 3), Wind Loads, Bureau of Indian Standards, New Delhi.
5. IS: 875 - 1987 (Part 5), Special Loads and Combinations, Bureau of Indian Standards, New Delhi.

6. IS: 1893 - 2016 (Part 1), Criteria for Earthquake Resistant Design of Structure, General Provisions and Buildings, Bureau of Indian Standards, New Delhi.

RESEARCH METHODS AND DOCUMENTATION

Course Code: EX60001
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE

Post-graduate engineering students carry out a year-long research-intensive thesis or project that requires them to have the full knowledge of general principles of defining and scoping a problem, deciding the approach to research design, implementing the design, making the analysis, drawing inferences, and communicating their research findings. This subject covers the essential features of research methods and research communications.

COURSE OUTCOMES

After successfully completing the course, the student will be able to

CO1: Define and scope a problem,
CO2: Make a review of literature,
CO3: Decide on an appropriate research design and develop an experimental setup and/or an appropriate model,
CO4: Generate and/or collect the necessary data, make the required data analysis, and draw inferences,
CO5: Initialize the art and science of scientific and technical writing, and
CO6: Write a project report following the principles of scientific writing.

COURSE CONTENT

A. <u>Research Methods</u>

A.1 Introduction to Research

Research Definition; Elements of Research: Novelty, Originality, Creativity, and Critical Thinking; Deductive, Inductive, and Abductive Approaches.

A.2 Selecting a Research Problem

Research Topics, Problems, Objectives and Scope, Questions, and Research Contribution.

A.3 Measurement, Data, and Data Analytics

Measurement Scales and Data Visualization; Revisiting Basic Statistics, Probability, and Probability Density Functions; Sampling and Sampling Distributions, Tests of Hypotheses, and Simple and Multivariate Regression Analysis

A.4 Models and Modelling

Characteristics and Types of Models, Discrete-Event Simulation, and Neural Networks Models.

A.5 Research Design

Qualitative Research: Survey, Case Study, Action Research,and Citizen Science; Experimental Research: Factors, Factor Levels, Replication, ANOVA, and Factorial Designs.

B. Research Documentation

B.1 Language Issues

Paragraphing, Unity of Ideas, Topic Sentences, Link Words, Transitions; Common English Errors;Use of Hyphen, Dashes, and Ampersand; Responsible Use of Generative AI Tools.

B.2 Organization of a Research Document

Front Matters, Body, and End Matters;Guidelines on Titles, Abstracts, Keywords, Symbols and Abbreviations, and Capitalization; Narrative and Systematic Literature Review, Referencing Systems, Reference Management Software; Guidelines on Tables, Figures, Mathematical Operations and Equations, SI Units, Scientific and Engineering Notations of Numbers, and Significant Digits.

B.3 Elements of Research and Publication Ethics

Research Misconduct: Types and Research Code of Conduct; Plagiarism and Copyright.

Reference Books

1. Dunn, P. K. (2021), Scientific Research and Methodology: An Introduction to Quantitative Research and Statistics in Science, Engineering, and Health, Available free at https://bookdown.org/pkaldunn/Book/. [***Covers most of the topics***]
2. Durdella, N. (2019), Qualitative Dissertation Methodology: A Guide for Research Design and Methods, California: SAGE Publications. [***For topics related to qualitative methods***]
3. Montegomery, D. C. (2019), Design and Analysis of Experiments, 10th Edition, John Wiley & Sons, Inc. [***For topics related to design of experiments, model and modelling***]
4. Perelman, L. C., J. Paradis, and E. Barrett, Eds. (1998), The Mayfield Handbook of Technical and Scientific Writing,Mayfield Publishing, Available free at http://www.mhhe.com/mayfieldpub/tsw/toc.htm.[***For topics related to research documentation***]
5. Kothari, C. R. (2004), Research Methodology: Methods and Techniques, 2nd Revised Edition, Hyderabad: New Age International.
6. Marder, M. C. (2011), Research Methods for Science, Cambridge University Press.

School of Civil Engineering

M. Tech. Programme

Specialization: Water Resources Engineering

Curricula & Syllabi

ACADEMIC CURRICULA – 2024

Kalinga Institute of
Industrial Technology (KIIT)
Deemed to be University
(Established U/S 3 of UGC Act, 1956)
Bhubaneswar, Odisha, India

SCHOOL OF CIVIL ENGINEERING
M. TECH. PROGRAM

Specialization: WATER RESOURCES ENGINEERING

SEMESTER-I

Sl. No	Subject Code	Course Title	Contact Hours			Credit
			L	T	P	
1	CE60003	Computational Methods in Civil Engineering	3	-	-	3
2	EX60001	Research Methods & Documentation	3	-	-	3
3	CE60301	Advanced Hydrology	3	-	-	3
4	CE60303	Advanced Fluid Mechanics	3	-	-	3
5	CE60305	Hydraulics of Free Surface Flow	3	-	-	3
6	CE60307	Geospatial Engineering in Water Resources	3	-	-	3
7	CE69303	GIS Lab	-	-	2	1
8	CE69305	Hydraulic Engineering Lab	-	-	2	1
					Total	20

SEMESTER-II

Sl. No	Subject Code	Course Title	Contact Hours			Credit
			L	T	P	
1	CE60004	Soft Computing Techniques in Civil Engineering	3	-	-	3
2	CE60302	Ground Water Engineering	3	-	-	3
3		**Elective-I**	3	-	-	3
4		**Elective-II**	3	-	-	3
5		**Elective-III**	3	-	-	3
6	CE69304	Hydrologic & Hydraulic Modeling Lab	-	-	4	2
7	CE68306	Statistical Design in Water Resources	-	-	2	1
8	CE68308	Comprehensive Viva Voce	-	-	-	2
					Total	20

SEMESTER-III

Sl. No	Subject Code	Course Title	Contact Hours			Credit
			L	T	P	
1		**Open Elective / Industry Elective**	3	-	-	**3**
2	CE68307	Seminar	-	-	2	**1**
3	CE67303	Thesis Part-I	-	-	-	**16**
					Total	**20**

SEMESTER-IV

Sl. No	Subject Code	Course Title	Contact Hours			Credit
			L	T	P	
1	CE67304	Thesis Part-II	-	-	-	**20**

LIST OF DEPARTMENT ELECTIVES

Elective-I

Sl. No	Subject Code	Subject Name	Credit
1	CE60326	Watershed Management	3
2	CE60334	Hydraulic Design of Irrigation Structures	3
3	CE60340	Advanced Irrigation & Drainage Engineering	3

Elective-II

Sl. No	Subject Code	Subject Name	Credit
1	CE60330	Computational Hydraulics & Hydrology	3
2	CE60336	Coastal & Estuarine Hydraulics	3
3	CE60338	River Engineering & Fluvial Hydraulics	3
4	CE60340	Hydropower Engineering	3

Elective-III

Sl. No	Subject Code	Subject Name	Credit
1	CE60322	Water Resources Systems Analysis	3
2	CE60328	Vadose Zone Hydrology	3
3	CE60342	Statistical Methods in Hydrology	3
4	CE60344	Environmental Impact Assessment	3

SCHOOL OF CIVIL ENGINEERING

M. TECH. PROGRAM

SPECIALIZATION: WATER RESOURCES ENGINEERING

SYLLABUS

COMPUTATIONAL METHODS IN CIVIL ENGINEERING

Course Code : CE60003
Credit : 3
L-T-P : 3-0-0
Prerequisite : Nil

COURSE OUTCOMES

After successfully completing the course, the students will be able to
After successfully completing the course, the students will be able to
CO1: Comprehend the measure of central tendency, dispersions and correlation coefficients,
CO2: Use the Curve Fitting & Least Square Techniques in the experimental methods,
CO3: Apply the concept of probability and set theory in practical problems,
CO4: Apply the concept of probability distribution functions,
CO5: Determine roots of algebraic equation by different methods and obtain interpolating polynomials, and
CO6: Solve ODE and PDE using numerical techniques.

COURSE DETAILS

Measures of Central Tendency & Dispersions; Covariance; Correlation Coefficients and their Properties in field data;
Curve Fitting & Least Square Techniques and their use in the experimental methods in Civil Engineering; Concept of Regressions; Regression curve in Bivariate Frequency Distributions;
Introduction to probability and set theory; Probabilistic measures; Conditional probability and Bayes' theorem; Discrete and continuous random variables;
Probability Density Functions; Probability Distributions of Single and Multiple Random Variables; Discrete & continuous distributions; Chi-Square Test; Kolmogorov-Smirnov Test; Analysis of Variance.
Linear equations and eigen value problems, Accuracy of approximate calculations, Non linear equations, interpolation, differentiation and evaluation of single and multiple integrals
Initial and boundary value problems by finite difference method, Newton's method, variation and weighted residual methods

Reference Books

1. Applied Statistics and Probability for Engineers by Douglas C. Montgomery and George C. Runger, Wiley India Pvt. Ltd, 2009.
2. Jay L. Devore, Probability and Statistics for Engineering and the Sciences, Brooke & Cole, 2009.

3. J.B. Scarborough, Numerical Mathematical Analysis, Oxford & IBH Publishing Co. Pvt. Ltd., 2000.
4. K. K. Jain, S. R. K Iyengar and R. K. Jain, Numerical Methods - Problem and Solutions, Wiley India Pvt. Ltd, 2001.
5. W. Mendenhall and T. Sincich, Statistics for Engineering and the Sciences, Prentice-Hall, 2000.
6. Steven Chapra and Raymond Canale , Numerical Methods for Engineers, McGraw-Hill Education; 6th edition 2012.

ADVANCED HYDROLOGY

Course Code : CE60301
Credit : 3
L-T-P : 3-0-0
Prerequisite : Nil

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO1: Analyze hydrological cycle, hydro-meteorological data and compute water balance
CO2: Compute various abstractions and apply different modeling approaches
CO3: Assimilate the concept and apply Reynolds transport theorem
CO4: Estimate runoff and peak flood flow
CO5: Perform both hydrologic and hydraulic flood routing
CO6: Apply statistical concept in hydrological analysis

COURSE DETAILS

Hydrologic Principles - hydrologic cycles and weather parameters, precipitation and abstractions, abstraction estimation and models, Reynolds transport theorem, continuity equation, momentum equation and energy equation, Atmospheric Water, hydrologic losses; Hydrologic Process, , rainfall-runoff, hydrograph analysis, unit hydrograph theory, synthetic unit hydrograph, Flood, Methods of Flood Estimation, Flood Routing, Lumped Flow Routing, Hydrologic Reservoir Routing, Modified Pul's Method, Goodrich Method, Hydrologic Channel Routing, Muskingum method, Distributed Flow Routing, Hydraulic Flood Routing; Saint - Venant Equations, Hydrologic Statistics - statistical parameter estimation, probability distribution, goodness of fit, concepts of probability analysis, Probability Distribution, Models of Watershed Hydrologic Simulation Models, Application of RS&GIS in hydrological modeling

Reference Books

1. V.T. Chow, D.R. Maidment and L.W. Mays, Applied Hydrology, Tata Mc. Graw Hill, 1st Ed. First Indian Reprint 2010.
2. K. Subramanya, Engineering Hydrology, 5th Edition, Mc-Graw hill, New Delhi.
3. R.C. Ward and M. Robinson, Principles of Hydrology by, 4th Edition, Mc-Graw Hill, New Delhi.

GROUNDWATER ENGINEERING

Course Code : CE60302
Credit : 3
L-T-P : 3-0-0
Prerequisite : NIL

COURSE OUTCOMES

After successfully completing the course, the students will be able to:

CO1: Explain the process of groundwater flow and functioning of groundwater wells.
CO2: Analyze and apply well hydraulics for steady and unsteady flow in aquifers
CO3: Explain modern methods of groundwater exploration
CO4: Address various environmental issues in groundwater
CO5: Estimate groundwater recharges using various techniques
CO6: Explain the concept of ground water pollution and management.

COURSE DETAILS

Fundamentals of Groundwater Flow and Groundwater Wells: (Basics of groundwater: aquifer, hydraulic head, storage character,. Darcy's law: hydraulic conductivity, heterogeneity and anisotropy, aquifer flow and transmissivity, Equations of groundwater flow, Radial flow to wells, pumping tests, Multiple well arrays, wells near hydro-geologic boundaries). Groundwater Resources Assessment: (Groundwater exploration: reconnaissance survey, surface and subsurface geophysical investigation, Hydrologic assessment: infiltration and groundwater recharge, water balance method, rainfall runoff models, and groundwater flow model). Environmental Issues: (Overcharging, Overexploitation: groundwater mining, land subsidence pumping, Groundwater quality and contamination, Saltwater intrusion), Groundwater Management: (Concepts of basin management quantity and quality aspects, Alternative basin yield, Evaluation of perennial yield, Modeling tools and techniques for management Integrated use of surface water and groundwater, Artificial recharge). Groundwater Pollution, Management of Groundwater Pollution: (General principles, Data requirement and data management, Groundwater protection, A comprehensive groundwater management program, Vulnerability assessment.

Reference Books

1. D. K. Todd and L.W. Mays, Groundwater Hydrology, 3rd Edition, John Wiley and Sons, 2011.
2. S. P. Garg, Groundwater and Tube Wells, Oxford and IBH Publishing Co., New Delhi.
3. H. M. Raghunath, Ground Water, New Age International Publishers; 3rd edition, Dec 2007.
4. Jacob Bear, Groundwater Hydrology, McGraw-Hill, 1979.

ADVANCED FLUID MECHANICS

Course code : CE60303
Credit : 3
L-T-P : 3-0-0
Prerequisite : Nil

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO1**:** Distinguish between flow properties and fluid properties
CO2**:** Analyze kinematic properties and ideal fluid flow patterns
CO3: Apply Reynolds Transport theorem
CO4: Apply Navier-Stokes equations for various flow conditions through parallel plates
CO5: Formulate and solve boundary layer equations and its applications
CO6: Apply theory of turbulence for solution of eddies and flow in pipes and over plates

COURSE DETAILS

Continuum hypothesis, Knudson number, definition of fluids, properties of fluids, kinematic properties (Lagrangian and Eulerian Approach, Streamline, Streak line, path line), Acceleration of fluid flow, deformation and conservation of mass of fluid element, Angular deformation of a fluid element, Angular deformation of a fluid element, vorticity and stream function and velocity potential. Ideal flow, standard flow patterns, combination of flow patterns. Transport properties, Reynolds transport theorem. Application of Reynolds transport theorem, Momentum conservation equation (Navier-Stokes equation), solution of Navier-Stokes equation for Poiseuille flow, Couette flow, and Couette-Poiseuille flow of Newtonian fluids through parallel plates and cylindrical geometry, Flow over a flat plate, Navier-Stokes equations, boundary layer theory, displacement and momentum thickness, Blasius solution, momentum-integral equation, solution of the momentum integral equation, drag force on the plate, condition for the boundary layer separation, techniques for avoiding boundary layer separation. Introduction to turbulence (basic concepts), Eddies, Mixing length concept and Reynolds stress equation.

Reference Books

1. Fox and McDonald, Introduction to Fluid Mechanics, 10th Edition, Wiley.
2. R. J. Garde and A. G. Mirajgaoker, Engineering Fluid Mechanics, SciTech Publication, Chennai.
3. V.L. Streeter, E.B. Wylie and K.W. Bedford, Fluid Mechanics, 2013, 9th Edition, McGraw-Hill Book, New York.
4. F. M. White and H. Xue, Fluid Mechanics, 2022, 9th Edition, Tata Mc Graw Hill, New Delhi.
5. R. K. Bansal, A Text Book of Fluid Mechanics & Hydraulic Machines. Laxmi Publications (P) Ltd., 10th Edition.

HYDRAULICS OF FREE SURFACE FLOW

Course Code : CE60305
Credit : 3
L-T-P : 3-0-0
Prerequisite : NIL

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO1: Classify various types of flow in open channels and apply energy principles

CO2: Analyze uniform flow in open channels
CO3: Compute the problems on gradually varied flow
CO4: Analyze rapidly varied flow phenomenon in open channels
CO5: Solve spatially varied flow situations
CO6: Compute the gradually and rapidly varied unsteady flow using numerical methods

COURSE DETAILS

Types of Channels, Classification of flows, Velocity Distribution, Energy Equation, Energy-Depth relationship: Specific Energy, Critical Depth and Transitions, Uniform flow: Introduction, Chezy and Manning's Equation, Determination of roughness coefficients and the factors affecting the roughness, computation of uniform flow, determination of normal depth, flow in composite roughness, Design of channels for uniform flow in non-erodible and erodible channels. Gradually varied flow (GVF): Theory, Classification of flow profiles, GVF computation (Direct Step & Standard Step Method), Spatially Varied Flow with increasing and decreasing discharge, Rapidly varied flow: classification, Hydraulic Jump, types with characteristics of jump, the surface profile and location of the jump, jumps as an energy dissipater, Unsteady flow, dynamics of gradually varied unsteady flow, solution of unsteady flow equations using numerical methods, rapidly varied unsteady flow, positive and negative surges.

Reference Books

1. V. T. Chow, Open Channel Hydraulics, McGraw-Hill, New York.
2. K. Subramanya, Flow in Open Channel, 5th Edition, Tata Mc Graw Hill, New Delhi.
3. M. H. Chaudhry, Open Channel Flow, 2nd Edition, Springer.
4. H. Chanson, The Hydraulics of Open Channel Flow: An Introduction, 2nd Edition, Elsevier.

GEOSPATIAL ENGINEERING IN WATER RESOURCES

Course Code : CE60307
Credit : 3
L-T-P : 3-0-0
Prerequisite : NIL

COURSE OUTCOMES

After successful completion of the course, the students will be able to:

CO1: Explain the principle of remote sensing
CO2: Interpret and analyze the digital images
CO3: Perform the fundamental operations of GIS
CO4: Manage GIS data files and also analyze the spatial and attribute data
CO5: Describe different applications of remote sensing & GIS
CO6: Interpret the application of remote sensing and GIS in various water resources areas

COURSE DETAILS

Principle of Remote Sensing: Introduction, Historical development of remote sensing, Passive and active remote sensing, Electromagnetic radiation, Energy interactions in the atmosphere and earth surface features, Spectral reflectance curves, Remote sensing system: Satellites and orbits, types of satellites, multispectral, thermal and hyperspectral sensing, remote sensing satellites and their features Digital image interpretation and analysis: Geometric corrections, Image enhancement techniques, Image classification, Image transformations, vegetation indices, Digital image processing software, Passive and active microwave remote sensing, Geographic Information Systems (GIS): Introduction, different components of GIS, maps and map scale, Geo referencing and projections, Spatial data modelling, GIS data management, Spatial interpolation techniques, Digital elevation models, Demonstration through GIS software, Limitations of GIS, Integration of Remote sensing and GIS Global positioning system (GPS): Introduction, principle and errors in GPS measurement, Differential global positioning system (DGPS), Case studies in Water Resources Planning & Management

Reference Books

1. T. M. Lillesand, R.W. Kiefer and J.W. Chipman, Remote sensing and Image Interpretation, 2015, 7th Edition, John Wiley & Sons Ltd., England
2. C.P.L.O. Albert, K.W. Yong , Concept and Techniques of GIS, Prentice Hall Publishers
3. P.A. Burrough and R. A. McDonnell, Principles of geographical information systems by, 1998, Oxford University Press
4. M.A. Reddy, Remote Sensing and Geographical Information Systems, 2008, 3rd Edition, BS Publications, India
5. P.J. Gibson, Introductory Remote Sensing- Principles and Concepts by, 2000, Routledge, London.
6. M.F. Goodchild, P.A. Longley, D.J. Maguire and D.W. Rhind, U. K. Geographic information systems and science by, 2001, John Wiley & Sons Ltd., England.

SOFT COMPUTING TECHNIQUES IN CIVIL ENGINEERING

Course Code: **CE60004**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OUTCOMES

At the end of the course, the students will be able to

CO1: Comprehend the basic concepts of soft computing,
CO2: Use generic algorithms and Particle swarm intelligence algorithms,
CO3: Prepare prediction model using neural network,
CO4: Apply supervised machine learning techniques,
CO5: Apply the techniques of unsupervised machine learning, and
CO6: Implement soft computing techniques in Civil Engineering problems.

COURSE DETAILS

Introduction to Soft Computing: Basic concepts, various Soft Computing Techniques, Overview of conventional computing vs. soft computing, Characteristics and advantages of soft computing techniques.

Genetic Algorithms (GA): Introduction to genetic algorithms, Representation schemes: binary, real-valued, permutation, Genetic operators: selection, crossover, mutation.

Particle Swarm Optimization (PSO): Introduction to particle swarm optimization, Swarm intelligence principles, PSO algorithm components: particles, velocity update, position update, Ant Colony Optimization (ACO): Basics of ant colony optimization, Ant behavior modeling, ACO algorithm: pheromone trails, ant movement, Pigeon search algorithm.

Artificial Neural Networks (ANN): Fundamentals of neural networks, Single-layer and multi-layer perceptrons, Training algorithms: back-propagation, gradient descent, Convolutional Neural Networks (CNN),

Fuzzy Logic Systems: Basics of fuzzy set theory, Fuzzy logic operations and rules, Fuzzy inference systems

Introduction to Machine Learning, Basic Concepts, Supervised learning, unsupervised learning, reinforcement learning, Python libraries

Supervised Learning Techniques: Decision trees and ensemble methods (Random Forests), Support Vector Machines (SVM), Basic concepts and principles, k-nearest neighbor (kNN)

Unsupervised Learning Techniques: Clustering, K-means clustering, Hierarchical clustering, Dimensionality Reduction, Principal Component Analysis (PCA)

Application of soft computing in Civil Engineering: Application of different algorithms to solve practical problems of Civil Engineering

Reference Books

1. Pratihar D.K., Soft Computing, Narosa Publishers, and ISBN: 978-81-8487-495-2, 2018.
2. Mangey Ram, J. Paulo Davim, Soft Computing Techniques and Applications in Mechanical Engineering, IGI Global, USA.
3. Simeone O, Machine learning for engineers, Cambridge University Press, 2022.
4. E. Alpaydin, Introduction to Machine Learning, Prentice Hall of India, 2006.

WATER RESOURCES SYSTEMS ANALYSIS

Course Code : CE60322
Credit : 3
L-T-P : 3-0-0
Prerequisite : NIL

COURSE OUTCOMES

After successfully completing the course, the student will able to:

CO1: Identify the basic structure of water resources system and its parameters
CO2: Apply the financial principles adopted in WR Projects
CO3: Identify and apply concept of system analysis in WR projects
CO4: Implement statistical concepts in water resources system
CO5: Apply different optimization techniques in WR projects
CO6: Apply operations and research technique for operating reservoirs

COURSE DETAILS

Water Resources System, Fundamentals of System Analysis: Financial Analysis of WR Projects, Basic Principles of Project Economics, Benefit-Cost Ratio, Discounting techniques, System Analysis Techniques; linear programming, dynamic programming (with different methods) and introduction to non—linear programming, geometric programming, Goal programming and Simulation. Introduction to modern heuristic methods, Statistical Techniques for data analysis (Probability Distribution, Hypothesis Testing, Regression, Time Series Analysis) , Systems concepts and its application in irrigation, flood control, hydropower generation, water supply and drainage storage-yield analysis, Rule curves, Reservoir sizing, Multi-reservoir systems, Real time operation, water conflicts.

Reference Books

1. S. K. Jain & V. P. Singh, Water Resources Systems Planning and Management, Elsevier Science B.V
2. S. P. Simonovic, Managing Water Resources: Methods and Tools for a Systems Approach, UNESCO Publishing, France, 2009.
3. S. Vedula and P. P. Mujumdar, Water Resources Systems: Modeling Techniques and Analysis by, Tata McGraw Hill, New Delhi, 2005.
4. Taha, H. (2007). Operations Research. Pearson, USA.Taylor, B. (1999). Introduction to management science. Prentice- Hall, New Jersey.
5. Hillier, F., Lieberman, G. (2010). Introduction to operations research, McGraw-Hill, New York.

WATERSHED MANAGEMENT

Course Code : CE60326
Credit : 3
L-T-P : 3-0-0
Prerequisite : NIL

COURSE OUTCOMES

After successful completion of the course, the students will be able to:

CO1: Explain the basic concept & parameters of a watershed
CO2: Identify the roles of legal, financial and institutional aspects of watershed management
CO3: Explain the factors affecting the erosion process
CO4: Identify and use methodology for water conservation measures
CO5: Prepare strategies for sustainability of resources

CO6: Apply different watershed models

COURSE DETAILS

Introduction and Basic Concepts: Concept of watershed, introduction to watershed management, different stakeholders and their relative importance, watershed management policies and decision making; Sustainable Watershed Approach & Watershed Management Practices: Sustainable integrated watershed management, natural resources management, agricultural practices, integrated farming, Soil erosion and conservation; Watershed Management Practices in Arid and Semiarid Regions, Case studies, short term and long term strategic planning; Integrated Watershed Management: Introduction to integrated approach, Integrated water resources management, conjunctive use of water resources, rainwater harvesting; roof catchment system; Watershed Modeling: Standard modeling approaches and classifications, system concept for watershed modeling, overall description of different hydrologic processes, modeling of rainfall-runoff process, subsurface flows and groundwater flow; Social Aspects of Watershed Management: Community participation, Private sector participation, Institutional issues, Socio-economy, Integrated development, Water legislation and implementations, Case studies; Use of modern techniques in watershed management: Applications of Geographical Information System and Remote Sensing in Watershed Management, Role of Decision Support System in Watershed Management; Storm Water and Flood Management: Storm water management, design of drainage system, flood routing through channels and reservoir, flood control and reservoir operation, case studies on flood damage; Drought Management: Drought assessment and classification, drought analysis techniques, drought mitigation planning; Water Conservation and Recycling: Perspective on recycle and reuse, Waste water reclamation.

Reference Books

1. Raj Vir Singh, Watershed Planning and Management, Yash Publishing House, Bikaner, 2000
2. Suresh, R. Soil & Water Conservation, Standard Publisher & Distribution, 2020
3. Peter E. Black, Watershed Hydrology, Prentice Hall, London, 1991.

VADOSE ZONE HYDROLOGY

Course Code : CE60328
Credit : 3
L-T-P : 3-0-0
Prerequisite : NIL

COURSE OUTCOMES

After successful completion of the course, the students will be able to:

CO1: Analyze how soil texture and structure affect water movement and storage in soil.
CO2: Explain relationships between soil water pressure, water content and hydraulic conductivity.
CO3: Apply basic techniques for monitoring soil water, storage, movement and characterizing soil hydraulic properties.
CO4: Use the concept of flow of water in unsaturated and saturated soil medium.
CO5: Use knowledge to analyze the movement of solute and soil salinity issues in the soil system.

CO6: Analyze the air and aeration process in the soil medium.

COURSE DETAILS

Introduction: Physical properties of soil; Properties of water in relation to porous media; Phases: Solid phase, liquid phase, soil water content and soil water potentials, soil water characteristic curves; Flow Process: Flow of water in saturated and unsaturated soil, Water Flow in Soils; Flow Principles: Darcy's Laws; unsaturated hydraulic conductivity models; Richards equation and its alternate forms;
Solution Process: Solutions of Richards equation: Analytical, approximate and numerical solutions of Richards equation; Solute Transport: Movement of Solutes and Soil Salinity, Soil Air and Aeration, Soil Temperature and Heat flow

Reference Books

1. Daniel B. Stephens , Vadose Zone Hydrology, 2003, Taylor & Francis Inc
2. James A Tindall, James R. Kunal, Dean E. Anderson, Unsaturated Zone Hydrology for Scientist & Engineers, 1999, USGS, USA
3. Daniel Hillel, Fundamentals of Soil Physics,1980, Academic Press
4. Daniel Hillel, Environmental Soil Physics, , 1998, Academic Press
5. Daniel Hillel, Introduction to Environmental Soil Physics, 2003, Academic Press
6. V.T. Chow, D.R. Maidment and L.W. Mays, Applied Hydrology, 2010, Tata Mc. Graw Hill.

COMPUTATATIONAL HYDRAULICS & HYDROLOGY

Course code : CE60330
Credit : 3
L-T-P : 3-0-0
Prerequisite : Nil

COURSE OUTCOMES

After successful completion of the course, the students will be able to:

CO1: Identify the differences between various discretization methods and analyse the close conduit flow both steady and unsteady modelling
CO2: Develop knowledge on the software HEC-RAS for the modelling of open channel flow problems
CO3: Use the software WaterCAD/ EPANET for the solution of pipe network analysis
CO4: Use the knowledge of surface hydrology for the estimation of hydrologic parameter using HEC-HMS
CO5: Aanalyze the groundwater flow system (both in the saturated and unsaturated flow conditions using MODFLOW.
CO6: Able to apply the soft computing methods in hydraulic and hydrological analysis

COURSE DETAILS

Introduction to Computational Hydraulics: Problem Definition and Governing Equations, Classification of Problems based on Initial Condition (IC) and/or Boundary Condition (BC), Classification of Differential Equations, Numerical Methods, overview and mesh generation, finite difference and finite volume method, solution process, Open channel flow: Unsteady flow, Saint Venant Equation, overland flow, steady and unsteady modelling using HEC-RAS. Close conduit flow: steady unsteady state modelling, pipe network analysis, introduction to Water CAD/EPANET. Surface hydrology: Hydrologic parameter estimation, Hydrologic modelling by HEC-HMS/MIKE-HYDRO, Groundwater Hydrology: Solving Ground water flow equation saturated and unsaturated flow, Introduction to MODFLOW, Application of soft computing methods in Hydraulic and Hydrologic modelling.

Reference Books

1. Applied Hydrology by V.T. Chow, D.R. Maidment and L.W. Mays, Tata Mc. Graw Hill, 2nd Ed., First Indian Reprint 2010. Engineering Hydrology by K. Subramanya, Tata McGraw Hill, 4th Ed. End reprint 2016.
2. Flow in Open Channels by K. Subramanya, 4th Edition, TMH Education Pvt. Ltd, New Delhi
3. Water Resources Engineering by L.W. Mays, Wiley Publication, 3rd Edition, First Indian Reprint 2001.
4. Fluid Mechanics by V.L. Streeter, E.B. Wylie & K.M. Bedford, 9th Edition, Tata McGraw-hill Publication, New Delhi.
5. Groundwater Hydrology, by D. K. Todd and L.W. Mays, 3rd Edition, John Wiley and Sons, 2011.
6. HEC-RAS 6.0, US Army Corps of Engineers, Hydrologic Engineering Centre
7. WATER CAD, Bentley Systems 2020
8. EPANET 2.2, United States Environmental Protection Agency, 2020
9. HEC-HMS,US Army Corps of Engineers, Hydrologic Engineering Centre
10. U.S. Army Corps of Engineers. (2001). "HEC-HMS Hydrologic Modeling System User's Manual," Hydrologic Engineering Center, Davis, CA.
11. MODFLOW 6, USGS water resources, 2020

HYDRAULIC DESIGN OF IRRIGATION STRUCTURES

Course Code : CE60334
Credit : 3
L-T-P : 3-0-0
Prerequisite : NIL

COURSE OUTCOMES

After successfully completing the course, the students will be able to:

CO1: Analyze and design of weirs and barrages.
CO2: Design head and cross regulator structures.
CO3: Determine the forces acting on gravity dam and design of gravity and earthen dam.
CO4: Design spillways and energy dissipaters.
CO5: Design cross drainage structures
CO6: Explain the principles of flow measurement structures

COURSE DETAILS

Diversion head works, Theories of seepage, Design of weirs and barrages, Design of head regulator and cross regulator structures, Dams: classification, site selection and economic height of dam, Gravity Dam: Forces acting on gravity dam, Modes of failure and criteria for structural stability of gravity dam, Stability analysis, Elementary profile of a Gravity dam, High and low gravity dam, profile of a dam, fixing the section of dam, design of gravity dam, Construction of gravity dam, Earthen Dam: Types of earthen dams, causes of failure of earth dams, seepage analysis, determination of phreatic line, measures to control seepage through earth dams and their foundations. Classifications of spillways, Design of spillways (ogee, chute and siphon), energy dissipaters, cross-drainage works, Flow Measurement Structures, Water Level and Flow Control Structures, Automatic Structures

Reference Books

1. S.K. Garg, Water Resources Engineering Vol. 2, Irrigation Engineering and Hydraulic Structures , Khanna Publishers, 35th Ed., End reprint 2022.
2. P. Novak, A. I. B. Moffat, C. Nalluri and R. Narayanan, Hydraulic Structures, Taylor and Francis, U. K.
3. R. M. Khatsuria, Hydraulics of Spillways and Energy Dissipators, Marcel Dekker Publishing, New York.
4. Publication 179, Manual on Barrages and Weirs on Permeable Foundation (Volumes I and II), Central Board of Irrigation and Power, New Delhi.

