B. Tech. Degree
in
Civil Engineering

SYLLABUS
FOR
CREDIT BASED CURRICULUM
(For students admitted in 2013-14)

DEPARTMENT OF CIVIL ENGINEERING
NATIONAL INSTITUTE OF TECHNOLOGY TIRUCHIRAPPALLI – 620 015
TAMIL NADU, INDIA

VISION OF THE INSTITUTE

- To provide valuable resources for industry and society through excellence in technical education and research.

MISSION OF THE INSTITUTE

- To offer state-of-the-art undergraduate, postgraduate and doctoral programmes.
- To generate new knowledge by engaging in cutting-edge research.
- To undertake collaborative projects with academia and industries.
- To develop human intellectual capability to its fullest potential.

VISION OF THE DEPARTMENT

- To shape infrastructure development with societal focus.

MISSION OF THE DEPARTMENT

- To achieve international recognition by
- Developing Professional Civil Engineers
- Offering Continuing Education
- Interacting with Industry with emphasis on R & D

PROGRAMME EDUCATIONAL OBJECTIVES

1. Graduates of the Programme will contribute to the development of infrastructure that is sustainable.
2. Graduates of the Programme, as part of an organization or as Entrepreneurs, will continue to learn to harness evolving technologies.
3. Graduates of the Programme will be professional Civil Engineers with ethical and societal responsibility.

PROGRAMME OUTCOMES

Graduates of the Civil Engineering Programme will be able to:

a) Apply the knowledge of mathematics, science, engineering fundamentals, and Civil Engineering principles to the solution of complex problems in Civil Engineering.

b) Identify, formulae, research literature, and analyse complex Civil Engineering problems reaching substantiated conclusions using first principles of mathematics and engineering sciences.

c) Design solutions for complex Civil Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

d) Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions related to Civil Engineering problems.

e) Create, select, and apply appropriate techniques, resources, and modern engineering tools such as CAD, FEM and GIS including prediction and modelling to complex Civil Engineering activities with an understanding of the limitations.

f) Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional Civil Engineering practice.

g) Understand the impact of the professional Civil Engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

h) Apply ethical principles and commit to professional ethics and responsibilities and norms of the Civil Engineering practice.

i) Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

j) Communicate effectively on complex Civil Engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

k) Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage Civil Engineering projects and in multidisciplinary environments.

l) Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadcast context of technological change.

CURRICULUM

B. Tech. (CIVIL ENGINEERING)

The total minimum credits required for completing the B.Tech. Program in Civil Engineering is 182 (45+137).

SEMESTER III

Code	Course of Study	L	T	P	C
MA203	Probability, Statistics and Linear Programming	3	0	0	3
CE201	Strength of Materials	3	0	0	3
CE203	Mechanics of Fluids	3	0	0	3
CE205	Surveying	3	0	0	3
CE207	Environmental Engineering – I	3	0	0	3
CE209	Concrete Technology	3	0	0	3
CE211	Strength of Materials and Concrete Laboratory	0	0	3	2
CE213	Survey Laboratory	0	0	3	2
	Total	**18**	**0**	**6**	**22**

SEMESTER IV

Code	Course of Study	L	T	P	C
MA204	Numerical Techniques	2	1	0	3
CE202	Mechanics of Solids	2	1	0	3
CE204	Applied Hydraulic Engineering	3	0	0	3
CE206	Geotechnical Engineering – I	3	0	0	3
CE208	Environmental Engineering – II	2	0	2	3
CE210	Transportation Engineering – I	3	0	0	3
CE212	Fluid Mechanics Laboratory	0	0	3	2
CE214	Environmental Engineering Laboratory	0	0	3	2
	Total	**15**	**2**	**8**	**22**

SEMESTER V

Code	Course of Study	L	T	P	C
CE301	Structural Analysis – I	3	0	0	3
CE303	Concrete Structures – I	3	0	2	4
CE305	Advanced Strength of Materials	3	0	0	3
CE307	Geotechnical Engineering – II	3	0	0	3
CE309	Transportation Engineering - II	3	0	0	3
	Elective 1	3	0	0	3
CE 311	Geotechnical Engineering Laboratory	0	0	3	2
CE313	Building Planning and Drawing	0	0	3	2
	Total	**18**	**0**	**8**	**23**

SEMESTER VI

Code	Course of Study	L	T	P	C
CE302	Structural Analysis – II	2	1	0	3
CE304	Concrete Structure – II	3	0	2	4
CE306	Design of Steel Structures	3	0	2	4
CE308	Water Resources Engineering	3	0	0	3
	Elective 2	3	0	0	3
	Elective 3	3	0	0	3
CE310	Highway Materials Laboratory	0	0	3	2
CE312	Computational Laboratory – I	0	0	3	2
CE314	Industrial Lectures				1
CE316	Internship / Industrial Training / Academic Attachment # (2 to 3 months duration during summer vacation)				2
	Total	**17**	**1**	**10**	**27**

To be evaluated at the beginning of VII semester by assessing the report and conducting seminar presentations.

SEMESTER VII

Code	Course of Study	L	T	P	C
CE401	Matrix Methods of Structural Analysis	2	1	0	3
CE403	Irrigation and Hydraulic Structures	2	0	2	3
CE405	Construction Engineering and Management	3	0	0	3
HM401	Industrial Economics	3	0	0	3
	Elective 4	3	0	0	3
	Elective 5*	3	0	0	3
CE407	Computational Laboratory – II	0	0	3	2
CE409	Estimation, Costing and Valuation	0	0	3	2
CE411	Comprehensive Examination	0	0	6	3
	Total	**16**	**1**	**14**	**25**

SEMESTER VIII

Code	Course of Study	L	T	P	C
MB491	Management Concepts and Practices	3	0	0	3
	Elective 6	3	0	0	3
	Elective 7*	3	0	0	3
	Elective 8*	3	0	0	3
CE498	Project Work	0	0	12	6
	Total	**12**	**0**	**12**	**18**

* Global electives also

ELECTIVES

Code	Course of Study	L	T	P	C
Structural Engineering					
CE451	Advanced Design of Steel Structures	3	0	0	3
CE452	Experimental Stress Analysis	3	0	0	3
CE453	Earthquake Resistant Structures	3	0	0	3
CE454	Structural Dynamics	3	0	0	3
CE455	Introduction to Finite Element Method	3	0	0	3
CE456	Steel-Concrete Composite Structures	3	0	0	3
CE457	Pre-stressed Concrete Structures	3	0	0	3
CE458	Ocean Structures and Materials	3	0	0	3
Water Resource Engineering					
CE461	Ground Water Hydrology	3	0	0	3
CE462	Simulation Modeling in Water Resources	3	0	0	3
CE463	Coastal Engineering	3	0	0	3
CE464	Remote Sensing and GIS for water resources Engineering	3	0	0	3
CE465	Disaster Modeling and Management	3	0	0	3
Transportation Engineering					
CE471	Transportation Planning	3	0	0	3
CE472	Pavement Analysis and Design	3	0	0	3
CE473	Geo-informatics in Transportation Engineering	3	0	0	3
CE474	Traffic Engineering and Safety	3	0	0	3
CE475	Bridge Engineering	3	0	0	3
Geo-Technical Engineering					
CE481	Advanced Foundation Engineering	3	0	0	3
CE482	Geotechnical Earthquake Engineering	3	0	0	3
CE483	Reinforced Earth and Geotextiles	3	0	0	3

CE484	Earth and Earth Retaining Structures	3	0	0	3
CE485	Marine Foundation Engineering	3	0	0	3
Environmental Engineering					
CE491	Air Pollution Management	3	0	0	3
CE492	Industrial Wastewater Engineering	3	0	0	3
CE493	Environmental Management and Impact Assessment	3	0	0	3
CE494	Solid Waste Management Techniques	3	0	0	3
CE495	Models for Air and Water Quality	3	0	0	3
Global Electives					
CE441	GIS and Remote Sensing	3	0	0	3
AR451	Urban and Regional planning	3	0	0	3
MA301	Operations Research Techniques in Civil Engineering	3	0	0	3
Other Electives					
CE442	Advanced Surveying Techniques	3	0	0	3

HONOURS ELECTIVES

Code	Course of Study	L	T	P	C
CE475	Bridge Planning and Design	3	0	0	3
CE476	Pavement Management System	3	0	0	3
CE466	Computational Fluid Dynamics	3	0	0	3
CE467	Free Surface Flow	3	0	0	3
CE651	Theory of Elasticity and Plasticity	3	0	0	3
CE656	Theory of Plates	3	0	0	3
CE666	Structural Optimisation	3	0	0	3
CE468	Soil Dynamics and Machine foundations	3	0	0	3
CE469	Numerical Modelling in Geotechnical Engineering	3	0	0	3
CE702	Biological Process Design For Wastewater Treatment	3	1	0	4
CE703	Physico Chemical Process For Water And Wastewater Treatment	3	1	0	4
CE477	Advanced Remote Sensing Techniques	3	0	0	3

SEMESTER III

MA203PROBABILITY, STATISTICS AND LINEAR PROGRAMMING

Course objectives

- To understand the concepts of Probability, Statistics and Linear Programming which arise in engineering applications.
- To study the defects arising in any of the engineering products.
- To study the quality of the components purchased for the projects.
- To study the optimization techniques for various problems.
- To study the Transportation and Assignment problems.

Course content

Total, Compound, Marginal and conditional probability, Bayes' theorem - Binomial, Poisson and Normal distributions, Moment generating function, Characteristic function.

Central Limit Theorem, Law of large numbers, Tests of significance, large and small samples, T- test, F-test and chi-square test for goodness of fit. Estimation theory, ANOVA table and analysis, Multiple and partial correlation – Regression.

Convex spaces, LPP statement, basic feasible solution, Graphical solution - Slack and surplus variables - Artificial variable technique - Charne's penalty method - Two phase method - Dual simplex method - Primal dual problems, Transportation and Assignment problems.

Integer programming - Gomory's cutting plane method - Branch and bound method.

References

1. *Gupta. S.C. and Kapoor. V.K., Fundamentals of Mathematical Statistics, 7th Edition, Sultan Chand and Sons, 1980.*
2. *Kantiswarup, Gupta P.K. and Man Mohan, Operations Research, 11th Edition, Sultan Chand and Sons, 2003.*

Course outcomes

On completion of the course, the students will be able to:

- Apply the principles and techniques learnt in this course for solving the practical problems which arise in the industry.
- Use Estimation Theory and Regression Analysis to estimate the present condition from previous history in any real life situation.
- Apply LPP to Transportations problems which are essential for a Civil Engineer.
- Apply Probability in Reliability and life testing machine tools in Civil Engineering.
- Solve the Linear Programming problems for minimizing the project cost and maximizing its profit.

CE201 STRENGTH OF MATERIALS

Course objectives

- To impart to the students the concepts of stresses and strains and Hooke's law.
- To enlighten the students about different types of truss analysis.
- To teach the students about the beam analysis
- To teach about thin cylindrical and spherical shell analysis when subjected to internal pressure
- To impart ideas of torsional stresses and how to evaluate it in circular sections and its applications in spring analysis.

Course content

Tension, compression and shear stresses - Hooke's law - elastic constants – compound stresses - composite bars - thermal stresses.

Analysis of Plane Truss - Method of Joints - Method of sections Strain Energy due to axial force - Resilience - stresses due to impact and suddenly applied load - Principal stress and principal planes - Mohr's circle.

Beams and support conditions -Types of supports and loads - shear force and bending Moment - their diagrams for simply supported beams, cantilevers and overhanging beams.

Theory of simple bending - Stress distribution at a cross section due to Bending Moment and Shear - strain energy.

Stresses in thin cylinders and spherical shells.

Theory of torsion - Torsion of circular and hollow circular shafts and shear stresses due to torsion - closed and open coiled helical springs - leaf spring.

References

1. *Vazirani, V.N. and Ratwani, N.M., Strength of Materials, Vol I, Khanna Publishers,1996.*
2. *Kazimi, Mechanics of Solids, Tata McGraw - Hill, 2004.*
3. *Timoshenko, S.P. and Gere, J.M., Mechanics of Materials, Tata McGraw Hill, 1992.*

Course outcomes

After this course the students would have understood

- The concepts of stresses, strains and Hooke's law.
- Different types of truss analysis.
- Beam behavior and analysis.
- Thin cylindrical and spherical shell analysis when subjected to internal pressure.
- Ideas of torsional stresses and how to evaluate it in circular sections and its applications in spring analysis.

CE203 MECHANICS OF FLUIDS

Course objectives

- To understand the properties of fluids and fluid statics.
- To solve kinematic problems such as finding particle paths and stream lines.
- To use important concepts of continuity equation, Bernoulli's equation and turbulence, and apply the same to problems.
- To study about specific speed and performance characteristics of different types of turbines.
- To study types of centrifugal Pumps, work done and efficiency of the different types centrifugal pumps and also study about performance of pumps & characteristic curves.

Course content

Continuum concept - CGS, MKS and SI systems - Properties of Fluids - Ideal and real fluid - Flow classification, stream lines, streak lines, continuity equation, velocity, tangential, normal, local and convective acceleration, types of fluid motions, stream function, velocity potential function, flownet.

Pressure at a point - pascal law - Hydrostatic law - pressure measurement - Hydrostatic forces on immersed plane and curved surfaces, Buoyancy, Stability of floating and submerged bodies. Bernoulli's equation, Energy correction factor, Coefficients of contraction, velocity and discharge, free vortex motion, Analysis of free liquid Jet, Cavitation.

Laminar and turbulent flow - Reynold's number - Navier stoke equations of motion - shear stress and pressure gradient - Laminar flow between parallel plates - Couette flow - Hagen Poiseuille equation for flow through circular pipes.

Turbulence - Major losses - Darcy-Weisbach equation for flow through circular pipe - Friction factor - Smooth and rough pipes - Moody diagram - Minor losses - pipes in series and parallel - Equivalent length - water hammer phenomena- flow measurement – orifice mouth piece, weirs, flow under sluice gates.

Centrifugal pump - minimum speed to start the pump – multistage Pumps – Positive displacement pumps – reciprocating pump - negative slip - flow separation conditions - air vessels -indicator diagram and its variation - savings in work done- Turbines - draft tube and cavitations – classification - radial flow turbines - axial flow turbines – Impulse and Reaction turbines.

References

1. Nagaratnam, S., Fluid Mechanics, Khanna Publishers, 1995.

2. Natarajan, M.K. Principles of Fluid Mechanics, Oxford & IBH Publishing Co, 1994.

3. JagdishLal, Hydraulics and Fluid Mechanics, Tata McGraw Hill, 2001.

4. Streeter V.L., Fluid mechanics, Tata McGraw Hill, 1998.

Course outcomes

By the end of this course the students

- Understand the basic principles of fluid mechanics.
- Understand the concepts of statics and dynamics of fluid flow.
- Develop skills in analyzing fluid flows through the proper use of modeling and the application of the basic fluid-flow principles.
- Acquire knowledge in the selection of type of turbine required with reference to available head of water and also used for Identification of type of turbine with estimated specific speed.
- Capable of estimating efficiency of different pumps and performance of the pumps with the study of characteristics curves.

CE205 SURVEYING

Course objectives

The student will be able to gain knowledge on

- Chain, Compass, Plane table and Theodolite surveying.
- Levelling, Engineering surveys.
- Skill to carry survey and to decide appropriate type of execution in construction works.
- Numerical solutions for carrying out surveying in civil engineering field.
- Advanced surveying equipments.

Course content

Introduction - Principles of surveying –Introduction to chain surveying – Chaining and ranging - Compass surveying – Prismatic compass only – Bearing of survey lines – systems and conversions – Local attraction – Latitude and departure – Traversing – Traverse adjustment of closing errors-Plane table Surveying- Two and Three Point Problems

Levelling – instruments – Temporary and permanent adjustments – Reduction to levels – Correction for Curvature and refraction – Classification of leveling – Profile Levelling – Differential levelling – Reciprocal levelling – longitudinal and cross sectioning.

Tacheometric surveying – Stadia Tachometry-Different Types of Tachometric Measurements– Analytic lens – Tangential method- Theodolite surveying – Vernier theodolite – Temporary and permanent adjustments – Measurement of horizontal and vertical angles – Methods of repetition and reiteration – errors in theodolite surveying – elimination of errors - Area and volume computation – area from latitude and departure – Simpson's rule and Trapezoidal rule.