COASTAL & ESTUARINE HYDRAULICS

Course code : CE60336
Credit : 3
L-T-P : 3-0-0
Prerequisite : Nil

COURSE OUTCOMES

After successful completion of the course, the students will be able to:

CO1: Understand the basic principles of fluid mechanics and their application to coastal and estuarine systems.
CO2: Learn about tidal dynamics, wave mechanics, and their interactions with coastal and estuarine environments.
CO3: Gain insight into sediment transport processes in coastal and estuarine regions.
CO4: Understand estuarine circulation patterns and their ecological significance.
CO5: Explore coastal engineering structures and their role in coastal protection and management.
CO6: Familiarize with numerical modeling techniques for simulating coastal and estuarine hydraulics.

COURSE DETAILS

Introduction to Coastal and Estuarine Hydraulics: Overview of coastal and estuarine environments, Importance of coastal and estuarine hydraulics, Historical developments and key concepts, Fluid Mechanics Review: Basic principles of fluid mechanics, Conservation laws (mass, momentum, energy), Fluid properties and viscosity, Tidal Dynamics: Tidal forces and constituents, Tidal datums and predictions, Tidal prism concept, Tidal asymmetry and resonance, Wave Mechanics: Wave characteristics and classification, Wave generation and propagation, Wave transformation and shoaling, Wave breaking and energy dissipation, Coastal Sediment Transport: Sediment properties and classification, Beach morphology and sediment budget, Longshore and cross-shore sediment transport, Coastal erosion and sedimentation processes, Estuarine Circulation: Estuarine classification and morphology, Saltwater intrusion and mixing processes, Estuarine exchange flow and tidal asymmetry, Estuarine flushing and residence time, Coastal Engineering Structures: Types of coastal structures (e.g., groins, breakwaters, seawalls), Design principles and criteria, Coastal protection measures and erosion control, Environmental impacts and considerations, Numerical Modeling in Coastal and Estuarine Hydraulics: Introduction to numerical modeling techniques, Finite difference, finite volume, and finite element methods, Applications of numerical models in coastal and estuarine studies, Model calibration, validation, and uncertainty analysis

Reference Books

1. J. Paul Guyer, An Introduction to Hydraulics of Coastal Estuaries for Professional Engineers, Guyer Partners, 2023
2. Mani J S, Coastal Engineering, 2nd Edition, PHI Learning

RIVER ENGINEERING & FLUVIAL HYDRAULICS

Course Code : CE60338
Credit : 3
L-T-P : 3-0-0
Prerequisite : NIL

COURSE OUTCOMES

After successfully completing the course, the students will be able to:

CO1: Describe different types of flow in the river system.
CO2: Explain different types of sediment in river system and its flow hydraulics
CO3: Design different types of canals & sediment control structures.
CO4: Use and explain different approaches for river morphological study
CO5: Design different river training structures
CO6: Formulate solution for reservoir sedimentation problem

COURSE DETAILS

River Flow Hydrology, Flow Characteristics (Laminar and Turbulent Flows, Velocity Distribution, Bed Shear Stress, and Depth— Discharge Relationship), Sediment Sources and Sediment Characteristics: Initiation of Motion of Sediment Transport, Mode of Sediment Transport, Estimation of Sediment

Transport and Alluvial Roughness: (Flow Regimes and Bed Forms, Sediment Transport Formulas for Bed Load and Total Load, Suspended Load Formula, Alluvial Channel Roughness. Design of Stable Channels, Flow and Sediment Transport Measurements), Waterways Engineering Works: (River Engineering Works, Flow Regime Control Structures, and Sediment Control Devices for Intake Structures). Modeling of Sediment Transport and River Morphology: (Governing Equations of Flow and Sediment Transport, Propagation of Bed Forms, Analytical Models of Sediment Transport and River Morphology, Numerical Models of Sediment Transport and River Morphology, Accuracy and Stability of Numerical Models), Classification and design of river training works, Sedimentation in Reservoirs: (Distribution of Sediment deposition in Reservoirs, Erosion of Sediment Deposits in Reservoirs, Computation of Sedimentation Volume in Reservoirs, Sedimentation Distribution in Reservoirs.

Reference Books

1. K.D. Gupta, River Engineering, Vayu Education of India, 2014.
2. A.A. Khan and W. Wu, Sediment Transport: Monitoring, Modeling and management, Earth Sciences in the 21st Century, NOVA Science Publishers, 2013.
3. P.Y. Julien, River Mechanics, Cambridge University Press, 2002.
4. C.T. Yang, Sediment Transport: Theory and Practice, Mcgraw-Hill, 1996.
5. H. Chang, Fluvial Processes in River Engineering by Howard, Krieger Publishing Company

ADVANCED IRRIGATION & DRAINAGE ENGINEERING

Course Code : CE60340
Credit : 3
L-T-P : 3-0-0
Prerequisite : NIL

COURSE OUTCOMES

After successfully completing the course, the students will be able to:

CO1: Understand the advanced principles of soil-water-plant relationships and their application in irrigation management.

CO2: Learn advanced techniques for irrigation scheduling and optimization.

CO3: Gain proficiency in the hydraulic design of irrigation systems, including pressurized and surface irrigation methods.

CO4: Understand the principles of drainage engineering and its role in water logging and salinity control.

CO5: Explore water management strategies for sustainable irrigation practices.

CO6: Familiarize with modern technologies, such as remote sensing and precision agriculture, in irrigation and drainage engineering.

COURSE DETAILS

Advanced Soil-Water-Plant Relationships: Soil water retention and hydraulic conductivity, Soil moisture dynamics and plant-water relations, Root zone dynamics and water uptake mechanisms,

Irrigation Scheduling and Optimization: Crop water requirements and evapotranspiration estimation, Irrigation scheduling methods (e.g., FAO Penman-Monteith method, crop coefficients), Optimization techniques for water use efficiency, Hydraulic Design of Irrigation Systems: Design criteria for pressurized irrigation systems (e.g., drip irrigation, sprinkler irrigation), Design of surface irrigation systems (e.g., border, furrow, and basin irrigation), Pumping systems and energy efficiency considerations, Drainage Principles: Drainage requirements and objectives, Subsurface drainage methods (e.g., tile drainage, mole drainage), Surface drainage techniques (e.g., open ditches, land grading), Water logging and Salinity Control: Causes and effects of water logging and salinity, Drainage design for water logging mitigation, Irrigation management strategies for salinity control, Water Management Strategies: Irrigation water management principles, Water conservation techniques (e.g., deficit irrigation, regulated deficit irrigation), Integrated water resources management approaches, Modern Technologies in Irrigation and Drainage: Remote sensing applications in irrigation management, Precision agriculture techniques for irrigation optimization, Sensor-based irrigation scheduling and automation

Reference Books

1. S.K. Garg, Water Resources Engineering Vol. 2, Irrigation Engineering and Hydraulic Structures , Khanna Publishers, 35th Ed., End reprint 2022.
2. S. K. Gupta, Drainage Engineering: Principles & Practices, Scientific Publishers

HYDRO POWER ENGINEERING

Course code : CE60342
Credit : 3
L-T-P : 3-0-0
Prerequisite : Nil

COURSE OUTCOMES

After successful completion of the course, the students will be able to:

CO1: Explain various aspects of hydro power engineering
CO2: Use various considerations to select location for power project
CO3: Estimate power potential of project and also different definitions related to it
CO4: Design various intake structures
CO5: Analyze flow through different turbines
CO6: Estimate water hammer and design of surge tanks

COURSE DETAILS

Concept of hydro power Engineering, Different heads such as Gross head, Effective head, Design head, rated head, critical head, classifications of water power plants based on hydraulic characteristics, topography, head, capacity of plant, load etc. Major hydroelectric schemes in India. Planning a site selection of hydropower projects according to availability of Quantity and head of water , estimating of power potential using Mass curve and flow duration curves Economics of water power plants load factor, capacity factor, load curve, effect of pondage on flow duration curve. Estimation of unit cost of

hydro power and comparison with unit cost of stream power station, General planning of hydropower projects. Various types of intake structures. Penstocks of steel pipes economic diameter, number of penstocks wall thickness of steel penstocks, shell theory of design, welded and riveted steel pipes, Accessories of penstocks. Expansion joints anchor blocks and pipe supports. Tunnels. Dimensions and shape economic size of tunnel Tunnel lining. Theory of water hammer, Arithmetic integration and graphical method of analysis, surge tanks and types of surge tanks theory of simple surge tank and design, Mathematical treatment f water surface oscillations including friction. Pressure relief valves stability of surge tank. Thoma formula, Balancing reservoir and fore bays Pressure. Selection of type of turbines according to head & specific speed, various types casing of turbines, Determination of their shapes, main relative dimension of runner. Draft tube, its functions, draft tube theory. In take conduits, Preliminary power house dimensioning, general arrangement of power house.

Reference Books

1. M. M. Dandikar & K. N. Sharma, Water Power Engineering, Vikas Publication.
2. P. N. Modi, Irrigation Water Resource & Water Power Engineering", Standard Book House Dec 2008.

STASTICAL METHODS IN HYDROLOGY

Course code : CE60344
Credit : 3
L-T-P : 3-0-0
Prerequisite : Nil

COURSE OUTCOMES

After successful completion of the course, the students will be able to:
CO1: Understand the fundamental concepts of probability theory and its application in hydrology.
CO2: Learn various statistical methods for analyzing hydrological data and interpreting results.
CO3: Gain proficiency in frequency analysis techniques for estimating extreme events.
CO4: Develop skills in time series analysis and modeling of hydrological processes.
CO5: Learn regression analysis techniques for understanding relationships between hydrological variables.
CO6: Understand uncertainty analysis and its importance in hydrological modeling and decision-making.

COURSE DETAILS

Introduction to Hydrological Data: Types of hydrological data, Data collection methods, Data quality assessment, Probability Distributions in Hydrology: Probability concepts, Common probability distributions in hydrology (e.g., normal, lognormal, gamma, Gumbel), Parameter estimation methods, Frequency Analysis: Return periods and risk analysis, Methods for frequency analysis (e.g., method of moments, maximum likelihood estimation), Flood frequency analysis, Drought frequency analysis, Hydrological Time Series Analysis: Characteristics of hydrological time series, Time series decomposition, Trend analysis, Seasonal analysis, Autocorrelation and cross-correlation analysis, Regression Analysis in Hydrology: Linear regression, Multiple regression, Nonlinear regression, Model selection and validation, Uncertainty Analysis: Sources of uncertainty in hydrological modeling, Monte

Carlo simulation, Sensitivity analysis, Uncertainty propagation, Stochastic Modeling: Introduction to stochastic processes, Stochastic hydrological models, Simulation techniques (e.g., Monte Carlo simulation, Markov chain Monte Carlo), Applications of stochastic modeling in hydrology

Reference Books

1. Charles T. Haan, Statistical Methods in Hydrology, Weily Publications
2. Dennis R. Helsel, Robert M. Hirsch, Karen R. Ryberg, Stacey A. Archfield, and Edward J. Gilroy, Statistical Methods in Water Resources, Chapter 3 of Section A, Statistical Analysis Book 4, Hydrologic Analysis and Interpretation
3. K. Subramanya, Engineering Hydrology, 5th Edition, Mc-Graw hill, New Delhi

ENVIRONMENTAL IMPACT ASSESSMENT

Course Code : CE60346
Credit : 3
L-T-P : 3-0-0
Prerequisite : NIL

COURSE OUTCOMES

After successful completion of the course, the students will be able to:

CO1: Comprehend basic principles of EIA
CO2: Identify the roles of EIA in water resource development projects
CO3: Apply EIA for clearance of WR projects
CO4: Comprehend different methodologies of EIA
CO5: Evaluate environmental impact of specific water resources project
CO6: Use specific laws and process of EIA for clearance of WR projects

COURSE DETAILS

Water and Ecosystem: (Structure and function, Land, water and air, EIA — Development and Basic Principles, Basic concept of EIA, Outline of EIA process. Subject oriented requirements, EIA and Management Requirements of WRD Projects, Dam projects, Irrigation projects, Hydropower projects, Water supply and sanitation projects, Inter-basin WRD projects EIA Methodologies: (Screening and scooping, Checklists, matrices, Networks, overlay mapping, Benefit-cost analysis, Modeling of water resources systems, Selection of methodologies, Impact identification, measurement, interpretation, evaluation soft communication, EIA laws of different countries, regulatory requirements, forest clearance, preservation of nature

Reference Books

1. L. W. Canter, Environmental Impact Assessment, 2nd Ed., McGraw-Hill, 1997.
2. R. Therivel, John Glasson and Andrew Chadwick, Introduction to Environmental Impact Assessment (Natural and Built Environment), Routledge, 2005.

3. C. H. Eccleston, Environment Impact Statements: A Comprehensive Guide to Project and Strategic Planning, John Wiley & Sons, 2000.
4. P. Judith and G. Eduljee, Environmental Impact Assessment for Waste Treatment and Disposal Facilities, John Wiley & Sons, 1994.
5. G. Burke, B. R. Singh and L. Theodore, Handbook of Environmental Management and Technology, 2nd Ed., John Wiley & Sons, 2000.
6. R. Welford, Corporate Environmental Management - Systems and Strategies by, Universities Press, 1996.

STATISTICAL DESIGN IN WATER RESOURCES

Course code : CE68306
Credit : 1
L-T-P : 0-0-2
Prerequisite : Nil

COURSE OUTCOMES

After successful completion of the course, the students will be able to:

CO1: Compute different aspects pf central tendency of data
CO2: Perform various regression and correlation analysis
CO3: Execute trend analysis of hydro-meteorological data
CO4: Perform analysis of time series and calculate ACF & PACF
CO5: Develop auto regressive models
CO6: Fit probability distribution of hydro-meteorological data

COURSE DETAILS

1. Characteristics of water resources Data & Exposure to SPSS & EXCEL
2. Classical Measure of Central Tendency—Mean, Median & Mode
3. Classical Measures of Variability: Variance, Standard Deviation, Coefficient of Variation
4. Measures of Distribution Symmetry: The Coefficient of Skewness
5. Linear egression
6. Multiple Linear Regression
7. Trend Analysis-I
8. Trend Analysis-II
9. Time Series Analysis: ACF & PACF
10. AR Models
11. Fitting of Probability Distribution-I
12. Fitting of Probability Distribution-II

Reference Books

1. Dennis R. Helsel, Robert M. Hirsch, Karen R. Ryberg, Stacey A. Archfield, and Edward J. Gilroy, Statistical Methods in Water Resources, Chapter 3 of Section A, Statistical Analysis Book 4, Hydrologic Analysis and Interpretation
2. K. Subramanya, Engineering Hydrology, 5th Edition, Mc-Graw hill, New Delhi.

GIS LAB

Course code : CE69303
Credit : 1
L-T-P : 0-0-2
Prerequisite : Nil

COURSE OUTCOMES

After successful completion of the course, the students will be able to:

CO1: Explain the fundamentals of GIS & related softwares
CO2: Describe the operations of Arc GIS tools and prepare the layout of study area
CO3: Manage GIS data files and analyze the spatial attribute of data
CO4: Delineate watershed using Arc GIS
CO5: Create interpolation maps
CO6: Interpret the application of remote sensing and GIS in various water resources applications

COURSE DETAILS

1. Familiarization with GIS Software
2. Geo Referencing and Projections
3. Digitization of Map / Toposheet
4. Creation of Thematic Maps
5. Base Map Preparation
6. Data Conversion – Vector to Raster, Raster to Vector
7. Adding Attribute Data – Querying On Attribute Data
8. Vector Analysis
9. Raster Analysis
10. Map Composition
11. Developing Digital Elevation Model
12. Applications of GIS in Water Resources Engineering

Reference Books

1. C. P.L.O. Albert, K.W. Yong , Concept and Techniques of GIS, Printice Hall Publishers.
2. P.A. Longley, D.J. Maguire and D.W. Rhind, 2001, Geographic information systems and science by M.F. Goodchild, John Wiley & Sons Ltd., England.

HYDROLOGIC AND HYDRAULIC MODELING LAB

Course code : CE69304
Credit : 2
L-T-P : 0-0-4
Prerequisite : Nil
COURSE OUTCOMES

After successful completion of the course, the students will be able to:

CO1: Describe the uses of physical models in Water Resources
CO2: Develop physical model for water resources problems
CO3: Assimilate concept of mathematical models in Water Resources
CO4: Explain the uses of developing mathematical models
CO5: Use hydrological models
CO6: Use hydraulic models

COURSE DETAILS

1. Concept of physical model and its application in water resources-I
2. Concept of physical model and its application in water resources-II
3. Mathematical modeling in Hydrology (HEC-HMS / MIKE-HYDRO-NAM)-I
4. Mathematical modeling in Hydrology (HEC-HMS / MIKE-HYDRO-NAM)-II
5. Mathematical modeling in Hydrology (HEC-HMS / MIKE-HYDRO-NAM)-III
6. Mathematical modeling in Hydrology (HEC-HMS / MIKE-HYDRO-NAM)-IV
7. Mathematical modeling in Hydrology (HEC-HMS / MIKE-HYDRO-NAM)-IV
8. Mathematical modeling in River System (HEC-RAS / MIKE-HYDRO-Hydrodynamic-I
9. Mathematical modeling in River System (HEC-RAS / MIKE-HYDRO-Hydrodynamic-II
10. Mathematical modeling in River System (HEC-RAS / MIKE-HYDRO-Hydrodynamic-III
11. Mathematical modeling in River System (HEC-RAS / MIKE-HYDRO-Hydrodynamic-IV
12. Mathematical modeling in River System (HEC-RAS / MIKE-HYDRO-Hydrodynamic-V

Reference Books

1. L. B. Roy (Editor), Ramakar Jha (Editor), Roshni Thendiyath (Editor), V. P. Singh (Editor), Vivekanand Singh (Editor) , Hydrological Modeling: Hydraulics, Water Resources and Coastal Engineering: 109 (Water Science and Technology Library), February 2022
2. Bill Addis (Editor), PHYSICAL MODELS: Their historical and current use in civil and building engineering design, Print ISBN: 9783433032572 |Online ISBN:9783433609613 |DOI:10.1002/9783433609613, September 2020.
3. User Manual of HEC-HMS & HEC-RAS, US Army Corps of Engineers**,** Hydrologic Engineering Center, USA
4. User Manual of MIKE-HYDRO-NAM and Hydrodynamics, DHI Water & Environment, Denmark

HYDRAULIC ENGINEERING LAB

Course code : CE69305
Credit : 1
L-T-P : 0-0-2
Prerequisite : Nil

COURSE OUTCOMES

After successful completion of the course, the students will be able to:

CO1: Study laminar and turbulent flow regimes
CO2: Analyze friction losses in pipes
CO3: Describe about the various types of turbines
CO4: Determine turbine efficiency and power output of Pelton, Francis and Kaplan
CO5: Measure water flow in open channels using flumes or weirs
CO6: Analyze critical flow and hydraulic jumps in open channels

COURSE DETAILS

1. Use of flow meters (e.g., Venturi meter, orifice plate)
2. Laminar and turbulent flow regimes using Reynold's apparatus
3. Measurement of minor losses in pipes
4. Measurement of major losses in pipes
5. Turbine efficiency and power output of Pelton
6. Turbine efficiency and power output of Francis
7. Turbine efficiency and power output of Kaplan
8. Measurement of water flow in open channels using flumes or weirs
9. Study of critical flow and hydraulic jumps in open channels
10. Analysis of hydraulic jumps in open channels

Reference Books

1. R. K. Bansal, Fluid Mechanics & Hydraulics Machines, Laxmi Publications,
2. Hydraulics & WR Lab. Manual, School of Civil Engineering, KIIT-DU.

RESEARCH METHODS & DOCUMENTATION

Course Code : EX60001
Credit : 3
L-T-P : 3-0-0
Prerequisite : Nil

COURSE OBJECTIVE
Post-graduate engineering students carry out a year-long research-intensive thesis or project that requires them to have the full knowledge of general principles of defining and scoping a problem, deciding the approach to research design, implementing the design, making the analysis, drawing inferences, and communicating their research findings. This subject covers the essential features of research methods and research communications.

COURSE OUTCOMES
After successfully completing the course, the student will be able to

CO1: Define and scope a problem.
CO2: Make a review of literature.
CO3: Decide on an appropriate research design and develop an experimental setup and/or an appropriate model.

CO4: Generate and/or collect the necessary data, make the required data analysis, and draw inferences.
CO5: Initialize the art and science of scientific and technical writing.
CO6: Write a project report following the principles of scientific writing.

COURSE CONTENT

A. Research Methods

A.1 Introduction to Research
Research Definition; Elements of Research: Novelty, Originality, Creativity, and Critical Thinking; Deductive, Inductive, and Abductive Approaches.

A.2 Selecting a Research Problem
Research Topics, Problems, Objectives and Scope, Questions, and Research Contribution.

A.3 Measurement, Data, and Data Analytics
Measurement Scales and Data Visualization; Revisiting Basic Statistics, Probability, and Probability Density Functions; Sampling and Sampling Distributions, Tests of Hypotheses, and Simple and Multivariate Regression Analysis

A.4 Models and Modelling
Characteristics and Types of Models, Discrete-Event Simulation, and Neural Networks Models.
A.5 Research Design
Qualitative Research: Survey, Case Study, Action Research, and Citizen Science; Experimental Research: Factors, Factor Levels, Replication, ANOVA, and Factorial Designs.

B. Research Documentation

B.1 Language Issues
Paragraphing, Unity of Ideas, Topic Sentences, Link Words, Transitions; Common English Errors;Use of Hyphen, Dashes, and Ampersand;Responsible Use of Generative AI Tools.

B.2 Organization of a Research Document
Front Matters, Body, and End Matters;Guidelines on Titles, Abstracts, Keywords, Symbols and Abbreviations, and Capitalization; Narrative and Systematic Literature Review, Referencing Systems, Reference Management Software; Guidelines on Tables, Figures, Mathematical Operations and Equations, SI Units, Scientific and Engineering Notations of Numbers, and Significant Digits.

B.3 Elements of Research and Publication Ethics
Research Misconduct: Types and Research Code of Conduct;Plagiarism and Copyright.

Reference Books

1. Dunn, P. K. (2021), Scientific Research and Methodology: An Introduction to Quantitative Research and Statistics in Science, Engineering, and Health, Available free at https://bookdown.org/pkaldunn/Book/. [***Covers most of the topics***]
2. Durdella, N. (2019), Qualitative Dissertation Methodology: A Guide for Research Design and Methods, California: SAGE Publications. [***For topics related to qualitative methods***]

3. Montegomery, D. C. (2019), Design and Analysis of Experiments, 10th Edition, John Wiley & Sons, Inc. [***For topics related to design of experiments, model and modelling***]
4. Perelman, L. C., J. Paradis, and E. Barrett, Eds. (1998), The Mayfield Handbook of Technical and Scientific Writing, Mayfield Publishing, Available free at http://www.mhhe.com/mayfieldpub/tsw/toc.htm. [***For topics related to research documentation***]
5. Kothari, C. R. (2004), Research Methodology: Methods and Techniques, 2nd Revised Edition, Hyderabad: New Age International.
6. Marder, M. C. (2011), Research Methods for Science, Cambridge University Press.

SCHOOL OF CIVIL ENGINEERING

M.TECH. PROGRAMME

Specialization: Transportation Engineering

Curricula & Syllabi

ACADEMIC CURRICULA – 2024

Kalinga Institute of
Industrial Technology (KIIT)
Deemed to be University
(Established U/S 3 of UGC Act, 1956)
Bhubaneswar, Odisha, India

SCHOOL OF CIVIL ENGINEERING
M. TECH. PROGRAM
SPECIALIZATION: TRANSPORTATION ENGINEERING

Semester-I

Sl. No	Subject Code	Course Title	Contact Hours per Week			Credit
			L	T	P	
1	CE60003	Computational Methods in Civil Engineering	3	0	0	3
2	EX60001	Research Methods & Documentation	3	0	0	3
3	CE61607	Pavement Materials & Design	3	1	0	4
4	CE60605	Fundamentals of Traffic Flow	3	0	0	3
5		**Elective-I**	3	0	0	3
6	CE69601	Pavement Engineering Laboratory	-	-	3	2
7	CE69602	Traffic Engineering Laboratory	-	1	1	1
8	CE69603	Computational Lab	-	-	2	1
					Total	20

Semester-II

Sl. No	Subject Code	Course Title	Contact Hour per Week			Credit
			L	T	P	
1	CE60002	Soft Computing Techniques in Civil Engineering	3	-	-	3
2	CE60602	Pavement Management System	3	-	-	3
3	CE60604	Urban Transportation System & Planning	3	-	-	3
4	CE60606	Geometric Design of Transportation Facilities	3	-	-	3
5		**Elective-II**	3	-	-	3
6		**Elective-III**	3	-	-	3
7		Comprehensive Viva-voce	-	-	-	2
					Total	20

Semester-III

Sl. No	Subject Code	Course Title	Contact Hour per Week			Credit
			L	T	P	
1		**Open Elective / Industry Elective**	3	0	0	3
2	CE67603	Thesis Part-I	-	-	-	16
8		Seminar	0	0	2	1
					Total	20

Semester-IV

Sl. No	Subject Code	Course Title	Contact Hour per Week			Credit
			L	T	P	
1	CE67604	Thesis Part-II	-	-	40	20

LIST OF DEPARTMENT ELECTIVES

Elective-I

Sl. No.	Course Code	Course Title	Credit
1	CE60607	Low Volume Roads	3
2	CE60609	Road Safety Engineering	3
3	CE60611	Railway Engineering	3
4	CE60613	Airport Planning & Design	3
5	CE60423	Geo-synthetics & Reinforced Earth Structures	3
6	CE60435	Geotechnical Investigation & Field Tests	3

Elective-II

Sl. No	Course Code	Course Title	Credit
1	CE60608	Intelligent Transportation System	3
2	CE60610	Transportation System Analysis & Modelling	3
3	CE60612	Data Analytics in Transportation Engineering	3
4	CE60221	Bridge Engineering	3
5	CE60308	Ground Improvement Methods and Design	3
6	CE60326	Tunnel Engineering	3

Elective-III

Sl. No	Course Code	Course Title	Credit
1	CE60614	Transportation Economics	3
2	CE60616	Environmental Impact Assessment of Transportation Projects	3
3	CE60618	Transportation Network Analysis & Optimization	3
4	CE60620	Highway Construction Practices	3
5	CE60622	Port and Harbour Engineering	3
6	CE60624	Remote Sensing & GIS Application in Transportation Engineering	3

COMPUTATIONAL METHODS IN CIVIL ENGINEERING

Course Code: CE60003
Credit:3
L-T-P: 3-0-0
Prerequisite: NIL

COURSE OUTCOMES

At the end of the course, the students will be able to
CO 1: Comprehend the measure of central tendency, dispersions and correlation coefficients,
CO 2: Use the Curve Fitting & Least Square Techniques in the experimental methods,
CO 3: Apply the concept of probability and set theory in practical problems,
CO 4: Apply the concept of probability distribution functions,
CO 5: Determine roots of algebraic equation by different methods and obtain interpolating polynomials, and
CO 6: Solve ODE and PDE using numerical techniques.

COURSE DETAILS

Measures of Central Tendency & Dispersions; Covariance; Correlation Coefficients and their Properties in field data;
Curve Fitting & Least Square Techniques and their use in the experimental methods in Civil Engineering; Concept of Regressions; Regression curve in Bivariate Frequency Distributions;
Introduction to probability and set theory; Probabilistic measures; Conditional probability and Bayes' theorem; Discrete and continuous random variables;
Probability Density Functions; Probability Distributions of Single and Multiple Random Variables; Discrete & continuous distributions; Chi-Square Test; Kolmogorov-Smirnov Test; Analysis of Variance.
Linear equations and eigen value problems, Accuracy of approximate calculations, Nonlinear equations, interpolation, differentiation and evaluation of single and multiple integrals
Initial and boundary value problems by finite difference method, Newton's method, variation and weighted residual methods,

Textbooks

1. Applied Statistics and Probability for Engineers by Douglas C. Montgomery and George C. Runger, Wiley India Pvt. Ltd, 2009.
2. Jay L. Devore, Probability and Statistics for Engineering and the Sciences, Brooke & Cole, 2009.
3. J. B. Scarborough, Numerical Mathematical Analysis, Oxford & IBH Publishing Co. Pvt. Ltd., 2000.
4. K. K. Jain, S. R. K Iyengar and R. K. Jain, Numerical Methods - Problem and Solutions, Wiley India Pvt. Ltd, 2001.

Reference Books

1. W. Mendenhall and T. Sincich, Statistics for Engineering and the Sciences, Prentice-Hall, 2000.

2. Steven Chapra and Raymond Canale , Numerical Methods for Engineers, McGraw-Hill Education; 6th edition 2012.

SOFT COMPUTING TECHNIQUES IN CIVIL ENGINEERING

Course Code: CE60004
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OUTCOMES

At the end of the course, the students will be able to

CO 1: Comprehend the basic concepts of soft computing,
CO 2: Use generic algorithms and Particle swarm intelligence algorithms,
CO 3: Prepare prediction model using neural network,
CO 4: Apply supervised machine learning techniques,
CO 5: Apply the techniques of unsupervised machine learning, and
CO 6: Implement soft computing techniques in Civil Engineering problems.

COURSE DETAILS

Introduction to Soft Computing: Basic concepts, various Soft Computing Techniques, Overview of conventional computing vs. soft computing, Characteristics and advantages of soft computing techniques

Genetic Algorithms (GA): Introduction to genetic algorithms, Representation schemes: binary, real-valued, permutation, Genetic operators: selection, crossover, mutation.

Particle Swarm Optimization (PSO): Introduction to particle swarm optimization, Swarm intelligence principles, PSO algorithm components: particles, velocity update, position update, Ant Colony Optimization (ACO): Basics of ant colony optimization, Ant behavior modeling, ACO algorithm: pheromone trails, ant movement, Pigeon search algorithm.

Artificial Neural Networks (ANN): Fundamentals of neural networks, Single-layer and multi-layer perceptrons, Training algorithms: back-propagation, gradient descent, Convolutional Neural Networks (CNN),

Fuzzy Logic Systems: Basics of fuzzy set theory, Fuzzy logic operations and rules, Fuzzy inference systems

Introduction to Machine Learning, Basic Concepts, Supervised learning, unsupervised learning, reinforcement learning, Python libraries

Supervised Learning Techniques: Decision trees and ensemble methods (Random Forests), Support Vector Machines (SVM), , Basic concepts and principles, k-nearest neighbor (kNN)

Unsupervised Learning Techniques: Clustering, K-means clustering, Hierarchical clustering, Dimensionality Reduction, Principal Component Analysis (PCA)

Application of soft computing in Civil Engineering
Application of different algorithms to solve practical problems of Civil Engineering.

Textbooks / Reference Books

1. Pratihar D.K., Soft Computing, Narosa Publishers, and ISBN: 978-81-8487-495-2, 2018.
2. Mangey Ram, J. Paulo Davim, Soft Computing Techniques and Applications in Mechanical Engineering, IGI Global, USA.
3. Simeone O. Machine learning for engineers. Cambridge University Press; 2022.
4. E. Alpaydin, Introduction to Machine Learning, Prentice Hall of India, 2006.

FUNDAMENTALS OF TRAFFIC FLOW

Course Code : CE60605
Credit : 3-0-0 3
Prerequisite : Nil

COURSE OUTCOME

At the end of the course, the student will be able to

CO 1: Describe the main characteristics of traffic flow
CO 2: Represent traffic phenomena using different methods and tools
CO 3: Recognize how traffic congestion starts and propagates
CO 4: Select and apply appropriate methods and techniques for analyzing traffic-related problems
CO 5: Interpret and elaborate different type of traffic data
CO 6: Learn the elements of design of various traffic facilities

COURSE CONTENT

Introductory concepts of traffic engineering, road user and vehicle characteristics, Traffic stream characteristics (Volume, speed, and density), and traffic flow theory basics.

Greensheild‘s and Greenberg‘s equations.
Statistical theories of traffic flow (Poisson arrivals, binomial and negative binomial distributions). Variable PCU concept.

Traffic data collection methods, speed, volume, travel time and delay studies. Parking studies. Headway distributions, gap acceptance, critical gap estimation, queuing theory, shock wave. Capacity and LOS of freeway and multilane highways - fundamental concepts, freeway segment analysis, two-way highways.

Analysis of signals and signal design by Webster‘s method.
Textbook(s)

1. Kadiyali, L. R. (2013). *Traffic engineering and transport planning*. Khanna publishers.

Reference book(s)

1. Khisty, C. J., & Lall, B. K. (2016). *Transportation engineering*. Pearson Education India.

2. Khanna, S. K., Justo, C. E. G., & Veeraraghavan, A. (2014). Highway Engineering, Nem Chand & Bros Publishers.
3. Papacostas, C. S., & Prevedouros, P. D. (1993). *Transportation engineering and planning*.
4. Kumar, R. S. (2018). *Introduction to traffic Engineering*. Universities Press.
5. Chakroborty, P., & Das, A. (2017). *Principles of transportation engineering*. PHI Learning Pvt. Ltd
6. Verma, A. (2011). Quantitative techniques. Asian, New Delhi.

PAVEMENT MATERIALS & DESIGN

Course Code : CE61607
Credit : 3-1-0 4
Prerequisite : Nil

COURSE OUTCOME

At the end of the course, the student will be able to

CO 1: Determine the resilient Modulus of unbound and bound layers
CO 2: understand and determine performance models of unbound and bound layers
CO 3: analyse the traffic considerations in pavement design
CO 4: analyze and design flexible pavement using empirical and mechanistic empirical methods.
CO 5: Design rigid pavements using IRC, AASHTO and other important methods of design.
CO 6: Design overlay on existing pavement based on the structural evaluation

COURSE CONTENT

Introduction to Pavement Materials
Introduction to pavement layers and materials, Unbound layer and Bound layer, Critical material properties required for construction of pavements and quality control point of view.

Elastic Design Parameters
Introduction to Elastic design parameters of pavement layers, Resilient Modulus of bound and unbound materials, Resilient Modulus Models, Dynamic Modulus of Bituminous Mixtures, Fatigue behaviour and model of unbound and bound layers, Rutting behaviour and model of unbound materials.

Principles of Pavement Design
Types of Pavements, Concept of pavement performance, Structural and Functional failures of pavements, Different types of pavement performance criteria, Different pavement design approaches, General framework for pavement design.

Traffic Considerations in Pavement Design
Vehicle types, Axle configurations, Contact shapes and contact stress distributions, Concept of standard axle load, Vehicle damage factor, Axle load surveys, Lateral placement characteristics of wheels, Estimation of design traffic.

Analysis of Flexible Pavements
Selection of appropriate theoretical models for analysis of flexible and concrete pavements, analysis of layered flexible pavement systems using linear elastic layered theory, Discussion of the need for use of advanced analytical techniques for flexible pavements, Discussion of different softwares available for analysis of flexible pavements.

Flexible Pavement Design Methods
Detailed discussion on design of flexible pavements as per Indian Roads Congress guidelines - IRC:37 (2018)

Analysis of Concrete Pavements
Discussion of different theoretical models for analysis of different types of concrete pavements, Analysis of wheel load stresses, curling/warping stresses due to temperature differential, critical stress combinations, Discussion of the need for use of advanced analytical techniques for concrete pavements.

Concrete Pavement Design Methods (7)
Detailed discussion on design of flexible pavements as per Indian Roads Congress guidelines - IRC:58 (2015)

Structural Evaluation and Strengthening (6)
Structural evaluation of in-service pavements using Benkelman beam and Falling Weight Deflectometer methods, Overlay design as per IRC:115-2014.

Textbook(s)

1. Huang, Y. H. (2004). *Pavement analysis and design* (Vol. 2, pp. 401-409). Upper Saddle River, NJ: Pearson Prentice Hall.
2. Mallick, R. B., & El-Korchi, T. (Eds.). (2022). *Pavement engineering: principles and practice*. CRC Press.

Reference book(s)

1. Yoder, E. J., & Witch, M. W. (1991). Principles of pavement design. John Wiley & Sons.
2. Specifications for Roads and Bridge Works‖, Ministry of Road Transport and Highways, Indian Road Congress, New Delhi, India.
3. IRC: 37 (2012) ―Guidelines for Design of Flexible Pavements‖, Indian Road Congress, New Delhi.
4. IRC: 58 (2011) ―Guidelines for Design of Plain Jointed Rigid Pavements for Highways‖, Indian Road Congress, New Delhi.
5. IRC: 81 (1997) ―Guidelines for Strengthening of Flexible Road Pavements using Benkel man Beam Deflection Technique‖, Indian Road Congress, New Delhi.
6. IRC: 115 (2014) Guidelines for Structural Evaluation and Strengthening of Flexible Road Pavements using Falling Weight Deflectometer (FWD) Technique‖, Indian Road Congress, New Delhi.

PAVEMENT MANAGEMENT SYSTEM

Course Code : CE60602
Credit : 3-0-0 3
Prerequisite : Nil

COURSE OUTCOME

At the end of the course, the students will be able to

CO 1: Evaluate functional health of pavement

CO 2: Evaluate the structural health of pavement by using BBD or FWD
CO 3: Collect data and develop models for pavement deterioration
CO 4: Design PMS and implement them
CO 5: Learn Life cycle cost analysis of pavement
CO 6: Compare different strategies of pavement maintenance by LCCA tools

COURSE CONTENT

Pavement Surface Condition & Its Evaluation
Various Aspects of Surface and their Importance; Causes, Factors Affecting, Deterioration and Measures to Reduce Pavement Slipperiness, Unevenness, Ruts, Pot holes and Cracks; Methods of Measurement of Skid Resistance, Unevenness, Ruts and Cracks. Pavement Surface Condition Evaluation by Physical Measurements, by Riding Comfort and Other Methods; their Applications.

Pavement Structure & Its Evaluation
Factors affecting Structural Condition of Flexible and Rigid Pavements; Effects of Subgrade Soil, Moisture, Pavement Layers, Temperature, Environment and Traffic on Structural Stability, Pavement Deterioration; Structural Heath Evaluation by Non-Destructive Tests such as FWD, Benkelman Beam Rebound Deflection, Plate Load Test, Wave Propagation and other methods of Load Tests; Evaluation by Destructive Test Methods, and Specimen Testing. and Overlay Design using FWD data

Pavement Management Process & Data Requirements
Establishing criteria, development of models for pavement deterioration, determining the future needs, rehabilitation and maintenance strategies, developing combined programmes for maintenance & rehabilitation

Project Level Design
Framework for pavement design, characterization of physical design inputs, basic structural response models, variability, reliability and risk, generating alternate design strategies, pavement analysis & design of AC & PC, rehabilitation design procedures, economic evaluation of alternate pavement design strategies, selection of optimal design strategy.

Implementation
Major steps in implementing PMS, pavement construction management & pavement maintenance management, information‘s, research needs, cost and benefit of pavement management, future directions and need for innovations in pavement management.

Textbook(s)

1. "Pavement Evaluation and Maintenance Management System", R Srinivasa Kumar, Universities Press (India)

Reference book(s)

1. "Modern pavement management", Ralph Haas, W. Ronald Hudson, John P. Zaniewski, Krieger Pub Co
2. "Pavement Engineering: Principles and Practice", Rajib B. Mallick,Tahar El-Korchi, Second Edition, CRC Press
3. Pavement Management for Airports, Roads and Parking Lots, M. Y. Shahin, 2nd edition, Springer Publication.
4. "Pavement Analysis and Design", Y. H. Huang, 2nd edition, Pearson Education
5. "The Design and Performance of Road Pavements", D. Croney & P. Croney, 3rd Edition, McGraw Hill Professional.
6. "Deterioration and Maintenance of Pavements", Derek E. Pearson, ICE Publishing.
7. OECD, Pavement Management Systems, O E C D, 1987.

8. Relevant AASHTO/ IRC and other Codes and Specifications

URBAN TRANSPORTATION SYSTEMS AND PLANNING

Course Code : CE60604
Credit : 3-0-0 3
Prerequisite : Nil

COURSE OUTCOME

At the end of the course, the students will be able to

CO 1: Justify the need for urban transportation system planning
CO 2: Undertake transport surveys followed by a report
CO 3: Plan the process of trip generation and distribution
CO 4: Justify the need of a modal split
CO 5: Prepare the transportation plans for urban mass rapid transit systems
CO 6: Prepare an optimal bus schedule according to demand of the locality

COURSE CONTENT

Introduction
Transport and socio-economic activities, historical development of transport, transportation in cities, freight transportation system, future development of transportation system: BRTS, MRTS, ITS.

Urban structure
Urban activity system, urban movement hierarchies. Goods movement: broad classes of urban goods movement demand, classification of urban goods movement, methodology of approach to analysis of goods movement, modeling demands for urban goods transport

Classification of roads
Arterial roads, secondary or sub-arterial roads, local road, other road: bypass road, outer and inner ring road, express way, freeway types of urban or road systems.

Urban transportation planning
Trip generation analysis, introduction, types of trip, methods of trip generation, trip production statistical analysis, category analysis or cross classification. Mode choice: modelling, influencing factors, socioeconomic characteristic of the trip makers, characteristics of the trip, characteristics of the transportation system.

Trip distribution
Methods of trip distribution, uniform constant factor method, average factor method, fractar method, furness method, growth factor model, gravity model model, tranner‘s model, opportunity model.

Route assignment
Objectives of traffic assignment, principle of traffic assignment, assignment technique, all-or nothing assignment, multiple route assignment, capacity restrain assignment, application of route assignment

Modal split
Factor affecting modal split, modal split in transportation planning process: trip end type modal split modal, Rip interchange modal split modal. trip interchange modal split modal, binary choice model, logit model Land Use

Transport Model
Introduction, selection of land use transport model, lowry derivative model, garin-lowry model, matrix operation for simplifying computations, application in India.

Textbook(s)

1. Traffic Engg & Transportation Planning‖, by L. R. Kadyali, 4th Ed, Khanna Publishers, 2003
2. Transportation Planning and Planning‖, by C. S. Papacostas and P. D. Prevedouros, 3rd Ed, PHI, 2002

Reference book(s)

1. Transportation Engg: An introduction‖, by C. J. Khisty & B. K. Lall, 3rd Edition, PHI, 2006.
2. Chakroborty, P., & Das, A. (2017). *Principles of transportation engineering*. PHI Learning Pvt. Ltd..
3. Highway Traffic Analysis and Design‖, by R. J. Salter, ELBS Macmilan, 2nd Edition, 1990.

GEOMETRIC DESIGN OF TRANSPORTATION FACILITIES

Course Code : CE60606
Credit : 3-0-0 3
Prerequisite : Nil

COURSE OUTCOME

At the end of the course, the students will be able to

CO 1: Comprehend the importance of various guidelines for road infrastructure design like HCM, IRC.
CO 2: Design horizontal and vertical curves for a road section with proper sight distances
CO 3: Understand and learn various elements of rural, urban, and roads.
CO 4: Design at grade intersections and roundabouts
CO 5: Analyse accidents and provide measures to prevent them through better planning
CO 6: Design various transportation infrastructures like parking layout, pedestrian and bicycle facilities and compute the LOS for the same.

COURSE CONTENT

Geometric design provisions for various transportation facilities, Discussion of controls governing geometric design, Route layout and selection, Elements of design - sight distances, horizontal alignment, transition curves, super elevation and side friction. Vertical alignment: - grades, crest and sag curves. Highway cross-sectional elements and their design for rural highways, urban streets and hill roads. At-grade Inter-sections - sight distance consideration and principles of design, channelisation, mini round-abouts, layout and design of round-abouts, Design of signalised intersections, capacity and LOS for signalised intersections, signal design, signal coordination, interchange design templates, entrance and exit ramps, acceleration and deceleration lanes, Bicycle and Pedestrian Facility Design; Parking Layout and Design; Terminal Layout and Design. Accident prevention through better planning, Designing for safety, Highway operation and accident counter measures, Road safety checklists, accident data analysis and its prediction models.

Textbook(s)

1. A policy on geometric design of highways and streets, American Association of State Highway Officials.
2. Geometric design standards for urban roads in plains (IRC:86-1983), The Indian Roads Congress.
3. Geometric design standards for rural (non-urban) highways (IRC:73-1980), The Indian Roads Congress, 1980.
4. Manual of specifications & standards for six laning of highway through public private partnership (IRC: SP: 87-2010), The Indian Roads Congress.
5. Manual of specifications & standards for four laning of highway through public private partnership (IRC:SP:84-2009), The Indian Roads Congress.
6. Hill road manual (IRC:SP:48-1998), The Indian Roads Congress.
7. Guidelines for expressways – Part I, Ministry of Road Transport & Highways.
8. Guidelines for the design of interchanges in urban areas (IRC:92-1985), The Indian Roads Congress.
9. Roadside design guide, American Association of State Highway Officials.
10. Manual of geometric design standards for Canadian roads, Transportation Associations of Canada.
11. Pline, J.L., Traffic Engineering Handbook, Institute of Transportation Engineers.
12. Manual on Uniform Traffic Control Devices, Federal Highway Administration.
13. Highway Capacity Manual 2010, Transportation Research Board.
14. Khanna, S. K., Justo, C. E. G., & Veeraraghavan, A. (2014). Highway Engineering, Nem Chand & Bros Publishers.
15. MXRoad Suite and manual for geometric design.

LOW VOLUME ROADS

Course Code **:** CE60607
Credit **:** 3-0-0 3
Prerequisite **:** Nil

COURSE OUTCOME

At the end of the course, the student will be able to

CO 1: Comprehend the factors controlling the alignment of low volume road
CO 2: Comprehend the geometrical features of low volume road
CO 3: Comprehend the impact of climate and environmental factors on low volume road
CO 4: Characterize material for low volume road
CO 5: Design pavement section for low volume road
CO 6: Design culvert and small bridge on low volume road

COURSE CONTENT

Introduction to low-volume road: introduction, classification of rural roads, planning of rural road, road alignment and survey, factors governing route selection, factors controlling alignment

Geometric design of low volume road: basic principle of geometric design, design speed, cross-sectional element, camber, sight distance, horizontal and vertical alignment, lateral and vertical clearance, traffic engineering requirement

Climate and environment: rainfall and temperature variation, climate aspects, environment al issues, erosion control, special techniques

Materials for low volume road: soil and marginal materials, stabilized soil, aggregate for base and subbase course, materials for bituminous construction, use of waste materials

Pavement Design: Design parameters, pavement components, design of flexible pavement, design of rigid pavement, design of semi-rigid pavement, drainage and shoulder

Culverts and Small Bridges: introduction, type of culvert, geometrics standards for culverts, design loading, design of culvert

Textbook(s)

1. Chakroborty, P., & Das, A. (2017). *Principles of transportation engineering*. PHI Learning Pvt. Ltd.
2. IRC, IRC SP 20: Rural Roads Manual, IRC
3. Relevant Latest AASHTO/ IRC and other Codes and Specifications

Reference book(s)

1. R. A. Douglas, Low-Volume Road Engineering: Design, Construction, and Maintenance, CRC Press, 1st Edition, 2015, ISBN: 978-1482212631

ROAD SAFETY ENGINEERING

Course Code : CE60609
Credit : 3-0-0 3
Prerequisite : Nil

COURSE OUTCOMES

At the end of the course, the students will be able to

CO 1: Know the scenario of road crashes in India and deaths accompanied.
CO 2: Comprehend the steps of crash investigation
CO 3: Learn various statistical techniques to model road crashes.
CO 4: Know various traffic management techniques to improve road safety
CO 5: Understand the process of road safety auditing
CO 6: Know about various Indian and world guidelines and codes targeting improvement of road safety.

COURSE CONTENT

Introduction
Road traffic accidents scenario in India, characteristics of accidents, accident vs. crash, effect of human factors, planning for road network, land use and road environment for safety, designing for road safety — links and junctions, road safety improvement strategies.

Crash investigation and analysis
Steps in treatment of crash locations, diagnosing crash problem and solutions, accident report form, storing of data, using and interpreting crash data, identifying and prioritizing hazardous locations, condition and collision diagrams; Vulnerable road users: crashes related to pedestrian and bicyclists, their safety, provision for disabled.

Statistical analysis of accidents
Descriptive statistics, confidence interval, hypothesis testing, models related to accident frequency, accident severity.

Before -after methods in crash analysis: Before and after study, before and after study with control sites, comparative parallel study, before, during and after study.

Traffic management system

Traffic flow improvements, expressway patrol, public transit, ridesharing, mobility rest areas, park-and-ride lots, bus bays, signage, markings; ITS applications - vehicular navigation, crash avoidance system, incident management, traffic management centre, highway side communication.

Road safety audits

Procedure, aims and objectives, roles and responsibility, history of road safety audit, design standards, tasks, various stages of safety audits; common identifiable problems, structuring of report, identifying common problems.

Textbook(s)

1. L.R Kadiyali, Traffic Engineering and Transport Planning, Khanna Publishers, New Delhi, India, 9th Edition, 1999, ISBN: 978-81-7409-220-5

Reference Book(s)

1. American Association of State Highway and Transportation Officials (AASHTO), Highway Safety Manual, AASHTO, 1st Edition,, 2010, ISBN: 978-1560514770
2. R. B. Mallick and T. El-Korchi, Pavement Engineering: Principles and Practice, CRC Press, 3rd Edition, 2017, ISBN:978-1498758802
3. M. Y. Shahin, Pavement Management for Airports, Roads and Parking Lots, Springer, 2nd Edition, 2006, ISBN:978-0387234649
4. Y. H. Huang, Pavement Analysis and Design, Pearson Education, 2nd Edition, 2008, ISBN: 978-8131721247
5. D. Croney and P. Croney, Design and Performance of Road Pavements, McGraw-Hill Education, 3rd Edition, 1997,ISBN: 978-0070144514
6. D. Pearson, Deterioration and Maintenance of Pavements, ICE Publishing, 1st Edition, 2011, ISBN:978-0727741141
7. Relevant AASHTO/ IRC and other Codes and Specifications

RAILWAY ENGINEERING

Course Code : CE60611
Credit : 3-0-0 3
Prerequisite : Nil

COURSE OUTCOME

At the end of the course, the student shall be able to

CO 1: Comprehend the function of various components of permanent way, their materials
CO 2: Comprehend the geometric design of railway track
CO 3: Explain the diverging, merging and crossings of railway tracks, stations, yards, signaling, interlocking and control systems.
CO 4: Comprehend the railway safety measures
CO 5: Explain the construction, maintenance and renovation of the railway tracks
CO 6: Illustrate the concepts of high speed tracks, station and yards of railways

COURSE CONTENT

General: Introduction to Railway Engineering, Role of Indian Railways in National Development, Engineering Surveys for track alignment, Railway terminology

Traction and Tractive resistance: Types of traction, locomotives and other rolling stock,resistance due to friction, wave action, wind, gradient, curvature, starting and acceleration, tractive effort of a locomotive, hauling power of a locomotive
Permanent way components: Cross section of Permanent Way, Function of various components like rails,sleepers and ballast, gauge, Creep of rails

Geometric Design of Railway Track: Gradients ,Grade compensation ,Cant and negative super elevation, Cant deficiency Degree of curve

Points and Crossing, Rail joints, Railway station &yards, Signalising & interlocking.

Construction and maintenance of railway track, Control of train movements Signals and interlocking, Modernisation of railways and future trends, Track standards and track rehabilitation.

Railway Safety and Regulations: Railway safety standards, regulations, and procedures related to railway operations. Safety measures, risk assessment, and emergency response planning in railway engineering.

Textbook(s)

1. J.S. Mundrey, Railway Track Engineering, Tata McGraw Hill Co. Ltd., 3rd Edition, 2000.
2. M.M. Agarwal, Railway Track Engineering, Standard Publishers, 1st Ed. 2005.

Reference book(s)

1. S. Chandra and Aqarwal, Railway Engineering, Oxford University Press, 1st Ed. Feb 2008.
2. A.D. Kerr, Fundamentals of Railway Track Engineering, Simmons Boardman Pub Co.

AIRPORT PLANNING AND DESIGN

Course Code **:** CE60613
Credit **:** 3-0-0 3
Prerequisite **:** Nil

COURSE OUTCOMES

At the end of the course, the student shall be able to

CO 1: Comprehend the importance of aviation system, including its planning and operations
CO 2: Analyze the master plan covering all the facilities needed in an airport
CO 3: Illustrate the design of runways and taxiways
CO 4: Comprehend the advantages of new technologies used in aviation industry
CO 5: Recommend the appropriate type of pavement based on the functional and structural characteristics of Runways and taxiways
CO 6: Represent the prototypes of runways, taxiways and the terminal area

COURSE CONTENT

Classification of airports- ICAO standards ; Planning for airport- Airport components- Zoning laws ; Runways orientation and geometric design- Runway patterns ; Taxiways- alignment- geometry and turning radius- exit taxiways ; Aprons- planning and design ; Design principles of critical, semi-critical, non-critical airport pavements
FAA and PCA methods ; Airport hangars- their planning and design criteria ; Airport landscaping, grading and drainage- general aspects ; Airport terminal and amenities ; Airport lighting and marking.

Textbook(s)

1. N.J. Ashford, P.H. Wright, Airport Engineering, 3rd Edition, 1992, John Wiley
2. R.M. Horonjeff, F.X. Mc Kelvey, W.J Sproule, Seth Young, Planning and Design of Airports, TMH International Publishers, Fifth Edition, 2009

Reference book(s)

1. Khanna, Arora and Jain, Planning and Design of Airports, Nemchand Bros., 2001
2. Wells, Alexander; Young, Seth, Airport Planning & Management, McGraw Hill,5th Edition, July,2009
3. De N. Richard, & Odoni, Airport Systems: Planning, Design, and Management, McGraw Hill Amedeo, 1st Edition, 2004.

GEOSYNTHETICS AND REINFORCED EARTH STRUCTURES

Course Code : CE 60423
Credit : 3-0-0 3
Prerequisite : Nil

COURSE OUTCOMES

At the end of the course, the students will be able to

CO 1: Explain the application of Geosynthesis
CO 2: Perform design and analysis of earth retaking wall and pavement with geosynthetics
CO 3: Learn the use of Geosynthetic in drainage and liner
CO 4: Know about the application of barrier
CO 5: Comprehend the process of bearing capacity enhancement using earth reinforcement
CO 6: Explain the case histories of applications

COURSE CONTENT

Historical background; Principles, concepts and mechanism of reinforced earth; Design consideration for reinforced earth and reinforced soil structures; Geosynthetics-their composition, manufacture, properties, functions, testing and applications in reinforced earth structures; Design of reinforced soil structures like retaining walls, embankments, foundation beds etc.; Designing for Separation, Filtration, Drainage and Roadway Applications; Designing for Landfill Liners and Barrier Applications; Case histories of applications.

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Textbooks:

1. Swami Saran, Reinforced Soil and its Engineering Applications, 2nd Edition, 2010
2. Jones, C.J.F.P, Earth Reinforcement and Soil Structures, Butterworth, 1985.
3. Koerner, R.M, Designing with Geosynthetics , Prentice Hall, 1993

GEOTECHNICAL INVESTIGATION AND FIELD TEST

Course Code: **CE60435**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

Course Outcomes

At the end of the course, the students will be able to

CO1: Comprehend geomaterial formation
CO2: Comprehend the geotechnical stratification of sub surface soil strata
CO3: Explain various boring techniques and sampling procedure
CO4: Explain various field tests
CO5: Explain application of field test
CO6: Comprehend various field instrument and its monitoring

Geologic material formation
Formation of rock, type of rock, weathering process, sedimentation process, subsurface stratification, geological features of rock, joints in rock, classification of rock, basic geotechnical properties of soil and rocks.

Sub surface exploration
Propose of soil exploration, stages of sub soil exploration, Planning of exploration, Methodology of exploration, geophysical investigation, Different types of borings., soil and rock sampling, groundwater measurement, bore log preparation, report preparation and data interpretation

Field test
Standard penetration test, , Plate load test, Cone penetration test, cross bore hole test, pressure meter test, field vane shear test, block vibration test, insitu compression , tension and shear strength of rock mass, Insitu permeability test

Field instrumentation and monitoring
Application of field instrumentation, Load cell, stress meter, strain meter, field and laboratory pore water pressure measurement, embedment gauge, inclinometer, settlement monitoring, surface extensometer, Terrestrial, deflectometer, surface movement monitoring using field instrument and GPS system,

Text Books

1. Murthy, V. N. S. (2010) Principles of Soil Mechanics and Foundation Engineering, Marcel Dekker, ISBN-13 : 978-0824708733
2. B M Das, (2015) Principles of Geotechnical Engineering (8th Edition), Cengage Learning India Private Limited, ISBN-13 : 978-8131526132

Reference Books

1. Hunt, R.E., (2005) Geotechnical engineering investigation handbook (2nd Edition), CRC Press Inc, ISBN-13 : 978-0849321825
2. Ranjan G. and Rao, A. S. R., (2016) Basic and Applied Soil Mechanics (3rd Edition), New Age international Publishers, ISBN-13 : 978-8122440393

INTELLIGENT TRANSPORTATION SYSTEM

Course Code : CE60608
Credit : 3-0-0 3
Prerequisite : Nil

COURSE OUTCOME

At the end of the course, the students will be able to

CO 1: Comprehend ITS & ATIS
CO 2: Explain about Advanced Transportation Management System
CO 3: Know about APTS, CVO, new technology and ETC
CO 4: Details about regional architecture, integration of infrastructure and operational planning
CO 5: Summarize ITS issues in terms of various factors and emerging issues.
CO 6: Apply the ITS in bus transport, metros, etc.

COURSE CONTENT

Introduction to ITS, including where ITS fits; roles and responsibilities, Advanced Traveller Information Systems (ATIS), including functionality; business models; field trip to Smart Route Systems

Advanced Transportation Management Systems (ATMS), including network operations; incident detection; congestion pricing, tolling, HOT lanes

Fleet-oriented ITS services, including Advanced Public Transportation Systems (APTS); BRT; Commercial Vehicle Operations (CVO); Intermodal Freight , including International Operations and Supply Chains, ITS and Technology, including automated highway systems (AHS); sensors, electronic toll collection (ETC); dedicated short range communication ,and standards

Regionally-scaled ITS deployment, including regional architecture; organizational and institutional issues; standards; developed vs. developing countries; ITS and strategic regional transportation planning; Integrating infrastructure and operations planning

Critical ITS Issues, including (as time permits) ITS and security; safety; human factors; privacy; sustainability; funding (as contrasted with conventional infrastructure); technology deployment/R &D/policy; other institutional issues, The future of ITS; International ITS Programs Case Studies: applications in bus transport, metro and highways; Emerging Issues.

Textbook

1. Ghosh, S., Lee, T.S. Intelligent Transportation Systems: New Principles and Architectures, CRC Press, 2000.
2. Mashrur A. Chowdhury, and Adel Sadek, Fundamentals of Intelligent Transportation Systems Planning, Artech House, Inc., 2003.

Reference book

1. R.P Roess, E.S. Prassas, W.R. McShane. Traffic Engineering, Pearson Educational International, Third Edition, 2004.
2. Sussman, J.M. Perspectives on Intelligent Transportation Systems, Springer, Berlin, 2010.

TRANSPORTATION SYSTEM ANALYSIS & MODELLING

Course Code : CE60610
Credit : 3-0-0 3
Prerequisite : Nil

COURSE OUTCOME

At the end of the course, the students will be able to

CO 1: Study the various techniques of transportation management
CO 2: Explore the performance of various transportation systems
CO 3: Gain Knowledge of various systems of transportation.
CO 4: Have an in-depth knowledge of Demand projection techniques of various transportation systems
CO 5: Model various trip assignments and plan the routing for various transporters
CO 6: Forecast and design the future traffic and provide solutions to various planning problems

COURSE CONTENT

General
Importance of transportation, transportation planning methodology, hierarchical levels of planning and its relation to rural, urban areas. Long range planning, Passenger and goods transportation, General concept and process of transport planning, Land-use transport interactions, Socio-economic characteristics of Land use

Transportation Systems
Multi modal transportation system; Characteristics of Mass Transit systems including technical, demand operational and economic problems, fixed Track Facility, Mass Rapid Transit System-Elevated, Surface and Underground construction , Express Bus System, integrated Operating Characteristics of Terminal and Transfer facilities

Urban Transportation Planning Studies
Urban Travel Characteristics, Private and Public Behavior analysis, Transportation demand Surveys, Delineation of the urban area, zoning, Origin-Destination Studies, Home Interviews, trip Classification and Socio- Economic variables in trip making projections

Planning Methodology and Systems analysis
Study of existing network-trip generation techniques, Category analysis, multiple regression techniques, Modal split analysis, Trip distribution techniques, Growth Factor model, Gravity models, Opportunity models and multiple regression models, Traffic assignment methods, Minimum Path tree-All or nothing assignment and capacity restraint techniques, analysis and evaluation technique

Textbook

1. "Traffic Engineering and Transport Planning" by Kadiyali L.R., Khanna Publishers, New Delhi, India, 1997

Reference book

1. Khanna, S. K., Justo, C. E. G., & Veeraraghavan, A. (2014). Highway Engineering, Nem Chand & Bros Publishers.
2. Transportation Planning and Planning, by C. S. Papacostas and P. D. Prevedouros, 3rd Ed, PHI, 2002

BRIDGE ENGINEERING

Course Code : CE60221
Credit : 3-0-0 3
Prerequisite : Nil

COURSE OUTCOMES

At the end of the course, the students will be able to

CO 1: Select appropriate site and types for a bridge
CO 2: Analysis and design of deckslabs.
CO 3: Design a simply supported T-beam bridge girder,
CO 4: Comprehend sub-structure for bridges like piers and foundations.
CO 5: Explain the methods of construction for different types of bridges
CO 6: Design construction joints and bearings for bridges

COURSE CONTENT

Introduction, historical review, engineering and aesthetic requirements in bridge design. Introduction to bridge codes. Economic evaluation of a bridge project, Loading standard, IRC specification, Impact factor.
Site investigation and planning; Scour - factors affecting and evaluation.
Superstructure - analysis and design of right, skew and curved slabs.
Girder bridges - types, load distribution, design. Orthotropic plate analysis of bridge decks. Design of simply supported T-beam bridge.
Bridge foundations - open, pile, well and caisson. Piers, abutments and approach structures-reinforced earth structure; Design of pier
Introduction to long span bridges, cantilever, arch, cable stayed and suspension bridges. Methods of construction of R.C Bridges, Prestressed concrete bridges and steel bridges Fabrication, Launching & creation.
Design and construction of construction joints

Textbooks

1. Essentials of Bridge Engineering by Dr. Johnson Victor; Oxford & IBH publishing Co. Pvt. Ltd.
2. Foundation of Structures by Dunhan, McGraw-Hill- 1950
3. Foundation of Bridges and Building by Jacoby and davis, , McGraw-Hill- 1953
4. Concrete Bridges, Concrete Association of India
5. Road Bridges- IRS Sec –I , II, III, Manual for standards and specification
6. IRS Codes of Practice for Railway bridges.