Trigonometrical levelling – Observations for heights and distances – Geodetic observations – Corrections for refraction, curvature, axis signal – Reciprocal observations-Errors – Types of errors.

Introduction to advanced surveying Equipments – Total station – GPS – Electronic theodolite.

References

1. Duggal, S.K. Surveying Vol. I and II, Tata McGraw Hill, 2004.
2. Punmia, B.C. Surveying Vol.I and II, Standard Publishers, 1994.
3. Arora, K. R. Surveying Vol. I and II, Standard Book House, 1996.
4. SatheeshGopi. Advanced Surveying, Pearson Education, 2007.

Course outcomes

By the end of this course, the students will be able to

- Understand the basic need for surveying.
- Explore the different surveying instruments for surveying.
- Describe the methods of measurement using level instrument and theodolite.
- Provides independent knowledge for carrying out individual projects.

CE207 ENVIRONMENTAL ENGINEERING – I

Course objectives

- To make the students conversant with sources and its demand of water
- To understand the basic characteristics of water and its determination
- To expose the students to understand the design of water supply lines
- To provide adequate knowledge about the water treatment processes and its design
- To have adequate knowledge on operation and maintenance of water supply

Course content

Physical, chemical and biological characteristics of water - water analysis- IS and WHO standards- Requirements of water supply - Types of demand and their contribution - rate of consumption - Forecasting the population- variation in demand pattern.

Sources of water - quantitative and qualitative studies. Intakes - Channels and pipes for conveying water -- Pipes- hydraulic design of pressure pipe- Materials - laying- joining- testing - pipe appurtenances- Pumps and pumping stations.

Treatment plants - process of treatments - mixing, aeration, sedimentation, coagulation, filtration, disinfection, softening - advanced water treatment. Distribution systems - analysis of distribution networks.

Operation and maintenance of water supply to buildings - Rural water supply - Protected water supply - Saline water intrusion.

Note: Assignments include the drawings of various water treatment units.

References

1. *Manual on Water supply and Treatment - CPHEEO, 1999.*
2. *Birdie, G.S. and Birdie, Water Supply and Sanitary Engineering, Dhanpat Rai & Sons, 1992.*
3. *Duggal, K.N. Elements of Environmental Engineering, S.Chand & Co, 2002.*
4. *Punmia B.C, Ashok Jain & Arun Jain, Water Supply Engineering, Laxmi Publications, Pvt. Ltd., New Delhi, 2004.*

Course outcomes

On completion of the course, the students will be able to:

- Identify the source of water and water demand.
- Apply the water treatment concept and methods.
- Apply water distribution processes and operation and maintenance of water supply.
- Prepare basic process designs of water and wastewater treatment plants collect, reduce, analyze, and evaluate basic water quality data.

CE209 CONCRETE TECHNOLOGY

Course objectives

- To understand the properties of ingredients of concrete
- To study the behavior of concrete at its fresh and hardened state
- To study about the concrete design mix
- To know about the procedures in concreting
- To understand special concrete and their use

Course content

Introduction - Concrete materials - Cement: Physical tests on cement - Concrete materials - Tests on aggregates - Quality of Water for mixing and curing - use of sea water for mixing concrete.

Mix Design - factors influencing mix proportion - Mix design by ACI method and I.S. code method - Design of high strength concrete.

Admixtures - accelerating admixtures - Retarding admixtures - water reducing admixtures - Air entraining admixtures - coloring agent - Plasticizers. Batching - Mixing -Transportation - Placing of concrete - curing of Concrete.

Strength of Concrete - Shrinkage and temperature effects - creep of concrete - permeability of concrete - durability of concrete - Corrosion - Causes and effects - remedial measures- Thermal properties of concrete - Micro cracking of concrete.

Special Concrete - lightweight concrete - Fibre reinforced concrete - Polymer-polymer modified concrete - Ferrocement - Mass concrete - Ready mix concrete- Self compacting concrete- Quality control - Sampling and testing-Acceptance criteria.

References

1. *Shetty, M.S., Concrete Technology, Theory & Practice, S.Chand and Co, 2004.*
2. *Gambhir, M.L., Concrete Technology, Tata McGraw Hill, 2004.*
3. *Nevile, Properties of Concrete, Longman Publishers, 2004.*
4. *Santakumar A.R., Concrete Technology, Oxford University Press, New Delhi, 2007.*

Course outcomes

On completion of the course, the students will be able to:

- Test all the concrete materials as per IS code.
- Design the concrete mix using ACI and IS code methods.
- Determine the properties of fresh and hardened of concrete.
- Design special concretes and their specific applications.
- Ensure quality control while testing/ sampling and acceptance criteria.

CE211 STRENGTH OF MATERIALS AND CONCRETE LABORATORY

Course objectives

- To find the Young Modulus, torsional strength, hardness and tensile strength of given specimens
- To find impact value and crushing value of coarse aggregates
- To find the compressive strength of concrete cubes and bricks
- To find stiffness of open coiled and closed coiled springs
- To find the physical properties of given coarse aggregate, fine aggregate and cement samples

Course content

1. Tests on springs - modulus of rigidity of the spring.
2. Deflection test
3. Stress-strain characteristics of HYSD bars.
4. Young's modulus of the given material (steel or wood) by conducting bending test on simply supported beam.
5. Brinel's, Vickers, Rockwell hardness tester.
6. Normal consistency, fineness, Initial setting and final setting time of cement.
7. Specific gravity, soundness and Compressive strength of Cement.
8. Specific gravity of fine and coarse aggregates.
9. Fineness modulus of fine aggregate and coarse aggregate.
10. Bulking of fine aggregate and water absorption test on coarse aggregate.
11. Concrete mix design (IS method).
12. Tests on Concrete.
13. Compressive and spilt-tensile strength of concrete.
14. Modulus of Elasticity/stress-strain curve in concrete.
15. Permeability test and NDT Tests (only Demonstration)

Course outcomes

On completion of the course, the students will be able to:

- Evaluate Young Modulus, torsional strength, hardness and tensile strength of given specimens.
- Determine the strength of coarse aggregates.
- Find the compressive strength of concrete cubes and bricks.
- Find stiffness of open coiled and closed coiled springs.
- Determine the physical properties of given coarse aggregates, fine aggregates and cement samples.

CE213 SURVEY LABORATORY

Course objectives

The Lab sessions would include experiments on

- Introduction to Chain Surveying and Compass Surveying.
- Plane Table Surveying – Radiation, intersection, Traverse, Resection Leveling.
- Tacheometry and Theodolite survey
- Trigonometriclevelling to determine heights/elevations.
- Total Station.

Course content

1) Chain and Compass surveying
2) Plane table surveying
3) Leveling: Fly leveling and contouring
4) Radiation, intersection-Traverse- Resection
5) Theodolite surveying
6) Single and two plane observation of trignometricleveling
7) Determination of Tacheometric Constants

8) Tangential Tacheometry
9) Subtense Bar
10) Total station

Course outcomes

On completion of the course, the students will be able to:

- Use conventional surveying tools such as chain/tape, compass, plane table, level in the field of civil engineering applications such as structural plotting and highway profiling.
- Apply the procedures involved in field work and to work as a surveying team.
- Plan a survey appropriately with the skill to understand the surroundings.
- Take accurate measurements, field booking, plotting and adjustment of errors can be understood.

SEMESTER IV

MA204 NUMERICAL TECHNIQUES

Course objectives

- To study various numerical techniques
- To study the behavior of the solution of linear/non-linear differential equations
- To study the solution of heat conduction/ wave equation numerically
- To find approximate solutions with minimum error
- To learn algorithms for computers to solve problems in math, science and engineering

Course content

Solution of linear system - Gaussian elimination and Gauss-Jordan methods - LV - decomposition methods - Crout's method - Jacobi and Gauss-Seidel iterative methods sufficient conditions for convergence - Power method to find the dominant eigenvalue and eigenvector.

Solution of nonlinear equation - Bisection method - Secant method - Regula falsi method - Newton- Raphson method for f(x) = 0 and for f(x,y) = 0, g(x,y) = 0 - Order of convergence - Horner's method - Graeffe's method - Bairstow's method.

Newton's forward backward and divided difference interpolation - Lagrange's interpolation - Numerical Differentiation and Integration - Trapezoidal rule - Simpson's 1/3 and 3/8 rules - Curve fitting - Method of least squares and group averages.

Numerical Solution of Ordinary Differential Equations- Euler's method - Euler's modified method - Taylor's method and Runge-Kutta method for simultaneous equations and 2^{nd} order equations - Multistep methods - Milne's and Adams' methods. Numerical solution of Laplace equation and Poisson equation by Liebmann's method solution of one dimensional heat flow equation - Bender - Schmidt recurrence relation Crank - Nicolson method - Solution of one dimensional wave equation.

References

1. *Gerald, C.F., and Wheatley, P.O., Applied Numerical Analysis, Mis. Addison Wesley, 1989.*

2. *Jain, M.K., Iyengar,S.R.,and Jain,R.K., Numerical Methods for Scientific and Engineering Computation, Wiley Eastern, 1991.*

3. *Kandasamy, P.Thilagavathy, K., and Gunavathy,S., Numerical Methods, Chand and Co., 1997.*

Course outcomes

On completion of the course, the students will be able to:

- Solve linear and non-linear equations using numerical techniques.
- Solve linear and non-linear differential equations using numerical techniques.
- Solve a system of equations using the techniques studied.

CE202 MECHANICS OF SOLIDS

Course objectives

- To understand the concept of Principle of virtual work
- To study the different methods of finding deflection of beam
- To analyze the Indeterminate beams subjected to various loading
- To study the different methods to find the deflection of truss
- To analyze the column with different end conditions and stress in thick cylinders

Course content

Principle of virtual displacement and virtual forces - Castigliano's first theorem - Maxwell's reciprocal theorem. Determination of deflection curve of beams- double integration - Macaulay's method - Area moment method - Conjugate beam method - strain energy and dummy unit load approaches to deflection of Simple and Curved members. Statically indeterminate Structures - Propped cantilever, fixed and continuous beams - Theorem of three moments - Bending moment and shear force diagrams.

Thick cylinders - Lame's equation - Shrink fit - compound cylinders.
Deflection of trusses - Dummy unit load method - Strain energy method - Williot Mohr's diagram.

Theory of columns: Axial load- Euler's theory - Rankines formula, combined bending and axial load.

References

1. *Vazirani,V.N. and Ratwani, N.M. Strength of Materials, Vol. II, Kanna Publishers, 1996.*
2. *Timoshenko, S.P. and Gere, J.M. Mechanics of Materials, Tata McGraw Hill, 1992.*
3. *Rajput R.K., Strength of Materials, S. Chand & Co., Ltd., 1996.*

Course outcomes

On completion of the course, the students will be able to:

- Apply the principle of virtual work.
- Determine deflection of a beam for various loading conditions.
- Apply unit load method to find the deflection of truss.
- Determine different stresses developed in thick cylinders.
- Visualize the behavior of column for combined bending and axial loading.

CE204 APPLIED HYDRAULIC ENGINEERING

Course objectives

- To classify the types of flows in open channel and also to design open channel sections in a most economical fashion with minimum wetted perimeter and learn about critical flows.
- To study about non uniform flows in open channel and longitudinal slopes in open channel and also to learn about the characteristics of hydraulic jump.
- To develop an understanding of fluid flow patterns and learn to use boundary layer theory and Drag.
- To Provide insights to the Open channel hydraulics and introduce dimensional analysis for fluid flow problems.

Course content

Open channel flow and its classifications, and properties, energy and momentum principles, Critical flow computation and its applications, transitions with sub critical and super critical flows. Types and regimes of flow - Velocity distribution in open channel - Wide open channel.

Design of non- erodible channels for uniform flow, Most efficient channel section, compound Sections. Velocity measurement - Manning's and Chezy's formula - Determination of roughness coefficients - Determination of normal depth and velocity. Gradually varied flow: Theory and analysis, gradually-varied flow computations in prismatic channels, gradually varied flow in non-prismatic channels. Characteristics of flow profiles - Draw down and back water curves - Profile determination - Graphical integration, direct stepand standard step method - Flow through transitions.

Rapidly varied flow - Theory of hydraulic jump, evaluation of jump elements in rectangular and non-rectangular channel, location of jump on horizontal floor, channel controls and transition - surges.

Boundary Layer Theory: Introduction, Development of boundary layer over a flat plate, boundary layer thickness, displacement, momentum and energy thicknesses, Application of momentum equation to boundary layer flow, local and mean drag coefficients.

References

1. Streeter, V.L. Fluid Mechanics, Tata McGraw Hill, 1998.

2. Chow, V.T. Open Channel Hydraulics, Tata McGraw Hill, 1975.

3. Nagaratnam, S. Fluid Mechanics, Khanna Publishers, 1989.

4. Chaudhry, M and Hanif.Open Channel Flow. Englewood Cliffs, NJ: Prentice-Hall, 1993.

5. Chanson, H (2004b).The Hydraulics of Open Channel Flow-An Introduction, (Butterworth- Heinemann, Oxford, UK) 2nd Edition (ISBN 07506 59785).

Course outcomes

On completion of the course, the students will be able to:

- Acquire specific knowledge regarding fluid flow phenomena observed.
- Understand the basic principles of fluid flow patterns and boundary layer theory
- Develop skills in analyzing fluid flows in open channel hydraulics and measurements such as weirs and flumes.
- Understand hydraulic jump phenomenon
- Design open channels for rectangular and non-rectangular channels for GVF and RVF.

CE206 GEOTECHNICAL ENGINEERING - I

Course objectives

- To explain what Geotechnical Engineering is and how it is important to civil engineering
- To explain how three phase system is used in soil and how are soil properties estimated using three phase system
- To explain role of water in soil behavior and how soil stresses, permeability and quantity of seepage including flow net are estimated
- To determine shear parameters and stress changes in soil due to foundation loads
- To estimate the magnitude and time-rate of settlement due to consolidation

Course content

Historical development of Soil Engineering - Origin and general types of soils - soil structure, clay minerals - Three phase system- Identification and Classification of soils Soil water - capillary phenomena - concept of effective and neutral stresses - Permeability - determination of coefficient of permeability in the laboratory - Seepage flow - Head, gradient, pressure - steady state flow - two dimensional - flow net.

Vertical stress distribution in soil - Boussinesq and Westergaard's equation - Newmark's influence chart - principle, construction and use - Equivalent point load and other approximate methods - pressure bulb. Compaction.

Shear strength - Mohr - Coulomb failure criterion - shear strength tests - Different drainage conditions - Shear properties of cohesionless and cohesive soils - Use of Mohr's circle - relationship between principal stresses and shear parameters.

Compressibility and consolidation - Terzaghi's one dimensional consolidation theory - pressure void ratio relationship - preconsolidation pressure - Total settlement and time rate of settlement - coefficient of consolidation - curve fitting methods - Correction for construction time.

References

1. *Gopal Ranjan and Rao, P. Basic and Applied Soil Mechanics, New Age International Pvt. Limited, New Delhi, 2002.*
2. *Murthy, V.N.S., A text book of Soil Mechanics and Foundation Engineering, UBS Publishers Distributors Ltd., New Delhi, 1999*
3. *Punmia, B.C. Soil Mechanics and Foundation Engineering, Laxmi Publications Pvt. Ltd., New Delhi, 1995.*
4. *Braja M. Das, Fundamentals of Geotechnical Engineering, Thomson Asia Pvt. Ltd., Singapore, 2005.*

Course outcomes

On completion of the course, the students will be able to:

- Carry out soil classification.
- Solve three phase system problems.
- Solve any practical problems related to soil stresses estimation, permeability and seepage including flow net diagram.
- Estimate the stresses under any system of foundation loads.
- Solve practical problems related to consolidation settlement and time rate of settlement.

CE208 ENVIRONMENTAL ENGINEERING - II

Course objectives

- To learn the basics of sewage composition and its characteristics
- To depict the information about various sewage treatment processes
- To provide the adequate information on various disposal standards for industrial effluents
- To study the information about air pollution and its effects
- To understand the knowledge about solid waste generation and disposal methods

Course content

Characteristics and composition of sewage-sampling-analysis- population equivalent - drainage in buildings-plumbing systems for drainage.

Primary treatment- Secondary treatment- biokinetics- Lagooning- sludge digestion- Tertiary treatment.

Disposal standards- self-purification of rivers- Streeter Phelps equation - oxygen sag curve.

Toxic and hazardous wastes - equalization and neutralization- biological degradation- recycle and reuse of waste effluents- treatment of industrial wastes- Dairy, Tannery, Petrochemical, Fertilizer, textiles, Pulp and paper.

Air pollution-effects- stack emission- automobile exhaust - control devices-solid waste Management - EIA.

Note: Assignments include the designs and drawings of various wastewater treatment units.

References

1. *Duggal, K.N., Elements of Environmental Engineering, S.Chand and Co., New Delhi, 2002.*
2. *Birdie, G.S. and Birdie, J.S., Water Supply and Sanitary Engineering, Dhanpat Rai and Sons, New Delhi, 1992.*

3. *Metcalf and Eddy, Waste Water Engineering, Collection, Treatment and Disposal, Tata McGraw Hill, Inc., New York, 2005.*
4. *Manual of Sewage and Sewage Treatment - CPHEEO, 1999.*

Course outcomes

On completion of the course, the students will be able to:

- Determine the sewage characteristics and design various sewage treatment plants.
- Analyze the status of surface water and ground water quality and the remediation technologies.
- Carry out municipal water and wastewater treatment system design and operation.
- Manage hazardous wastes, risk assessment and treatment technologies apply environmental treatment technologies and design processes.

CE210 TRANSPORTATION ENGINEERING - I

Course objectives

- To understand the importance of transportation and characteristics of road transport
- To know about the history of highway development, surveys and classification of roads
- To study about the geometric design of highways
- To study about traffic characteristics and design of intersections
- To know about the pavement materials and design

Course content

Introduction: Importance of transportation, different modes of transportation, characteristics of road transport, scope of highway and traffic engineering.

Highway development and planning: Importance, classification of roads, road patterns, planning surveys; highway alignment and surveys.

Highway Geometric Design: Cross section elements, sight distance, design of horizontal and vertical alignment.

Traffic Engineering: Traffic characteristics - Traffic studies-speed, volume, speed and delay, origin-destination, parking and accident studies; capacity of urban roads and highways; traffic operations - regulation and control; design of intersections - at grade and grade separated.

Pavement Materials and Design: Specifications and tests on pavement materials, pavement design factors, design of flexible and rigid pavements as per IRC.

References

1. *Khanna, S.K and Justo, C.E.G., Highway Engineering, Nem Chand and Bros. Roorkee (U.P), 1998.*
2. *Kadiyali, L.R, Traffic Engineering and Transport Planning, Khanna Publishers, New Delhi, 2005.*
3. *Kadiyali, L.R, and Lal, N.B. Principles and Practice of Highway Engineering, Khanna Publishers.2005.*

Course outcomes

On completion of the course, the students will be able to:

- Carry out surveys involved in planning and highway alignment.
- Design cross section elements, sight distance, horizontal and vertical alignment.
- Implement traffic studies, traffic regulations and control, and intersection design.
- Determine the characteristics of pavement materials.
- Design flexible and rigid pavements as per IRC.

CE212 FLUID MECHANICS LABORATORY

Course objectives

- To understand the flow measurement in a pipe flow
- To determine the energy loss in pipe flow
- To study the characteristics of turbines
- To study the characteristics of pumps
- To measure the discharge in a open channel flow

Course content

1. Determination of pipe friction
2. Calibration of flow meters - Venturimeter and Orifice meter
3. Determination of discharge coefficients for notches
4. Determination of minor losses
5. Pressure gauge calibration.
6. Centrifugal pump
7. Submersible pump
8. Reciprocating pump
9. Jet pump
10. Gear pump
11. Screw pump
12. Francis Turbine

Course outcomes

On completion of the course, the students will be able to:

- Measure discharge in pipes.
- Determine the energy loss in conduits.
- Demonstrate the characteristics curves of pumps.
- Demonstrate the characteristics curves of turbines.
- Carry out discharge measurements in open channel.

CE214 ENVIRONMENTAL ENGINEERING LABORATORY

Course objectives

- To quantify the water and wastewater pollutant
- To measure the concentration of air pollutants
- To analyse the characteristics of water, wastewater and ambient air
- To study the growth of microorganism and its quantification

Course content

1. Physical characteristics of water
2. Chemical characteristics of water
3. Bacteriological tests
4. Microscopic tests
5. Jar test
6. Chlorine demand and residual test
7. Total solids and settleable solids.
8. Organic and inorganic solids.
9. Determination of pH and chemical constituents like Cl^-, Fe^{2+} etc.

Course outcomes

On completion of the course, the students will be able to:

- Quantify the pollutant concentration in water, wastewater and ambient air.
- Recommend the degree of treatment required for the water and wastewater.
- Analyse the survival conditions for the microorganism and its growth rate.

SEMESTER V

CE301 STRUCTURAL ANALYSIS – I

Course objectives

- To understand the concept of analysis of indeterminate structures by various classical methods
- To study the use of ILD for determinate structure
- To learn the concepts of moving loads and its effect on structures
- To understand the concept of equivalent UDL
- To study the reversal of stress under live load

Course content

Slope deflection method - analysis of indeterminate structures- Settlement.

Moment distribution method - analysis of indeterminate structures - settlement of supports - sway.

Energy methods - Kani's method - analysis of indeterminate structures - settlement of supports - sway.

Moving loads for statically determinate structures -single load - two point loads - several points loads - maximum bending moment and maximum shear force - equivalent u.d.l. - absolute maximum bending moment.

Enveloping curves for maximum bending moment and maximum shear force and determination of equivalent UDL, ILD for shear, moment and reactions for statically determinate beams and pinjointed trusses - Reversal of stresses under live load.

References

1. *Jindal. R.L, Indeterminate Structures, Chan Tea, New Delhi, 2000*
2. *Punmia B.C., Theory of Structures, Standard Book House, New Delhi, 2000*

Course outcomes

On completion of the course, the students will be able to:

- Use various classical methods for analysis of indeterminate structures.
- Determine the effect of support settlements for indeterminate structures.
- Apply the concepts of ILD and moving loads on determinate structures.
- Apply the concept of equivalent UDL.
- Determine the reversal of stresses in trusses using ILD.

CE303 CONCRETE STRUCTURES – I

Course objectives

- To study the stress strain behavior of steel and concrete
- To understand the concept of working stress and limit state methods
- To gain the knowledge of limit state design for flexure, shear, torsion, bond and anchorage
- To understand the behavior of columns subjected to eccentric load and use of interaction diagrams
- To study the design of various foundation

Course content

Stress strain behavior of steel and concrete- Introduction to working stress method - permissible stresses. Limit state method-Limit states - Characteristic strength and load - Partial safety factor - Design of singly and doubly reinforced beams, T and L beams - Design for Shear and Torsion. Slabs - one way and two way slabs for different edge conditions - Yield line theory - Flat slab - continuous slabs - stair cases - different types.Columns - axially loaded and eccentrically loaded columns - Interaction Diagrams. Footings - isolated footings - square, rectangular and circular footings - Combined footing Pile and pile cap- Introduction to masonry structures.

Note: Assignments include the design and drawings of various R.C.C structural elements.

References

1. *Ashok, Kumar Jain, Reinforced Concrete Limit State Design, Nem Chand Brothers, 1990.*
2. *Sinha. S.N. Reinforced Concrete Design, Tata McGraw Hill, 2002.*
3. *Varghese, Limit state design of concrete, Oxford IBH, 2000.*
4. *IS456-2000: Code of practice for Plain and reinforced concrete code of practice.*

Course outcomes

On completion of the course, the students will be able to:

- Apply the fundamental concepts of working stress method and limit state method.
- Use IS code of practice for the design of concrete elements.
- Design the beams, slab, stairs, column and footing.
- Draw detailing of various RCC structural elements.
- Design masonry structures.

CE305 ADVANCED STRENGTH OF MATERIALS

Course objectives

- To understand the mechanical properties of materials.
- To understand the different theories of failure for brittle and ductile materials.
- To know the features of unsymmetrical bending and different methods of analysis.
- To understand the concept of shear centre and to know different methods for its location.
- To know the fundamentals of vibration of structure.

Course content

Mechanical Properties of Materials - Stress-Strain Diagrams- Elastic and Plastic Deformation - Brittle and Ductile Failures of Materials - Mechanical Tests like Surface Hardness, Fatigue, Creep etc. Principal stresses in a 3D field.- Computation -Mohr's Circle - Lame's Ellipsoid. Theories of failure - Criteria for Failure - Different failure theories for ductile and brittle materials. Equivalent bending and twisting moments.

Unsymmetrical bending- Properties of unsymmetrical sections- Circle of inertia - Dyadic circle - Momental ellipse- Stresses and deflection due to unsymmetrical bending - Concept and relevance of Z polygon.

Shear Centre - Concept and significance - Shear flow for thin walled open sections- Location of shear centre for singly symmetric sections. Stresses in curved flexural members-Winkler Bach Formula - Crane hooks - rings and links.

Fundamentals of vibration - free vibration of single degree of freedom systems - Undamped and damped free vibration with different types of damping.- Resonance- Harmonic response of single degree of freedom systems with and without damping.

References

1. *Srinath, L. S., Advanced Mechanics of Solids , Tata McGraw Hill,1980.*
2. *Kazimi, S.M.A., Solid Mechanics, Tata McGraw Hill, 1976.*
3. *Punmia, B.C., Strength of Materials Part II, Standard Publishers and Distributors, 1991.*
4. *Shames I.H., Engineering Mechanics, Prentice Hall of India,1996*

Course outcomes

On completion of the course, the students will be able to:

- Determine the important mechanical properties of materials.
- Demonstrate the different theories of failure for brittle and ductile materials.
- Apply the different methods of unsymmetrical bending analysis.
- Demonstrate the significance and concept of shear centre.
- Apply the principles of structural dynamics.

CE307 GEOTECHNICAL ENGINEERING - II

Course objectives

- To emphasize the importance of soil investigations including destructive and non-destructive methods.
- To explain how earth pressure theory is important in retaining structure design.
- To explain the concept of bearing capacity and how to estimate the safe bearing capacity for various foundation system including settlement consideration.
- To explain how do select a suitable shallow foundation system for various site conditions and also analysis of different foundation system.
- To explain in what circumstances pile is needed and how do analysis the pile and pile group under various soil conditions.

Course content

Soil exploration - Planning - Augur boring - Soundings - Sampling - Plate load test, static and dynamic penetrations tests - geophysical explorations - Lateral Earth Pressure - Plastic equilibrium - Rankine's theory - Active and passive earth pressure for cohesionless and cohesive soils - Earth pressure at rest - Coloumb's wedge theory - Rebhann's and Culmann's graphical solutions, Stability analysis.

Foundation - functions and requisites - Different types - choice of foundation type - general principles of design. Bearing capacity - types of failures - Prandtl's and Terzaghi's bearing capacity analysis - Bearing capacity based on settlement and building codes.

Shallow foundation - spread footings - combined footings - trapezoidal and strap footings - Raft foundation - Contact pressure distribution - settlement analysis - Types of settlement, control.

Deep foundation - piles - types - load carrying capacity of pile - static and dynamic formula - pile load test - penetration test - pile groups - Efficiency - Feld's rule - Converse Labarre formula, Settlement of piles and pile groups - Negative skin friction - under reamed piles.

References

1. *Murthy, V.N.S, A text book of Soil Mechanics and Foundation Engineering, UBS Publishers & Distributors Pvt. Ltd., New Delhi 1999.*
2. *Punmia, B.C., Soil Mechanics and Foundation Engineering, Laxmi Publications Pvt. Ltd., New Delhi, 1995.*
3. *Gopal Ranjan and Rao, Basic and Applied Soil Mechanics, New Age International (P) Limited, New Delhi, 2002.*
4. *Braja M.Das, Principles of Foundation Engineering, Thomson Asia Pvt. Ltd., Singapore, 2005.*

Course outcomes

On completion of the course, the students will be able to:

- Carry out soil investigation for any civil engineering construction.
- Analyse earth retaining structures for any kind of soil medium
- Estimate bearing capacity using IS code methods.
- Design proper foundations for any kind of shallow foundation system.
- Estimate pile and pile group capacity for any kind of soil including group efficiency and negative friction.

CE309 TRANSPORTATION ENGINEERING - II

Course objectives

- To know about the basics and design of various components of railway engineering.
- To study about the types and functions of track, junctions and railway stations.
- To learn about the aircraft characteristics, planning and components of airport.
- To study about the types and components of docks and harbours.
- To know about various urban transportation systems and Intelligent Transportation Systems.

Course content

Railway Engineering - Location surveys and alignment - Permanent way - Gauges - Components - Functions and requirements - Geometric design.

Track Junctions-Points and crossings - types and functions - design and layout - simple problems - Railway stations and yards. Signaling and interlocking - control systems of train movements.

Airport Engineering-Aircraft characteristics - Airport obstructions and zoning - Runway - taxiways and aprons- Terminal area planning.

Docks and Harbours - Types - Layout and planning principles- breakwaters - docks- wharves and quays - Transit sheds- warehouses- navigation aids.

Urban transportation systems - Bus transit - Mass Rapid Transit System - Light Rail Transit. Transport economics and Financing - Intelligent Transportation Systems (ITS)

References

1. *M.M. Agarwal, Railway Engineering, Prabha & Co. 2007.*
2. *Khanna, S.K. and Arora, M.G. Airport Planning and Design, Nemchand and Bros. 1999.*
3. *Oza and Oza, Elements of Dock and Harbour Engineering, Charotar Publishing House, 1996.*

Course outcomes

On completion of the course, the students will be able to:

- Carry out the surveys for railways, airports and harbours.
- Perform geometric design for the three modes.
- Plan the layout of different types of terminals.
- Apply the principles of bus transit, MRTS and LRT.
- Demonstrate the fundamentals of Intelligent Transportation Systems.

CE311 GEOTECHNICAL ENGINEERING LABORATORY

Course objectives

- To estimate index properties of soils (coarse and fine).
- To estimate consistency limit of fine grained soils.
- To estimate shear strength of soils by direct shear test, triaxial shear test, vane shear test & unconfined compressive test.
- To estimate the engineering properties of the soils by density test, CBR test permeability test and consolidation test.

Course content

1. Grain Size analysis
2. Consistency limits
3. Specific gravity
4. Permeability tests
5. Unconfined compression test
6. Direct shear test
7. Core cutter and sand replacement
8. Compaction test
9. California bearing ratio test
10. Vane shear test
11. Tri-axial test
12. Consolidation test

Course outcomes

On completion of the course, the students will be able to:

- Classify soil by physical observation of the soils.
- Classify soil based on estimated index and engineering characteristics of soils.
- Carry out interpolation among the estimated soil design parameters.

CE313 BUILDING PLANNING AND DRAWING

Course objectives

- To understand the principles of planning and bylaws
- To draw plan, elevation and section of load bearing and framed structures
- To draw plan, elevation and section of public and industrial structures
- To prepare detailed working drawing for doors, windows, etc.

Course content

Classification of buildings - Principles of planning - Dimensions of buildings - Building bye-laws for floor area ratio, open spaces - Orientation of buildings - Lighting and Ventilation - Planning and preparing sketches and working drawings of Residential buildings (Flat and sloping roof), Schools, Hostels, Hospitals, Single-storey factory buildings with trusses. Detailed working drawings of the component parts - Doors and Windows - Roof Trusses - Staircases-Toilets.

References

1. *Shah M.G. Kalec. M. & Patki SY Building Drawing, Tata Mcgraw Hill, New Delhi, 2000*

Course outcomes

On completion of the course, the students will be able to:

- Apply the principles of planning and bylaws used for building planning.
- Draw plan, elevation and section for various structures.

SEMESTER VI

CE302 STRUCTURAL ANALYSIS – II

Course objectives

- To understand the influence line concepts for indeterminate structures
- To understand the methods of analysis of intermediate trusses for external loads, lack of fit and thermal effect
- To study behaviour of arches and their methods of analysis
- To know the concept and analysis of cable stayed bridge
- To study the multi storey frames subjected to gravity loads and lateral loads

Course content

Influence lines - Maxwell Betti's theorem - Muller Breslau's principle and its application. Influence lines for continuous beams and single bay, single storey portals with prismatic members.

Analysis of plane truss with one or two redundants - trusses with lack of fit - Thermal stresses - Settlement of supports - Trussed beams.

Theory of arches - Analysis of three hinged, two hinged and fixed arches - influence lines, rib shortening, settlement and temperature effects.

Analysis of cables - Suspension bridges with three and two hinged stiffening girders - influence lines.

Analysis of multistorey frames for gravity and lateral loads by approximate methods - Substitute frame - Portal and Cantilever methods.