GROUND IMPROVEMENT METHODS AND DESIGN

Course Code : CE60308
Credit : 3-0-0 3
Prerequisite : Nil

COURSE OUTCOMES

At the end of the course, the students will be able to

CO 1: know the methods of soil stabilization
CO 2: explain the ground improvement technique for sandy and clay soil
CO 3: use the Geosynthesis and design practice for retaining wall
CO 4: express the ground improvement required for earthquake resistance structures

CO 5: understand themechanism of earth reinforced soil
CO 6: describe the case studies on ground improvement

COURSE CONTENT

Introduction
Engineering properties of soft, week and compressible deposits, Natural on land, off-shore and Man-made deposits; Role of ground improvement in foundation engineering, methods of ground improvement, Selection of suitable ground improvement techniques

In-situ treatments methods
In-situ densification soils, Dynamic compaction and consolidation, Vibro-floation ,Sand pile compaction, Preloading with sand drains and fabric drains, Granular columns, Micro piles, Soil nailing, Ground Anchors, Lime piles, Injections, Thermal, Electrical and Chemical methods, Electro osmosis, Soil freezing

Reinforced Soil
The Mechanism, Reinforcement materials, Reinforcement - Soil Interactions, Geosynthetics, Principles, Analysis and Design of Reinforced Retaining Structures, Embankments and Slopes

Ground Improvement Techniques for Geotechnical Earthquake Engineering, Case studies on ground improvement techniques.

Textbook(s):

1. Gulhati& Datta, Geotechnical Engineering, Eleventh edition, 2011
2. P. Purushothama Raj, Ground Improvement Techniques, Tata McGraw-Hill, New Delhi, 1995.
3. B. M. Das, Principles of Foundation Engineering, Thomson, Indian Edition, 2003.
4. G. V. Rao and G. V. S. Rao, Text Book On Engineering with Geotextiles, Tata McGraw Hill
5. T. S. Ingold and K. S. Miller, Geotextile Hand Book, Thomas Telfrod, London, 1988
6. N. V. Nayak, Foundation Design Manual, DhanpatRai and Sons, Delhi

TUNNEL ENGINEERING

Course Code : CE60326
Credit : 3-0-0 3
Prerequisite : Nil

COURSE OUTCOMES

At the end of the course, the students will be able to

CO1: Comprehend the tunneling process in soft soil, hard soil and rock strata
CO2: Design tunnel cross-section and other necessary requirement of tunnels
CO3: Plan for tunnel excavation
CO4: Learn about the tunnel excavation equipment
CO5: Analyze the stability of tunnel
CO6: Describe the tunnel operation

COURSE CONTENT

Introduction: Scope and application, historical developments, art of tunneling, tunnel engineering, Geotechnical Considerations of tunneling, Shapes, Site investigations

Types and Methods: Types and purpose of tunnels, factors affecting choice of excavation technique, Methods -soft ground tunneling, hard rock tunneling, shallow tunneling, deep tunneling; supporting, problems encountered and remedial measures.
Tunnelling: Design of Tunnels, Thick wall cylinder formulae, Kreish equation, green span method, pressure tunnels, lined and unlined tunnels, Tunnel support design., support pressure and slip of the joint
Excavation and equipment: Tunnelling by Roadheaders and Impact Hammers, tunnelling by Tunnel Boring Machines, TBM applications Tunnel Services and tunnelling hazards, Ventilation, drainage and pumping, explosion, flooding, chimney formation, squeezing ground

Text Books

1. R. Srinivas, Harbour, Dock and Tunnel Engineering, Charotar Publishing House Pvt. Ltd.,2009
2. Z T Bieniawski, Rock Mechanics Design in Mining & Tunneling, A.A. Balkema, 1984
3. David Chapman, Nicole Metje, Alfred Stark, Introduction to tunnel construction, CRC Press, 2017
4. John O. Bickel, Thomas R. Kuesel, Elwin H. King, Tunnel Engineering Handbook, 2004

TRANSPORT ECONOMICS

Course Code : CE60614
Credit : 3-0-0 3
Prerequisite : Nil

COURSE OUTCOME

At the end of the course, the students will be able to

CO 1: Describe principles of transport economics
CO 2: Apply the theory of Demand and Supply of Transport
CO 3: Explain the investment policy and pricing
CO 4: Explain system selection and cost analysis
CO 5: Develop Conventional Economic Evaluation in Transportation Planning
CO 6: Demonstrate the ways of private sector participation

COURSE CONTENT

Introduction
Transport as a catalyst to development; measuring the impact of transport on the economy- case studies of impacts. An overview of transportation activities in India: network and performance; issues for the future. Some basic considerations: transportation and land-use, the transport planning process

Demand and Supply Analysis
Transport Demand: The Basic Framework- measuring the demand in a spatial and temporal setting. Traditional Four-Stage Demand Model; modern approaches to modelling demand and practical issues in demand estimation. Supply: the nature of output in transport, output and costs, economies of size, density and scope, empirical estimation of transport cost functions- the approaches and illustrations.

Market Structure and Pricing
The spectrum of transport market structures: market power and the scope for pursuing different strategies. Pricing Principles – First Best Rules, Ramsey Pricing – Second Best Solution, Price Discrimination, Pricing with Stochastic Demand, Road Pricing and Congestion. Pricing in practice – public transport fares, rail tariffs, pricing by shipping conferences and electronic road pricing schemes

Investment Decisions
The nature of investment decisions; financial evaluation of transport investments; social cost benefit analysis: economic evaluation of transport investments. Practical issue in evaluation and case studies of road and rail projects evaluation.

Market Regulation and Policy
Theory of Regulation, Deregulation and Privatisation in Transport. Approaches to privatisation of transport infrastructure and services and a competition policy for transport. Evolution of transport policy in India with focus on case studies regarding different modes.

Textbook(s)

1. McCarthy, P. S., Transportation Economics, Massachusetts: Blackwell Publishers. 2001 (All Modules) 2. Button, K. J., Transport Economics, Second edition, London: Heinemann. 1993 (All Modules)

Reference Book(s)

1. Boyer, K. D., Principles of Transport Economics, Massachusetts: Addison-Wesley, 1998
2. Cole, S., Applied Transport Economics: Policy, Management and Decision Making, London: Kogan Page, 1998
3. Winston, C., Conceptual Developments in the Economics of Transportation: An Interpretive Survey, Journal of Economic Literature, Vol. XXIII (March 1985), pp.57-94

ENVIRONMENTAL IMPACT ASSESSMENT IN TRANSPORTATION ENGINEERING

Course Code : CE60616
Credit : 3-0-0 3
Prerequisite : Nil

COURSE OUTCOME

At the end of the course, the students will be able to

CO 1: Develop an understanding of the principles, methods, and processes involved in conducting EIA specifically for transportation engineering projects
CO 2: Comprehend various environmental indicators
CO 3: Analyse environmental issues in the industrial development
CO 4: Develop knowledge of national and international environmental laws, policies, and frameworks relevant to transportation engineering
CO 5: Understand the methodology for EIA
CO 6: Gain proficiency in preparing comprehensive and accurate Environmental Impact Assessment reports

COURSE CONTENT

Introduction
Environment and its interaction with human activities - Environmental imbalances - Attributes, Impacts, Indicators and Measurements - Concept of Environmental Impact Assessment (EIA), Environmental Impact Statement, Objectives of EIA, Advantages and Limitations of EIA

Environmental Indicators

Indicators for climate - Indicators for terrestrial subsystems - Indicators for aquatic subsystems - Selection of indicators - Socio-economic indicators - Basic information - Indicators for economy - Social indicators - Indicators for health and nutrition - Cultural indicators - Selection of indicators.

Environmental Impact Assessment For Transportation Projects
Basic Concepts, Objectives, Transportation Related Environmental Impacts – Vehicular Impacts – Safety & Capacity Impacts – Roadway Impacts – Construction Impacts, Environmental Impact Assessment – Environmental Impact Statement, Environment Audit, Typical case studies

Environmental Issues in Industrial Development
On-site and Off-site impacts during various stages of industrial development, Long term climatic changes, Green house effect, Industrial effluents and their impact on natural cycle, Environmental impact of Highways, Mining and Energy development

Methodologies for Carrying Environmental Impact Assessment
Overview of Methodologies Adhoc, Checklist, Matrix, Network, Overlays, Benefit Cost Analysis, Choosing a Methodology, Review Criteria.

Text Books:

1. Jain, R.K., Urban, L.V., Stracy, G.S., (1991), "Environmental Impact Analysis", Van Nostrand Reinhold Co., New York
2. Rau, J.G. and Wooten, D.C., (1996), "Environmental Impact Assessment", McGraw Hill Pub. Co., New York
3. UNESCO, (1987), "Methodological Guidelines for the Integrated Environmental Evaluation of Water Resources Development", UNESCO/UNEP, Paris Canter, L.W., (1997), "Environmental Impact Assessment", McGraw Hill Pub. Co., New York

TRANSPORTATION NETWORK ANALYSIS & OPTIMIZATION

Course Code : CE60618
Credit : 3-0-0 3
Prerequisite : Nil

COURSE OUTCOME

At the end of the course, the students will be able to

CO 1: Comprehend the basics of graph theory to represent transportation network.
CO 2: Solve several transportation network problems using various algorithms and techniques
CO 3: Formulate mathematical models of resource-constrained problems.
CO 4: Solve linear programs using graphical method and simplex algorithm.
CO 5: Formulate dual of a primal problem and apply duality theory.
CO 6: Formulate and solve integer programs of transportation problems

COURSE CONTENT

Network Problems: network representation, shortest path, minimum spanning tree, maximum flow and minimum cost network flow problems
Mathematical Modeling: math problem formulation of resource-constrained problems using decision variables, objective function, constraints and parameters
Linear Programming Applications in Transportation Engineering: problem examples and formulations, properties of linear programs, graphical solution, and simplex algorithm

Duality Theory: primal vs. dual formulations, duality theory, complementary slackness, and sensitivity analysis
Integer Programming Applications in Transportation Engineering: problem examples and formulations, either-or and if-then else constraints, branch and bound method, Lagrangian relaxation
Transportation network problems: examples of problems to be covered – shortest path, minimum spanning trees, maximum flow, minimum cost flow, transportation problem, assignment problem, facility location, traveling salesman problem

Textbook

1. Frederick S. Hillier, Gerald J. Lieberman, Bodhibrata Nag, and Preetam Basu, Introduction to Operations Research, McGraw Hill Education; Tenth edition (5 July 2017), ISBN-13 : 978-9339221850.

Reference book(s)

1. Ravindra Ahuja, Thomas Magnanti, and James Orlin. Network Flows: Theory, Algorithms, and Applications, Pearson; 1st edition (1 March 1993), ISBN-13: 978-0136175490.
2. Richard C. Larson, and Amedeo R. Odoni. Urban Operations Research, Prentice-Hall, 1981.

HIGHWAY CONSTRUCTION PRACTICE

Course Code **:** CE60620
Credit **:** 3-0-0 3
Prerequisite **:** Nil

COURSE OUTCOMES

At the end of the course, the students will be able to

CO 1: Comprehend and select the materials used in various layers of pavement.
CO 2: Learn the construction procedures of subgrade, subbase, base and surface layer of pavement
CO 3: Understand the types, selection, and operation of construction equipment and machinery used in highway construction
CO 4: Learn about quality control and quality assurance processes in highway construction.
CO 5: Understand the road drainage
CO 6: Understand highway maintenance practices, including routine maintenance, periodic maintenance, and rehabilitation techniques.

COURSE CONTENT

Embankment Construction
Formation cutting in Soil and hard rock, Preparation of Subgrade, Ground improvement, Retaining and Breast walls on hill roads, Granular and Stabilized, Sub – bases / bases, Water Bound Macadam (WBM), Wet Mix Macadam (WMM), Cement treated bases, Dry Lean Concrete (DLC).

Bituminous Constructions
Types of Bituminous Constructions, Interface Treatments, Bituminous Surfacing and wearing Courses for roads and bridge deck slabs, Selection of wearing Course under different Climatic and Traffic conditions, IRC specifications, Construction techniques and Quality Control.

Concrete road construction
Test on Concrete mixes, Construction equipments, Method of construction of joints in concrete pavements, Quality Control in Construction of Concrete pavements, Construction of Continuously

reinforced, Prestressed, Steel Fibre Reinforced (SFRC) Pavements, IRC, MORT&H, ACI Specifications, AASHTO Specifications, Recycled pavements, Non – Conventional Pavements, Overlay Construction.

Hill Roads Construction
Stability of Slopes, Landslides – Causes and Control measures, Construction of Bituminous and Cement Concrete roads at high altitudes, Hill road drainage, Construction and maintenance problems and remedial measures.

Construction Equipment and Machinery
Understand the types, selection, and operation of construction equipment and machinery used in highway construction, such as excavators, graders, pavers, rollers, and asphalt plants. Learn about safety considerations in equipment operation.

Road Drainage
Significance of highway drainage, Requirements of highway drainage, Surface drainage, Cross drainage, Sub-Surface drainage, Road construction in water-logged area.

Textbook

1. Kandhal, P. S., VEERARAGAVAN, A., & CHOUDHARY, R. (2023). Bituminous road construction in India. PHI Learning Pvt. Ltd..
2. IRC (Indian Roads Congress). (2013). Specifications for road and bridge works (5th Revision), Ministry of Road Transport and Highways MoRTH. New Delhi: Indian Roads Congress.

PORTS AND HARBOURS ENGINEERING

Course Code **:** CE60622
Credit **:** 3-0-0 3
Prerequisite **:** Nil

COURSE OUTCOMES

At the end of the course the student will be able to

CO 1: Explain the significance of port and harbours as a mode of transport
CO 2: Know the components of ports and harbours
CO 3: Demonstrate the fundamental principles of wave hydrodynamics and port cargo handling.
CO 4: Demonstrate the basic design of port layout
CO 5: Design, plan and integrate port and harbour infrastructure.
CO 6: Explain the construction, maintenance and renovation aspects of ports and inland waterways

COURSE CONTENT

Introduction
Ports and harbours as the interface between the water and land infrastructure – an infrastructure layer between two transport media.

The Fundamentals
Wave conditions inside harbour, water circulation; breakwaters, jetties & quay walls; mooring, berthing and ship motion inside the port; cargo handling – bulk material storage & handling.

Design Issues
Sea port layout with regards to (1) Wave action (2) Siltation (3) Navigability berthing facilities

Design of Port Infrastructures
Design of port infrastructures with regards to (1) Cargo handling (2) Cargo storage (3) Integrated transport of goods, Planning multipurpose port terminals.

Construction Aspects
Planning and construction of expansion and renovation of existing Inland Port Infrastructure.

Inland Waterways and ports
Maintenance of waterways, Construction of environmentally engineered banks, Dredging, Processing and storing of polluted dredged materials, development of river information services.

Textbook(s)

1. S.P. Bindra, A Course in Docks and Harbour Engineering, Dhanpat Rai Publishing Co Pvt. Ltd, New Delhi, ISBN: 9788189928858
2. H.P. Oza and G.H. Oza, Dock & Harbour Engineering, Charotar Publishing House Pvt. Ltd., 8th Edition, 2017, ISBN: 978-9385039256

REMOTE SENSING & GIS APPLICATION IN TRANSPORTATION ENGINEERING

Course Code : CE60624
Credit : 3-0-0 3
Prerequisite : Nil

COURSE OUTCOME

At the end of the course, the students will be able to

CO1: Understand the concept, principle and application of remote sensing
CO2: Know the various types of platforms and sensors used in remote sensing
CO3: Interpret satellite images
CO4: Explain the fundamental operations of GIS
CO5: Manage GIS data files and also analyze the spatial and attribute data
CO6: Apply the concept of GIS in ITS and transportation planning.

COURSE CONTENT

Remote sensing : Physics of remote sensing, Ideal remote sensing system, Remote sensing satellites and their data products, Sensors and orbital characteristics, Spectral reflectance curves, resolution and multiconcept, FCC, Interpretation of remote sensing images.

Digital image processing : Satellite image – characteristics and formats, Image histogram, introduction to image rectification, Image enhancement, Land use and land cover classification system.

Geographic information system (GIS) : Basic concept of geographic data, GIS and its components, Data acquisition, Raster and vector formats, Topography and data models, Spatial modeling, Data output, GIS applications.

Global positioning system (GPS) : Introduction, Satellite navigation system, GPS- space segment, Control segment, User segment, GPS satellite signals, Receivers; Static, Kinematic and Differential GPS.

Applications in Transportation Engineering : Intelligent Transport System, Urban Transport Planning, Accident Studies, Transport System Management, Road Network Planning, Collecting Road Inventory

Textbook(s)

1. Remote Sensing and GIS‖, by Basudev Bhatta, Oxford, 2013
2. Remote Sensing and GIS‖, by M. Chandra and S. K. Ghosh, Narosa Pub, 2007.
3. Surveying Volume -2‖ by S. K. Duggal, Third Edition, Tata Mecgraw Hill- 2011.

Reference book(s)

1. An Introduction to GIS‖, by I. Heywood, S. Cornelius and S. Carver, 2nd Ed, Pearson Education, 2002.
2. Fundamentals of Remote Sensing‖, by George Joseph, Universities Press, Second Edition-2011.
3. Advanced Surveying- Total station, GIS, Remote Sensing‖ by Satheesh Gopi, R. Sathikumar, N. Madhu, Pearson Eduction-2007
4. Remote Sensing and Image Interpretation‖, by T. M. Lillisand, R. W. Kaifer & J. W. Chipman, 6th Edition, John Wiley and sons Inc, Nov 2007.
5. Remote Sensing and its Applications‖, by LRA Narayan, Universities Press-2012

PAVEMENT ENGINEERING LABORATORY

Course Code : CE69601
Credit : 0-0-3 1.5
Prerequisite : Nil

COURSE OUTCOME

At the end of the course, the student will be able to

CO 1: Characterize soils and aggregate pavement application
CO 2: Characterise bitumen and bituminous binders
CO 3: Design bituminous mix by Marshall Method
CO 4: Perform quality control tests on pavements and pavement materials
CO 5: Determine the resilient modulus of bound materials
CO 6: Determine fatigue life of bound layers

COURSE CONTENT

Characterization of soil and aggregate for pavement application: grain size distribution of coarse and fine aggregate, specific gravity and water absorption of coarse aggregate, CBR

Characterization of bitumen and bituminous binders for pavement application: Penetration, softening point, ductility and viscosity of paving bitumen and bituminous binders. Tests on aged bitumen.

Bituminous mix design: Dry mix design, volumetric analysis of bituminous mix, determination of optimum bitumen content

Quality Control Tests: DCP, Moisture susceptibility test of bituminous mixtures, bitumen content in bituminous mix

Advance characterisation of pavement materials: Resilient modulus soil, aggregate and bituminous mixtures, Fatigue test of bituminous mixtures

Characterisation of cement stabilised materials: UCS test, IDT Test, Flexure Test, 4-P Fatigue Test

Textbook(s)

1. Khanna, S. K., Justo, C. E. G., & Veeraraghavan, A. (2014). Highway Engineering, Nem Chand & Bros Publishers.
2. Relevant IRC, ASTM and AASTHO Codes

Reference book(s)

1. Chakroborty, P., & Das, A. (2017). *Principles of transportation engineering*. PHI Learning Pvt. Ltd.

TRAFFIC ENGINEERING LABORATORY

Course Code : CE69602
Credit : 0-0-3 2
Prerequisite : Nil

COURSE OUTCOME

At the end of the course, the student will be able to

CO 1: Comprehend and conduct field data collection for traffic studies.
CO 2: Learn and perform various statistical analyses for evaluating traffic conditions.
CO 3: Estimate LOS for various traffic facilities including pedestrian facilities.
CO 4: Assess the road safety conditions.
CO 5: Forecast and model traffic parameters based on historical data.
CO 6: Gain practical knowledge on research aspects of traffic safety and congestion.

COURSE CONTENT

- Classified traffic counts, calculation of spot speed of vehicles and plotting of fundamental curves.
- Determining journey speed based on moving observer method.
- Estimation of LOS for various traffic facilities like midblock section and at-grade intersections.
- Estimation of LOS various pedestrian facilities like crosswalks, footpaths, foot-over bridge.
- Safety audit for existing roads based on signs, markings, and signals.
- Estimating various traffic congestion indices like TTI, PTI, BI.
- Determination of area occupancy for midblock sections.
- Assessment of surrogate safety measures like PET, TTC at intersections.
- Modelling and forecasting road crashes based on historical crash data.

Textbook(s)

1. Khanna, S. K., Justo, C. E. G., & Veeraraghavan, A. (2014). Highway Engineering, Nem Chand & Bros Publishers.
2. Relevant IRC codes, HCM, HSM, Indo-HCM, U.S. Department of Transportation Federal Highway Administration publications.

COMPUTATIONAL LAB

Course Code : CE69603
Credit : 0-0-3 1.5
Prerequisite : Nil

COURSE OUTCOME

At the end of the course, the student will be able to

CO 1: Design flexible pavement using IIT Pave
CO 2: Design rigid pavement using design spreadsheets
CO 3: Compare pavement alternatives using LCCA software.
CO 4: Conduct statistical analysis using MS Excel
CO 5: Model and forecast the various aspects of traffic engineering using statistical tools
CO 6: Simulate various traffic scenarios using software

COURSE CONTENT

- Design of flexible pavement using linear elastic analysis using IIT Pave, Cross Pave
- Design of rigid pavement using spreadsheets.
- Design of Overlay using KGPback and IIT Pave.
- Life cycle cost analysis using spreadsheets/software
- Microscopic traffic modelling using VISSIM
- Basic statistical analysis of traffic data using MS excel
- Predictive and specialized modelling techniques using like SPSS/Minitab/JMP SAS.
- Distribution fitting and Time series forecasting like ARIMA using SPSS/JMPSAS/Minitab.

RESEARCH METHODS AND DOCUMENTATION

Course Code: EX60001
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE

Post-graduate engineering students carry out a year-long research-intensive thesis or project that requires them to have the full knowledge of general principles of defining and scoping a problem, deciding the approach to research design, implementing the design, making the analysis, drawing inferences, and communicating their research findings. This subject covers the essential features of research methods and research communications.

COURSE OUTCOMES

After successfully completing the course, the student will be able to

CO1: Define and scope a problem,
CO2: Make a review of literature,

CO3: Decide on an appropriate research design and develop an experimental setup and/or an appropriate model,
CO4: Generate and/or collect the necessary data, make the required data analysis, and draw inferences,
CO5: Initialize the art and science of scientific and technical writing, and
CO6: Write a project report following the principles of scientific writing.

COURSE CONTENT

A. Research Methods

A.1 Introduction to Research
Research Definition; Elements of Research: Novelty, Originality, Creativity, and Critical Thinking; Deductive, Inductive, and Abductive Approaches.

A.2 Selecting a Research Problem
Research Topics, Problems, Objectives and Scope, Questions, and Research Contribution.

A.3 Measurement, Data, and Data Analytics
Measurement Scales and Data Visualization; Revisiting Basic Statistics, Probability,and Probability Density Functions; Sampling and Sampling Distributions, Tests of Hypotheses,and Simple and Multivariate Regression Analysis

A.4 Models and Modelling
Characteristics and Types of Models, Discrete-Event Simulation, and Neural Networks Models.

A.5 Research Design
Qualitative Research: Survey, Case Study, Action Research, and Citizen Science; Experimental Research: Factors, Factor Levels, Replication, ANOVA, and Factorial Designs.

B. Research Documentation

B.1 Language Issues
Paragraphing, Unity of Ideas, Topic Sentences, Link Words, Transitions; Common English Errors; Use of Hyphen, Dashes, and Ampersand; Responsible Use of Generative AI Tools.

B.2 Organization of a Research Document
Front Matters, Body, and End Matters; Guidelines on Titles, Abstracts, Keywords, Symbols and Abbreviations, and Capitalization; Narrative and Systematic Literature Review, Referencing Systems, Reference Management Software; Guidelines on Tables, Figures, Mathematical Operations and Equations, SI Units, Scientific and Engineering Notations of Numbers, and Significant Digits.

B.3 Elements of Research and Publication Ethics
Research Misconduct: Types and Research Code of Conduct; Plagiarism and Copyright.

Reference Books

1. Dunn, P. K. (2021), Scientific Research and Methodology: An Introduction to Quantitative Research and Statistics in Science, Engineering, and Health, Available free at https://bookdown.org/pkaldunn/Book/. [***Covers most of the topics***]
2. Durdella, N. (2019), Qualitative Dissertation Methodology: A Guide for Research Design and Methods, California: SAGE Publications. [***For topics related to qualitative methods***]
3. Montegomery, D. C. (2019), Design and Analysis of Experiments, 10th Edition, John Wiley & Sons, Inc. [***For topics related to design of experiments, model and modelling***]
4. Perelman, L. C., J. Paradis, and E. Barrett, Eds. (1998), The Mayfield Handbook of Technical and Scientific Writing, Mayfield Publishing, Available free at http://www.mhhe.com/mayfieldpub/tsw/toc.htm. [***For topics related to research documentation***]
5. Kothari, C. R. (2004), Research Methodology: Methods and Techniques, 2nd Revised Edition, Hyderabad: New Age International.
6. Marder, M. C. (2011), Research Methods for Science, Cambridge University Press.

SCHOOL OF CIVIL ENGINEERING
M.TECH. PROGRAMME

Specialization: Geotechnical Engineering

Curricula & Syllabi

ACADEMIC CURRICULA – 2024

Kalinga Institute of
Industrial Technology (KIIT)
Deemed to be University
(Established U/S 3 of UGC Act, 1956)
Bhubaneswar, Odisha, India

School of Civil Engineering
M. Tech. Program
Specialization: Geotechnical Engineering

Semester-I

Sl. No	Subject Code	Course Title	Contact Hours per Week			Credit
			L	T	P	
1	CE60003	Computational Methods in Civil Engineering	3	-	-	3
2	EX60001	Research Methods & Documentation	3	-	-	3
3	CE60401	Advanced Soil Mechanics	3	-	-	3
4	CE60403	Foundation Engineering: Principles and Practices	3	-	-	3
5		**Elective-I**	3	-	-	3
6		**Elective-II**	3	-	-	3
7	CE69405	Experimental Geotechnics	-	-	2	1
8	CE68412	Seminar	-	-	-	1
					Total	20

Semester-II

Sl. No	Subject Code	Course Title	Contact Hour per Week			Credit
			L	T	P	
1	CE60004	Soft Computing Techniques in Civil Engineering	3	-	-	3
2	CE60404	Soil Dynamics and Machine Foundations	3	-	-	3
3	CE60408	Ground Improvement Methods and Design	3	-	-	3
4	CE60410	Geotechnical Stability Analysis	3	-	-	3
5		**Elective – III**	3	-	-	3
6		**Elective-IV**	3	-	-	3
7	CE68408	Comprehensive Viva Voce	-	-	-	2
8	CE68407	Site investigation and interpretation of test data	-	-	2	1
					Total	21

Semester-III

Sl. No	Course Code	Course Title	Contact Hour per Week			Credit
			L	T	P	
1		**Open Elective / Industry Elective**	3	0	0	**03**
2	CE67403	Thesis Part-I	-	-	-	16
3	CE68414	Geotechnical Design	-	-	2	1
					Total	20

Semester-IV

Sl. No	Course Code	Course Title	Contact Hour per Week			Credit
			L	T	P	
1	CE67404	Thesis Part-II	-	-	-	20
					Total	20

LIST OF DEPARTMENT ELECTIVES

Elective I & II

Sl.No	Course Code	Course Title	Credit
1	CE 60413	Earth Retaining Structure	3
2	CE 60415	Theory of Elasticity and Plasticity	3
3	CE 60417	Rock Mechanics	3
4	CE 60419	Pavement analysis and design	3
5	CE 60421	Finite Element analysis in geomechanics	3
6	CE 60423	Geosynthetics and Reinforced Earth Structures	3
7	CE 60425	Soil Structure Interaction,	3
8	CE 60431	Reliability Analysis in Geotechnical Engineering	3
9	CE 60435	Geotechnical investigation and field test	3

Elective III & IV

10	CE 60424	Critical state soil mechanics	3
11	CE 60426	Tunnel Engineering	3
12	CE 60428	Environmental Geotechnics	3
13	CE 60432	Deep Excavation Planning and Design	3
14	CE 60436	Offshore Geotechnical Engineering and Foundation	3
15	CE 60438	Ground Water and Flow Through Porous Media	3
16	CE 60440	Design of Foundation Structures	3
17	CE 60442	Analysis and design of deep foundations	3
18	CE 60444	Risk Assessment and Management in Geotechnical Engineering	3
19	CE 60446	Analysis and Design of Geotechnical Structures	3

COMPUTATIONAL METHODS IN CIVIL ENGINEERING

Course Code: CE60003
Credit:3
L-T-P: 3-0-0
Prerequisite: NIL

COURSE OUTCOMES

At the end of the course, the students will be able to
CO 1: Comprehend the measure of central tendency, dispersions and correlation coefficients,
CO 2: Use the Curve Fitting & Least Square Techniques in the experimental methods,
CO 3: Apply the concept of probability and set theory in practical problems,
CO 4: Apply the concept of probability distribution functions,
CO 5: Determine roots of algebraic equation by different methods and obtain interpolating polynomials, and
CO 6: Solve ODE and PDE using numerical techniques.

COURSE DETAILS

Measures of Central Tendency & Dispersions; Covariance; Correlation Coefficients and their Properties in field data;
Curve Fitting & Least Square Techniques and their use in the experimental methods in Civil Engineering; Concept of Regressions; Regression curve in Bivariate Frequency Distributions;
Introduction to probability and set theory; Probabilistic measures; Conditional probability and Bayes' theorem; Discrete and continuous random variables;
Probability Density Functions; Probability Distributions of Single and Multiple Random Variables; Discrete & continuous distributions; Chi-Square Test; Kolmogorov-Smirnov Test; Analysis of Variance.
Linear equations and eigen value problems, Accuracy of approximate calculations, Nonlinear equations, interpolation, differentiation and evaluation of single and multiple integrals
Initial and boundary value problems by finite difference method, Newton's method, variation and weighted residual methods,

Texts

1. Applied Statistics and Probability for Engineers by Douglas C. Montgomery and George C. Runger, Wiley India Pvt. Ltd, 2009.
2. Jay L. Devore, Probability and Statistics for Engineering and the Sciences, Brooke & Cole, 2009.
3. J. B. Scarborough, Numerical Mathematical Analysis, Oxford & IBH Publishing Co. Pvt. Ltd., 2000.
4. K. K. Jain, S. R. K Iyengar and R. K. Jain, Numerical Methods - Problem and Solutions, Wiley India Pvt. Ltd, 2001.