References

1. *Punmia, B.C, Theory of Structures, Laxmi Publications, 2000.*
2. *Timoshenko, S.P.,Young, D.H., Theory of Structures, Tata McGraw Hill, 1983.*
3. *Wang. C.K., Intermediate Structural Analysis, International Text Book Co, 1983.*
4. *Hibbeler. R.C., Structural Analysis, Pearson Education (Singapore) Ptc. Ltd., Indian Branch, 2002.*

Course outcomes

On completion of the course, the students will be able to:

- Demonstrate the concepts of qualitative influence line diagram for continuous beams and frames.
- Apply the methods of indeterminate truss analysis.
- Demonstrate the behavior of arches and their methods of analysis.
- Analyse cable suspension bridges.
- Analyse multistory frames subjected to gravity loads and lateral loads.

CE306 CONCRETE STRUCTURES – II

Course objectives

- To understand the design concept of various structures and detailing of reinforcements.
- To understand the design of underground and elevated liquid retaining structures.
- To study the design of material storage structures.
- To know the effect of temperature on concrete structures.
- To study the design of bridges subjected to IRC loading.

Course content

Earth Retaining structures - Retaining walls- types - cantilever and counterfort - design - drainage and other construction details. Liquid Retaining structure - Water tanks - types - square, rectangular, circular - Design of underground and elevated tanks - design of staging - spherical & conical roof for circular tanks. Material storage structures - Determination of lateral pressure on side walls of bunker - Rankine's theory - design of bunker - design of circular silo using Jansen's theory. Environmental Structures - Chimneys - Principles and Design - Design of long columns. Transportation structures - Bridges - Slab bridge - Design of single span slab bridge -

Tee beam bridge - Design of Tee beam bridge with stiffness - Tee beam bridge with cross girders.

Note: *Assignments include the design and drawings of various RCC structures.*

References

1. *Vazirani, V.N., and Ratwani, Concrete Structures, Vol. IV, Khanna Publishers, New Delhi, 1995.*
2. *Dayaratnam, P., Design of Reinforced Concrete Structures, Oxford & IBH Publishers & Co., New Delhi, 2005.*
3. *Victor, D.J., Essentials of Bridge Engineering, Oxford & IBH Publishers Co., New Delhi, 1991.*
4. *IS456 - 2006 Code of practice for Plain and reinforced concrete code of practice.*

Course outcomes

On completion of the course, the students will be able to:

- Apply the concepts of liquid retaining structures.
- Design material storage structures using various theories.
- Apply the concepts of environmental and transportation structures.
- Demonstrate the detailing of reinforcement.
- Draw the various RCC structures.

CE306 DESIGN OF STEEL STRUCTURES

Course objectives

- To learn IS 800-2007 code of practice for the design of Compression, Tension and Flexural members using various cross-sections.
- To study the behaviour and design of compression and tension members using simple and built-up sections.

- To understand behaviour of flexural members and the design laterally restrained and unrestrained beams.
- To study the components of truss, loads on trusses, analysis and design of purlins and truss members.
- To study the design of bolted and welded connections and arranging field visit to industries.

Course content

Introduction - elastic and plastic properties of sections - shape factor - stress distribution under tension, compression, bending and shear. Design of axially loaded tension members - Types of tension members - modes of failures - shear lag effect - IS code provisions and design.

Design of axially loaded compression members - section classifications - effective length - slenderness ratio – simple sections - built-up sections - design of lacings and battens - single angle and double angle strut – continuous and discontinuous strut.

Flexural members – types of steel beams – Lateral stability of beams –effective length - design of laterally restrained and unrestrained beams – rolled sections - built-up beams/compound beams - Design for strength and serviceability, web yielding, web crippling, bearing stiffeners.

Bolted connections - types of bolts - resistance of bolted connections under various failure modes – shear moment resistant connections - design of beam and columns splice.

Welded connections - types - strength of welds - design of fillet and butt welds - shear and moment resistant connections - design and detailing of connections.

Note: *Assignments include the design and drawings of various steel structural elements.*

References

1) *Subramanian N, Design of Steel Structures, Oxford University Press, New Delhi 2008.*
2) *Bhavikatti, S.S., Design of Steel Structures, I.K. International Publishing House Pvt. Ltd., New Delhi, 2010*
3) *Krishnaraju, N. Structural Design and Drawing, Universities Press, 2009*
4) *IS 800 - 2007, Code of practice for general construction in steel, Bureau of Indian Standards, New Delhi.*
5) *SP6 (1)-1964, IS hand book for structural Engineers. Bureau of Indian Standards, New Delhi.*

Course outcomes

On completion of the course, the students will be able to:

- Apply the IS code of practice for the design of steel structural elements.
- Design compression and tension members using simple and built-up sections.
- Calculate forces on the various members of the truss and design them.
- Analyze the behavior of bolted connections and design them.
- Design welded connections for both axial and eccentric forces.

CE308 WATER RESOURCES ENGINEERING

Course objectives

- To build on the student's background in hydrology and hydraulics an understanding of water resources systems.
- To develop the skills in modelling of flood flows and flood routing
- To develop skills in the ground water flow, type of aquifer and yield from the well.
- To provide the knowledge of design of reservoir, operation and sedimentation.

Course content

Hydrologic cycle - rainfall and its measurement - Precipitation circulation - temperature - Humidity - wind formation and forms of precipitation - Interpretation of precipitation data - snow cover and snow fall. Factors affecting and methods of determining evaporation, infiltration and Evapotranspiratio.

Runoff -infiltration indices - Storm Hydrograph and unit hydrograph - Derivation of unit hydrograph from complex storms - unit hydrographs for various duration - Synthetic unit hydrograph - Transposing unit hydrograph - Application of the unit hydrograph.

Flood estimation - Flood forecasting - Flood routing - Basics of Stochastic and Deterministic models Linear Regression - Statistical and probability analysis of hydrological data - Flood frequency probability and stochastic methods.

Reservoir planning - Investigations - zones of storage in a reservoir - single purpose and multipurpose reservoir - determination of storage capacity and yield - reservoir sedimentation - Reservoir life - sediment prevention.

Water logging - causes and effects of water logging - remedial measures - land reclamation - land drainage - benefits - classification of drains - surface drains - subsurface drains - design principles and maintenance of drainage systems.

References

1. *Punmia, B.C., Irrigation and Water Power Engineering, Standard Publishers, 2001.*
2. *Ragunath. H.M., Hydrology, Willey Eastern Limited, New Delhi, 2000.*
3. *Subramanya, Engineering Hydrology, Tata-McGraw Hill, 2004.*

Course outcomes

On completion of the course, the students will be able to:

- Incorporate the analytical abilities in the planning and design of water resource systems.
- Apply the knowledge on reservoir planning and investigation.

- Understand the fundamentals of water logging, soil salinity and land reclamation.
- Understand the concepts of different types of hydrograph.
- Carryout Flood estimation and Flood routing.

CE310 HIGHWAY MATERIALS LABORATORY

Course objectives

- To learn the characteristics, properties and testing procedures of aggregate
- To learn the characteristics, properties and testing procedures of bitumen

Tests on aggregate

1. Specific Gravity
2. Sieve Analysis
3. Water Absorption
4. Shape Test- Flakiness Index
5. Shape Test- Elongation Index
6. Aggregate Impact Value
7. Aggregate Crushing Value
8. Los Angeles Abrasion Test

Tests on bitumen

9. Specific Gravity
10. Penetration Grade
11. Softening Point
12. Ductility Value
13. Flash and Fire Point
14. Viscosity Value

Mix design

15. Granular Sub-base
16. Bituminous Layer

Course outcomes

Upon completing of this course, the students should be able to:

- Characterize the aggregate used for road construction
- Characterize the bitumen used for road construction

CE312 COMPUTATIONAL LABORATORY – I

Course objectives

- To learn the software developing skills for structural design.
- To understand the computing techniques in the field of transportation.
- To gain knowledge in problem solving in water resources.

Course content

Solution of the following problems using MATLAB / C language / Excel

1) Design of the structural elements in concrete and steel.
2) Development of simple programs for solving Transportation Engineering problems: Highway geometrics, pavement design.
3) Development of simple programs for solving Geotechnical Engineering problems: Earth pressure, Foundation settlement and stress analysis, Consolidation.
4) Problems in Environmental and Water resources engineering: Treatment systems, Pipe networks analysis, Synthetic Unit hydrograph derivation, Flood routing, Water balance model.

Course outcomes

On completion of the course, the students will be able to:

- Apply the software skills in the design of infrastructure.
- Apply computing techniques to transportation engineering.
- Apply computing skills to water resources and environmental engineering.
- Apply computing skills to geotechnical engineering.

SEMESTER VII

CE401 MATRIX METHODS OF STRUCTURAL ANALYSIS

Course objectives

- To understand the importance of degrees of freedom and the concept of principle of superposition.
- To know about the concept of strain energy and principle of virtual work.
- To study the transformation of system matrices and element matrices for the determinate and indeterminate structures.
- To analyze the forces in structures like continuous beam, truss and frames using stiffness and flexibility method.
- To understand the behavior of structures due to thermal expansion and lack of fit.

Course content

Generalized measurements - Degrees of freedom - Constrained Measurements - Behavior of structures - Principle of superposition. Stiffness and flexibility matrices - Constrained measurements - Stiffness and flexibility coefficients from virtual work.

Strain energy - Stiffness and flexibility matrices from strain energy - Symmetry and other properties of stiffness and flexibility matrices - Betti's law and its applications - Strain energy in systems and in elements.

Determinate and indeterminate structures - Transformation of element matrices to system matrices - Transformation of system vectors to element vectors - Normal coordinates and orthogonal transformations.

Flexibility method applied to statically determinate and indeterminate structures - Choice of redundants - Transformation of redundants - Internal forces due to thermal expansion and lack of fit.

Development of the method - Internal forces due to thermal expansion and lack of fit - Application to symmetrical structures - Comparison between stiffness and flexibility methods.

References

1. *Moshe, F., Rubenstein, Matrix Computer Analysis of Structures, Prentice Hall, New York, 1986.*
2. *Rajasekaran S, Computational Structural Mechanics, Prentice Hall of India, New Delhi, 2001.*
3. *Manickaselvam V.K., Elements of Matrix and Stability Analysis of Structures, Khanna Publishers, New Delhi, 1998.*

Course outcomes

On completion of the course, the students will be able to:

- Apply the basic concepts of matrix methods in structural analysis.
- Develop stiffness and flexibility matrices.
- Analyse the structures using flexibility and stiffness method.
- Transform system coordinates to element coordinates.
- Determine the forces in various members due to lack of fit and thermal expansion.

CE403 IRRIGATION AND HYDRAULIC STRUCTURES

Course objectives

- To understand the basic types of irrigation, irrigation standards and crop water assessment
- To study the different aspects of design of hydraulic structures
- To provide knowledge on various hydraulic structures such as energy dissipaters, head and cross regulators, canal falls and structures involved in cross drainage works
- To understand the analysis of seepage and hydraulic jump
- To design different types of dams

Course content

Advantages and disadvantages of irrigation, water requirements of crops, consumptive use, Duty of water, relation between delta, duty and base period.

Diversion Structures-Functions and components of a diversion head work - Function-selection of site - type of weirs on pervious foundations - cause of failure - Bligh's creep theory and Khosla's theory - complete design of a vertical drop weir. Dam: Gravity dams - Non overflow section - forces acting - stability rules - elementary profile - Low and High dams - drainage gallery - Construction joints - Earthen dams.

Canal Irrigation- Classifications of canals, canal alignment, Silt theories – Kennedy's theory, Lacey's theory, Drawbacks in Kennedy's and Lacey's theories, comparison of Lacey's and Kennedy's theories, Design of unlined canals based on Kennedy and Lacey's theories, suspended and bed loads.Lined Canals: Types of lining, design of lined canal, Losses in canals-evaporation and seepage, water logging, causes and ill effects of water logging, anti-water-logging measures.

Cross drainage works: Canal falls - Necessity and location - Design of sand type fall - design of a cross regulator - cross drainage works - selection of suitable type of cross drainage work - canal outlets.

River training methods - Investigation and preparation of irrigation project: Classification of projects, concepts of multipurpose projects-major, medium and minor projects, planning.

Note: Assignments include the design and drawings of various irrigation structures.

References

1. *Sharma, S.K., Principles and Practice of Irrigation Engg, S.Chand & Co, 1984.*
2. *Arora K R "Irrigation Water Power & Water Resources Engineering" Standard Publishers Distributors, Delhi, 2002.*
3. *Garg S K "Irrigation Engineering & Hydraulic Structures" Khanna Publishers, Delhi, 1995.*

4. Varshney, Gupta & Gupta "Irrigation Engineering & Hydraulic Structure" Nem Chand & Bros., Roorkee, 1982.

5. Punmia, B.C., Irrigation and Water Power Engineering, Standard Publishers, 2001.

Course outcomes

On completion of the course, the students will be able to:

- Find the crop water requirement for various crops in the command area.
- Understand the complete design of Dams and channel systems.
- Understand the different types of cross drainage works.
- Design various river training methods.

CE405 CONSTRUCTION ENGINEERING AND MANAGEMENT

Course objectives

- To explain how do optimize construction period by suing management techniques
- To explain the role of construction planning in civil construction projects
- To emphasis project monitoring during execution time and quality control
- To understand different construction methods and selection of methods based on the project requirements
- To explain role of construction equipments in civil construction projects and selection of equipment with project specific.

Course content

Introduction- Construction Industry - Project Participants - characteristics of projects- Project life cycle - construction Organization Introduction contracts- Work Breakdown Structure.

Estimating project time and cost Planning - Developing a network plan - Bar chart - Activity on Arrow (AOA) - Activity on Node (AON), Precedence network, Introduction to computer software MS PROJECT and PRIMAVERA

Scheduling - network analysis- Start and finish time – floats - critical path Project Update - Project Controls - Schedule Compression- Cost-Time Trade Off (Network Crashing) – Cost - Time Trade Off.

Resource Management Resource scheduling, Construction Procurement - Inventory control – equipment management, material management.

Cost Management – introduction to financial management - Quality management and safety - Site Management & Administration.

References

1) *Vazirani V.N. & Chandola S.P., Heavy Construction.*
2) *Jha J. & Sinha S.K., Construction & Foundation Engineering, Khanna Publications.*
3) *Verma L.C., Standardisation - A New Discipline.*
4) *Peurifoy R.L., & Ledbetter W.B., Construction Planning Equipment & Methods.*

Course outcomes

Upon completion of this course, the students will be able to

- Understand the importance of management techniques in civil construction
- Do proper construction planning for effective project execution
- Prepare tender & contract documents and project quality control as per national and international standards
- Select proper and effective construction methods and equipments

CE407 COMPUTATIONAL LABORATORY – II

Course objectives

- To learn the software skills in structural engineering.
- To learn the software skills in the field of transportation engineering.
- To learn the software skills in water resources engineering.

- To learn the software skills in geotechnical engineering.
- To learn the software skills in GIS and Remote Sensing.

Course content

1. Analysis, Design and Detailing packages in Structural Engineering
2. Analysis and design packages in Transportation Engineering
3. Analysis and design packages in Environmental and Water Resources Engineering
4. Analysis and design packages in Geotechnical Engineering
5. GIS and Remote sensing applications
6. Use of Project Management Software

Course outcomes

On completion of the course, the students will be able to:

- Apply the software skills in the field of structural engineering.
- Apply the software skills in the field of transportation engineering
- Apply the software skills in the field of water resource engineering.
- Apply the software skills in the field of geotechnical engineering.
- Apply the software skills in the field of GIS and Remote Sensing.

CE409 ESTIMATION, COSTING AND VALUATION

Course objectives

- To know the importance of preparing the types of estimates under different conditions.
- To know about the rate analysis and bill preparations.
- To study about the specification writing.
- To understand the valuation of land and buildings.

Course content

Preparation of detailed estimates - Preparation of specifications report accompanying the estimate Approximate methods of Costing - types of estimate - costing for various structures - rate analysis - rate for material and labour - schedule of rates -data sheets - abstract estimate. Values and its kinds - Valuation - purpose- scope - methods - land and building method - Factors affecting the value of plot and building - depreciation - Valuation of residential building with case study.