References

1. 3.W. Mendenhall and T. Sincich, Statistics for Engineering and the Sciences, Prentice-Hall, 2000.
2. Steven Chapra and Raymond Canale , Numerical Methods for Engineers, McGraw-Hill Education; 6th edition 2012.

SOFT COMPUTING TECHNIQUES IN CIVIL ENGINEERING

Course Code: CE60004
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OUTCOMES

At the end of the course, the students will be able to

CO 1: Comprehend the basic concepts of soft computing,
CO 2: Use generic algorithms and Particle swarm intelligence algorithms,
CO 3: Prepare prediction model using neural network,
CO 4: Apply supervised machine learning techniques,
CO 5: Apply the techniques of unsupervised machine learning, and
CO 6: Implement soft computing techniques in Civil Engineering problems.

COURSE DETAILS

Introduction to Soft Computing: Basic concepts, various Soft Computing Techniques, Overview of conventional computing vs. soft computing, Characteristics and advantages of soft computing techniques

Genetic Algorithms (GA): Introduction to genetic algorithms, Representation schemes: binary, real-valued, permutation, Genetic operators: selection, crossover, mutation.

Particle Swarm Optimization (PSO): Introduction to particle swarm optimization, Swarm intelligence principles, PSO algorithm components: particles, velocity update, position update, Ant Colony Optimization (ACO): Basics of ant colony optimization, Ant behavior modeling, ACO algorithm: pheromone trails, ant movement, Pigeon search algorithm.

Artificial Neural Networks (ANN): Fundamentals of neural networks, Single-layer and multi-layer perceptrons, Training algorithms: back-propagation, gradient descent, Convolutional Neural Networks (CNN),

Fuzzy Logic Systems: Basics of fuzzy set theory, Fuzzy logic operations and rules, Fuzzy inference systems

Introduction to Machine Learning, Basic Concepts, Supervised learning, unsupervised learning, reinforcement learning, Python libraries

Supervised Learning Techniques: Decision trees and ensemble methods (Random Forests), Support Vector Machines (SVM), , Basic concepts and principles, k-nearest neighbor (kNN)

Unsupervised Learning Techniques: Clustering, K-means clustering, Hierarchical clustering, Dimensionality Reduction, Principal Component Analysis (PCA)

Application of soft computing in Civil Engineering
Application of different algorithms to solve practical problems of Civil Engineering.

Textbooks / Reference Books

1. Pratihar D.K., Soft Computing, Narosa Publishers, and ISBN: 978-81-8487-495-2, 2018.
2. Mangey Ram, J. Paulo Davim, Soft Computing Techniques and Applications in Mechanical Engineering, IGI Global, USA.
3. Simeone O. Machine learning for engineers. Cambridge University Press; 2022.
4. E. Alpaydin, Introduction to Machine Learning, Prentice Hall of India, 2006.

ADVANCED SOIL MECHANICS

Course Code: **CE60401**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Comprehend the fundamental concepts of soil formation and its subsequent effect on geotechnical properties of soil.
CO 2: Explain clay behavior in terms of its mineralogy
CO 3: Explain the properties of cohesionless soil and its composition.
CO 4: Apply the seepage analysis in practical problem
CO 5: Interpret consolidation test data and subsequent analysis of one dimensional vertical settlement
CO 6: Comprehend the basic concept on critical soil mechanics

COURSE DETAILS

Introduction: Origin of soil and its types, mineralogy and structure of clay minerals, X-ray and Differential Thermal Analysis.
Behavior of clay (cohesive soil): Origin of clay minerals, synthesis patterns and classification of the clay minerals, isomorphous substation, inter sheet and interlayer bonding in the clay mineral, discuss the clay minerals (Kaolinite, Montmorillonite and Ilite) in terms of its structure, isomorphous substitution, exchange capacity, shape, surface area and its occurrence in the soil, nature of water in clay, behavior of clay; Atterberg's limits, particle size, anisotropic behavior, hydraulic conductivity, shear strength, compressibility, swelling & Shrinkage and time dependant behavior
Behavior of granular soil (Cohessionless soil):Mineral composition, discuss the minerals (Quartz, Feldspars and Mica) of cohesionless soil in terms of its structure, stability, cleavge planes, bonded ions and hardness, Behavior of granular soil; Particle size and distribution, particle shape, particle stiffness and particle strength.
Seepage analysis and Consolidation:Steady State flow, 2D and 3D seepage,Seepage force, transient flow, mathematical and graphical solution for seepage, uplift force under hydraulic structure, drainage design, seepage through earth dam, steady state well hydrology, Compressibility and rate of consolidation, one, two, and three dimensional consolidation theories; one-dimensional consolidation test and interpretation of test data, one-dimensional consolidation settlement, One-dimensional consolidation with viscoelastic models, Finite difference analysis of consolidation, radial consolidation and its application in sand drains.
Critical state soil mechanics: Critical State Line, Hvorslev Surface, Yield Surfaces: Modified Cam-clay and Original Cam-clay; Constitutive relationships of soil;

Textbooks

1. Das, B.M. and Sobhan, K., (2016) Principles of Geotechnical Engineering (9th Edition), CL Engineering, ISBN-13 : 978-1305970953.
2. Mitchell, J. K. and Soga, K., (2005) Fundamentals of Soil Behaviour (3rd Edition), John Wiley and Sons, ISBN: 978-0-471-46302-3.

Reference books

1. Holtz,R.D, William D. K. and Sheahan, T.C., (2010) An Introduction to Geotechnical Engineering(2nd Edition), ISBN-13 : 978-0130317216.
2. R.O. Davis and A.P.S. Selvadurai, (1996) Elasticity and Geomechanics, Cambridge University Press, New York, ISBN: 9780521498272.
3. Wood, D. M., (1991) Soil behaviour and critical state soil mechanics, Cambridge University Press, ISBN-13 : 978-0521337823.

FOUNDATION ENGINEERING: PRINCIPLES AND PRACTICES

Course Code: **CE60403**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Apply the fundamental concept to Foundation Design knowing the relevant parameters:
CO 2: Carryout the analysis and design of shallow foundation based on theoretical, experimental and codal provisions of bearing capacity analysis
CO 3: determine Settlement of shallow foundation for recommendation of allowable bearing capacity
CO 4: Comprehend the load transfer mechanism and recommend load carrying capacity of various types of piles as individual and in a group
CO 5: Determine the pile and pile group settlement in various soil condition
CO 6: Know about other alternative fundamentals and its structure specific used

COURSE DETAILS

Introduction to Foundation Design: Motivation for using Different Foundation Types, Issues to Consider in Design, Shear Strength of Soils, and Application to Foundation Analysis, Subsurface Sampling and Characterization Methods, and Application to Foundation Design.
Shallow Foundations: Bearing Capacity Analysis, Concept of upper and lower bound solutions, Undrained analyses (simple circular arc, theories of Prandtl and Reissner), Drained analyses (Terzaghi's theory), Special factors (for depth, slope, inclined load, shape, layered soils, anisotropy), Overview of settlement analysis methods on clay and sand, Induced stress beneath the foundations, Balancing bearing capacity and settlement in design, Strategies to mitigate the effects of expansive soils on foundations, Structural and Geotechnical design of spread footings and mat foundations, Design for eccentric or moment loads
Deep Foundations: Types and their definition, Load transfer, Pile Foundations, Pile types and deterioration issues, Pile driving and allowable stresses, Axial load capacity by static and dynamic load tests, piles bearing on rock, downdrag of piles, uplift capacity of piles, lateral load capacity, group action in piled

foundation, pile group in coarse-grained and fine grained soil, effect on pile groups of installation, Structural issues and design, Construction, inspection, specifications and case histories,
Other types of foundations (micro piles, helical anchors, anchors, soil nails, drilled shafts, caissions etc.)

Textbooks

1. Bowles, J. E. (2001) Foundation Analysis and Design (5th Edition). McGraw-Hill Education, 2001, ISBN-13: 978-0071188449.
2. Principles of Foundation Engineering" by B.M. Das, 9th Edition, Cengage Learning India Pvt. Ltd, New Delhi.

Reference books

1. Varghese, P.C. (2012) Foundation Engineering (9th Edition), PHI New Delhi, ISBN:978-81-203-2652-1.
2. Tomlinson, M. and Woodward, J. (2014) Pile design and construction practice, CRC Press, ISBN-13 : 978-1466592636.

SOIL DYNAMICS AND MACHINE FOUNDATIONS

Course Code: **CE60404**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Comprehend the effect of vibration on soil
CO 2: Determine the soil dynamic properties
CO 3: Design basic machine foundations
CO 4: Identify the effect of machine foundation to the adjacent foundation
CO 5: Apply the concept of soil dynamic to the other type of foundations
CO 6: Design of vibration isolation system

COURSE DETAILS

Vibration of elementary systems, Analysis of systems with Single degree and multi-degree of freedom; Natural frequencies of continuous systems, Elastic Constants of soil and their experimental determination; Effect of vibration on soil properties; Bearing capacity of dynamically loaded foundations, Principles of Machine foundation design, Experimental and analytical determination of design parameters, Design of foundations for turbines, vertical and horizontal reciprocating engines, forges hammers, Effect of machine foundation on adjoining structures, vibration isolation .

Textbook

1. Das, B. M. (2010) Principles of Soil Dynamics (2nd Edition), Wadsworth Publishing Co, ISBN-13 : 978-0534931292.

Reference books

1. Saran, S. (1999) Soil Dynamics and Machine Foundations (2nd Edition), Galgotia Publications Private Ltd, ISBN-13 : 978-8175154414.
2. Kramer, S.L., (2003) Geotechnical Earthquake Engineering(1st Edition), Prentice Hall, ISBN-13 : 978-8131707180.
3. Bhatia, K.G.(2009) Foundations For Industrial Machines (1st Edition), CRC Press , ISBN-13 : 978-8190603201.
4. A Major, (1962) Vibration Analysis and Design of Foundations for Machines and Turbines: Dynamical Problems in Civil Engineering, Akademiai Kiado Budapest Collets Holding Ltd.

GROUND IMPROVEMENT METHODS AND DESIGN

Course Code: **CE60408**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO1: know the engineering properties of various types of soil deposits and selection of suitable ground improvement techniques using mechanical modification and deep compaction methods of improvement
CO2: apply design methods to accelerate the consolidation settlement of cohesive soil using preloading methods, vertical drains; design of dewatering system
CO3: understand the ground improvement technique for design using admixtures and grouting
CO4: identify the relevance of reinforcing elements to resist the lateral earth pressures and perform design of reinforced earth (RE) wall and soil nailing
CO5: understand the use of geosynthetics in ground improvement to satisfy the various functional requirements and its design for various applications
CO6: express the ground improvement required for earthquake resistance structures and understand the case studies on ground improvement

COURSE DETAILS

Introduction: Engineering properties of soft, weak and compressible deposits, Natural on land, off-shore and Man-made deposits; Role of ground improvement in foundation engineering, methods of ground improvement and selection of suitable ground improvement techniques
In-situ treatments methods: In-situ densification soils, Dynamic compaction and consolidation, Vibro-floatation, Sand pile compaction, Preloading with sand drains and fabric drains, Granular columns, Lime piles, Injections, Thermal, Electrical and Chemical methods, Electro osmosis, Soil freezing and dewatering techniques.
Reinforced Soil: The Mechanism, Reinforcement materials, Reinforcement - Soil Interactions, Geosynthetics, Principles, Analysis and Design of Reinforced Retaining Structures, Embankments and Slopes using Soil nailing, Ground Anchors
Ground Improvement Techniques for Geotechnical Earthquake Engineering & Case studies on ground improvement techniques

Text books

1. Datta, M. and Gulhati, S. (2017) Geotechnical Engineering, McGraw Hill, ISBN-13 : 978-0070588295.
2. P. Purushothama Raj (1999) Ground Improvement Techniques (1st Edition), ISBN-13 : 978-8131808573.

Reference books

1. Das, B. M. (2018) Principles of Foundation Engineering (9th Edition), Cl-Engineering, ISBN-13 : 978-1337705028.
2. Ingold, T. S. and Miller, K. S. (1990) Geotextile Hand Book, Thomas Telfrod, London, ISBN-13 : 978-0727713339.
3. Nayak, N. V. (2018) Foundation Design Manual (7th Edition), Dhanpat Rai and Sons, Delhi, ISBN-13 : 978-9383182909

GEOTECHNICAL STABILITY ANALYSIS

Course Code: **CE60410**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Comprehend the causes of landslide and its prediction
CO 2: Apply various method fo analyses the slope stability of fine slope
CO 3: Analyze the slope stability of infinite slope
CO 4: Determine stability of slope under seismic load
CO 5: Comprehend method of slope stabilization
CO 6: Explain various method of slope repair.

COURSE DETAILS

Landslide phenomenon: Types and causes of slope failures, Practical applications, case studies.
Analysis of slope stability: Stability analysis of infinite slopes with or without water pressures ; Stability analysis of finite and Infinite slopes: concept of factor of safety, pore pressure coefficients, important details of stability analysis, Mass analysis, Wedge methods, friction circle method ; Method of slices, Bishop's method, Janbu's method ; Effect of seepage, submerged and sudden draw down conditions
Seismic slope stability: pseudostatic screening analysis, determination of peak acceleration, shear strength for pseudostaic analysis, postearthquake stability analysis
Slope stabilization: factors governing selection of method of stabilization, drainage, retaining structures, reinforcing piles and drilled shafts, injection methods, vegetation, repair of failed slopes.

Textbook

1. Chowdhury, R., Flentje, P. and Bhattacharya, G. (2009) Geotechnical Slope Analysis (1st Edition), CRC press, ISBN-13 : 978-0415469746.

Reference books

1. Abramson, L. W., Lee, T. S., Sharma, S. and Boyce, G, M. (2001) Slope Stability and Stabilization Methods (2nd Edition), Willey Inter science publications, ISBN: 978-0-471-38493-9.
2. Lambe, T. W. and R. V. Whitman,(2012) Soil Mechanics, Wiley India Pvt Ltd, ISBN-13: 978-8126539918.
3. Duncan, J.M., and Wright, S.G.(2005) Soil Strength & slope Stability, John Wiley & Sons, ISBN-13 : 978-0471691631.

EARTH RETAINING STRUCTURES

Course Code: **CE60413**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Comprehend about various earth pressure theories
CO 2: Explain the fundamental concept behind the lateral earth pressure
CO 3: Determine the passive and active earth pressure acting along the wall
CO 4: Explain the role of earth pressure against the bracing in open cut
CO 5: Comprehend the concept behind the sheet piling
CO 6: Explain the various methods of deep excavation

COURSE DETAILS

Earth Pressure: Fundamental relationships between the lateral pressures and the strain with a back fill. Rankine and Coulomb theories, Active, passive and pressure at rest ; Backfill with broken surface, wall with broken back, concentrated surcharge above the back fill, earth pressure due to uniform surcharge, earth pressure of stratified backfills, saturated and partially saturated backfill. Passive earth pressure in engineering practice; Assumption and conditions, point of application of passive earth pressures;
Bulkheads: Definition and assumptions, conditions of end supports and distribution of active earth pressure and bulkheads, bulkheads with free and fixed earth supports, equivalent beam method, Improvements suggested by Rowe, Tschebotarioff's method, Anchorage of bulkheads and resistance of anchor walls, spacing between bulkheads and anchor walls, resistance of anchor plates, Consideration of effects of ground water, seepage, surcharge loading together with possibility of shallow and deep sliding failures on retaining structure ;
Sheet Pile wall: Free earth system, fixed earth system, Dead man; Tunnel and Conduit: Stress distribution around tunnels, Types of conduits, Load on projecting conduits;
Arching and Open Cuts: Arching in soils, Braced excavations, Earth pressure against bracings in cuts, Heave of the bottom of cut in soft clays;
Reinforced earth retaining structures: Design of earth embankments and slopes Recent advances in Earth retaining structures.

Textbook

1. P. Raj, (2007) Soil Mechanics & Foundation Engineering, Pearson, ISBN-13 978-8131711774.

Reference books

1. Knappett, J. and Craig, R. F. (2012) Craig's Soil Mechanics (8th Edition), CRC Press, ISBN-13: 978-0415561266.
2. Das, B. M. (2018) Principles of Foundation Engineering (9th Edition), Cl-Engineering, ISBN-13: 978-1337705028.
3. Bowls, J. E. (2001) Foundation Analysis and Design (5th Edition). McGraw-Hill Education, ISBN-13: 978-0071188449.

THEORY OF ELASTICITY AND PLASTICITY

Course Code: **CE60415**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Comprehend stress-strain and equilibrium of structure
CO 2: Explain the various yield surface and formation of material models
CO 3: Explain about centrifuge modeling
CO 4: Explain the effect of circular hole on stress distribution
CO 5: Analyze two-dimensional plastic flow problem
CO 6: Apply the concept of dynamic analysis

COURSE DETAILS

Plane stress and plane strain problems: General stress and strain equations (Equilibrium and compatibility equations), Two dimensional problems in rectangular coordinates, Stress and strain components, differential equation, equilibrium equations and compatibility
Equations in polar coordinate: Stress distribution for axisymmetric problems. Pure bending of curved bars, thick walled cylinder, Concentrated force at a point of straight boundary. Force acting on the end of a wedge. Concentrated force acting on a beam.
Effect of circular holes on stress distributions in plates: Dynamic analysis of offshore structures, Centrifugal modelling, Anchor design, Break out resistance analysis and geotechnical aspects of offshore pipeline and cable design, Field instrumentation and performance observation.
Torsion of non–circular prismatic bars: Saint Venant's Theory, Various Analogies, Torsion of hollow and thin sections
Introduction to the theory of plasticity: The yield criteria of metals, stress space representation of yield criteria. Stress strain relations, plastic potential, flow rules and maximum work hypothesis, Two dimensional plastic flow problems. Incompressible two dimensional flow, stresses in plastic materials in condition of plane strain, equation of equilibrium, the simple slip-line fields.

Textbook

1. Timoshenko S.P. and Goodier, J.N. (1970) Theory of Elasticity (3rd Edition), McGraw- Hill.

Reference books

1. Hoffman, O. and Sachs, G. (2012) Introduction to the Theory of Plasticity for Engineers, Literary Licensing, ISBN-13 : 978-1258431471.
2. Johnson, W. and Meller, P.B. (1973) Plasticity of Mechanical Engineers, North-Holland Publishing Company.
3. Nadai, A. (1950) Theory of Flow and Fracture of Solids (2nd Edition), McGraw-Hill,.

ROCK MECHANICS

Course Code: CE60417
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Explain the process of formation of rocks
CO 2: Comprehend various rock properties and related laboratory and field tests
CO 3: Explain the defects and strength behaviour of rock
CO 4: Explain the parameters influencing rock slope stability and its stabilization
CO 5: Comprehend about the rock tunneling
CO 6: Apply the concept on design of foundation on rock

COURSE DETAILS

Rock formation: Structure and composition of the Earth, Minerals and mineralogical analysis,rock weathering, Rock formations and types
Rock classification and rock testing: Classification of rocks and rock masses, laboratory and field tests on rock
Strength behaviour and defects in rock: Compression, Tension and Shear, Stress-Strain relationship**s,**
Rheological behaviour; Strength/ Failure Criterion: Coulomb- Mohr, concept of instability, defects in rocks , causes of defects and its effect
rock slope stability :modes of rock slope failure, slope stability analysis, different types of failure, slope stabilization process
Rock tunnelling: concept, criteria, design concept on tunnelling in rock,
Foundation on rock: shallow foundation and deep foundation, design criteria, foundation construction

Text Books:

1. Sivakugan , Shukla and Das, Rock Mechanics: An Introduction ,2013, taylor and Francis(CRC Press),ISBN-13: 978-0-203-12759-9 (eBook - PDF).
2. Verma, B.P., (1985) Rock mechanics for Engineers (1st Edition), Khanna Publisher.

Reference books:

1. Goodman, R. E. (1988) Introduction to Rock Mechanics (2nd Edition), John Wiley & Sons, ISBN-13 : 978-0471812005.

PAVEMENT ANALYSIS AND DESIGN

Course Code: **CE60419**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Comprehend the current design practice for pavement
CO 2: Explain the stress distribution under flexible pavement
CO 3: Comprehend the material characterization under cyclic load
CO 4: Analyze the performance of pavement
CO 5: Explain th**e** methodology for traffic study
CO 6: Explain the use of non destructive testing

COURSE DETAILS

Introduction: Pavement type, road test, factors affecting design, IRC recommendation
Flexible Pavements: stress-strain behavior, stress distribution through homogeneous mass, layered system, viscoplastic solution.

Rigid Pavements: stress due to curling, stress and deflection due to loading, Stress due to friction, use of dowels and joints
Traffic: Traffic Loading, traffic Volume, equivalent single wheel load, equivalent axle factor
Material Characterization: Resilient Modulus, Dynamic Modulus of Bituminous Mixtures, Fatigue Characteristics, Permanent Deformation Parameters
Pavement Performance: Distress, Serviceability, Surface Friction nondestructive testing, pavement performance analysis

Textbook

1. Yuang, Y. H. (2003) Pavement Analysis and Design (2nd Edition), Pearson, ISBN-13 : 978-0131424739.

Reference books

1. Srinivasa, K. (2013) Pavement Design , Orient Blackswan Private Limited, ISBN-13 : 978-8173718854.
2. Yoder, E. J. and Witczak, M.W. (2011) Principles of pavement design (2nd Edition), Wiley India Pvt Ltd, ISBN-13 : 978-8126530724.

FINITE ELEMENT METHODS IN GEOMECHANICS

Course Code: CE60421
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Comprehend the basic of FE analysis
CO 2: Apply the FE analysis in two dimensional problem
CO 3: Solve numerical solution for truss and beam element
CO 4: Apply FEM using CST approach
CO 5: Comprehend FEM for axisymmetric loading
CO 6: Apply FEM in 3D modeling

COURSE DETAILS

Introduction: The Continuum, Equations of Equilibrium, Boundary Conditions, Strain displacement relations, Stress strain Relations, Plane stress and plane Strain problems, Different methods of structural analysis including numerical methods. Basics of finite element method (FEM), different steps involved in FEM, Different approaches of FEM, Direct method, Energy approach, Weighted residual Method.
One and Two Dimensional Problems: Detail formulation including shape functions. stress strain relations, strain displacement relations and derivation of stiffness matrices using energy approach, Assembling of element matrices, application of displacement boundary conditions, Numerical solution of one dimensional problems using bar, truss, beam elements and frames. Derivation of shape function using Lagrange's interpolation, Pascal's triangle, Convergence criteria, Finite Element modelling of two dimensional problems using Constant strain Triangle(CST) elements, Stress strain relations for isotropic and orthotropic materials, Four nodded rectangular elements, axisymmetric solids subjected to axisymmetric loading.
Isoparametric Elements: Natural coordinates, iso-parametric elements, four nodes, eight node elements, Numerical integration, order of integration
Plate Bending: Bending of plates, rectangular elements, triangular elements and quadrilateral elements, Concept of 3D modelling

Textbook

1. Debasis D., (2012) Finite Element Method: Concept & Application in Geomechanics, Prentice hall of India, ISBN-13 : 978-8120342958.

Reference books

1. Logan, D. L., (2010) A First Course in the Finite Element Method (5th Edition), CL Engineering, ISBN-13 : 978-0495668251.
2. Krishnamoorthy, C., (2017) Finite Element Analysis-Theory and Programming (2nd Edition), McGraw Hill Education, ISBN-13 : 978-0074622100.

GEOSYNTHETICS AND REINFORCED EARTH STRUCTURES

Course Code: **CE60423**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Explain the application of Geosynthesis
CO 2: Design and analysis of earth retaking wall and pavement with Geosynthetics
CO 3: Comprehend the use of Geosynthetic in drainage and liner
CO 4: Explain the application of barrier
CO 5: Comprehend the process of bearing capacity enhancement using earth reinforcement
CO 6: Explain the Case histories of applications

COURSE DETAILS

Historical background; Principles, concepts and mechanism of reinforced earth;Design consideration for reinforced earth and reinforced soil structures; Geosynthetics-their composition, manufacture, properties, functions, testing and applications in reinforced earth structures; Design of reinforced soil structures like retaining walls, embankments, foundation beds etc.;Designing for Separation, Filtration, Drainage and Roadway Applications; Designing for Landfill Liners and Barrier Applications; Case histories of applications.

Textbook

1. Koerner, R.M, (2012) Designing with Geosynthetics (6th Editiion) , Xlibris, ISBN-13 : 978-1462882885.

Reference books

1. Saran, S., (2019) Reinforced Soil and its Engineering Applications (3rd Edition), Dreamtech Press, ISBN-13 : 978-9389307900.
2. Jones, C.J.F.P, (1996) Earth Reinforcement and Soil Structures (3dr Edition), Thomas Telford Ltd, ISBN-13 : 978-0727734891.

SOIL STRUCTURE INTERACTION

Course Code: **CE60425**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Comprehend the basic concept of Beam on Elastic foundation

CO 2: Apply the Beam on Elastic foundation for shallow foundation
CO 3: Apply the Beam on Elastic foundation for pile foundation
CO 4: Analyze load deflection using Beam on Elastic foundation
CO 5: Analyze pile group using Beam on Elastic foundation
CO 6: Explain the elastic and non linear behavior of soil

COURSE DETAILS

Soil-Foundation Interaction: Introduction to soil-foundation interaction problems, Soil behaviour, Foundation behaviour, Interface behaviour, Scope of soil foundation interaction analysis, soil response models, Winkler, Elastic continuum, Two parameter elastic models, Elastic plastic behaviour; Time dependent behaviour.
Beam on Elastic Foundation- Soil Models: Infinite beam, Two parameters, Isotropic elastic half space, Analysis of beams of finite length, Classification of finite beams in relation to their stiffness. Plate on Elastic Medium: Thin and thick plates, Analysis of finite plates, Numerical analysis of finite plates, simple solutions.
Elastic Analysis of Pile: Elastic analysis of single pile, Theoretical solutions for settlement and load distributions, Analysis of pile group, Interaction analysis, Load distribution in groups with rigid cap.
Load deflection prediction for laterally loaded piles, Subgrade reaction and elastic analysis

Textbook

1. Selvadurai, A. P. S., (1979) Elastic Analysis of Soil-Foundation Interaction, Elsevier.

Reference books

1. Desai, C. S. and Zaman, M., (2013) Advanced Geotechnical Engineering: Soil Structure Interaction using Computer and Material Models (1st Edition), CRC Press, ISBN-13 : 978-1466515604.
2. Poulos, H.G. and Davis, E. H. (1980) Pile foundation analysis and design, Wiley (John) & Sons, Limited, England.
3. E.S.Melersk, Design Analysis of Beams, Circular Plates and Cylindrical Tanks on Elastic Foundation (1st Edition), CRC Press, ISBN-13 : 978-9058093042.
4. Hetenyi, M., (1946) Beams of Elastic Foundation, University Michigan Press, ISBN-13 : 978-0472084456.

RELIABILITY ANALYSIS IN GEOTECHNICAL ENGINEERING

Course Code: **CE60431**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Comprehend various probabilistic methods and reliability analysis
CO 2: Explain reliability analysis on load carrying capacity of deep foundation
CO 3: Explain reliability analysis on load carrying capacity of shallow foundation
CO 4: Apply the first order and second order reliability method in geotechnical problem

CO 5: Characterization of uncertainty
CO 6: Comprehend the reliability base liquefaction analysis

COURSE DETAILS

Introduction: Sources and types of uncertainties associated with geotechnical analysis, importance of probabilistic methods and reliability-based analysis in geotechnical engineering
Review of probability and statistics: Discrete and continuous random variables, parameter estimation, testing of hypothesis, regression analysis (8hrs)
Fundamentals of reliability analysis: First Order Second Moment (FOSM) method, First Order Reliability Method (FORM), Second Order Reliability Method (SORM), Monte Carlo simulation
Application towards geotechnical problems: Characterization of uncertainty in field measured and laboratory measured soil properties, uncertainty in interpretation techniques, spatial variability of soil properties, scale of fluctuations, estimation of auto correlation and auto covariance, probabilistic groundwater modelling, flow through earth dams, probabilistic slope stability analysis, reliability based design of shallow and deep foundations, settlement analysis, reliability based liquefaction analysis.

Textbook

1. Baecher, G. B. and John T. C., (2003) Reliability and Statistics in Geotechnical Engineering (1st Edition), John Wiley & Sons, ISBN-13 : 978-0471498339.

Reference books

1. Phoon, K.K. and Ching, J., (2014) Risk and Reliability in Geotechnical Engineering (1st Edition), CRC press, ISBN-13 : 978-1482227215.

GEOTECHNICAL INVESTIGATION AND FIELD TEST

Course Code: **CE60435**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

Course Outcomes

After successfully completing the course, the students will be able to

CO 1: Comprehend geomaterial formation
CO 2: Comprehend the geotechnical stratification of sub surface soil strata
CO 3: Explain various boring techniques and sampling procedure
CO 4: Explain various field tests
CO 5: Explain application of field test
CO 6: Comprehend various field instrument and its monitoring

COURSE DETAILS

Geologic material formation
Formation of rock, type of rock, weathering process, sedimentation process, subsurface stratification, geological features of rock, joints in rock, classification of rock, basic geotechnical properties of soil and rocks.

Sub surface exploration

Propose of soil exploration, stages of sub soil exploration, Planning of exploration, Methodology of exploration, geophysical investigation, Different types of borings., soil and rock sampling, groundwater measurement, bore log preparation, report preparation and data interpretation

Field test

Standard penetration test, , Plate load test, Cone penetration test, cross bore hole test, pressure meter test, field vane shear test, block vibration test, in-situ compression , tension and shear strength of rock mass, In-situ permeability test

Field instrumentation and monitoring

Application of field instrumentation, Load cell, stress meter, strain meter, field and laboratory pore water pressure measurement, embedment gauge, inclinometer, settlement monitoring, surface extensometer, Terrestrial, deflectometer, surface movement monitoring using field instrument and GPS system,

Text Books

1. Murthy, V. N. S. (2010) Principles of Soil Mechanics and Foundation Engineering, Marcel Dekker, ISBN-13: 978-0824708733.
2. B M Das, (2015) Principles of Geotechnical Engineering (8th Edition), Cengage Learning India Private Limited, ISBN-13: 978-8131526132.

Reference Books

1. Hunt, R.E., (2005) Geotechnical engineering investigation handbook (2nd Edition), CRC Press Inc, ISBN-13 : 978-0849321825.
2. Ranjan G. and Rao, A. S. R., (2016) Basic and Applied Soil Mechanics (3rd Edition), New Age international Publishers, ISBN-13: 978-8122440393.

CRITICAL SOIL MECHANICS

Course Code: **CE60424**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Comprehend various component of stress-strain behavior of soil
CO 2: Explain the CSL and NCL
CO 3: Apply critical soil mechanics to predict pile installation effect
CO 4: Analyze of test results in P-e space
CO 5: Comprehend drain and undrained critical state soil mechanics
CO 6: Apply critical soil mechanics to predict consolidation and bearing capacity of foundation

COURSE DETAILS

Elastic and plasticity, Stress-strain behavior of soil. Hardening and softening of soils, principle stress space, yield function, plastic potential function and the normality condition, constitutive relationships of soil, failure theories.