References

1. *Dutta, Estimating and Costing in Civil Engineering, S. Datta & Co, 2002.*
2. *Bhasin, P.L., Quantity Surveying, 2nd Edition, S.Chand & Co., 2000.*

Course outcomes

On completion of the course, the students will be able to:

- Apply different types of estimates in different situations.
- Carry out analysis of rates and bill preparation at different locations.
- Demonstrate the concepts of specification writing.
- Carry out valuation of assets.

SEMESTER VIII

MB491 MANAGEMENT CONCEPTS & PRACTICES

Course objectives

- To enrich the students with the concepts and applications of Management
- To make the learners understand the basic functions of Financial Management
- To facilitate the students with the fundamental concepts of Technology management
- To enhance the understanding of Project Management techniques
- To impart the importance of Human Resources in the organizational context

Course content

Introduction to management - Evolution of Scientific and Modern Management Principles - Functions of Management-Types of Business Organization – Managerial Roles – Levels of Management.

Decision Making. Nature Purpose and Steps involved in Planning. Objectives - Strategies and Planning Premises. Nature and purpose of Organizing. Formal and informal Organization. Span of control - Delegation of Authority.

Introduction to Human Resource Management. Creativity and Innovation. Motivation theories (Hierarchy of Needs by Maslow, Herzberg's Two-Factor theory) - Motivational Techniques - Monetary & Non-monetary, Job Enrichment.

Types of Leadership - Leadership Theories. Communication - Process of Communication – Barriers and Breakdown - Effective Communication.

System and process of Controlling – Requirements for effective control - The budget as control Technique. Globalization and Liberalization - International Management and Global Theory of Management, Corporate Social Responsibility.

References

1. *Harold Kooritz & Heinz Weihrich "Essentials of Management", Tata McGraw - Hill.*
2. *L.M. Prasad, Principles of Management , Sultan Chand & sons, New Delhi.*
3. *Sherlekar & sherlekar, Principles of Management, Himalaya Publishing House, New Delhi.*
4. *Stephen Robbins, Organizational Behavior, Pearson Education, New Delhi.*

Course outcomes

On completion of the course, the students will be able to:

- Demonstrate the nuances of management functions.
- Analyze the framework of a business organization.
- Adopt an empirical approach toward business situations.
- Apply various Project Management techniques.
- Implement roles of team players.

ELECTIVES

CE451 ADVANCED DESIGN OF STEEL STRUCTURES

Course objectives

- To introduce the concept of plastic analysis.
- To study the behaviour and design of compression member subjected to eccentric force and design of base plate.
- To study the design of Gantry girder, welded plate girder, stiffeners and connections.
- To calculate the wind forces on steel stacks as per IS 875 and design the self-supporting steel stacks including base plate and anchor bolts.

Course content

Introduction to beam - column - behaviour - equivalent moment factor - strength interaction - design of beam column - beam - column subjected to tension and bending - column bases - slab base - gusseted base - moment resistant base plate.

Welded plate girders – analysis and design using IS800-2007 - curtailment of flange plates –stiffeners – analysis and design of gantry girder.

Design of industrial building - roofing, cladding and wall material - structural components and framing - types of roof trusses - components - wind load estimation as per IS875 part 3 - design of purlins and wall girts using Channel and Angle sections - truss members - joints - cold formed steel purlin.

Analysis and design of steel stacks - functional and structural requirements – self - supporting and guyed stacks - base plate and anchor bolt.

Introduction to Plastic analysis - ductility - plastic bending of beams - stages of bending - shape factor - plastic hinge - load factor - failure mechanism - upper and lower bound theorems of plastic analysis - collapse load for beams and frames.

Note: *Assignments include the design and drawings of various steel structures.*

References

1. *Subramanian N, Design of Steel Structures, Oxford University Press, New Delhi 2008.*
2. *Bhavikatti, S.S., Design of Steel Structures, I.K. International Publishing House Pvt. Ltd., New Delhi, 2010.*
3. *IS 800 - 2007, Code of practice for general construction in steel, Bureau of Indian Standards, New Delhi.*
4. *IS875 Part (3) - 1987, Code of Practice for Design Loads (other than earthquake) for buildings and structures: Wind loads., Bureau of Indian Standards, New Delhi.*
5. *SP6 (1) - 1964, IS hand book for structural Engineers. Bureau of Indian Standards, New Delhi.*

Course outcomes

On completion of the course, the students will be able to:

- Calculate shape factor and plastic moment capacity.
- Design eccentrically loaded compression members (Beam-Columns) and their base plates.
- Design welded plate girder and other components and Gantry girder.
- Carry out wind load calculations for tall structures and design of steel chimneys.

CE452 EXPERIMENTAL STRESS ANALYSIS

Course objectives

- To study the working principles of different types of strain gauges
- To understand the model analysis
- To know the fundamentals of photo elastic coatings
- To study the effects of 2-D photo elasticity
- To study the working principle of load, pressure and displacement transducers

Course content

Strain gauges – Mechanical, optical, acoustic, electrical inductance and capacitance pneumatic types – description and working principles.

Electrical resistance strain gauges, gauge characteristics and types – Equipment for recording static strain – reduction of strain gauge data. Load, pressure and displacement transducers.

Model analysis – direct and indirect models – law of structural similitude – choice of scales – Model materials – limitations of model studies –Buckingham PI theorem – design of direct and indirect models – Beggs deformeter and its applications.

Two dimensional photo – elasticity – optical principles stress optic law – Methods of producing isoclines and isochromatics using polariscopes – Methods of measuring fractional fringe orders – model materials – separation techniques.

Fundamental of Photo elastic coatings, Moire fringe and brittle coating techniques – Introduction to stress freezing techniques – Introduction to non-destructive testings.

References

1. *Daley and Riley, Experimental Stress Analysis, McGraw Hill Book Company, 1987*
2. *Srinath, L.S. et al., Experimental Stress Analysis, Tata McGraw Hill 1984.*
3. *Hetenyi, M., Hand Book of Experimental Stress Analysis, John Wiley & Sons. Inc New York. 1980.*

Course outcomes

On completion of the course, the students will be able to:

- Identify the different types of strain gauges.
- Carry out model analysis.
- Apply the concepts of photo elastic coatings.

- Analyse the behavior of 2-D photo elasticity.
- Apply the working principles of transducers.

CE453 EARTHQUAKE RESISTANT STRUCTURES

Course objectives

- To introduce the basics of Earthquake Engineering
- To introduce the engineering seismology, building geometrics & characteristics, structural irregularities,
- To introduce tips on earthquake engineering - do's and don'ts
- To introduce cyclic loading behaviour of RC, steel and pre-stressed concrete elements
- To discuss code provisions and their application on different types of structures

Course content

Elements of engineering seismology - Indian Seismicity -Earthquake History - Behavior of structures in the past Earthquakes - Seismic zoning - strong motion characteristics. Elements of EQ resistant design - load path - diaphragm action - Lateral load resisting systems - building configurations - vertical irregularities - plan irregularities - torsion due to irregularities – estimation of eccentricities and torsion.

Code based lateral load estimation - seismic co-efficient method - Response Spectrum- Design spectrum - effect of brick masonry infill - structural modeling of multi storied RC buildings – planar models - space frame and reduced 3D models - application of lateral load - analysis of building frames under lateral load.

Earthquake resistant design Concepts – virtues of EQR design - capacity based design - design of shear wall and frame members as per IS13920:1993 - Ductile detailing of frame members and shear walls.

Non - structural damage - Seismic evaluation - pushover analysis - seismic retrofitting - modern concepts - base isolation - adoptive systems - Case studies

References

1. *Pankaj Agarwal and Manish ShriKhande, Earthquake Resistant Design of Structures, Prentice - Hall of India, New Delhi, 2003.*
2. *S.K. Duggal, Earthquake resistant design of structures, Oxford University Press, New Delhi - 1.*
3. *Bullen K.E., Introduction to the Theory of Seismology, Great Britain at the University Printing houses, Cambridge University Press 1996.*

Course outcomes

- On completion of the course, the students will be able to:
- apply the basics of Earthquake Engineering
- demonstrate the dynamics of structural system under earthquake load
- analyze the influence of the structural / geometrical design in building characteristics
- demonstrate the cyclic loading behaviour of RC steel and pre-stressed concrete elements
- apply codal provisions on different types of structures

CE454 STRUCTURAL DYNAMICS

Course objectives

- To introduce the concepts of dynamic systems
- To study the dynamic response of SDOF
- To study the dynamic response of MDOF

- To introduce the continuous systems subjected to different types of dynamic loads
- To learn free and forced vibrations response of structural systems

Course content

Dynamic analysis - Elements of vibratory systems and simple Harmonic Motion- Mathematical models of SDOF systems - Principle of Virtual displacements - Evaluation of damping resonance.

Fourier series expression for loading - (blast or earthquake) - Duhamel's integral - Numerical evaluation - Expression for generalized system properties - vibration analysis Rayleigh's method - Rayleigh - Ritz method.

Differential equation of motion - Beam flexure including shear deformation and rotatory inertia - Vibration analysis using finite element method for beams and frames.

Evaluation of structural property matrices - Natural vibration - Solution of the eigen value problem - Iteration due to Holzer and Stodola.

Idealization of multi-storeyed frames - analysis to blast loading - Deterministic analysis of earthquake response - lumped SDOF system - Design of earthquake resistant structures.

References

1. *Mario Paz, Structural Dynamics, CBS, Publishers, 1987.*
2. *Roy R Craig, Jr., Structural Dynamics, John Wiley & Sons, 1981.*
3. *A.K. Chpora "Dynamics of Structures Theory and Application to Earthquake Engineering" Pearson Education, 2001.*

Course outcomes

On completion of the course, the students will be able to:

- Apply the concepts of dynamic systems.
- Identify, formulate and solve dynamic response of SDOF.
- Identify, formulate and solve dynamic response of MDOF.

- Analyse continuous systems subjected to different types of dynamic loads.
- Identify, formulate and solve free and forced vibrations response of structural systems.

CE455 FINITE ELEMENT METHOD

Course objectives

- To study the strain – displacement and linear constitutive relation
- To understand the numerical techniques applied in FEM
- Establishment of element stiffness and load vector
- To study about the 2-D isoparametric concepts
- To analyze the 2-D frame elements using FEM techniques

Course content

Differential equilibrium equations - strain displacement relation - linear constitutive relation - special cases - Principle of stationary potential energy - application to finite element methods - Some numerical techniques in finite element Analysis.

Displacement models - convergence requirements. Natural coordinate systems - Shape function. Interpolation function. Linear and quadratic elements - Lagrange & Serendipity elements. Strain displacement matrix - element stiffness matrix and nodal load vector.

Two dimensional isoparametric elements - Four noded quadrilateral elements - triangular elements. Computation of stiffness matrix for isoparametric elements - numerical integration (Gauss quadrature) Convergence criteria for isoparametric elements.

Assemblage of elements – Direct stiffness method. Special characteristics of stiffness matrix - Boundary condition & reaction - Gauss elimination and LDLT decomposition. Basic steps in finite element analysis.

Analysis of framed Structures: 2D – truss element - 2D - beam element. Analysis of plate bending- displacement functions - plate bending Elements. Plane stress and plane strain analysis: Triangular elements - Rectangular elements

References

1. *Krishnamoorthy, C.S, Finite Element Analysis Theory & Programming, McGraw-Hill, 1995.*
2. *Desai C.S and Abel, J.F., Introduction to the finite element Method, Affiliated East west Press Pvt. Ltd. New Delhi 2000.*

Course outcomes

On completion of the course, the students will be able to:

- Demonstrate the differential equilibrium equations and their relationship.
- Apply numerical methods to FEM.
- Demonstrate the displacement models and load vectors.
- Compute the stiffness matrix for isoperimetric elements.
- Analyse plane stress and plane strain problems.

CE456 STEEL - CONCRETE COMPOSITE STRUCTURES

Course objectives

- To introduce the concept of composite construction and their applications in engineering
- To discuss shear connector types, degree of shear connector, interaction and their strength
- To introduce design of composite beams under propped and un-propped condition
- To introduce design of different types of composite deck slabs
- To discuss effects of temperature, shrinkage and creep and cyclic loading on composite sections

Course content

Introduction – types – advantages – comparison – applications - limit states of composite sections – introduction to plastic analysis – mechanism of composite members.

Shear connectors – types of shear connectors – degree of shear connection – partial and complete shear connections – strength of shear connectors – experimental evaluation of shear connectors.

Analysis and design of composite beams without profile sheet - propped condition – un-propped condition – deflection - design of partial shear connection.

Design of composite beam with profile sheet – propped and un-propped condition – deflection of composite beams –design of partial shear connection.

Introduction – Composite slabs – profiled sheeting – sheeting parallel to span – sheeting perpendicular to span – analysis and design of composite floor system.

References

1. *Johnson R.P., "Composite Structures of Steel and Concrete"' Volume-I, Black Well Scientific Publication, U.K., 1994*
2. *Teaching Resources for "Structural Steel Desgin". Vol.2 of 3, Institute of Steel Development and Growth (INSDAG), 2000*
3. *Narayanan R., "Composite Steel Structures – Advances, Design and construction, Elsevier, Applied Science, U.K., 1987*
4. *Owens, G.W & Knowels, P., Steel Designers Manual," (fifth edition), Steel Concrete Institute (U.K), Oxford Blackwell Scientific Publication, 1992.*
5. *IS 11384 – 1985 Indian Standard Code of Practice for Composite Construction in Structural Steel and Concrete, Bureau of Indian Standards, New Delhi*

Course outcomes

On completion of the course, the students will be able to:

- Apply the concepts of composite construction in engineering.
- Analyse the behaviour of shear connectors, degree of shear connection and their interaction.

- Design composite beams under propped and un-propped condition.
- Design different types of composite deck slabs.
- Analyse the effects of temperature, shrinkage and creep and cyclic loading on composite sections.

CE457 PRESTRESSED CONCRETE STRUCTURES

Course objectives

- To learn the principles, materials, methods and systems of prestressing
- To know the different types of losses and deflection of prestressed members
- To learn the design of prestressed concrete beams for flexural, shear and tension and to calculate ultimate flexural strength of beam
- To learn the design of anchorage zones, composite beams, analysis and design of continuous beam
- To learn the design of water tanks

Course content

Principles of prestressing - Materials of prestressing - Systems of prestressing - Loss of prestress - Deflection of Prestressed Concrete members.

Slabs - Pre-tensioned and Post-tensioned beams - Design for flexure, bond and shear - IS code provisions - Ultimate flexural and shear strength of prestressed concrete sections - Design of end anchorage zones using IS code method.

Composite beams - Analysis and design.Partial prestressing - non-prestressed reinforcements.

Analysis of Continuous beams - Cable layout - Linear transformation - Concordant cables.

Design of compression members and tension members. Circular prestressing - Water tanks - Pipes - Analysis and design - IS Codal provisions.

References

1. *Lin. T.Y., Burns, N.H., Design of Prestressed Concrete Structures, John Wiley & Sons, 1982.*
2. *RajaGopalan N. Prestressed Concrete, Narosa Publishing House, New Delhi, 2002.*

Course outcomes

On completion of the course, the students will be able to:

- Design a pre-stressed concrete beam accounting for losses.
- Design the anchorage zone for post tensioned members.
- Design composite members.
- Design continuous beams.
- design water tanks

CE458 OCEAN STRUCTURES AND MATERIALS

Course objectives

1. To introduce different types of ocean structures.
2. To describe the different types of environmental loads on ocean structures.
3. To understand the codes of practice for marine structures.
4. To provide knowledge on repair and rehabilitation of marine structures.

Course content

Introduction to different types of ocean structures- near shore structures, different structural systems of ocean structures namely: fixed, floating, compliant type, semi-submersibles etc.

Types of environmental loads- structural action of ocean structures- planning guidelines and design principles- regulations and codes of practice- foundation of ocean structures- sea bed anchors- dredging methods and equipments.

Different materials for marine applications: metals, concrete and other materials for marine environment- their characteristics, properties and selection guidelines. Problems associated with deterioration of materials in marine environment, their remedies and protection methods.

Codes of practice. Inspection and testing of marine structures- methods and equipments- non-destructive techniques.

Repair and rehabilitation of marine structures. Structural health monitoring of marine structures.

References

1. *Robert T Hudspeth, Waves and wave forces on coastal and ocean structures.*
2. *Subratakumar Chakrabarti, Offshore structure modelling.*

Course outcomes

By the end of this course the students will be able to

- Understand the different materials used in the ocean structures.
- Apply the knowledge on different structural systems such as offshore and coastal structures.
- Understand the planning and design guide lines of structural systems.
- Apply basic design concepts for fixed and floating platforms.