Consolidation, stress path, The Hvorslev's surface, Critical state line, NCL, interpretation of test result in P', q and v space, critical state line for clay, critical state line and qualitative soil response, critical state for sand.
Soil behavior in Drained and Undrain condition, critical state line and pore water pressure, total and effective stress analysis, critical state and residual strength, stress-strain behavior using cam clay and modified cam clay model,
Use of critical soil mechanics: installation pile, bearing capacity of foundation and consolidation

Textbook

1. Wood, D. M., (1991) Soil behaviour and critical state soil mechanics, Cambridge University Press, ISBN-13 : 978-0521337823.

Reference books

1. Mitchell, J. K. and Soga, K., (2005) Fundamentals of Soil Behaviour (3rd Edition), John Wiley and Sons, ISBN: 978-0-471-46302-3.

TUNNEL ENGINEERING

Course Code: CE60426
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OUTCOMES
After successfully completing the course, the students will be able to

CO 1: Explain the tunneling process in soft soil, hard soil and rock strata
CO 2: Design tunnel cross-section and other necessary requirement of tunnels
CO 3: Comprehend the tunnel excavation planning
CO 4: Explain various tunnel excavation equipment
CO 5: Analyze the stability of tunnel
CO 6: Comprehend the tunnel operation

COURSE DETAILS

Introduction: Scope and application, historical developments, art of tunneling, tunnel engineering, Geotechnical Considerations of tunneling, Shapes, Site investigations
Types and Methods: Types and purpose of tunnels, factors affecting choice of excavation technique, Methods -soft ground tunneling, hard rock tunneling, shallow tunneling, deep tunneling; supporting, problems encountered and remedial measures.
Tunnelling: Design of Tunnels, Thick wall cylinder formulae, Kreish equation, green span method, pressure tunnels, lined and unlined tunnels, Tunnel support design., support pressure and slip of the joint
Excavation and equipment: Tunnelling by Roadheaders and Impact Hammers, tunnelling by Tunnel Boring Machines, TBM applications Tunnel Services and tunnelling hazards, Ventilation, drainage and pumping, explosion, flooding, chimney formation, squeezing ground

Textbook

1. R. Srinivas, Harbour, (2016) Dock and Tunnel Engineering (28th Edition), Charotar Publishing House Pvt.Ltd., ISBN-13 : 978-9385039195.

Reference books

1. Bieniawski, Z. T., (1984) Rock Mechanics Design in Mining & Tunneling, A.A. Balkema, ISBN-13 : 978-9061915072.
2. Chapman, D., Metje, N., and Stark, A., (2017) Introduction to tunnel construction (2nd Edition), CRC Press, ISBN-13: 978-1498766241.
3. Bickel, O.J., Kuesel, T. R. and King, E. H. (2011) Tunnel Engineering Handbook (2nd Edition), Springer, ISBN-13: 978-1461380535.

ENVIRONMENTAL GEOTECHNICS

Course Code: CE60428
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO1	Comprehend the importance, principle and scope of geo-environmental engineering,
CO2	Explain the soil mineralogical characterization and its significance in determining soil-water-contaminant interaction,
CO3	Identify contaminant transport mechanisms in soils,
CO4	Comprehend the concept of engineered landfills and waste containment facilities,
CO5	Explain various remediation methods for contaminated soil and groundwater, and
CO6	Apply the concept of reclamation, restoration and re-utilization of waste dump.

COURSE DETAILS

Fundamentals of Geo-environmental Engineering: Scope of geo-environmental engineering; multiphase behavior of soil; role of soil in geo-environmental applications; Soil properties based on its formation (or type of weathering process), typical values of soil's index, engineering and hydraulic properties., importance of soil physics, soil chemistry, hydrogeology, biological process; sources and type of ground contamination; impact of ground contamination on geo-environment

Soil-Water-Contaminant Interaction: Soil mineralogy characterization and its significance in determining soil behavior; soil-water interaction and concepts of double layer; forces of interaction between soil particles; Soil-water-contaminant interaction; Theories of ion exchange

Concepts of unsaturated soil; importance of unsaturated soil in geo-environmental problems; measurement of soil suction; water retention curves; water flow in saturated and unsaturated zone

Waste Containment Facilities: Evolution of waste containment and disposal practices; Landfills; Methods for landfill site selection**,** Design of landfills; Contaminant transport and retention

Contaminant Site Remediation: Site characterization; risk assessment of contaminated site; remediation methods for soil and groundwater

Advanced Soil Characterization: Contaminant analysis; water content and permeability measurements; gas permeation in soil; electrical and thermal properties

Textbook

1. Reddi L.N. and Inyang, H. I., (2020) Geoenvironmental Engineering, Principles and Applications, CRC Press, ISBN-13 : 978-0367578992.

Reference books

1. Rowe R.K., (2012) Geotechnical and Geoenvironmental Engineering Handbook (1st Edition), Springer, ISBN-13 978-0792386131.
2. Yong, R. N., (2000) Geoenvironmental Engineering, Contaminated Soils, Pollutant Fate, and Mitigation (1st Edition), CRC Press, ISBN-13 : 978-0849382895.
3. Sharma H.D. and Reddy K.R., (2004) "Geoenvironmental Engineering: Site Remediation, Waste Containment, and Emerging Waste Management Technologies" John Wiley & Sons, Inc., ISBN-13 : 978-0471215998.
4. Fredlund D.G. and Rahardjo, H., (1993) Soil Mechanics for Unsaturated Soils, Wiley-Interscience, ISBN:9780471850083.
5. Mitchell, J. K. and Soga, K., (2005) Fundamentals of Soil Behaviour (3rd Edition), John Wiley and Sons, ISBN: 978-0-471-46302-3.
6. Hillel D., (2003) Introduction to Environmental Soil Physics, Academic Press, ISBN-13: 978-0123486554.

DEEP EXCAVATION PLANNING AND DESIGN

Course Code: **CE60432**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Comprehend the need of deep excavation and related health and safety issues
CO 2: Explain about the various stages of planning for deep excavation
CO 3: Comprehend various methods to analysis soil settlement due to the deep excavation
CO 4: Design the lateral support used in deep excavation
CO 5: Explain how to asses effect of deep excavation to the adjacent structures
CO 6: Comprehend various dewatering methods and design

COURSE DETAILS

Introduction: Excavation and their classification, basic excavation terminology, excavation health and safety issues
Excavation planning: Planning responsibility of design engineer and contractor, element of excavation plane, design standards for excavation and shoring system, standard practice for open cut excavation, short term soil loading
Methods and supporting system for excavation: full open cut method, braced excavation method, anchored excavation methods, island excavation methods, top down construction method, piles and diaphragm retaining wall, shutting system, selection of strut system.
Analysis: settlement induces due to the installation of diaphragm wall, wall and ground movement induced by excavation, time dependent ground surface settlement by the excavation,
Design of retaining wall: Preliminary design of sheet pile and diaphragm wall, anchor system
Protection of adjacent structures: excavation induces permissible settlement, soil improvement, other remedial measures for protection to adjacent structures, dewatering and its importance in deep excavation.

Textbook

1. Change-Yu Ou, (2006) Deep excavation theory and practice (1st Edition), CRC Press, ISBN-13: 978-0415403306.

Reference books

1. Turner, J. M., (2008) Excavation systems planning, design and safety, Mc Graw Hill, ISBN-13: 978-0071498692.

OFFSHORE GEOTECHNICAL ENGINEERING AND FOUNDATION

Course Code: CE60436
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Explain Offshore topographic features and environmental loads
CO 2: Comprehend Offshore site investigation
CO 3: Design pile foundation under offshore environmental load
CO 4: Design gravity based foundation
CO 5: Explain the concept of anchoring and performed preliminary design of anchor system
CO 6: Comprehend Offshore pipeline and issues of offshore construction

COURSE DETAILS

Offshore environments
Introduction, Feature of offshore engineering, Types of offshore foundation, Introduction to the topographical feature of ocean floors, Marine sediments, Environmental loads, wind, wave, current
Offshore site investigation
Geophysical investigation (Bathymetric mapping), Geotechnical investigation, Investigation platforms, In situ testing, Cone penetrometer, T- bar & Ball penetrometer, field vane shear tests, Brief discussion on laboratory test, fabric study
Pile Foundations
Wave, wind, and current force on structures, Ultimate lateral load carrying capacity of short and long piles, Elastic analysis of lateral load vertical piles, Problem solving and doubt clearing, Uplift load carrying capacity of single pile and group of piles, Pile group analysis with vertical load, horizontal load and moment acting on the pile cap,
Gravity foundation
Types of shallow foundation in offshore condition, Basics of design of shallow foundation, cyclic loading and uplift, Bearing capacity under drained and undrained and undrained condition, factor of safety, settlement criteria,
Offshore anchoring system
Introduction, Buoyant platform, mooring system, Types of anchor, Anchor line response for embedded anchors, installation of drag anchors, design overview of drag anchor and dynamically installed anchor, Design overview of drag anchor and dynamically installed anchor
Offshore pipeline
Introduction, pipeline network, Geotechnical input to pipeline design, design issue, Pipe soil interaction

Offshore construction
Construction vessel, offshore construction planning and scheduling, issues of offshore construction

Textbook

1. Randolph, M. & Susan G., (2011) Offshore Geotechnical Engineering (1st Edition), CRC Press, , ISBN-10: 0415477441.

Reference Books

1. Tomlinson, M. and Woodward, J. (2014) Pile design and construction practice, CRC Press, ISBN-13: 978-1466592636.
2. Aubeny, C. (2017) Geomechanics of Marine anchors (1st Edition), CRC Press, ISBN-10: 1498728774.

GROUND WATER AND FLOW THROUGH POROUS MEDIA

Course Code: CE60438
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Explain various forms of ground water
CO 2: Apply Laplace's equation in ground water problem
CO 3: Explain ground water hydraulic
CO 4: Explain the consolidation theory
CO 5: Comprehend geophysical method for ground water
CO 6: Explain the development of secondary consolidation

COURSE DETAILS

Soil Water: Modes of occurrence of water in soils, Adsorbed water, capillary water, Capillary potential, Capillary tension and soil suction, Effective and Neutral pressures in soil;
Flow through porous Media: Darcy's law and measurement of permeability in laboratory and field, Steady State flow solutions of Laplace's equation, Plane problems, 3-dimensional problems, Partial cut-offs, uplift pressure
Consolidation theory: One and three dimensional consolidation. Secondary consolidation;
Ground water Hydraulics: Water table in regular materials, Geophysical exploration for locating water table, Confined water, Equilibrium conditions, Non-equilibrium conditions, Water withdrawal from streams, Method of ground water imaging

Textbook

1. Raghunath, H.M., (2007) Ground Water (3rd Edition), new age publishers, ISBN-13 : 978-8122419047.

Reference books

1. Fitts, C. R. (2012) Ground Water Science (3rd Edition), Academic Press, ISBN: 13 978-0122578557.

DESIGN OF FOUNDATION STRUCTURES

Course Code: CE 60440
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Comprehend the IS codal provisions of foundation analysis and design
CO 2: Determination design parameters for foundation design and analysis
CO 3: Design of isolated and mat footing,
CO 4: Analysis the load deformation behaviour of pile under compression
CO 5: Analysis and design of pile foundation under lateral and compression
CO 6: Analysis and design of a well foundation

COURSE DETAILS

Soil as foundation material: Type of foundation, Basic geotechnical properties for foundation analysis and design, interpretation of geotechnical investigation report, foundation types, distribution of pressure, estimation of settlement, foundation failure, General structural requirement for foundation (Shallow and deep), IS:1904 requirements, depth of foundation, permissible settlement and differential settlement for various foundation.

Shallow foundation: Soil contact pressure under the footing at various loading combinations, bending moment and shear force in square, rectangular and circular footing, reinforced concrete design of speared footing and combined footing, design of foundation walls, design of uniform mat foundation, design example.

Pile foundation: Choice of type of pile, spacing of pile, behaviour of piles and pile group subjected to compressive and lateral load, using IS 2911. Structural design of pile and pile cap, combine footing on pile, mats on pile.

Well foundation (Caissons): introduction, analysis of well foundation, depth of well foundation and bearing capacity, shape of the wells, design of open caissons, material and detailing

Textbook

1. Tomlinson, M. and Woodward, J. (2014) Pile design and construction practice, CRC Press, ISBN-13 : 978-1466592636.
2. Pillai, S. U. and Menon, D. (2017) Reinforced Concrete Design - Third Edition, McGraw Hill Education, 978-0070141100
3. Reese, L.C. and Impe, W. F., (2011) Single piles and pile groups under lateral loading (2nd Edition), CRC Press, ISBN-13 : 978-0415469883.

Reference books

1. Turner, J. M., (2008) Excavation systems planning, design and safety, Mc Graw Hill, ISBN-13 : 978-0071498692.
2. Mark Randolph & Susan Gourvenec, Offshore Geotechnical Engineering, CRC Press, 1st Edition, 2011, ISBN-10: 0415477441.
3. Bowls, J. E. (2001)Foundation Analysis and Design (5th Edition). McGraw-Hill Education, ISBN-13 : 978-0071188449.

ANALYSIS AND DESIGN OF DEEP FOUNDATIONS

Course Code: CE60442
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Comprehend pile foundation with respect to the type of installation
CO 2: Analyze load deformation behavior of piles
CO 3: Analyze the lateral load response of piles
CO 4: Comprehend of API and IS on pile
CO 5: Design well foundation
CO 6: Explain the various method used to determine t-z and P-w relationship

COURSE DETAILS

Piles type and its installation effect: pile type, displacement pile, methods of pile driving, Non-displacement piles, continuous flight auger piles, residual stress along the pile length, change in pore water pressure and subsequent consolidation due installation effect in soft clay, downdrag.
Pile in compression: axial capacity of piles and pile group in cohesive and cohesionless soil, pile bearing on rock, optimization of pile group, linear and non linear T-z and P_b-w curve, load settlement behavior of pile using T-z and P_b-w curve, axial uplift capacity of pile, IS2911 and API recommendations
Piles under lateral load: differential equation for lateral loaded pile, solution in reduce form of differential equation, IS 2911 (3) method for approximate solution for lateral loaded pile, P-Y curve for sand and clay, finite different solution for lateral loaded single pile, pile group subjected to lateral loading
Well foundation: shape and various component of well foundation, comparison with piles foundation, installation of well foundation, analysis and design of well foundation

Textbook

1. Tomlinson, M. and Woodward, J. (2014) Pile design and construction practice, CRC Press, ISBN-13 : 978-1466592636.
2. Mark Randolph & Susan Gourvenec, Offshore Geotechnical Engineering, CRC Press, 1st Edition, 2011, ISBN-10: 0415477441.

Reference books

1. Reese, L.C. and Impe, W. F., (2011) Single piles and pile groups under lateral loading (2nd Edition), CRC Press, ISBN-13 : 978-0415469883.
2. Fleming, K., Weltman, A., Randolph, M. and Elson, K. (1994) Pile Engineering (1st Edition), CRC Press, ISBN-13: 978-0751401943.

RISK ASSESSMENT & MANAGEMENT IN GEOTECHNICAL ENGINEERING

Course Code: **CE60444**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Explain site Conceptual Model
CO 2: Identify health and safety issue at a construction site
CO 3: Comprehend the risk assessment and disaster response
CO 4: Analyze the operational management
CO 5: Analyze occupational risk
CO 6: Assess risk for fire and explosion

COURSE DETAILS

Introduction Methodologies and Guidelines: Principles, Code of practice – Appointment of personnel and their responsibilities – Emergency plans: onsite and offsite.
Steps in risk assessment: Identification of risk, Extent of risk and disaster, Risk-Based Decisions for Corrective Action –Timely updating. Developing a Site Conceptual Model - Focusing on Risk- Based Decisions in Corrective Action - Risk Assessment: Dose Response and Target Level Calculations - Experiences in Environmental Risk Assessment;
Occupational risk analysis survey and health evaluation, behavioural studies, occupational injury, disease reporting, investigation: monitoring and control of environmental hazards. Occupationally induced illness, non-occupational illness, and discomfort at work, the epidemiological approach, occupational health practice: investigation, monitoring, control, examples of occupational health hazards: nasal cancer, asbestosis, bronchitis, heart disease. Occupational health services;
Risk assessment techniques for accidental release of toxic and inflammable materials, hazard analysis, potential risk, conceivable release mechanisms and release rates, fire and explosion hazards and simplified models for their assessment; Operations Management (OM), Risk Assessment and Disaster Response, Quantification Techniques, NGO Management, SWOT Analysis based on Design & Formulation Strategies, Insurance & Risk Management.

Textbook

1. Kolluru, R. V. (1993) Environmental Strategics hand book, Mc-Graw Hill Inc., ISBN-13 : 978-0070358584.

Reference books

1. Woodsen W.E., (1991) Human factors design handbook – information and guidelines for design to systems, facilities, equipment and product for human use (2nd Edition), McGraw Hill, ISBN-13 : 978-0070717688.

ANALYSIS AND DESIGN OF GEOTECHNICAL STRUCTURES

Course Code: **CE 60446**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Comprehend the IS codal provisions of foundation analysis and design
CO 2: Analyse settlement of shallow foundation as per the IS codal provision
CO 3: Design the isolated footing,
CO 4: Analyse the load deformation behaviour of pile under compression
CO 5: Analyse pile in lateral load and moment
CO 6: Comprehend deep excavation and dewatering

COURSE DETAILS

Introduction: General structural requirement for foundation (Shallow and deep), IS:1904 requirements, depth of foundation, permissible settlement and differential settlement for various foundation, factor of safety, briefly discuss important clauses given in IS: 6403 on bearing capacity of soils. Settlement analysis using IS 8009, assumptions used in footing design.
Isolated footing: Soil contact pressure under the footing at various loading combination, bending moment and shear force in square, rectangular and circular footing, reinforced concrete design of speared footing, design Example -1 and Example-2.

Pile foundation: Behaviour of piles and pile group subjected to compressive and lateral load, using IS 2911 determine the load carrying capacity of piles and pile group at various loading and soil condition. Determine size, number and length of pile, P-y curve in soft and stiff clay and its use in study lateral load response of piles, linear and nonlinear T-z and P_b-w curve for pile in compression, load settlement behaviour of pile using T-z and P_b-w curves, analytical solution for pile load settlement behaviour. .
Deep excavation: Description, method of excavation, types of retention structure, sheet piles, column piles, diaphram wall, earth pressure theories, failure of strutted wall using Push in, bearing capacity method, negative bearing capacity method, control of ground water, method of dewatering, type aquifer, design of dewatering using well point and deep well method, earth pressure calculations against the a sheet pile wall, depth of embedment, analysis of cantilever sheet piling

Textbook

4. Change-Yu Ou, (2006) Deep excavation theory and practice (1st Edition), CRC Press, ISBN-13 : 978-0415403306.

5. Tomlinson, M. and Woodward, J. (2014) Pile design and construction practice, CRC Press, ISBN-13 : 978-1466592636.
6. Reese, L.C. and Impe, W. F., (2011) Single piles and pile groups under lateral loading (2nd Edition), CRC Press, ISBN-13 : 978-0415469883.

Reference books

4. Turner, J. M., (2008) Excavation systems planning, design and safety, Mc Graw Hill, ISBN-13 : 978-0071498692.
5. Mark Randolph & Susan Gourvenec, Offshore Geotechnical Engineering, CRC Press, 1st Edition, 2011, ISBN-10: 0415477441.
6. Bowls, J. E. (2001) Foundation Analysis and Design (5th Edition). McGraw-Hill Education, ISBN-13: 978-0071188449.

RESEARCH METHODS AND DOCUMENTATION

Course Code: **EX60001**
Credit: **3**
LTP: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

Post-graduate engineering students carry out a year-long research-intensive thesis or project that requires them to have the full knowledge of general principles of defining and scoping a problem, deciding the approach to research design, implementing the design, making the analysis, drawing inferences, and communicating their research findings. This subject covers the essential features of research methods and research communications.

COURSE OUTCOMES

After successfully completing the course, the student will be able to

CO1: Define and scope a problem.
CO2: Make a review of literature.
CO3: Decide on an appropriate research design and develop an experimental setup and/or an appropriate model.
CO4: Generate and/or collect the necessary data, make the required data analysis, and draw inferences.
CO5: Initialize the art and science of scientific and technical writing
CO6: Write a project report following the principles of scientific writing.

COURSE DETAILS

A. **Research Methods**

A.1 Introduction to Research

Research Definition; Elements of Research: Novelty, Originality, Creativity, and Critical Thinking; Deductive, Inductive, and Abductive Approaches.

A.2 Selecting a Research Problem
Research Topics, Problems, Objectives and Scope, Questions, and Research Contribution.

A.3 Measurement, Data, and Data Analytics
Measurement Scales and Data Visualization; Revisiting Basic Statistics, Probability,and Probability Density Functions; Sampling and Sampling Distributions, Tests of Hypotheses,and Simple and Multivariate Regression Analysis

A.4 Models and Modelling
Characteristics and Types of Models, Discrete-Event Simulation, and Neural Networks Models.

A.5 Research Design
Qualitative Research: Survey, Case Study, Action Research,and Citizen Science; Experimental Research: Factors, Factor Levels, Replication, ANOVA, and Factorial Designs.

B. **Research Documentation**

B.1 Language Issues
Paragraphing, Unity of Ideas, Topic Sentences, Link Words, Transitions; Common English Errors;Use of Hyphen, Dashes, and Ampersand;Responsible Use of Generative AI Tools.

B.2 Organization of a Research Document
Front Matters, Body, and End Matters; Guidelines on Titles, Abstracts, Keywords, Symbols and Abbreviations, and Capitalization; Narrative and Systematic Literature Review, Referencing Systems, Reference Management Software; Guidelines on Tables, Figures, Mathematical Operations and Equations, SI Units, Scientific and Engineering Notations of Numbers, and Significant Digits.

B.3 Elements of Research and Publication Ethics
Research Misconduct: Types and Research Code of Conduct; Plagiarism and Copyright.

Reference Books

1. Dunn, P. K. (2021), Scientific Research and Methodology: An Introduction to Quantitative Research and Statistics in Science, Engineering, and Health, Available free at https://bookdown.org/pkaldunn/Book/. [*Covers most of the topics*]
2. Durdella, N. (2019), Qualitative Dissertation Methodology: A Guide for Research Design and Methods, California: SAGE Publications. [*For topics related to qualitative methods*]
3. Montegomery, D. C. (2019), Design and Analysis of Experiments, 10th Edition, John Wiley & Sons, Inc. [*For topics related to design of experiments, model and modelling*]
4. Perelman, L. C., J. Paradis, and E. Barrett, Eds. (1998), The Mayfield Handbook of Technical and Scientific Writing, Mayfield Publishing, Available free at http://www.mhhe.com/mayfieldpub/tsw/toc.htm. [*For topics related to research documentation*]
5. Kothari, C. R. (2004), Research Methodology: Methods and Techniques, 2nd Revised Edition, Hyderabad: New Age International.
6. Marder, M. C. (2011), Research Methods for Science, Cambridge University Press.

SCHOOL OF CIVIL ENGINEERING
M.TECH. PROGRAMME

Specialization: Environmental Engineering

Curricula & Syllabi

ACADEMIC CURRICULA – 2024

Kalinga Institute of
Industrial Technology (KIIT)
Deemed to be University
(Established U/S 3 of UGC Act, 1956)
Bhubaneswar, Odisha, India

SCHOOL OF CIVIL ENGINEERING
M. TECH. PROGRAM
SPECIALIZATION: ENVIRONMENTAL ENGINEERING

SEMESTER-I

Sl. No	Course Code	Course Title	Contact Hours per Week			Credit
			L	T	P	
1	CE60003	Computational Methods in Civil Engineering	3	0	0	3
2	EX60001	Research Methods & Documentation	3	0	0	3
3	CE60501	Municipal Water and Wastewater Systems	3	0	0	3
4	CE61517	Physico-Chemical and Biological Principles and Processes	3	1	0	4
		Elective – I	3	0	0	3
5	CE69501	Environmental Quality Monitoring Laboratory	0	0	4	2
6	CE68502	Environmental Infrastructure Design	0	0	4	2
					Total	20

SEMESTER-II

Sl. No	Course Code	Course Title	Contact Hour per Week			Credit
			L	T	P	
1	CE60004	Soft Computing Techniques in Civil Engineering	3	0	0	3
2	CE60502	Municipal Solid and Hazardous Waste Management	3	0	0	3
3	CE60504	Environmental Impact Assessment & Auditing	3	0	0	3
4	CE60506	Air Pollution Control Technologies	3	0	0	3
5		**Elective – II**	3	0	0	3
6		**Elective – III**	3	0	0	3
8	CE68504	Comprehensive Viva Voce	-	-	-	2
					Total	20

SEMESTER-III

Sl. No	Course Code	Course Title	Contact Hour per Week			Credit
			L	T	P	
1		**Open Elective / Industry Elective**	3	0	0	**03**
2	CE67503	Thesis Part-I	-	-	-	16
3	CE68505	Seminar	0	0	2	01
					Total	20

SEMESTER-IV

Sl. No	Course Code	Course Title	Contact Hour per Week			Credit
			L	T	P	
1	CE67504	Thesis Part-II	-	-	-	20
					Total	20

LIST OF DEPARTMENT ELECTIVES

Elective-I

Sl. No	Course Code	Course Name	Credit
1	CE60428	Environmental Geotechnics	3
2	CE60507	Water & Pollutant Transport in Porous Media	3
3	CE60509	Membrane Technologies for Water and Wastewater Treatment	3
4	CE60511	Hydraulics of Fluid Flow	3
5	CE60513	Hydrological Processes & Water Security	3
6	CE60515	Design and Analysis of Experiments	3

Elective-II

Sl. No	Course Code	Course Name	Credit
1	CE60321	Geo-spatial Engineering	3
2	CE60508	Geotechnics of Waste and Waste Containment	3
3	CE60510	Industrial Wastewater Management	3
4	CE60512	Global Warming and Climate Change	3
5	CE60514	Cleaner Production and Environmental Sustainable Management	3
6	CE60516	Indoor Air Quality	3

Elective-III

Sl. No	Course Code	Course Name	Credit
1	CE60518	Highway Environment and Noise Pollution Control	3
2	CE60520	Life Cycle Assessment for the Circular Economy	3
3	CE60522	Bioremediation – Principles and Applications	3
4	CE60524	Faecal Sludge and Septage Management	3
5	CE60526	Environmental Law and Policy	3
6	CE60528	Storm Water & Urban Flooding Management	3

COMPUTATIONAL METHODS IN CIVIL ENGINEERING

Course Code: CE60003
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OUTCOMES

After successful completion of the course, the students will be able to:

CO 1: Comprehend the measure of central tendency, dispersions and correlation coefficients,
CO 2: Use the Curve Fitting & Least Square Techniques in the experimental methods,
CO 3: Apply the concept of probability and set theory in practical problems,
CO 4: Apply the concept of probability distribution functions,
CO 5: Determine roots of algebraic equation by different methods and obtain interpolating polynomials, and
CO 6: Solve ODE and PDE using numerical techniques.

COURSE DETAILS

Measures of Central Tendency & Dispersions; Covariance; Correlation Coefficients and their Properties in field data;
Curve Fitting & Least Square Techniques and their use in the experimental methods in Civil Engineering; Concept of Regressions; Regression curve in Bivariate Frequency Distributions;
Introduction to probability and set theory; Probabilistic measures; Conditional probability and Bayes' theorem; Discrete and continuous random variables;
Probability Density Functions; Probability Distributions of Single and Multiple Random Variables; Discrete & continuous distributions; Chi-Square Test; Kolmogorov-Smirnov Test; Analysis of Variance.
Linear equations and eigen value problems, Accuracy of approximate calculations, Nonlinear equations, interpolation, differentiation and evaluation of single and multiple integrals
Initial and boundary value problems by finite difference method, Newton's method, variation and weighted residual methods,

Textbooks

1. Applied Statistics and Probability for Engineers by Douglas C. Montgomery and George C. Runger, Wiley India Pvt. Ltd, 2009.
2. Jay L. Devore, Probability and Statistics for Engineering and the Sciences, Brooke & Cole, 2009.
3. J. B. Scarborough, Numerical Mathematical Analysis, Oxford & IBH Publishing Co. Pvt. Ltd., 2000.
4. K. K. Jain, S. R. K Iyengar and R. K. Jain, Numerical Methods - Problem and Solutions, Wiley India Pvt. Ltd, 2001.

Reference Books

1. W. Mendenhall and T. Sincich, Statistics for Engineering and the Sciences, Prentice-Hall, 2000.
2. Steven Chapra and Raymond Canale, Numerical Methods for Engineers, McGraw-Hill Education; 6th edition 2012.

SOFT COMPUTING TECHNIQUES IN CIVIL ENGINEERING

Course Code: CE60004
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OUTCOMES

After successful completion of the course, the students will be able to:

CO 1: Comprehend the basic concepts of soft computing,
CO 2: Use generic algorithms and Particle swarm intelligence algorithms,
CO 3: Prepare prediction model using neural network,
CO 4: Apply supervised machine learning techniques,
CO 5: Apply the techniques of unsupervised machine learning, and
CO 6: Implement soft computing techniques in Civil Engineering problems.

COURSE DETAILS

Introduction to Soft Computing: Basic concepts, various Soft Computing Techniques, Overview of conventional computing vs. soft computing, Characteristics and advantages of soft computing techniques

Genetic Algorithms (GA): Introduction to genetic algorithms, Representation schemes: binary, real-valued, permutation, Genetic operators: selection, crossover, mutation.

Particle Swarm Optimization (PSO): Introduction to particle swarm optimization, Swarm intelligence principles, PSO algorithm components: particles, velocity update, position update, Ant Colony Optimization (ACO): Basics of ant colony optimization, Ant behavior modeling, ACO algorithm: pheromone trails, ant movement, Pigeon search algorithm.

Artificial Neural Networks (ANN): Fundamentals of neural networks, Single-layer and multi-layer perceptrons, Training algorithms: back-propagation, gradient descent, Convolutional Neural Networks (CNN),

Fuzzy Logic Systems: Basics of fuzzy set theory, Fuzzy logic operations and rules, Fuzzy inference systems

Introduction to Machine Learning, Basic Concepts, Supervised learning, unsupervised learning, reinforcement learning, Python libraries

Supervised Learning Techniques: Decision trees and ensemble methods (Random Forests), Support Vector Machines (SVM), , Basic concepts and principles, k-nearest neighbor (kNN)

Unsupervised Learning Techniques: Clustering, K-means clustering, Hierarchical clustering, Dimensionality Reduction, Principal Component Analysis (PCA)

Application of soft computing in Civil Engineering
Application of different algorithms to solve practical problems of Civil Engineering.

Textbooks / Reference Books

1. Pratihar D.K., Soft Computing, Narosa Publishers, and ISBN: 978-81-8487-495-2, 2018.

2. Mangey Ram, J. Paulo Davim, Soft Computing Techniques and Applications in Mechanical Engineering, IGI Global, USA.
3. Simeone O. Machine learning for engineers. Cambridge University Press; 2022.
4. E. Alpaydin, Introduction to Machine Learning, Prentice Hall of India, 2006.