CE461 GROUND WATER HYDROLOGY

Course objectives

- To know the types of aquifers
- To understand the surface and subsurface investigation in detail
- To integrate the fundamental and basic knowledge of ground water movement
- To understand the process of sea water intrusion and recharge
- To introduce the different model studies

Course content

Groundwater occurrence – distribution – aquifer – types - Surface investigation - Geophysical - electrical resistivity - Seismic refraction - Gravity and magnetic - Geologic - Air photo interpretation - Dowsing.

Subsurface investigation - test drilling - resistivity logging- potential logging - temperature and caliper logging.

Steady unidirectional flow - well in a uniform flow - steady flow with uniform recharge - unsteady radial flow to a well - well flow near aquifer boundaries - Multiple well systems - partially penetrating wells - characteristic well losses.

Secular and seasonal variations - Fluctuations due to evapo-transpiration, Meteorological phenomena, tides, external loads and earthquakes - control by drains and wells.Recharge through sewage pits, shafts and wells.

Occurrence of sea water intrusion - Ghypon-Heizberg relation between fresh and saline waters - shape length and structure of the fresh salt water interface - prevention and control of seawater intrusion - role of sea water in ground water - coastal zoning.

Sand models - Electrical models - Viscous fluid models - membrane models - numerical analysis methods

References

1. *Raghunath H.M., Ground Water Hydrology, New-Age International, 2nd Edition, 1990.*
2. *Todd, D.K, Ground Water Hydrology, Prentice hall, 2004*

Course outcomes

On completion of the course, the students will be able to:

- Identify types of aquifers.
- carry out surface and subsurface investigation to locate groundwater.
- visualise the occurrence and movement of groundwater.
- select suitable type of ground water recharge.
- assess sea water intrusion and its control.

CE462 SIMULATION MODELING IN WATER RESOURCES

Course objectives

- To build on the student's background in basics of simulation modelling.
- To develop the skills in modelling of linear and nonlinear regression.
- To develop skills in the artificial intelligence tools such as fuzzy systems, neural networks and genetic programming.
- To provide wide knowledge on optimization tools.

Course content

Introduction – Concepts of systems and systems Analysis; Systems Techniques in Water Resources: Optimization with methods using calculus.

Regression – linear regression - multiple regression – non linear regression – types – modelling concepts – montecarlo simulation - Linear Programming- simplex method – dual simplex method graphical method.

Dynamic programming – forward recursion – backward recursion – water allocation problem – shortest path algorithm – water distribution network – stochastic dynamic programming.

Artificial Intellingence – Neural networks – concepts – back propogation – bias, neuron, weights - radial basis function – case studies – Genetic algorithm – ANN basics.

Optimization tool- roulette wheel selection – mutation – crossover- case studies Reservoir optimization – Fuzzy inference system – Fuzzy linear programming.

References

1. *Water Resources systems, Vedula and Majumdar, Tata Mcgraw hill Publishers.*
2. *Engelen, G.B., Kloosterman, F.H.Hydrological Systems Analysis, Water Science and Technology Library, Vol. 20.*
3. *Hydrologic Analysis and Design, Richard H. McCuen, Prentice-Hall, 1989. 3rdEdt*
4. *Engineering Hydrology: Principles and Practices,Ponce, Victor Miguel, Prentice-Hall, Inc., 1989.*

Course outcomes

By the end of this course the students are able to

- Incorporate skills in developing models for various systems.
- Acquire knowledge on fundamentals of regression techniques.
- Develop and improve the knowledge in dynamic programming and stochastic programming.
- Apply the basic knowledge on fuzzy system and optimization tools.

CE463 COASTAL ENGINEERING

Course objectives

- To provide basic knowledge on two dimensional wave equation
- To describe the various types of wave theories.
- To study the effect of wave loads on different coastal structures
- To improve the knowledge on physical modelling tools in offshore and onshore activities.

Course content

Basic Fluid Mechanics: Conservation of mass and momentum, Euler Equation, Bernoullis equation, potential flow, stream function. Waves: Classification of water waves - Two dimensional wave equation and wave characteristics.

Wave theories - Small amplitude waves – Finite amplitude waves - Stoke, Solitary and CnoidalWater particle kinematics - wave energy, power - wave deformation - Reflection, Refraction, Diffraction Breaking of waves - Spectral description of Ocean Waves - Design wave.

Currents: Classification - Behaviour - Design Criteria, Scour and other effects of currents.Forces: Wave forces - Morison equation - wave loads on vertical, inclined and horizontal cylinders. Diffraction theory - wave slamming and slapping.

Wave impact pressures and forces on Coastal Structures - Breakwaters - Seawalls – Coastal Sediment transport - Limits for littoral drift - Suspended and Bed Load - longshore sediment transport rate - Distribution of longshore currents and Sediment transport rates in Surf zone.

Physical modelling in Coastal Engineering. On shore offshore sediment transport - Coastal Features - Beach Features - Beach cycles - Beach Stability - Beach profiles - artificial nourishment - planning of coast protection works - Design of shore defence structures - Case studies.

References

1. *Subratakumar Chakrabarti, Hand book of offshore engineering.*
2. *Coastal, Estuaries and Harbour Engineer's reference book, Michael Abbott, W Alan price.*
3. *Coastal Engineering Research reports.*

Course outcomes

By the end of this course the students will be able to

- Develop knowledge in sediment transport along coastal areas.
- Apply the basics of wave hydrodynamics.
- Understand wave forces, wave pressures and currents in the coastal areas.
- Apply the knowledge on sea defence structures.

CE 464 REMOTE SENSING AND GIS FOR WATER RESOURCES ENGINEERING

Prerequisite: GIS and Remote Sensing

Course objectives

- To gain a sound fundamental understanding of the GIS and remote sensing technologies
- To understand the basic principles underlying the GIS/model-based management of water resources and environment.
- To become familiar with the GIS-based analytical and problem-solving techniques for sustainable planning and management of water resources and environmental problems.
- Different types of remotely sensed images and data available for water resource applications.

Course content

Hydrological modelling-variation in precipitation distribution – analysis and interpretation of precipitation data Tropical Rainfall Measuring Mission (TRMM).

Runoff estimation for Gauged and Ungauged basin, SCS-CN Model and Snow hydrology applications flood modeling and flood plain mapping.

Evapotranspiration over land surface–Factors controlling evapotranspiration–NDVI, SPI and Palmer index, Microwave remote sensing on soil moisture estimation-RS and GIS applications on Evapotranspiration modeling and drought warning system.

RS and GIS application on ground water potential mapping, artificial recharge zone identification, ground water quality mapping and modeling, coastal aquifers recharge and sea water intrusion.

Approaches to planning and development of water resources-Soil erosion and reservoir sedimentation-catchment nutrient transport- water balance- water supply and sewerage utilization – Various case studies.

References

1. *Olson, R. E., (1970) A Geography of Water Resources, WMC Brown Company Publishers, Iowa.*
2. *Sewell, W.R.D., (1975) Geography of Water Resources, Prentice Hall, New York.*
3. *Lyon, J.G., (2003) GIS for Water Resource and Watershed Management, Taylor and Francis,New York.*
4. *Sabins, F., Remote Sensing Principles and Interpretation, W. H. Freeman and Company, New York, 3rd edition, 2007.*
5. *George Joseph, Fundamentals of Remote sensing, University Press, Second edition, 2005.*

Course outcomes

By the end of this course the students will be able to

- Develop fundamental understanding of the GIS and remote sensing technologies

- Understand the basic principles underlying the GIS based management of water resources and environment.
- Apply the GIS-based analytical and problem-solving techniques for sustainable planning and management of water resources and environmental problems.
- Understand the types of remotely sensed images and data available for water resource applications.
- Develop a project report and can develop Water Resource Information Systems (WRIS) for regional and basin scale.

CE 465 DISASTER MODELING AND MANAGEMENT

Course objectives

Upon successful completion of the course, you will be able to

- To know the types of Disasters and its triggering factures.
- Understand the stages of emergency management and GIS capabilities and kinds of data are required to support emergency management work during the disasters.
- Assess the potential of new, evolving GIS technologies to meet vulnerability mapping, modeling and emergency management needs.
- Develop a report or project proposal that identifies or responds to needs for GIS solutions in emergency management.
- Develop a Disaster Management Systems (DMS) for regional and large scale.

Course content

Disasters: Definition- Hazard Risk, Mitigation, Natural and human-induced disasters-types of hazards, disasters and catastrophes – Disaster Management.

Hydrological Hazards: Cyclone – damage assessment- Flooding: Topography, land use and flooding– flood prone area analysis and management Tsunami and floods.

Drought- types of drought, -factors influencing drought - delimiting drought prone areas - drought index, SPI and Palmer.

Geological Hazards: Earthquakes; location, faults, causes, types, associated hazards and impacts, Richter scale and Modified Mercalli scale. Important examples from India. Structural damage and its prevention - Dams and earthquakes.-Tsunamis - earthquake induced landslide.

Geomorphic Hazards: Mass movements: Definition of landslides, causes, debris flows, landslides in soil and rock, slope stability analysis.

Mitigation and Management: Hazard, Risk and Vulnerability mapping and modeling using GIS. Case studies for earth quake zonation.Preparedness- GIS case studiesfor earthquake, landslide–risk assessment–GIS case studies for earthquake, landslide and cyclones. Emergency Management Systems (EMS) in the Disaster Management Cycle.

References:

1. *National Disaster Management Division (2004) Disaster Management in India - A Status Report, Ministry of Home Affairs, Government of India, New Delhi.*
2. *UNDRO (1995) Guidelines for Hazard Evaluation Procedures, United Nations Disasters Relief Organization, Vienna.*
3. *Nagarajan, R., (2004) Landslide Disaster Assessment and Monitoring, Anmol Publications, New Delhi.*
4. *Ramkumar, Mu, (2009) Geological Hazards: Causes, Consequences and Methods of Containment, New India Publishing Agency, New Delhi.*
5. *Arnold M et.al Ed. (2006) Natural Disaster Hotspots:Case Studies. The World Bank Hazard Management Unit Washington, D.C.204p.*

Course outcomes

By the end of this course the students will be able to

- Understand the types of disasters and their triggering factors.
- Understand the stages of emergency management and GIS capabilities and kinds of data are required to support emergency management work during the disasters.
- Assess the potential of new, evolving GIS technologies to meet vulnerability mapping, modeling and emergency management needs.
- Prepare a report or project proposal that identifies or responds to needs for GIS solutions in emergency management.
- Develop a Disaster Management Systems (DMS) for regional and large scale.

CE471 TRANSPORTATION PLANNING

Course objectives

- To know about the process and concepts of transportation planning
- To study about trip generation
- To study about trip distribution
- To study about modal split analysis
- To study about trip assignment

Course content

Transportation Planning Process and Concepts - Role of transportation - Transportation problems - Urban travel characteristics - Concept of travel demand - Demand function - demand estimation - Sequential, recursive and simultaneous processes.

Trip Generation Analysis - Zoning - Types and sources of data - Expansion factors - Accuracy checks - Trip generation models - Zonal models - Household models - Category analysis - Trip attractions of work centers.

Trip Distribution Analysis - Trip distribution models - Growth factor models - Gravity models - Opportunity models.

Mode Split Analysis - Mode split Models - Mode choice behavior, Competing modes, Mode split curves, Probabilistic models.

Traffic Assignment - Route split analysis: Elements of transportation networks, Nodes and links - minimum path trees - all-or-nothing assignment - Multipath assignment - Capacity restraint.

References

1. *Hutchinson B.G., Principles of Urban Transportation System Planning, McGraw Hill, 2007.*
2. *Bruton M.J., Introduction to Transportation Planning, Hutchinson, London, 1992.*
3. *C. Jotin Khisty, B. Kent Lall, Transportation Engineering, Prentice Hall of India, 2002.*

Course outcomes

On completion of the course, the students will be able to:

- Apply the principles of the transportation planning process and demand estimation.
- Analyse the trip production and trip attraction models.
- Analyse the growth factor, gravity and opportunity models.
- Apply the mode choice behaviour and mode split models.
- Apply the shortest path models for route assignment.

CE472 PAVEMENT ANALYSIS AND DESIGN

Course objectives

- To study about the types and components of pavements
- To learn about the stresses in flexible pavements and equivalent single wheel load
- To study the design of flexible pavements
- To learn about the stresses in rigid pavements
- To study the design of rigid pavements

Course content

Pavements - Types and Component - Factors affecting Design and Performance of Pavements, Comparison between Highway and Airport pavements - Functions and Significance of Sub grade properties

Stresses in Flexible Pavements - Stresses and Deflections in Homogeneous Masses - Burmister's 2-layer, 3-layer Theories - Wheel Load Stresses, ESWL of Multiple Wheels Repeated Loads and EWL factors.

Flexible Pavement Design - Empirical - Semi-empirical and Theoretical Approaches; Principles and procedure, design, Advantages and Applications of different Pavement Design Methods - Stresses in Rigid pavements - Types of Stresses and Causes - Factors influencing the Stresses, General conditions in Rigid Pavement Analysis, ESWL, Wheel Load Stresses, Warping Stresses, Friction Stresses, Combined Stresses.

Rigid Pavement Design - Types of Joints in Cement Concrete Pavements and their Functions, Joint Spacings, Design of Slab Thickness, Design of Joint Details for Longitudinal Joints, Contraction Joints and Expansion Joints, IRC Method of Design

References

1. *Yoder and Witezak, Principles of pavement design¸ John Wiley and sons, 1975*
2. *Yang, Design of functional pavements, Mc Graw -Hill, 2004.*
3. *IRC: 58 - 2002, Guidelines for the Design of Plain Jointed Rigid Pavements for Highways*
4. *IRC:37 - 2001, Guidelines for the Design of Flexible Pavements*

Course outcomes

On completion of the course, the students will be able to:

- Identify the pavement components and compare highway and airport pavements.
- Calculate stresses and ESWL in flexible pavements.
- Design the flexible pavement using empirical and semi empirical methods.
- Analyze the warping, friction, wheel load stress and calculate the combined stress.
- Design rigid pavements by IRC method and evaluate the pavements.

CE473 GEO-INFORMATICS IN TRANSPORTATION ENGINEERING

Prerequisite: GIS and Remote Sensing

Course objectives

- To learn the basic concepts of geo-informatics in brief that includes Geographical Information System (GIS), Remote Sensing (RS), and Global Positioning System (GPS).
- To understand these basic concepts in context of transportation and transportation networks.
- To learn the data needs and database development for doing transportation analysis in GIS environment.

- To understand the concepts of transportation networks and algorithms and how they are incorporated into GIS.
- To understand various applications of GIS in Transportation (GIS-T) including Intelligent Transport Systems (ITS) and learn from some case studies.

Course content

Concept of GIS and RS; land use and transportation data Spatial and Non spatial data for land use and transportation. Traffic Analysis Zone (TAZ) and screen lines. Network and Routes. Database development, map generation and analysis;Concept of map layers, Land cover analysis.

Network creation and linear route building. Map accuracy and location expression.Generation of Themes and charts. Transportation network development and algorithms;Network development and management. Network properties, Shortest path algorithms, Transit network and paths.

Transportation Models and their Applications in GIS:Transportation and land use Models.Linear and Network Models.

GIS-T applications: Background and trends of GIS-T application. GIS-T application areas. Transportation models and their applicationsin GIS.

GIS-T applications; Intelligent Transport Systems (ITS);Intelligent Transport Systems (ITS): Components of ITS. Architecture and integration with GIS. Analysis and visualizations of traffic data in GIS. Integration of GPS and GIS. Some case studies.

References

1. *Burrough P.A. and Rachel A. McDonell, Principles of Geographical Information Systems, Oxford Publication, 2004.*
2. *Thomas. M. Lillesand and Ralph. W. Kiefer, Remote Sensing and Image Interpretation, John Wiley and Sons, 2003.*

3. *Sabins, F., Remote Sensing Principles and Interpretation, W. H. Freeman and Company, New York, 3rd edition, 2007.*
4. *George Joseph, Fundamentals of Remote sensing, University Press, Second edition, 2005.*

Course outcomes

On completion of the course, the students will be able to:

- Understand the various satellites data products available for the Urban and transportation applications.
- Apply the GIS and Remote Sensing techniques for various Urban and transportation problems.
- Apply the GIS-based analytical and problem-solving techniques for sustainable planning and management of urban infrastructure and Intelligent Transportation System problems.
- Develop a Transportation network Information Systems (TNIS) for regional and basin scale.
- Prepare project proposal that identifies or responds to needs for GIS solutions in urban- transport management.

CE474 TRAFFIC ENGINEERING AND SAFETY

Course objectives

- To learn the fundamentals of traffic engineering
- To learn the methods of intersection design
- To learn the skills of traffic control
- To be introduced to the different theories of traffic flow
- To be aware of the importance of traffic safety

Course content

Scope, traffic elements - Characteristics- vehicle, road user and road - Traffic studies – Geometric Design - Safety considerations.

Intersection Design - Types of intersections - Conflict diagrams –Control hierarchy- Design of rotaries & at-grade intersections – Signal design - Grade separated interchanges & their design.

Traffic System Management - Speed, vehicle, parking, enforcement regulations - Mixed traffic regulation - Management techniques, one-way, tidal flow, turning restrictions etc. – Transportation System Management Process – TSM Planning & Strategies.

Traffic Flow Theory - Macroscopic, Microscopic & Mesoscopic approach – Types of Flow- Traffic stream characteristics – Space – Time diagram – Relationship between speed, flow & density-Level of service & capacity analysis – Shockwave theory.

Road Safety Audit - Global & Local perspective – Road safety issues – Road safety programmes – Types of RSA, planning, design, construction & operation stage audits – Methodology – Road safety audit measures

References

1. *Kadiyali, L.R., Traffic Engineering and Transport Planning, Khanna Publishers, New Delhi, 2012.*
2. *Khisty C J,Lall B.Kent; Transportation Engineering-An Introduction, Prentice-Hall,NJ, 2005*
3. *May, A.D., Traffic Flow Fundamentals, Prentice – Hall, Inc., New Jersey,1990.*
4. *Pignataro, L.J., Traffic Engineering – Theory & Practice, John Wiley, 1985.*

Course outcomes

Upon completing of this course, the students should be able to:

- Carry out traffic studies
- Design intersections
- Implement traffic system management
- Be aware of traffic flow theory
- Enhance safety in all design aspects

CE481 ADVANCED FOUNDATION ENGINEERING

Course objectives

- To explain the analysis of sheet pile wall under different support conditions
- To explain overall stability analysis of well foundation
- To explain fundamentals of soil dynamics and its application to machine foundation analysis including codel provisions
- To explain problems related to expansive soils and solution to overcome
- To explain the concept of slope stability analysis for various slope conditions including graphical methods

Course content

Sheet pile structures - cantilever sheet pile walls in granular and cohesive soils - Anchored bulk heads - Free earth support and fixed earth support methods - Anchors.

Cofferdams - types - cellular cofferdam - uses - Design by TVA and Cumming's method.

Well foundations - Types of caissons - Analysis of well foundations - determination of scourdepth - steining thickness - well sinking.

Foundations subjected to vibrations - elements of vibrations - Free, damped, free and forced vibrations - Design criteria - Pauw's analogy - IS Code of practice for impact and reciprocating machines.

Foundation drainage and water proofing - Dewatering well points system, sand drains. Foundations in expansive soils - Mechanism - factors influencing swelling - Use of Geosynthetics.

Stability analysis of slopes - infinite slopes in sand and clays - finite slope - Swedish circle - stability of earth dam slope during steady and sudden draw down - friction circle method - Taylor's stability number. Sheet pile structures - Anchored bulk heads

References

1. *Bowles, J.E., Foundation Analysis and Design, McGraw Hill., 1996.*
2. *Braja M. Das, Principles of Foundation Engineering, Thomos Asia Pvt. Ltd., Singapore, 2005.*
3. *Shamsher Prakash, Soil Dynamics, McGraw - Hill Book Company, 1985.*

Course outcomes

On completion of the course, the students will be able to:

- Analyse and design any kind of sheet pile wall system including coffer dam.
- Analyse and design well foundation including complete stability analysis.
- Estimate soil parameters under dynamic conditions including machine foundations.
- Design a suitable foundation system for any kind of problematic soils.
- Analyse the stability of any kind of slope by using both theoretical and graphical methods.

CE482 GEOTECHNICAL EARTHQUAKE ENGINEERING

Course objectives

- To explain the mechanism of earthquake and its related causes to build structures and in-situ soils.
- To explain how ground motion is recorded and how do quantify the earthquake intensity and frequency related parameters.
- To explain how seismic site investigation will be done and seismic soil design parameters are estimated.
- To explain how seismic resistant design of foundation will be done and also explain the concept of liquefaction and related causes including codal recommendations.
- To explain how to do hazard assessment and mitigation and explain how do prepare a risk and microzonation mapping

Course content

Mechanism of Earthquakes - Causes of earthquake - Earthquake Fault sources - Elastic Rebound theory - Seismic wave in Earthquake shaking - terminology - Locating an earthquake - Quantification of earthquakes. Strong Motion Records -characteristics of ground motion - Factors influencing Ground motion - Estimation of frequency content parameters.

Seismic site investigations – Selected Case Studies - Evaluation of Dynamic soil properties – Codal Provisions.

Design Ground Motion - Developing Design Ground Motion-Codal recommendations. Earthquake Resistant Design of foundation of buildings - Design considerations -. Earthquake Response of slopes - Evaluation of slope stability - Liquefaction-Susceptibility - Liquefaction Resistance-Codal recommendations.

Risk mapping - Hazard assessment – Mitigation measures - Seismic microzonation and its importance

References

1. *Kameswara Rao, N.S.V., Dynamics soil tests and applications, Wheeler Publishing - New Delhi, 2000.*
2. *Krammer S.L., Geotechnical Earthquake Engineering, Prentice Hall, International Series, Pearson Education (Singapore) Pvt. Ltd., 2004.*
3. *Kameswara Rao, Vibration Analysis and Foundation Dynamics, Wheeler*
4. *Robert W. Day, Geotechnical Earthquake Engineering Hand book, McGraw Hill, 2002*

Course outcomes

On completion of the course, the students will be able to:

- Demonstrate the principles of earthquake loading.
- Quantify earthquake intensity and ground motion.
- Estimate seismic soil design parameters.
- Analyse and design seismic resistant foundation for buildings.
- Prepare soil risk and microzonation maps.

CE483 REINFORCED EARTH AND GEOTEXTILES

Course objectives

- To explain the basic mechanisms of soil reinforcement and design principles in reinforced earth wall.

- To understand the applications of geosynthetics in geotechnical problems and its design principles.
- To explain the usage of geosynthetics in geoenvironmental and pavement engineering with design .
- To explain the present status of development in geo-synthetics and filed instrumentation and control

Course content

Reinforced Earth – The mechanisms of the reinforced earth techniques – Design principles – Materials used for construction – Advantages of reinforced earth – Reinforced earth construction techniques.

An overview of Geosynthetics, Description of Geotextiles – Geogrids – Geonets – Geomembranes – Geocomposites– Geocells – Designing with Geotextiles – Geotextile properties and test methods – Functions of Geotextile – Design methods for separation – stabilization – filtration – Drainage.

Designing with Geogrids – Geogrid properties and test methods – Designing with Geonets – Geonet properties and test methods – Designing with Geomembranes – Geomembrane properties and test methods – construction practices with Geotextiles, Geogrids, Geonets, Geomembranes.

Design of liquid Contaminant liners – liquid contaminant liners – Covers for reservoirs- Water conveyance (Canal liners)-- solid material liners – underground storage tanks – Design of pavements – Geo composites as liquid /Vapour Barriers –Improvement in bearing capacity – Erosion Control for water ways.

Geo Synthetics: Recent research and Developments. Control of Improvement – Field Instrumentation – design and analysis for bearing capacity and settlement of improved deposits.

References

1. Robert M. Koerner, Designing with Geosynthetics, Prentice Hall ,1989 .

2. Rao, G. V., and Suryanarayana Raju, G. V. S., Engineering with Geosynthetics, Tata Mc Graw Hill Publishing Co. New Delhi, 1990.

3. Shukla, S. K., Geosynthetics and their Applications, Thomas Telford, London,2002.

Course outcomes

Upon completion of this course, the students will be able to

- Understand the principles of soil reinforcement and they can able to do any reinforced wall design using steel strip or geo-reinforcement
- Understand the application of geosynthetics in geotechnical engineering.
- Decide what kind of geosynthetics should be used for the problem specific application including its design principles.
- Do proper field test using the recent development in geosynthetics.

CE484 EARTH AND EARTH RETAINING STRUCTURES

Prerequisite: Geotechnical Engineering I & II

Course objectives

- To explain the concept of earth dam design including stability analysis under seepage.
- To evaluate stability of slopes under different drainage conditions using different methods including slope protection and quality control.
- To estimate active and passive earth pressure using different earth pressure theory including graphical method.
- To explain design principles of retaining structures and coffer dams.

Course content

Introduction: Earth dams – types of dams – selection of type of dam based on material availability – foundation conditions and topography- Design details – crest, free board, upstream and downstream slopes, upstream and downstream slope protection – central and inclined cores – types and design of filters- Seepage analysis and control – seepage through dam and foundations – control of seepage in earth dam and foundation.

Stability analysis – critical stability conditions – evaluation of stability by Bishop's and sliding wedge methods under critical conditions - Construction techniques – methods of construction –quality control Instrumentation – measurement of pore pressures.

Rigid retaining structures – active and passive earth pressures against gravity retaining walls – Surcharge - computation of earth pressures by Trial wedge method – a mathematical approach for completely submerged and partly submerged backfills – importance of capillarity tension in earth pressure.

Graphical methods of earth pressure computation – trial wedge method for coulomb's and Rankine's conditions, for regular and irregular ground and wall conditions – Rebhan's construction for active pressure – friction circle method – logarithmic spiral method.

Design of gravity retaining wall – cantilever retaining walls - Flexible retaining structure – type and methods of construction – design strength parameters – safety factor for sheet pile walls – computation of earth pressures against cantilever sheet piles in cohesion less and cohesive soils – anchored sheet piles – free earth method – fixed earth method – Rowe's moment reduction method – stability of sheet piling Diaphragm walls and coffer dams – type of diaphragm walls and their construction techniques in various soil types –earth pressure on braced cuts and coffer dams – design of coffer dams.

References

1. *Clayton, Milititsky and Woods, Earth Pressure and Earth-Retaining Structures, Taylor and Francis, 1996*
2. *Bowles, Foundation Analysis and Design, 1968.*
3. *Jones, Earth Reinforcements and Soil structures, 1996.*
4. *Prakash, Ranjan and Saran, Analysis and Design of Foundations and Retaining structures, SarithaPrakashan, Meerut, 1977.*

Course outcomes

Upon completion of this course, the students will be able to

- Do earth dam design and stability analysis for all kind of drainage conditions.
- Do stability analysis of any kind of slope and its protection.
- Understand the earth pressure theories and able to calculate lateral earth pressure for different conditions.
- Do retaining structure design and its stability analysis.

CE485 MARINE FOUNDATION ENGINEERING

Course objectives

- To emphasize the importance of offshore soil investigations for offshore structures
- To analysis the response of foundations of gravity structures under offshore environmental loading
- To analysis the foundation response of jacket and jack-up platforms under static and dynamic loading
- To provide a suitable foundation system for mooring structures and offshore pipe lines

Course content

Offshore soil investigation: General characteristics of offshore soil exploration – sampling using free corer, gravity corer, tethered systems and manned submersibles – deep penetration sampling using wire line techniques – sampling disturbances – mechanical and environmental - In-situ determination of strength of submarine soils – penetrometer, piezocone, vane and pressure meter techniques – penetration tests from tethered submersible platforms, manned submersibles and using wire line techniques - classification of marine soils – relative distribution of marine soils in the different marine regions – general characteristics of marine deposits in some specific locations and in the Indian sub continent.

Foundations for gravity structures: Types of gravity structures – Installation techniques – movement of gravity structures –settlement of soil beneath gravity structures – stress distribution beneath gravity structures – stability of gravity structures under static and cyclic loads.

Foundation for jacket type structures: Types – installation techniques – design considerations – axial and lateral load capacity of piles – lateral load deformation behaviour of piles – calculation of bearing capacity of piles- design of piles subjected to lateral loads – Reese-Matlock method and p-y curves method.

Foundations for jack up platforms: Types of jack up platforms – piles and mat supported – spud cans – different types – installation techniques – techniques for removal ofjack ups – stability of jack up platforms –determination of penetration of supports – stability under lateral loads –stability under static and cyclic load effects.

Sea bed anchors, submarine pipe lines: General introduction to sea bed anchors, moorings, submarine pipe line etc., - general design considerations (brief outline only) – geotechnical aspects in the design and installation of sea bed anchors, moorings, submarine pipelines etc

References

1. *Arous, D.A. (Ed.), Offshore Site Investigation, Graham Trotman*
2. *Chaney, R.C and Demars, K.R , Strength Testing of Marine Sediments – Laboratory and In-situ Measurements, ASTM, STP-883*
3. *George P. and Wood D., Offshore Soil Mechanics, Cambridge University Press.*
4. *Le Tirant, Sea Bed Reconnaissance and offshore Soil Mechanics for the Installation of Petroleum Structures, Gulf Publ. Company*
5. *Poulos, H.G and Davis, E.H, Pile Foundation Analysis Design, John Wiley, New York*

Course outcomes

Upon completion of this course, the students will be able to

- Recommend suitable offshore investigation techniques for the proposed project and able to provide appropriate soil design parameters
- Perform foundation analysis for gravity structures, jacket and jack-up kind of offshore structures
- Analyse suitable anchor system for mooring structures and able to provide foundation system for offshore pipeline.

CE491 AIR POLLUTION MANAGEMENT

Course objectives

The students will

- Develop an understanding of the classification, sources and effects of pollutants
- Understand the fundamentals of meteorology
- Study the principles and equipment description of control technologies
- Review the sources and control of indoor air pollution

Course content

Air Pollutants - Sources - Classification of Air Pollutants - Particulates and Gaseous Pollutants - Effects of Air Pollutants on Human Health, Vegetation and Property - Global Issues and Air Pollution - Global Warming - Ozone Layer Depletion - Ambient Air Quality and Emission Standards - Air Pollution Indices - Air Act.

Fundamentals of Meteorology - Wind Roses - Atmospheric Stability - Atmospheric Diffusion of Pollutants - Transport, Transformation and Deposition of Air Contaminants - Plume Behaviour - Atmospheric Diffusion Theories - Plume Rise - Gaussian Dispersion Models.

Control Principles - Principles and equipment description of control technologies - Particulates Control by Gravitational, Centrifugal, Filtration, Scrubbing, Electrostatic Precipitation - Absorption, Adsorption, Condensation, Incineration and Biofiltration for control of gaseous air pollutants - Biological Air Pollution Control Technologies - Bioscrubers, Biofilters.

Air Pollutants in Indoor Environments - Levels of Pollutants in Indoor and Outdoor Air - Indoor Air Pollution from Outdoor Sources - Measurement Methods - Control Technologies

Sources, Effects and Control of Noise – Noise Standards – Measurement – Control and Preventive Measures.

References

1. *Anjaneyulu, D., "Air Pollution and Control Technologies", Allied Publishers, Mumbai, 2002.*
2. *Rao, C.S. Environmental Pollution Control Engineering, Wiley Eastern Ltd., New Delhi, 1996.*
3. *Rao M.N., and Rao H. V. N., Air Pollution Control, Tata-McGraw-Hill, New Delhi, 1996.*

4. *W.L.Heumann, Industrial Air Pollution Control Systems, McGraw-Hill, New Yark, 1997.*
5. *Mahajan S.P., Pollution Control in Process Industries, Tata McGraw-Hill Publishing Company, New Delhi, 1991.*

Course outcomes

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

- Understand the sources and effects of key types of environmental pollutants
- Have insight into fundamentals of meteorology
- Appreciate different pollution control strategies
- Understand indoor air pollution and be aware of the control technologies

CE492 INDUSTRIAL WASTEWATER ENGINEERING

Course objectives

The students will

- Study the basic characteristics of industrial waste water
- Understand the environmental impacts caused by the industrial effluents
- Learn about physio-chemical treatment of industrial wastewater
- Recognise the possibility for reuse of industrial wastewater
- Study various Industrial Manufacturing Processes and understand their waste treatment requirements

Course content

Industrial Wastewater – Characteristics - Environmental Impacts - Effects of Industrial Wastes on Streams, Land - Effluent Standards - Scenario In India - Regulatory Requirements for Industrial Wastewater - Prevention Vs control of Industrial Pollution -

Volume Reduction - Process Modification - Strength Reduction- Methods and Materials Changes - Waste Minimization Strategies - Zero Discharge Concept.