GEO-SPATIAL ENGINEERING

Course Code: CE60321
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OUTCOMES

After successful completion of the course, the students will be able to:

CO 1: Explain the principle of remote sensing,
CO 2: Interpret and analyze the digital images,
CO 3: Explain the fundamental operations of GIS,
CO 4: Manage GIS data files and also analyze the spatial and attribute data,
CO 5: Describe different applications of remote sensing & GIS, and
CO 6: Interpret the application of remote sensing and GIS in various water resources applications.

COURSE DETAILS

Principle of Remote Sensing: Introduction, Historical development of remote sensing, Passive and active remote sensing, Electromagnetic radiation, Energy interactions in the atmosphere and earth surface features, Spectral reflectance curves, Remote sensing system: Satellites and orbits, types of satellites, multispectral, thermal and hyperspectral sensing, remote sensing satellites and their features Digital image interpretation and analysis: Geometric corrections, Image enhancement techniques, Image classification, Image transformations, vegetation indices, Digital image processing software, Passive and active microwave remote sensing, Geographic Information Systems (GIS): Introduction, different components of GIS, maps and map scale, Geo referencing and projections, Spatial data modelling, GIS data management, Spatial interpolation techniques, Digital elevation models, Demonstration through GIS software, Limitations of GIS, Integration of Remote sensing and GIS Global positioning system (GPS): Introduction, principle and errors in GPS measurement, Differential global positioning system (DGPS).

Textbooks/ Reference Books

1. T.M. Lilles, R.W. Kiefer and J.W. Chipman, Remote sensing and Image Interpretation, 2015, 7th Edition, John Wiley & Sons Ltd., England.
2. C.P.L.O. Albert, K.W. Yong, Concept and Techniques of GIS, Prentice Hall Publishers.
3. P.A. Burrough and R. A. McDonnell, Principles of geographical information systems by, 1998, Oxford University Press.
4. M.A. Reddy, Remote Sensing and Geographical Information Systems, 2008, 3rd Edition, BS Publications, India.
5. P.J. Gibson, Introductory Remote Sensing- Principles and Concepts by, 2000, Routledge, London.
6. M.F. Goodchild, P.A. Longley, D.J. Maguire and D.W. Rhind, U.K. Geographic information systems and science by, 2001, John Wiley & Sons Ltd., England.

ENVIRONMENTAL GEOTECHNICS

Course Code: **CE60428**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

This course will provide learners with an in-depth understanding of modern geo-environmental engineering abilities, allowing them to solve environmental concerns and sustainable approaches associated to infrastructure development. It will also help to identify, formulate and solve complex geotechnical/geo-environmental problems. Learners will gain knowledge on the practical aspects related to various geotechnical characteristic of waste and waste containment, transport process of contaminants on the subsurface, design and stability of waste containment facilities and methods of contaminant site remediation. Learners will also gain a basic understanding of slurry waste, related case studies, characterization, reclamation, and re-use.

COURSE OUTCOMES

At the end of the course, the students will be able to

CO 1: Comprehend the importance, principle and scope of geo-environmental engineering,
CO 2: Explain the soil mineralogical characterization and its significance in determining soil-water-contaminant interaction,
CO 3: Identify contaminant transport mechanisms in soils,
CO 4: Comprehend the concept of engineered landfills and waste containment facilities,
CO 5: Explain various remediation methods for contaminated soil and groundwater, and
CO 6: Apply the concept of reclamation, restoration and re-utilization of waste dump.

COURSE DETAILS

Fundamentals of Geo-environmental Engineering
Introduction to fundamentals, importance, and scope of geo-environmental engineering. Soil properties based on its formation (or type of weathering process). Sources, type, and impact of ground contamination on geo-environment.

Soil-Water-Contaminant Interaction
Soil mineralogy characterization and its significance in determining soil behavior; soil-water interaction and concepts of double layer; forces of interaction between soil particles, soil-water-contaminant interaction, theories of ion exchange.

Waste Containment Facilities
Evolution of waste containment and disposal practices. Contaminant transport and retention mechanism.

Landfills
Methods for landfill site selection, Liner for landfills, Liner components, Liner system, Design process of landfill liners. Landfill gas management, Landfill cover, Surface water drainage system, Closure and post closure plan. Design of landfills, Case study on landfills, Contaminant transport and retention.

Contaminant Site Remediation
Site characterization; risk assessment of contaminated site. Different in-situ and ex-situ remedial approaches for soil and groundwater

Advanced Soil Characterization
Advanced soil characterization and properties of slurry deposited waste. Case study on failures of slurry pond, control and reuse of waste, end review.

Textbooks / Reference Books

1. H. D. Sharma and Krishna R. Reddy, Geoenvironmental Engineering: Site Remediation, Waste Containment, and Emerging Waste Management Technologies, Wiley Publication, 2004, ISBN: 978-0-471-21599-8.
2. L.N. Reddi and H. I. Inyang, Geoenvironmental Engineering, Principles and Applications, Marcel Dekker Inc. New York, 2000, ISBN: 0-8247-0045-7.
3. R.K. Rowe, Geotechnical and Geoenvironmental Engineering Handbook, Kluwer Academic Publications, London, 2000, ISBN: 978-1-4615-1729-0.
4. R. N. Yong, Geoenvironmental Engineering, Contaminated Soils, Pollutant Fate, and Mitigation, CRC Press, New York, 2001, ISBN:9780429075100.
5. H.D. Sharma and K.R. Reddy, Geoenvironmental Engineering: Site Remediation, Waste Containment, and Emerging Waste Management Technologies, John Wiley & Sons, Inc., USA, 2004, ISBN: 978-0-471-21599-8.
6. J. K. Mitchell, Fundamentals of Soil Behavior, Wiley, 2005, ISBN: 978-0-471-46302-3
7. D. Hillel, Introduction to Environmental Soil Physics, Academic Press, New York, 2003, ISBN: 9780080495774.

MUNICIPAL WATER AND WASTEWATER SYSTEMS

Course Code: CE60501
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE

This course is designed to enable the students to explore different issues related to water supply and disposal of wastewater.

COURSE OUTCOMES

At the end of the course, the students will be able to

CO 1: Estimate the capacity of the storage reservoirs,
CO 2: Design water supply pipelines,
CO 3: Select pumps based on hydraulic requirement,
CO 4: Design sewer network under various field conditions,
CO 5: Explain the hydraulics of flow in stormwater drains, and
CO 6: Design stormwater drainage systems.

COURSE DETAILS

Water Supply Systems
Storage requirements, impounding reservoirs, intake structures, pipe hydraulics, design of distribution systems, distribution and balancing reservoirs, pipe materials, appurtenances, design for external loads, maintenance and operation

Sanitary Sewerage Systems
Flow estimation, sewer materials, hydraulics of flow in sewers, sewer layout, sewer transitions, materials for sewers, appurtenances, manholes, sewer design, conventional and model-based design, sewage pumps and pumping stations, corrosion prevention, operation and maintenance, safety

Stormwater Drainage Systems
Drainage layouts, storm runoff estimation, hydraulics of flow in stormwater drains, materials, cross sections, design of stormwater drainage systems, inlets, stormwater pumping, operation and maintenance

Textbooks / Reference Books

1. Manual on Sewerage and Sewage Treatment, 2nd Edition, Ministry of Urban Development, New Delhi, 1993.
2. Manual on Water Supply and Treatment, 3rd Edition, Ministry of Urban Development, New Delhi, 1991.
3. Water and Wastewater Technology by M.J. Hammer, Prentice Hall, New Jersey, 2001.
4. Peavy, H. S., Rowe, D. R., and Tchobanoglous, G., Environmental Engineering, McGraw Hill Book Company, Singapore, 1985.
5. Benefield, L.D., Judkins, J.F., and Parr, A.D., Treatment Plant Hydraulics for Environmental Engineers, Prentice-Hall Inc, New Jersey, 1984.

MUNICIPAL SOLID AND HAZARDOUS WASTE MANAGEMENT

Course Code: CE60502
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE

This course is designed to enable the students to understand different types of solid waste, learn about the different waste management rules, characterize wastes and select proper methods for collection, transportation and treatment and size waste containment systems for disposable wastes.

COURSE OUTCOMES

At the end of the course, the students will be able to

CO 1: Appreciate the importance of municipal solid waste management hierarchy in the context of environmental pollution,
CO 2: Explain different waste management rules,
CO 3: Characterize waste based on physical and chemical properties,
CO 4: Comprehend methods of waste sampling, segregation and collection,
CO 5: Recognize proper biochemical and thermal technologies for conversion of waste to wealth, and
CO 6: Size engineered landfills for disposable wastes.

COURSE DETAILS

Introduction to Municipal Solid Waste Management
Introduction, different types of municipal solid waste, Waste Management hierarchy – prevention, reduce, reuse, recycle, energy recovery and disposal.

Waste Management Rules
Solid waste management rules 2016, Plastic waste management rules 2016, Construction & demolition waste management rules 2016, Electronic waste management rules 2016, Biomedical Waste Management rules 2016, Hazardous & other wastes (management and transboundary movement) rules, 2016.

Sampling and characterization of solid waste
Waste composition, sampling, characterization based on physical and chemical properties.

Collection and transportation of solid wastes
Basic waste collection system, Collection methods – Hauled Container System (HCS), Stationary Collection System (SCS), Transfer and Transport, Transfer stations.

Biochemical conversion technologies
Aerobic stabilization - composting, important design considerations, stages of composting, factors affecting composting process, different composting techniques
Anaerobic stabilization - Anaerobic digestion, Stages and operational parameters of anaerobic digestion, Different types of digesters.

Thermal conversion Technologies
Fundamentals of thermal processing, Incinerable waste, Refuse derived fuel, Process description of combustion, gasification and pyrolysis, co-processing of hazardous waste.

Engineered landfills
Selection criteria of landfill site, Principles of landfill design, essential components of landfill, types of landfills, Landfill planning and design. Leachate control, gas collection system.

Textbooks / Reference Books

1. CPHEEO, Manual on Municipal Solid Waste, Ministry of Urban Development, GoI, New Delhi, 2016.
2. Sunil Kumar, Municipal Solid Waste Management in Developing Countries, CRC press Reference - 178 -42B/W illustrations, 2016, ISBN 978498737746-CAT# K26553.
3. S.K. Garg, Environmental Engineering (Vol. II) Sewage Disposal and Air Pollution Engineering, Khanna Publishers, 42nd Edition, 2022, ISBN-13: 978-81-7409-230-4.
4. H.S. Peavy, D.R. Rowe, & G. Tchobanoglous, Environmental Engineering, McGraw Hill, 7th Edition, ISBN-13: 978-9351340263.

ENVIRONMENTAL IMPACT ASSESSMENT & AUDITING

Course Code: CE60504
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE

In this course, a complete detail of the process of evaluating impact assessment due to various types of Projects will be provided.

COURSE OUTCOMES

At the end of the course, the students will be able to

CO 1: Identify the roles of EIA and environmental audits,
CO 2: Prepare an EIA Report required to evaluate the environmental sustainability of any project,
CO 3: Predict and assess impacts of projects on physical, biological and socio-economic environment,
CO 4: Comprehend legislative and environmental clearance procedures in India and other countries,
CO 5: Appreciate the requirement of public participation in EIA, and
CO 6: Conduct an environmental audit and evaluate its result.

COURSE DETAILS

Evolution of EIA; EIA at project; Regional and policy levels; Strategic EIA; EIA process; Screening and scoping criteria; Rapid and comprehensive EIA.
Specialized areas like environmental health impact assessment; Environmental risk analysis; Economic valuation methods; Cost-benefit analysis; Expert system and GIS applications; Uncertainties; Practical applications of EIA; EIA methodologies; Baseline data collection; Prediction and assessment of impacts on

physical, biological and socio-economic environment.
Environmental management plan; Post project monitoring, EIA report and EIS; Review process.
Case studies on project, regional and sectoral EIA; Legislative and environmental clearance procedures in India and other countries, Sating criteria; CRZ; Public participation.
Resettlement and rehabilitation. Environmental auditing.

Textbooks / Reference Books

1. B.M. Noble, Introduction to Environmental Impact Assessment: A Guide to Principles and Practice, Oxford University Press, USA, 2005.
2. J. Glasson, Routledge, Introduction to Environmental Impact Assessment: Principles, and Procedures, Process, Practice and Prospects (The Natural and Built Environment Series), 3rd Edition, 2005.
3. P. Morris, Methods of Environmental Impact Assessment (The Natural and Built Environment Series), 2nd Edition, Spon Press, USA, 2001.
4. R.K. Jain, L. V. Urban, G. S., Stacey, Harold, E. Balbach, Environmental Assessment, 2nd Edition, Mc-Graw Hill Professional, 2001.

AIR POLLUTION CONTROL TECHNOLOGIES

Course Code: CE60506
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE

The course is designed to enable the students to know the sources, characteristics and effects of air pollution, their effects on environment and human health and the methods of controlling the same.

COURSE OUTCOMES

At the end of the course, the students will be able to:
CO 1: Identify the sources of air pollutants,
CO 2: Classify the air pollutants and understand the effects of air pollutants on health and environment,
CO 3: Comprehend the meteorological parameters and their effect on dispersion of air pollutants into the atmosphere,
CO 4: Determine the air quality index,
CO 5: Adopt suitable measures for controlling particulate air pollutants, and
CO 6: Adopt suitable measures for controlling gaseous air pollutants.

COURSE DETAILS

Introduction to Air Pollution
Structure of the atmosphere, Natural and anthropogenic sources of pollution, Atmospheric sources,

Air Pollutants and their effects
Gaseous and particulate matter, Primary pollutants, Secondary pollutants, Criteria pollutants, Hazardous pollutants, greenhouse gases, Effects of air pollution on human health, vegetation and animals, building materials and structures, atmosphere, soil and water bodies,

Meteorological parameters and Air Pollution
Lapse rates, atmospheric stability, plume behaviour, boundary layer, mixing height, stack height and Plume rise

Air Quality Standards
Air Quality Index (AQI), Air Quality Standards, Air Pollution Legislations and Regulations

Control of Air Pollutants

- **Particulate pollutants -** Control of particulate air pollutants using gravitational settling chambers, cyclone separators, wet collectors, fabric filters (Bag-house filter), electrostatic precipitators (ESP).
- **Gaseous Pollutants -** Control of gaseous contaminants: absorption, adsorption, condensation and combustion; Control of sulfur oxides, nitrogen oxides, carbon monoxide, and hydrocarbons

Textbooks / Reference Books

1. Daniel Vallero, Fundamentals of Air Pollution, Academic Press, 5th Edition, 2014, ISBN: 978-0-12-401733-7.
2. Wark, K., Warner, C.F., and Davis, W.T., Air Pollution: Its Origin and Control, Addison-Wesley Longman. 1998.
3. Boubel, R.W., Fox, D.L., Turner, D.B., Stern, A.C., Fundamentals of Air Pollution, Academic Press. 2005.
4. Gurjar, B.R., Molina, L., Ojha, C.S.P. (Eds.), Air Pollution: Health and Environmental Impacts, CRC Press. 2010.
5. Karl B. Schnelle, Jr. and Charles A. Brown, Air Pollution Control Technology Handbook, CRC Press, 1st Edition, 2001.
6. Jeremy Colls, Air Pollution, SPON Press, 2nd Edition, 2003.

WATER & POLLUTANT TRANSPORT IN POROUS MEDIA

Course Code: CE60507
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE

The course is designed to enable the students to understand the water movement in subsurface environment and understand the fate and transport of contaminants through porous media.

COURSE OUTCOMES

At the end of the course, the students will be able to

CO 1: Develop flow and transport model for contaminant in subsurface water,
CO 2: Differentiate various numerical techniques for solving flow and transport equations,
CO 3: Develop reactive transport model for reactive species,
CO 4: Explain the fate and transport of contaminants through porous media,
CO 5: Explain groundwater modeling tools for model development and prediction, and
CO 6: Develop contaminant transport model for field condition.

COURSE DETAILS

Water Movement in the Subsurface - Groundwater Environment - Types of Aquifers - Sources of Contamination - Saturated Flow - Continuity Equation - Darcy's Law - Equation of Flow - Analytical Solutions and Numerical Modeling - Transport of Contaminants – Transport Equation - Dispersion and Diffusion in Porous Media - Reaction Terms - Adsorption and Surface Complexation Models - Soil Chemical Kinetics - Modeling Groundwater Pollution -
Coupling of Contaminant - Soil Interactions with Transport - Reaction and Transport of Trace

Metals, Ligands and Non-polar Organic Solutes - Model Input Parameters - Initial and Boundary Conditions - Calibration - Sensitivity Analysis - Groundwater Transport Modelling.

Textbooks / Reference Books

1. Zheng, C. and Bennett, G. D., Applied contaminant Transport Modeling, A John Wiley & Sons Inc, 2002.
2. Freeze, R.A. and Cherry. J.A. Groundwater, Prentice Hall, 1979.
3. Grathwohl, P., Diffusion in Natural Porous Media: Contaminant Transport, Sorption, desorption and Dissolution Kinetics, Kluwer Academic, Boston, 1998.

GEOTECHNICS OF WASTE AND WASTE CONTAINMENT

Course Code: CE60508
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE

This course will focus on the geotechnical aspects associated with waste containment.

COURSE OUTCOMES

At the end of the course, the students will be able to

CO 1: Describe the types and properties of various waste substances
CO 2: Explain the fundamentals of waste-soil interaction
CO 3: Design a conventional landfill
CO 4: Explain contaminant transport and seepage flow
CO 5: Design a bioreactor landfill, and
CO 6: Apply the techniques of Integrated waste management

COURSE DETAILS

Sources and types of wastes; Environmental and engineering properties of wastes; New and developing government policies; Beneficial re-use of wastes.
Fundamentals of waste-soil interaction; Containment systems and basic principles; Lining and capping systems; Leachate and gas collection systems.
Compacted soil liners; Admixed soil liners; Geosynthetic clay liners; Geomembranes; Drainage layers; Geosynthetic composites.
Seepage flow; Contaminant transport; Landfill settlement; Landfill slope stability; Conventional caps, ET caps; Ground water monitoring; Landfill gas; Post-closure monitoring; Bioreactor landfills.
Landfill mining; End-use of closed landfills; Impoundments; Integrated waste management and alternative landfills.

Textbooks / Reference Books

1. H.D. Sharma and K.R. Reddy Geo-environmental Engineering: Site Remediation, Waste Containment, and Emerging Waste Management Technologies, John Wiley, New Jersey, 2004.
2. R.N. Yong, Geoenvironmental Engineering: Contaminated Ground: Fate of Pollutions and Remediation, Thomson Telford, 2000.
3. L.N. Reddy & H.I. Inyang, Geoenvironmental Engineering: Principles and Applications, Marcel Dek, 2000.

4. Datta, M., Parida, B.P., Guha, B.K. and Sreekrishnan, T., (Eds.), Industrial Solid Waste Management and Landfilling Practice, Narosa Publishers, Delhi, 1999.
5. David E. Daniel, Geotechnical Practice for Waste Disposal, Published by Chapman & Hall, London, 1993.
6. Bagchi, A., Design of landfills and integrated solid waste management, John Wiley & Sons, Inc., USA, 2004.
7. Qian, X., R. M. Koerner, and D. H. Gray. Geotechnical Aspects of Landfill Design and Construction. New Jersey: Prentice Hall, Upper Saddle River, 2002.

MEMBRANE TECHNOLOGIES FOR WATER AND WASTEWATER TREATMENT

Course Code: CE60509
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE

The students will get a general overview of membrane materials, modules, transport phenomena, and process engineering fundamentals

COURSE OUTCOMES

At the end of the course, the students will be able to
CO 1: Differentiate various membrane processes, principles, separation mechanisms and their applications,
CO 2: Explain the selection criteria for different membrane processes,
CO 3: Design membrane bioreactors,
CO 4: Comprehend the conventional membrane processes used for water purification,
CO 5: Develop synthetic membranes by various preparation techniques, and
CO 6: Explain the membrane preparation methods and their applications.

COURSE DETAILS

Principles of Membrane Processes - Types and Classification - Theory of Membrane Separation - Types and Choice of Membranes - Liquid Membranes - Characterization of Membranes - Recent Development in Membranes - Modules and Washing Process - Electrodialysis - Principles, Electrodialysis Stack and its Various Components - Ion Exchange Capacity - Electrical Resistance of Ion Exchange Membrane - Donnon Dialysis – Reverse Osmosis - Theory and Principle - Membrane Materials - Design Considerations – Filtration Theory - Nanofiltration - Ultrafiltration -Microfiltration - Membrane Module/Element Designs - Design of Membrane Systems - Membrane Bioreactors - Bio treatment Fundamentals - Biomass Separation - Principles - MBR Design Principles – Submerged Anaerobic Membrane Bioreactors - Fouling - Pretreatment Methods and Strategies - Langlier and Silt Indexes - Cleaning Methods - Foulants Analysis - Disposal of RO Concentrate - Rejects in Membranes - Synthetic Membranes - Preparation Methods - Composite Membranes - Preparation Methods and Applications - Immersion Precipitation Preparation Techniques - Phase Inversion Membranes - Introduction to Module and Process Design.

Textbooks / Reference Books

1. R.D. Noble and S.A. Stern, Membrane Separations Technology: Principles and Applications, Elsevier, 1995.
2. E.D. Schroeder, Water & Wastewater Treatment, McGraw Hill, 1977.
3. J.G. Crespo and K.W. Boddekes, Membrane Processes in Separation and Purification, Kluwer Academic Publications, 1994.
4. R. Rautanbach and R. Albrecht, Membrane Process, John Wiley & Sons, 1989.

INDUSTRIAL WASTEWATER MANAGEMENT

Course Code: CE60510
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE

The students will get exposure to various pollution prevention options and gain idea about waste treatment flow sheet for different industries.

COURSE OUTCOMES

At the end of the course, the students will be able to

CO 1: Assess general characteristics of industrial wastewaters,
CO 2: Evaluate the impacts of wastewater discharge on the environment,
CO 3: Explore suitable pre-treatment techniques,
CO 4: Identify suitable advanced wastewater treatment options,
CO 5: Evaluate wastewater characteristics of different types of industries, and
CO 6: Suggest treatment strategies for different industries.

COURSE DETAILS

Introduction
Characteristics of Industrial Effluents, Effects on Environment – Codal provision for tolerance limits for discharging industrial effluents into surface water, into public sewers, onto land for irrigation and marine environment- Toxic chemicals from industry, Zero waste approach.

Pre-treatment of Industrial Wastewater
Necessity of pre-treatment – Strength Reduction – Volume Reduction – Equalization and Proportioning- Neutralization - Segregation - Process Changes - Salvaging - By product Recovery.

Advanced Wastewater Treatment
Necessity – Treatment Techniques - Removal of Solids - Reverse Osmosis, Ion Exchange, Electro dialysis, Solvent Extraction, Floatation - Removal of Refractory Organics - Removal of Nitrogen and Phosphorus – Wastewater disinfection

Major Industrial Effluents
Sources, Characteristics and Treatment Strategies. Food Industries: Sugar, Dairy, Distilleries Chemical and other Industries: Paper and Pulp, Tanneries, Textiles, Fertilizers, Pharmaceuticals, Cement, Steel and refineries.

Textbooks / Reference Books

1. Eckenfelder, W. W., Industrial Water Pollution Control, 3 rd Edition, McGraw-Hill, 1999.
2. Arceivala, S.J., Wastewater Treatment for Pollution Control, 3rd Edition, McGraw-Hill, 2006.
3. Frank Woodard, Industrial waste treatment Handbook, Butterworth Heinemann, 2nd Edition, New Delhi, 2006.

HYDRAULICS OF FLUID FLOW

Course code: CE60511
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE

To learn and use the concept of fluid and its various aspects like static, kinematics, dynamic behavior; understand and apply concept of pipe flow and its application; concept of free surface flow, specific energy, critical depth, uniform flow and most efficient open channel section.

COURSE OUTCOMES

At the end of the course, the students will be able to:

CO 1: Ascertain different fluid properties,
CO 2: Apply the basic equations of fluid statics to determine pressure, forces on planar and curved surfaces submerged in a static fluid,
CO 3: Apply the concept of fluid kinematics and develop Laplace equation,
CO 4: Apply Euler‘s and Bernoulli‘s equations in venturimeter, orificemeter, and analyze the momentum principles,
CO 5: Determine minor and major head losses in pipes, design pipe water distribution systems, and
CO 6: Analyze specific energy, critical depth and use of this in transitions and determine most efficient section using uniform flow concept.

COURSE DETAILS

Introduction
Properties of Fluids, Newton's law of viscosity, Newtonian, Types of fluids.

Fluid-Statics
Fluid Pressure, Pascal’s Law, Manometers, Pressure on Plane Surface, Buoyancy and Floatation of Bodies, Stability of Floating Bodies, Metacentre.

Fluid Kinematics
Types of fluid Flows, Continuity Equation, Rotational and Irrotational Motion.

Fluid Dynamics
Bernoulli‘s Energy Equation, Application of Bernoulli‘s Energy Equation in Venturimeter and Orifice Meter.

Pipe flow problem
Major loss of energy in pipes due to fluid friction, Loss of head due to sudden expansion, sudden contraction, and loss in fitting etc. determination of TEL and HGL in a pipe flow; Pipe Network solution using Hardy-Cross Method.

Free Surface Flow
Introduction, Types of channels, Classification of flows.

Energy Principles
Energy equation, specific energy, critical depth, transitions.

Uniform flow
Chezy's equation, Manning's formula, hydraulically efficient channel section.

Gradually Varied Flow
Governing equation, types of flow profiles, computation of gradually varied profile using standard step method.

Textbooks / Reference Books

1. R.K. Bansal, A Text Book of Fluid Mechanics & Hydraulic Machines. Laxmi Publications (P) Ltd., 10th Edition.
2. K. Subramanya, Flow in Open Channels, McGraw Hill, 5th Edition, 2019.

GLOBAL WARMING AND CLIMATE CHANGE

Course Code: CE60512
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE

The course deals with various environmental issues and their adverse effects on ecosystem.

COURSE OUTCOMES

At the end of the course, the students will be able to

CO 1: Identify the sources of air pollutants and understand the effects of air pollutants on health and environment,
CO 2: Classify the air pollutants and understand their impacts on global warming,
CO 3: Explain the meteorological parameters and their effect on dispersion of air pollutants into the atmosphere,
CO 4: Explain the causes of climate change,
CO 5: Realize the issues of climate change, and
CO 6: Explain the social and economic impacts of climate change.

COURSE DETAILS

Atmosphere and Air Pollutants
Structure of the atmosphere, Natural and anthropogenic sources of pollution, Atmospheric sources, Effects of air pollution on human health, vegetation and animals, building materials and structures, atmosphere, soil and water bodies, Gaseous and particulate matter, Primary pollutants, Secondary pollutants, Criteria pollutants, Hazardous pollutants, greenhouse gases.

Meteorological parameters and Air Pollution
Lapse rates, atmospheric stability, plume behaviour, boundary layer, mixing height, stack height and Plume rise.

Climate Science & Fundamentals of Climate Change
Weather, Climate and Climate Change – An Introduction, Basic Elements of Global Climate, Solar Radiation & Energy Balance, Inter-Year Climate Change.

Anthropogenic Global Warming & Climate Change
Anthropogenic Character of Global warming, Intergovernmental Panel on Climate Change, UNFCCC 1992 & International Conferences on Climate Change, Major UN Climate Change Conferences till date.

Social and Economic Impacts of Climate Change
Elements of Economics of Climate Change, Carbon Trading, Urban Climate Change, Climate Change & Human Migration.

Textbooks / Reference Books

1. M.K. Ghosh Roy, Global Warming and Climate Change, Medtech, 1st Edition, 2023, ISBN: 9789384007737.
2. S.K. Garg, Environmental Engineering (Vol. II) Sewage Disposal and Air Pollution Engineering, Khanna Publishers, 42nd Edition, 2022, ISBN-13: 978-81-7409-230-4.
3. H.S. Peavy, D.R. Rowe, & G. Tchobanoglous, Environmental Engineering, McGraw Hill, 7th Edition, 2017, ISBN-13: 978-9351340263.
4. Gopal Bhargava, Global Warming and Climate Changes Transparency and Accountability (Vol. 3), Gyan Publishing House 2004.

HYDROLOGICAL PROCESS & WATER SECURITY

Course Code: CE60513
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE

To learn and use the knowledge to analyze hydrological cycle, precipitation, abstractions, runoff, groundwater hydrology, well hydraulics and recharging of groundwater.

COURSE OUTCOMES

At the end of the course, the students will be able to

CO 1: Estimate water balance, optimal rain gauge network, consistency of rainfall data,
CO 2: Determine the mean rainfall and probability of rainfall events,
CO 3: Estimate infiltration capacity, infiltration indices and apply infiltration models,
CO 4: Compute runoff from the catchments,
CO 5: Comprehend groundwater properties, and
CO 6: Analyze well hydraulics, recharging of aquifers & water security.

COURSE DETAILS

Hydrologic cycle
Components, process and Applications in Engineering.

Precipitation
Forms and weather systems for precipitation, Measurement, preparation and presentation ofrainfall data, Mean precipitation over an area, Frequency of point rainfall.

Abstractions
Different types of abstractions, Evaporation, Evaporimeters, Transpiration, Evapo-transpiration, Interception and Depression storage, Infiltration-process, measurement, Modelinginfiltration capacity.

Runoff
Catchment characteristics, Runoff estimation methods, SCS-CN method.

Groundwater
Forms of sub surface water, Saturated formation, Aquifer properties - Porosity, Specific yield.

Darcy's law, Coefficient of permeability and Stratification.

Well Hydraulics
Steady flow into a well - Confined flow and unconfined flow.

Recharge
Concept of Recharge, Estimation, Artificial Recharge Methods.

Water-Balance
Methods, models and supply-demand analysis of catchment.

Concept of water security
Distinction between water scarcity and water security, factors shaping water security; attempts to measure water scarcity and security.

Textbooks / Reference Books

1. K. Subramanya, Engineering Hydrology, Tata Mc-Graw Hill, 5th Edition, 2019.
2. V.T. Chow, D.R. Maidment and L.W. Mays, Applied Hydrology, Tata Mc. Graw Hill, 1st Edition, First Indian Reprint, 2010.
3. L.W. Mays, Water Resources Engineering, Wiley Publication, 2nd Edition, First Indian Reprint 2001.
4. D.K. Todd and L.W. Mays, Groundwater Hydrology, 3rd Edition, John Wiley and Sons, 2011.
5. H.M. Raghunath, Ground Water, New Age International Publishers; 3rd Edition, Dec 2007.

CLEANER PRODUCTION AND ENVIRONMENTAL SUSTAINABLE MANAGEMENT

Course Code: CE60514
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE

The students will be able to understand the concept of sustainable development and learn about concepts of cleaner production and its importance.

COURSE OUTCOMES

At the end of the course, the students will be able to

CO 1: Discuss the schemes applied at different governance levels to achieve sustainable innovation,
CO 2: Prepare process flow diagram and material balance for various industrial processes.
CO 3: Summarize various techniques for cleaner production and apply environmental sustainable management concepts in industries,
CO 4: Examine the toxicological and ecological aspects of ecotoxicology and to transfer knowledge of Eco toxicological theory to new environmental situations,
CO 5: Discuss the green processes and green energy management in various industrial processes, and
CO 6: Explain the principles and methods of occupational safety and health, risk assessment and its management.

COURSE DETAILS

Concepts of Sustainable Development - Indicators of Sustainability – Sustainability Strategies, Barriers to Sustainability - Resource Degradation - Industrialization and Sustainable Development - Industrial Ecology - Socio Economic Policies for Sustainable Development - Clean Development Mechanism, - Principles and

Concepts of Cleaner Production - Definition - Importance - Historical Evolution - Benefits - Promotion - Barriers - Regulatory versus Market Based Approaches - Environmental Management Hierarchy - Source Reduction Techniques - Process and Equipment Optimization, Reuse, Recovery, Recycle, Raw Material Substitution - Overview of CP Assessment Steps and Skills - Process Flow Diagram - Material Balance - CP Option Generation - Technical and Environmental Feasibility Analysis - Economic Valuation of Alternatives - Total Cost Analysis – Pollution Prevention and Cleaner Production Awareness Plan - Waste Audit - Environmental Statement - Green House Gases and Carbon Credit - Carbon Sequestration- Sustainable Development through Trade - Carbon Trading - Ecotoxicology - Hazards by Industry and its Environmental Effects - Relationship of Occupational Hygiene / Safety and Disease - Overview, Planning, Hazard Identification and Risk Assessment - Pesticides and Environment - Response to Toxic Exposures - Dose Response, Frequency Response and Cumulative Response - Lethal and Sub-Lethal Doses - Dose - Response Relationships between Chemical and Biological Reactions - Detoxification in Human Body - Detoxification Mechanisms, Organs of Detoxification - Green Energy and Green Process Management in Pharmaceutical, Construction, Textiles, Petroleum Refineries, Iron and Steel Industries.

Textbooks / Reference Books

1. J. Kirkby, P. O'Keefe and Timberlake, Sustainable Development, Earthscan Publication, London, 1999.
2. P.L. Bishop, Pollution Prevention: Fundamentals and Practice, McGraw Hill International, 2004.
3. P. Modak, C. Visvanathan and M. Parasnis, Cleaner Production Audit, Environmental System Reviews, Asian Institute of Technology, Bangkok, 1995.
4. H. Koren, Handbook of Environmental Health and Safety -principle and practices, Lewis Publishers, 3rd Edition, 1995.
5. I. C. Shaw and J. Chadwick, Principles of Environmental Toxicology, Taylor & Francis ltd, 2000.

DESIGN AND ANALYSIS OF EXPERIMENTS

Course Code: CE60515
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE

Experiments are conducted to learn about how a process or system works and to optimize design and process parameters for improved performance. To draw meaningful conclusions, one must be able to remove (or at least control or isolate) the effect of extraneous uncontrolled variables, design experiments such that the effect of large number of factors can be studied with relatively less number of experiments, and analyze the experimental results statistically. The course will cover various methods to design experiments and analyze experimental results. The students will acquire the skills to carry out their laboratory- and simulation-based projects more effectively and take up challenging real-life problems in future at their workplace.

COURSE OUTCOMES

At the end of the course, the students will be able to

CO 1: Comprehend the strategies of experimental design
CO 2: Apply basic statistical concepts in simple comparative experiments
CO 3: Design single factor experiments,
CO 4: Design experiments using Randomized Complete Block Design (RCBD), Latin Square Design, and Graeco-Latin Square Design and Balanced Incomplete Block Design,
CO 5: Design experiments using different Factorial designs, and
CO 6: Design experiments using different types of response surface designs.

COURSE DETAILS

Introduction
Strategy of Experimentation; Typical Applications; Basic Principles of Randomization, Replication, and Blocking; and Design Guidelines.

Simple Comparative Experiments
Basic Statistical Concepts, Sampling, Sampling Distributions, and Choice of Sample Size; Inferences about the Differences in Means; and Paired Comparison Designs.

Single Factor Experiments
The Analysis of Variance; Analysis of the Fixed Effects Model; Model Adequacy Tests; Practical Interpretation of Results; Determining Sample Size; and Nonparametric Methods.

Randomized Blocks, Latin Squares, and Related Designs
Randomized Complete Block Designs, Latin Square and Graeco-Latin Square Design; and Balanced Incomplete Block Designs.

Factorial Designs
2^2, 3^2, and 2^k Designs, Single Replicate in 2^k Designs; 2^k Designs with Centre Points; Fractional Factorial Designs; and Blocking and Confounding in Factorial Designs.

Response Surface Methodology
Regression Models; The Method of Steepest Ascent; Analysis of a Second-Order Response Surface; Experimental Designs for Fitting Response Surfaces; Mixture Design, Evolutionary Operations.

Textbooks / Reference Books

1. D. C. Montgomery, Design and Analysis of Experiments, John Wiley & Sons, Wiley Student Edition, International Student Version, 7th Edition, 2009.
2. D. W. Cunningham and C. Wallraven, Experimental Design: From User Studies to Psychophysics, CRC Press, 2011.
3. M. Morris, Design of Experiments: An Introduction Based on Linear Models, Chapman & Hall/CRC Texts in Statistical Science, 1st Edition, 2010.
4. C. F. J. Wu and M.S. Hamada, Experiments: Planning, Analysis, and Optimization Wiley Series in Probability and Statistics, Wiley, 2009.
5. Statistics for Experimenters: Design, Innovation, and Discovery, G. E. P. Box, J. S. Hunter, and W. G. Hunter, Wiley, 2nd Edition, 2005.

INDOOR AIR QUALITY

Course Code: CE60516
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE

The students will learn about the level of pollutants in indoor and outdoor air as well as modeling tools and concepts for indoor air quality assessment.

COURSE OUTCOMES

At the end of the course, the students will be able to
CO 1: Recognize the factors affecting Indoor Air Quality (IAQ),
CO 2: Predict the indoor air quality using mathematical model,
CO 3: Develop material balance models and statistical models of Indoor Air Pollution,
CO 4: Suggest the control techniques for indoor air pollution,
CO 5: Explain bio aerosols and infectious disease transmission, and
CO 6: Analyze the pollutant concentration in indoor environment.

COURSE DETAILS

Indoor Activities of Inhabitants - Levels of Pollutants in Indoor and outdoor Air - Design and Operation of Buildings for Improvements of Public Health - IAQ Policy Issues - Sustainability - Air Pollutants in Indoor Environments - Private Residences, Offices, Schools, Public Buildings - Ventilation - Control of Several Pollutant Classes - Radon - Toxic Organic Gases - Combustion Byproducts - Microorganisms such as Molds and Infectious Bacteria - Concepts and Tools - Exposure - Material Balance Models - Statistical Models - Indoor Air Pollution from Outdoor Sources - Particulate Matter and Ozone - Combustion Byproducts - Radon and its Decay Products - Volatile Organic Compounds - Odors and Sick - Building Syndrome - Humidity - Bio Aerosols - Infectious Disease Transmission - Special Indoor Environments - A/C Units in Indoor - Measurement Methods - Control Technologies - Control Strategies.

Textbooks / Reference Books

1. Thaddes Godish, Indoor air and Environmental Quality, CRC press, 2000.
2. Nazaroff ,W.W. and L. Alvarez-Cohen, Environmental Engineering Science, Wiley sons, Newyork, 2001.
3. John D. Pengler, John F. McCarthy, and Jonathan M. Same, Indoor Air Quality Handbook, McGraw Hill, 2000.

PHYSICO-CHEMICAL & BIOLOGICAL PRINCIPLES AND PROCESSES

Course Code: CE61517
Credit: 4
L-T-P: 3-1-0
Prerequisite: Nil

COURSE OBJECTIVE

This course is designed to enable the students to learn about different physico-chemical and biological processes for the treatment of water and wastewater.

COURSE OUTCOMES

At the end of the course, the students will be able to

CO 1: Explain the concept of mass transfer and reactor theory,
CO 2: Comprehend various unit operations and processes required for water purification,
CO 3: Design conventional physico-chemical units for the treatment of water and wastewater,
CO 4: Design adsorption-based column for water purification,
CO 5: Design appropriate aerobic and anaerobic treatment unit for removal of BOD, and
CO 6: Design proper biological nitrogen and phosphorus removal system.

COURSE DETAILS

Mass transfer and reactor concepts
Mass transport mechanisms; Ideal reactors, non-idealities, Mass balance in various reactor configurations.
Unit operations and processes in Water Purification system
Mixing, sedimentation, Aeration and gas transfer, Coagulation and flocculation, Clariflocculation.
Filtration processes - slow sand filtration - rapid sand filter; mechanism of filtration; modes of operation and operational problems; negative head and air binding; dual and multimedia filtration, Ion Exchange-processes.

Adsorption Process
Adsorption, Types of adsorption, Physisorption, Chemisorption, Adsorption isotherms, Adsorption column, design and applications.
Aerobic biological wastewater treatment process

Concept, growth rule of activated sludge, kinetics of activated sludge, designing of activated sludge process, Oxidation ditch process, Sequential Batch Reactor process, Membrane Biological Reactor process, Basic principle of biofilm, Biological contact oxidation process, Rotating Biological Contactor.

Anaerobic biological wastewater treatment process

Anaerobic digester, Anaerobic contact process and anaerobic biofilter, UASB process.

Biological nitrogen and phosphorus removal process

Biological nitrogen removal process and technology, Biological phosphorus removal process and technology, Simultaneous nitrogen and phosphorus removal process.

Textbooks / Reference Books

1. Weber, W.J. Physicochemical processes for water quality control, John Wiley and sons, Newyork, 1983.
2. Peavy, H.S., Rowe, D.R., Tchobanoglous, G. Environmental Engineering, Tata McGraw Hills, New York 1985.
3. Metcalf and Eddy, Wastewater engineering, Treatment and Reuse, Tata McGraw-Hill, New Delhi, 2003.
4. Sawyer, C.N., McCarty, P.L., and Parkin, G.F. Chemistry for Environmental Engineers, 4th Edition, McGraw Hill, New Delhi, 1994.
5. Benefield, Judkins and Weand, Process Chemistry for Water and Wastewater Treatment, Prentice Hall.
6. Maier R. M., Pepper I. L., and Gerba C. P., Environmental Microbiology, Second Edition, Elsevier-AP, 2009.
7. Pelczar, Jr, M.J., Chan, E.C.S., Krieg, R.N., and Pelczar M. F, Microbiology, 5th Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, 1996.
8. Rittman B, McCarty, P. L, Environmental Biotechnology: Principles and Applications, 2nd Edition, McGraw-Hill, 2000.

HIGHWAY ENVIRONMENT AND NOISE POLLUTION CONTROL

Course Code: **CE60518**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

The students will learn about source, measurement and mitigation of noise pollution in highway environment.

COURSE OUTCOMES

At the end of the course, the students will be able to

CO 1: Identify sources of noise and classify accordingly,
CO 2: Describe the instruments related to noise measurement,
CO 3: Discuss noise standards in India and abroad,
CO 4: Assess the impact of noise pollution on environment,
CO 5: Describe the transport related air and noise pollution, and
CO 6: Explain vehicular emission parameters and pollution standards.

COURSE DETAILS

Sources and Classification of Noise, Effects of Noise, Noise Measuring Instruments and Survey: Sound level meter, audiometer, dose meter, octave band analyzer; Noise Indices: L_{eq}, L_{dn}, TNI, NII, Noise Control Measures: noise control at source, path and receiver, acoustic barriers, enclosures, control of machinery noise, community and industrial noise control strategies; Noise Standards in India and Abroad; Noise Impact Assessment and Prediction Techniques.

Human factors in road user behaviour, vehicle characteristics, driver, road and environment. Environmental Factors: impacts and mitigation measures of air quality, noise, severance, visual intrusion, impact on water quality, use of limited resources, impact on flora & fauna, vibration, dust ; Transport related pollution. Urban and non-urban traffic noise sources, Traffic calming, Measures, Road transport related air pollution, sources of air pollution, effects of weather conditions, Vehicular emission parameters, pollution standards, measurement and analysis of vehicular emission; control measures.

Textbooks / Reference Books

1. Tripathy D.P., Noise Pollution, APH Pub., New Delhi.
2. Sengupta M., Environmental Engineering (Vol. 2), CRC Press, Boca Raton.
3. Pandey G.N. and Carney G.C., Environmental Engineering, Tata McGrawHill, New Delhi.
4. Beranek L., Noise and Vibration Control, McGrawHill Co, NY.
5. Trivedy P.R. Int. Encyclopedia of Ecology & Environment, Noise Pollution (Vol. 13), IIEE, New Delhi.
6. Wark K., Warner C.F. and Davi, W.T., Air Pollution: Its Origin and Control, Prentice Hall.
7. Boubel R.W. Fundamentals of Air Pollution, Academic Press.
8. Vallero D., Fundamentals of Air Pollution, Academic Press.
9. Canter L., Environmental Impact Assessment, McGraw-Hill International.

LIFE CYCLE ASSESSMENT FOR THE CIRCULAR ECONOMY

Course Code: CE60520
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE

The course will introduce students to the fundamental concepts of Life Cycle Assessment (LCA) with reference to sustainability.

COURSE OUTCOMES

At the end of the course, the students will be able to

CO 1: Explain the concepts of life cycle analysis (LCA) in the context of sustainability,

CO 2: Realize the importance of environmental risk assessment,
CO 3: Define a goal and scope statement of an LCA,
CO 4: Carry out ISO compliant LCA,
CO 5: Perform life cycle impact analysis (LCIA), and
CO 6: Design a product based on the concept of sustainability.

COURSE DETAILS

Life Cycle Analysis (LCA) and Sustainability concepts
Material flow and waste management, Concept of Sustainability, Water energy and food nexus.

Risk and Life Cycle Framework for Sustainability
Introduction, Risk, Environmental Risk Assessment.

LCA Methodology
Overview of LCA Methodology - Goal Definition, Life Cycle Inventory, Life Cycle Impact Assessment, Life Cycle Interpretation, LCA Software tools. Life Cycle Assessment – Detailed Methodology and ISO Framework, LCA Benefits and Drawbacks, Historical Development and LCA Steps from ISO Framework.

Life Cycle Inventory and Impact Assessments
Unit Processes and System Boundary Data Quality, Procedure for Life Cycle Impact Assessment, LCIA in Practice with Examples, Interpretation of LCIA Results.

Design for Sustainability
Economic, Environmental Indicators, Social Performance Indicators, Sustainable Engineering Design Principles and Environmental Cost Analysis.

Textbooks / Reference Books

1. H. Scott Mathews, Chris T. Hendrickson, Deanna H. Matthews, Life Cycle Assessment: quantitative approaches for decisions that matter, 2014. Open access textbook, retrieved from https://www.lcatextbook.com/
2. David T. Allen and David R. Shonnard, Sustainable Engineering: Concepts, Design and Case studies, Pearson, 2011, ISBN-9780132756563.
3. Walter Klöpffer, Birgit Grahl, Life Cycle Assessment (LCA): A Guide to Best Practice, Wiley, 2014, ISBN: 978-3-527-32986-1.

BIOREMEDIATION – PRINCIPLES AND APPLICATIONS

Course Code: CE60522
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE

The students will learn about application of biological technologies in waste management.

COURSE OUTCOMES

At the end of the course, the students will be able to

CO 1: Explain the fundamental principles and concepts of bioremediation,
CO 2: Describe the applications of various biotechnological tools for the treatment and betterment of environment,
CO 3: Enumerate the various biotechnological remedies for environmental pollution,

CO 4: Explain the environmental effects and ethics of microbial technology,
CO 5: Discuss the methods of in-situ bioremediation, and
CO 6: Elaborate on management of bioremediation project.

COURSE DETAILS

Current bioremediation practice and applications; Microbial systems of bioremediation; Factors influencing bioremediation (environmental factors, physical factors and chemical factors); Genetic responses of microorganisms to the presence of pollutants (plasmid coded inducible degradative enzymes); Application of genetically engineered microorganisms for hazardous waste management; Microbial transformation reactions (aerobic and anaerobic biotransformations); Microbial detoxification of specialty chemicals (insecticides, herbicides, fungicides, polychlorinated biphenyls, heavy metals); Bioremediation systems and processes (solid, liquid and slurry phase bioremediation); Microbial cleaning of gases (biofiltration and bioscrubbing); In situ bioremediation; Laboratory scale bio-treatability studies for bioremediation; Management of bioremediation project.

Textbooks / Reference Books

1. Baker, K H., and Herson, D. S., Bioremediation, McGraw-Hill Publishing Company, New York, 1994.
2. Eweis, J. B., Ergas, S. J., Chang D. P. Y., and Schroeder E. D., Bioremediation Principles, McGraw-Hill Publishing Company, Singapore, 1998.
3. Cookson, J.T. Jr., Bioremediation Engineering – Design and Application, McGraw Hill Publishing Company, New York, USA, 1995.
4. Young, L.Y., and Cerniglia, C.E., Microbial Transformation and Degradation of Toxic Organic Chemicals, Wiley–liss Publishers, New York, USA, 1995.

FAECAL SLUDGE AND SEPTAGE MANAGEMENT

Course Code: CE60524
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE

This course is designed to enable the students to gain the basic idea of national and international status of sanitation, design of faecal sludge treatment plant and its operation and maintenance.

COURSE OUTCOMES

At the end of the course, the students will be able to

CO 1: Recognize the importance of sanitation and situation in national and global level,
CO 2: Explain the method for the quantification of faecal sludge,
CO 3: Discuss the different mechanisms of faecal sludge treatment,
CO 4: Describe the methods of collection and transport of faecal sludge,
CO 5: Explain various strategies for co-treatment of Faecal Sludge, and
CO 6: Execute operation and maintenance of FSTP.

COURSE DETAILS

Introduction to Faecal Sludge and Septage Management
The Global Situation, Global relevance, Basic design of faecal sludge treatment plant.

Quantification of faecal sludge
Sludge production method, sludge collection method, Characterization of faecal sludge, Operational factors that impact the variability of faecal sludge, Physical-chemical constituents, Pathogens in faecal sludge.

Treatment Mechanisms
Physical mechanisms - Gravity separation, Filtration, Evaporation and evapotranspiration, Centrifugation, Heat drying.
Chemical mechanisms - Alkaline stabilization, Ammonia treatment, Conditioning.
Biological mechanisms - Aerobic treatment, Composting, Anaerobic treatment, Nitrogen cycling, Pathogen reduction.

Methods and Means for Collection and Transport of Faecal Sludge
Manual collection, manually operated mechanical collection, fully mechanized collection, Transport of faecal sludge, Transfer stations.

Co-treatment of Faecal Sludge in Municipal Wastewater Treatment Plants
Faecal sludge biodegradability and fractionation, Co-treatment in activated sludge wastewater treatment systems, Anaerobic co-treatment of faecal sludge.

Operation, Maintenance and Monitoring of Faecal Sludge Treatment Plant
Monitoring, Record keeping, Plant security and safety, Administrative management.

Textbooks / Reference Books

1. Faecal Sludge Management. Systems Approach for Implementation and Operation. IWA Publishing, 2014, UK.
2. Septage Management. A Practitioner's Guide. Centre for Science and Environment, 2017, New Delhi.
3. Sanitation 21: A Planning Framework for Improving City-wide Sanitation Services. Published by IWA.

ENVIRONMENTAL LAW AND POLICY

Course Code: **CE60526**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

The course will introduce the students regarding various national and international law related to the environment.

COURSE OUTCOMES

At the end of the course, the students will be able to

CO 1: Explain the significance of developments in international environmental law and the fundamental principles that have emerged,
CO 2: Recognize the human right to environment and constitutional framework governing environment,
CO 3: Comprehend the statutory and regulatory mechanisms pertaining to environment,
CO 4: Explain judicial response to environmental issues in India,
CO 5: Report sustainability issues, and

CO 6: Interpret the role of international/national environmental institutions, NGOs, civil society and community involvement in promoting the cause of environment.

COURSE DETAILS

Models of environmental management; Incentives; Context; Theories of corporate strategy and environmental policy; Environmental guidelines and charters; Auditing, Monitoring; Reporting, economics and accounting; Local economic development and environmental management; Role of government; Law and policies beyond environmentalism; Sustainability issues; Role of government and non-government organizations and citizens.

Textbooks / Reference Books

1. Tripathy D.P., Noise Pollution, APH Pub., New Delhi.
2. Sengupta M., Environmental Engineering (Vol. 2), CRC Press, Boca Raton.
3. Pandey G.N. and Carney G.C., Environmental Engineering, Tata McGraw Hill, New Delhi.
4. Beranek L., Noise and Vibration Control, McGraw Hill Co, NY.
5. Trivedy P.R., Int. Encyclopedia of Ecology & Environment, Noise Pollution (Vol. 13), IIEE, New Delhi.
6. Wark K., Warner C.F. and Davi, W.T., Air Pollution: Its Origin and Control, Prentice Hall.
7. Boubel R.W., Fundamentals of Air Pollution, Academic Press.
8. Vallero D., Fundamentals of Air Pollution, Academic Press.
9. Canter L., Environmental Impact Assessment, McGraw-Hill International.

STORM WATER & URBAN FLOOD MANAGEMENT

Course Code: CE60528
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE

This course will introduce students to the process of estimating, designing, planning of storm water and its disposal including modern modeling methods applied for such purpose.

COURSE OUTCOMES

At the end of the course, the students will be able to

CO 1: Recognize the impact of urbanization on storm water and urban flood,
CO 2: Estimate various rainfall characteristics and infiltration process,
CO 3: Use various methods for estimating urban flood quantity including peak floods,
CO 4: Plan and design various drainage related structures,
CO 5: Use hydrological models for storm water management, and
CO 6: Apply hydraulic models for routing urban flood.

COURSE DETAILS

Introduction
Urbanization and its effect on water cycle – urban hydrologic cycle – Effect of urbanization on hydrology. Precipitation Analysis: Importance of short duration of rainfall and runoff data, methods of estimation of time of concentration and design of urban drainage systems, Intensity-Duration -Frequency (IDF) curves, design storms for urban drainage systems, abstractions of rainfall, infiltration process.

Methods of Urban Drainage
Time of concentration, peak flow estimation approaches, rational method, NRCS/SCS curve number approach, runoff quantity and quality, wastewater and storm water reuse , major and minor systems. Drainage systems: Open channel, underground drains, appurtenances, pumping, source control.

Analysis and Management
Storm water drainage structures, design of storm water network- Best Management Practices–detention and retention facilities.

Flood Estimation & Hydrological models
Principles of hydrological modeling - The Rational Method - The time-area method-The unit hydrograph method - Physically based distributed models - Physically based partially distributed models.

Flood Estimation & Hydraulic modeling
Flow in open channel. Unsteady flow phenomenon, Governing Equations, Solution Methods, Hydraulic Routing, Model calibration and validation.

Master drainage plans
Issues – typical urban drainage master plan, interrelation between water resources investigation and urban planning processes, planning objectives, comprehensive planning, and use of models in planning.

Textbooks / Reference Books

1. Akan A.O and R.L. Houghtalen, Urban Hydrology, Hydraulics and Storm water Quality: Engineering Applications and Computer Modeling, Wiley International, 2006.
2. Hall M. J., Urban Hydrology, Elsevier Applied Science Publisher, 1984.
3. Geiger W.F., J Marsalek, W. J. Rawls and F.C. Zuidema, Manual on Drainage in Urbanized area, UNESCO, 1987.
4. Wanielista M. P. and Eaglin, Hydrology, Quantity and Quality Analysis, Wiley and Sons, 1997.
5. Stahre P. and Urbonas B., Stormwater Detention for Drainage, Water Quality and CSO Management, Prentice Hall, 1990.
6. Maksimovic C. and J. A. Tejada-Guibert, Frontiers in Urban Water Management, Deadlock or Hope (2001), IWA Publishing.

ENVIRONMENTAL INFRASTRUCTURE DESIGN

Course Code: **CE68502**
Credit: **2**
L-T-P: **0-0-4**
Prerequisite: **Nil**

COURSE OBJECTIVE

This course will enable the students to design water supply, sanitary sewerage systems for water and wastewater treatment.

COURSE OUTCOMES

At the end of the course, the students will be able to

CO 1: Design water supply network
CO 2: Design Sanitary Sewers
CO 3: Design a conventional water treatment plant
CO 4: Design a conventional sewage treatment plant

COURSE DETAILS

- Design of water supply network
- Design of Sewerage network
- Design of conventional water treatment plant
- Design of conventional sewage treatment plant

Textbooks / Reference Books

1. Qasim S.R, Wastewater Treatment Plants Planning, Design and Operation, Taylor & Francis, 2nd Edition,1999.
2. AWWA, Water Treatment Plant Design, McGraw-Hill, 4th Edition, 2005.

ENVIRONMENTAL QUALITY MONITORING LABORATORY

Course Code: CE69501
Credit: 2
L-T-P: 0-0-4
Prerequisite: Nil

COURSE OBJECTIVE

This course is designed to enable the students to determine the physical, chemical and biological characteristics of water and wastewater.

COURSE OUTCOMES

At the end of the course, the students will be able to

CO 1: Assess the physico-chemical characteristics of water and wastewater,
CO 2: Fix optimum dosage of coagulant needed for a water sample by Jar Test,
CO 3: Design a settling chamber for flocculating particles using settling column analysis,
CO 4: Assess the bacteriological quality of water sample using MPN Technique,
CO 5: Determine the concentration of PM10, SOX and NOX in a given area, and
CO 6: Determine the Equivalent Sound Pressure Level in a given area.

COURSE DETAILS

- Introduction to various physical, chemical and biological parameters of water and wastewater and their significances as per the IS Codes and CPCB Standards
- Determination of pH, turbidity, Total Suspended Solids, Total Dissolved Solids, Total Solids present in water sample
- Determination of Total Alkalinity and Total Hardness of water sample
- Determination of optimum dosage of coagulant needed for a water sample by Jar Test
- Settling column analysis for flocculating particles
- Determination of concentration of chlorides in water sample
- Determination of dissolved oxygen and BOD in a water sample
- Assessment of bacteriological quality using MPN Technique
- Determination of C, H and N present in a solid waste sample
- Determine the concentration of PM10, SOX and NOX in a given area
- Determine the Equivalent Sound Pressure Level in a given area

Textbooks

1. IS: 3025 – 2019, Methods of sampling and test (Physical and Chemical) for water and wastewater.
2. IS: 10500 – 2012 Indian Standard Drinking Water — Specification.
3. S.K. Garg, Environmental Engineering (Vol. I) Water Supply Engineering, Khanna Publishers, 36th Edition, 2022, ISBN-13: 978-81-7409-120-8.

Reference Book

1. C.N. Sawyer and Perry L. McCarty, Chemistry for Environmental Engineering, 5th Edition, McGraw-Hill Education, 2002, ISBN-10: 0072480661.

ENVIRONMENTAL MODELING LABORATORY

Course Code: CE69502
Credit: 2
L-T-P: 0-0-4
Prerequisite: Nil

COURSE OBJECTIVE

This course will provide students an exposure to fate and transport mechanism of contaminant in water and air system.

COURSE OUTCOMES

At the end of the course, the students will be able to

CO 1 Predict the quality of natural systems using mass balance concept,
CO 2: Develop contaminant transport model for natural systems,
CO 3: Predict the quality of water in natural water bodies using specific models,
CO 4: Predict water quality changes in water distribution systems,
CO 5: Solve the transport equation using numerical techniques, and
CO 6: Estimate the concentration of pollutant in ambient air using dispersion models.

COURSE DETAILS

- Application of Mass Balance concept in prediction of quality of natural systems
- Development of contaminant Transport Model for natural systems
- Prediction of water quality through mathematical models
- Prediction of water quality changes in water distribution systems
- Solution of transport equation using numerical techniques
- Estimation of the concentration of pollutant in ambient air using dispersion models

Textbooks / Reference Books

1. Chapra, Steven C., Surface water quality modeling, McGraw Hill International Edition, 1997.
2. Thomann R. V. And Muller J. A. Principles of surface water quality modelling and control Harper international edition 1987.
3. Davis, M.L., and Cornell, D.A. Introduction to Environmental Engineering, McGraw Hill International Editions, 1998.
4. Peavy, Rowe, and Tchobanoglous, Environmental Engineering, McGraw Hill Publishing company, Newyork, 2007.
5. Gilbert M. Masters, Introduction to Environmental Engineering and Science, PrenticeHall of India Pvt. Ltd., Newdelhi, 3rd Edition, 2007.

6. Martin, L.J. and McCucheon, S.C, Hydrodynamics of transport for water quality modeling, Lewis Publishers, Boca Raton, 1999.

RESEARCH METHODS AND DOCUMENTATION

Course Code: EX60001
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE

Post-graduate engineering students carry out a year-long research-intensive thesis or project that requires them to have the full knowledge of general principles of defining and scoping a problem, deciding the approach to research design, implementing the design, making the analysis, drawing inferences, and communicating their research findings. This subject covers the essential features of research methods and research communications.

COURSE OUTCOMES

After successfully completing the course, the student will be able to

CO1: Define and scope a problem,
CO2: Make a review of literature,
CO3: Decide on an appropriate research design and develop an experimental setup and/or an appropriate model,
CO4: Generate and/or collect the necessary data, make the required data analysis, and draw inferences,
CO5: Initialize the art and science of scientific and technical writing, and
CO6: Write a project report following the principles of scientific writing.

COURSE CONTENT

A. Research Methods

A.1 Introduction to Research
Research Definition; Elements of Research: Novelty, Originality, Creativity, and Critical Thinking; Deductive, Inductive, and Abductive Approaches.

A.2 Selecting a Research Problem
Research Topics, Problems, Objectives and Scope, Questions, and Research Contribution.

A.3 Measurement, Data, and Data Analytics
Measurement Scales and Data Visualization; Revisiting Basic Statistics, Probability,and Probability Density Functions; Sampling and Sampling Distributions, Tests of Hypotheses,and Simple and Multivariate Regression Analysis

A.4 Models and Modelling
Characteristics and Types of Models, Discrete-Event Simulation, and Neural Networks Models.

A.5 Research Design

Qualitative Research: Survey, Case Study, Action Research, and Citizen Science; Experimental Research: Factors, Factor Levels, Replication, ANOVA, and Factorial Designs.

B. Research Documentation

B.1 Language Issues

Paragraphing, Unity of Ideas, Topic Sentences, Link Words, Transitions; Common English Errors; Use of Hyphen, Dashes, and Ampersand; Responsible Use of Generative AI Tools.

B.2 Organization of a Research Document

Front Matters, Body, and End Matters; Guidelines on Titles, Abstracts, Keywords, Symbols and Abbreviations, and Capitalization; Narrative and Systematic Literature Review, Referencing Systems, Reference Management Software; Guidelines on Tables, Figures, Mathematical Operations and Equations, SI Units, Scientific and Engineering Notations of Numbers, and Significant Digits.

B.3 Elements of Research and Publication Ethics

Research Misconduct: Types and Research Code of Conduct; Plagiarism and Copyright.

Reference Books

1. Dunn, P. K. (2021), Scientific Research and Methodology: An Introduction to Quantitative Research and Statistics in Science, Engineering, and Health, Available free at https://bookdown.org/pkaldunn/Book/. [***Covers most of the topics***]
2. Durdella, N. (2019), Qualitative Dissertation Methodology: A Guide for Research Design and Methods, California: SAGE Publications. [***For topics related to qualitative methods***]
3. Montegomery, D. C. (2019), Design and Analysis of Experiments, 10th Edition, John Wiley & Sons, Inc. [***For topics related to design of experiments, model and modelling***]
4. Perelman, L. C., J. Paradis, and E. Barrett, Eds. (1998), The Mayfield Handbook of Technical and Scientific Writing, Mayfield Publishing, Available free at http://www.mhhe.com/mayfieldpub/tsw/toc.htm. [***For topics related to research documentation***]
5. Kothari, C. R. (2004), Research Methodology: Methods and Techniques, 2nd Revised Edition, Hyderabad: New Age International.
6. Marder, M. C. (2011), Research Methods for Science, Cambridge University Press.