Physio – Chemical Treatment of Industrial Wastewater - Equalization and Neutralization - Separation of Solids - Removal of Organic and Inorganic Solids - Oil Separation - Precipitation - Membrane Methods - Reverse Osmosis - Biological Treatment Methods - Aerobic and Anaerobic Methods.

Separation vs Degradation Methods – Chemical Oxidation – Photocatalysis - Ozonation - Ion exchange - Advanced Oxidation Processes - Electrochemical Methods - Nutrient removal - Land treatment - Sludge Production and its Management – Quantification and characteristics of sludge - Treatment of Sludge and Its Disposal .

Reuse of Industrial Wastewater – Advantages - Quality Requirements for Reuse - Zero Effluent Discharge Systems - Residuals of Industrial Wastewater Treatments - Individual and Common Effluent Treatment Plants.

Industrial Manufacturing Process Description Waste Treatment Flow Sheets - Wastewater Characteristics and Effluent Treatment Flow Sheet for Tanneries, Textiles, Fertilizers, Diary, Sugar, Pulp And Paper, Distilleries, Refineries, Thermal Power Plants.

References

1. *Eckenfelder, W.W., Industrial Water Pollution Control, McGraw Hill, 1999*
2. *Nemerow N. L., "Industrial Water Pollution", Addison - Wesley Publishing Company Inc., USA, 1978.*
3. *Narayana Rao M. and Amal K. Dutta, "Wastewater Treatment", Oxford & IBH Publishing Co., Pvt.Ltd., New Delhi, 2001.*
4. *Bhatia S.C., Handbhook of Industrial Pollution and Control, Volume I & II, CBS Publishers, New Delhi, 2003*
5. *Mahajan, S.P., Pollution Control in Process Industries, Tata McGraw Hill Publishing Company, New Delhi, 1991.*

Course outcomes

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

- Understand the characteristics and environmental impacts of industrial waste water
- Determine appropriate strategies for treatment and management of industrial pollutants
- Analyse the quality requirements for reuse of industrial effluents
- Study and obtain the flow sheets for waste treatment in various Industrial Manufacturing Processes

CE493 ENVIRONMENTAL MANAGEMENT AND IMPACT ASSESSMENT

Course objectives

- To be introduced to environmental impact assessment and the current legislation covering it.
- To understand Prediction and Assessment of Impact.
- To learn planning for mitigation of adverse impact on environment.
- To analyse case studies.
- Through case studies, learn to present and explain the components and decision making processes involved in environmental assessment.

Course content

Impact of Development projects on Environment and Environmental Impact Assessment (EIA) and Environmental Impact Statement (EIS) – Objectives – EIA Types – EIA in project cycle – capacity and limitations – Legal provisions on EIA – Environmental Impact Assessment Notifications – Environmental Impact Assessment Consultants – Legal provisions on EIA.

Methods of Categorization of industries for EIA - Elements of EIA – Process screening, baseline studies, mitigation, matrices, checklist - Methods of EIA – Strengths, weaknesses and applicability – appropriate methodology solution.

Prediction and Assessment of Impact on land, water, air, noise and energy, flora and fauna, Socio Economic Impact, Mathematical models for Impact prediction, Rapid EIA, Public participation – Post Environmental Audit.

Plan for mitigation of adverse impact on environment – options for mitigation of impact on water, air and land, water, energy, flora and fauna; Addressing the issues related to the Project Affected People – Environment management Plan – ISO 14000.

EIA case studies for new and expansion projects - wastewater treatment plants, water supply and drainage, Highways and bridges, Railways, Dams, Irrigation projects, Power plants.

References

1. *Canter, R.L. Environmental impact Assessment, McGraw Hill Inc., New Delhi 1996.*
2. *Anjaneyulu, Y, Environmental Impact Assessment methodologies B.S. Publications, Hyderabad, 2002.*
3. *S.K. Shukla and P.R. Srivastava, Concepts in Environmental Impact Analysis, Common Wealth Publishers, New Delhi, 1992.*
4. *John G. Rao and David C.Hooten (Ed.), Environmental Impact Analysis Handbook, McGraw Hill Book Company, 1990.*

Course outcomes

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

- Review the key concepts of environmental impact assessment and the current legislation covering it
- Understand the Prediction and Assessment of Impact on land, water, air, noise and energy, flora and fauna and Socio Economics

- Plan options for mitigation of adverse impact on environment
- Present and explain the components and decision making processes involved in environmental assessment through various case studies.

CE494 SOLID WASTE MANAGEMENT TECHNIQUES

Course objectives

- To understand the components of solid waste management system
- To learn about recycling, reuse and reclamation of solid wastes
- To study the collection, transfer, and transport of municipal solid waste
- To examine the operation of a resource recovery facility
- To study the design and operation of a municipal solid waste landfill

Course content

Sources and types of municipal solid waste - Waste generation rates - factors affecting generation, composition, characteristics - methods of sampling, Effects of improper disposal of solid wastes - Public health and environmental effects. Elements of solid waste management - Municipal solid waste rules

Source reduction of waste - Reduction, Reuse and Recycling - Onsite storage methods- materials used for containers - Handling and segregation of wastes at source - Public health and economic aspects of open storage – waste segregation and storage – case studies under Indian conditions.

Methods of collection of municipal solid wastes - Collection vehicles - Manpower - Collection routes - Analysis of collection systems; Need for transfer and transport, Transfer stations - Selection of location, operation & maintenance

Objectives of waste processing - processing technologies - biological and chemical conversion technologies; Resource recovery from solid waste composting and biomethanation. Thermal processing options.

Land disposal of solid waste; Sanitary landfills - site selection, design and operation of sanitary landfills - Landfill liners - Management of leachate and landfill gas - landfill closure and environmental monitoring, Landfill bioreactor - Dumpsite Rehabilitation.

References

1. *George Tchobanoglous and Frank Kreith (2002). Handbook of Solid waste Management, McGraw Hill, New York.*
2. *Manual on Municipal Solid Waste Management, CPHEEO, Ministry of Urban Development, Government of India, New Delhi, 2000.*
3. *Bhide A.D. and Sundaresan, B.B. Solid Waste Management Collection, Processing and Disposal, 2001*
4. *Manser A.G.R and Keeling A.A (1996) ,Practical Handbook of Processing and Recycling of Municipal solid Wastes, Lewis Publishers, CRC Press.*

Course outcomes

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

- review the components of solid waste management system
- be aware of the significance of recycling, reuse and reclamation of solid wastes
- develop an insight into the collection, transfer, and transport of municipal solid waste
- understand the importance and operation of a resource recovery facility
- understand the design and operation of a municipal solid waste landfill

CE495 MODELS FOR AIR AND WATER QUALITY

Course objectives

- To introduce the mathematical models and the modeling approach to water quality
- to present the mass balance basis for water quality models, simplified water quality models for streams and rivers, lakes and reservoirs for conservative and non-conservative materials.
- to describe the various models for microbial growth and limitations
- to address the simple air quality models for point and line sources
- to review the simple models for estuaries

Course content

Introduction to Mathematical Models: Modeling approaches to water quality - classification of models.

Mathematical models for water quality - model development, calibration and verification - cost: benefit analysis using models, Model requirements and limitations. D.O. Models for Streams: Dissolved oxygen model for streams - sources and sinks of dissolved oxygen.

Estimation of system parameters - Streeter - Phelps model - oxygen 'sag' curve - determination of deoxygenation and reaeration coefficients - Benthal oxygen demand - mass transport mechanisms - Advective and diffusive mass transport.

Models by O'connor, Dobbins and Thomann. Models for Estuary and Lakes: Physical chemical and biological processes in estuaries - water quality distribution in estuaries - modeling estuaries and lakes for water quality - temperature models for lakes and rivers.

Models for microorganisms decay, nitrogen and phytoplankton. Air quality models: Micrometeorological processes, wind rose, dispersion, coefficients and stability classes, Gaussian and dispersion model, Regional air quality models,

References

1. *Chapra, Steven C., "Surface water quality modeling", McGraw Hill Book Company, New York, 1997.*
2. *Gilbert M. Masters, "Introduction to Environmental Engineering and Science", 2nd Edition, Prentice Hall, 1998.*

Course outcomes

On completion of the course, the students will be able to:

- evaluate the physical, chemical and biological water quality which is essential for the abatement of water pollution
- predict the quality of water and air through modeling
- recognize the risks of disposal of treated wastewater into the riverdesign sound and sustainable water and air models under specified conditions

CE441 GIS AND REMOTE SENSING

Course objectives

- To know about the principles of remote sensing and spectral signatures
- To know about satellites, types of remote sensing and digital image processing
- To study about the history and components of GIS
- To study about data types and operations.
- To know the applications of remote sensing and GIS for various applications on Civil Engineering,

Course content

Remote Sensing – Principle - Electro-magnetic energy, spectrum - EMR interaction with atmosphere – Atmospheric Windows and its Significance – EMR interaction with Earth Surface Materials – Spectral Signature and Spectral Signature curves for water, soil and Earth Surface.

Satellites - Classification – Satellite Sensors – satellite and sensor parameters - Resolution – Types of Remote Sensing - Visual Interpretation of Satellite Images – Digital Image processing – Characteristics of different platforms: Landsat, SPOT, IRS series, IKONOS, QUICKBIRD – Radar, LIDAR, SAR, MODIS, AMSRE, Sonar remote sensing systems introduction of GPS- data receiving mode- DTM generation-View shed analysis.

GIS - History of Development - Components of GIS – Hardware, Software and Organizational Context – Data – Spatial and Non-Spatial – Data Input Sources— DBMS – Data Output - Data models - Raster and Vector data structures – Data compression – Raster vs. vector comparison.

Analysis using Raster and Vector data – Operations – Overlaying - Buffering – Modelling in GIS - Digital Terrain Modelling, Analysis and application – Products of DEMs and their uses – Sources of errors in GIS and their elimination.

Applications of Remote Sensing and GIS – Advanced applications of GIS – Disaster management, Water resource, Landuse – Land cover – Urban planning - Intelligent Transport Systems - Development of Resources Information Systems.

References

1. *Burrough P.A. and Rachel A. McDonell, Principles of Geographical Information Systems, Oxford Publication, 2004.*
2. *C.P. Lo and Albert K. W. Yeung, Concepts and Techniques of Geographical Information Systems, Prentice- Hall India, 2006.*
3. *Thomas. M. Lillesand and Ralph. W. Kiefer, Remote Sensing and Image Interpretation, John Wiley and Sons, 2003.*

Course outcomes

On completion of the course, the students will be able to:

- Demonstrate the concepts of Electro Magnetic energy, spectrum and spectral signature curves.
- Apply the concepts of satellite and sensor parameters and characteristics of different platforms.
- Apply the concepts of DBMS in GIS.
- Analyze raster and vector data and modeling in GIS.
- Apply GIS in land use, disaster management, ITS and resource information system.

CE442 ADVANCED SURVEYING TECHNIQUES

Course objectives

- To know about significance of advanced surveying in field measurements in terms of utility and precision of data collection
- To learn on the principles of Electronic distance measurements, Total station and their accuracy
- To get introduced to the concept of photogrammetry in preliminary identification and map making
- To know in detail the concept of remote sensing in identification of land features from space and to get introduced to different data acquisition techniques like LIDAR, RADAR
- To get introduced to the field of geodesy, coordinate systems, Map projections, GPS, its working principles, data collection, data processing and analysis

Course content

Electromagnetic distance measurement (EDM) – Principle of EDM Carrier waves – Types of EDM instruments – Distomat – Total Station – Principle – procedure & surveying using Total Station – precise leveling - micro-optic theodolite.

Photogrammetry – Terrestrial and Aerial Photogrammetry – Horizontal position of a point from photographic measurement – elevation of a point – Determination of focal length of camera - Geometry and scale of vertical photographs – Ground co-ordinates from vertical photographs - Relief displacement – Planimetric mapping from vertical photos – Stereoscopy– Photo interpretation.

Remote sensing from space – Data products- interpretation – application of remote sensing on terrain processing- DEM and DTM- View shed Analysis– Accuracy of DEM- ASTER, SRTM LIDAR – RADAR - SONAR.

Geodesy – Figure of earth – Classification – Earth surface - Geodetic reference surfaces - Coordinate systems – Geodetic Datums and elements– Projection- Types of projection – UTM – Map projection of India.

GPS Basics – system overview – working principle of GPS – Satellite ranging – calculating position – Ranging errors and its correction – GPS surveying Methods – static, Rapid static, DGPS and Kinematic methods – Real time and post processing DGPS – visibility diagram – GAGAN.

References

1. *Duggal, S.K. Surveying Vol. II, Tata McGraw Hill, 2004.*
2. *Arora, K. R. Surveying Vol. III, Standard Book House, 1996.*
3. *SatheeshGopi. Advanced Surveying, Pearson Education, 2007.*
4. *SatheeshGopi. The Global Positioning System and Surveying using GPS, Tata McGraw, 2005.*

Course outcomes

On completion of the course, the students will be able to:

- Apply advanced surveying techniques in different fields of civil engineering.
- Select the advanced surveying technique which is best suited for a work.
- Apply total station and EDM in distance measurement and traversing.

- Demonstrate the principles of the earth surface, its projections and different coordinates involved in map making.
- Apply GPS in transportation engineering, structural engineering and land use planning.

HONOURS ELECTIVES
CE475 BRIDGE PLANNING AND DESIGN

Course objectives

- To develop an understanding of basic concepts in bridge engineering like components, classification, importance, investigation of bridges and loading conditions.
- To study the design of Culvert, Foot Bridge, Slab Bridge, T-beam Bridge and Box Culvert using IRC.
- To study the design of various sub-structures like piers, abutments, foundations and study the importance of the bearing and joints in construction of the bridge.

Course content

Components of Bridges – Classification – Importance of Bridges – Investigation for Bridges – Selection of Bridge site – Economical span – Location of piers and abutments – Subsoil exploration – Scour depth – Traffic projection – Choice of bridge type.

Specification of road bridges – width of carriageway – loads to be considered – dead load – IRC standard live load – Impact effect.

General design considerations – Design of culvert – Foot Bridge - Slab Bridge – T-beam bridge – Pre-stressed concrete bridge – Box Culvert - Fly over bridges.

Evaluation of sub structures – Pier and abutments caps – Design of pier – Abutments – Type of foundations.

Importance of Bearings – Bearings for slab bridges – Bearings for girder bridges – Electrometric bearing – Joints – Expansion joints. Construction and Maintenance of bridges – Lessons from bridge failures.

References

1. *Ponnuswamy, s., Bridge Engineering, Tata McGraw - Hill, New Delhi, 1997*
2. *Victor, D.J., Essentials of Bridge Engineering, Oxford & IBH Publishers Co., New Delhi, 1980.*
3. *N. Rajagopalan, Bridge Superstructure, Narosa Publishing House, New Delhi, 2006.*

Course outcomes

Upon completion of this course, the student will be able to:

- prepare a detailed project report for the construction of bridge giving hydraulic particulars of the river and soil details and be able to select the suitable site and type of the bridge.
- design various types of bridges like Culvert, Slab Bridge and T-beam Bridge using provisions of IRC.
- design pier, abutment, foundations, bearing and detailing of joints.

CE476 PAVEMENT MANAGEMENT SYSTEMS

Course objectives

- To learn the techniques in measuring surface condition and structural evaluation.
- To study the pavement management process.
- To develop project designs and implementation.

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; Evaluation by Non-Destructive Tests such as FWD, Benkelman Beam Rebound Deflection, Plate Load Test, Wave Propogation and other methods of Load Tests; Evaluation by Destructive Test Methods, and Specimen Testing

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.

References

1. *Haas R. C. G., W. Ronald Hudson, John P. Zaniewski, Modern Pavement Management, Krieger Publishing Company, 1994*
2. *OECD, Pavement Management Systems, O E C D, 1987.*

3. *SHAHIN, M Y, Pavement management for airport, roads and parking lots, Chapman and hall, 1994*
4. *Susan Brown, Pavement Management Systems, Transportation Research Board, 1993.*

Course outcomes

Upon completion of this course, the student will be able to:

- evaluate the surface condition of the pavement and its structural adequacy.
- collect data and develop models for pavement deterioration.
- design PMS and implement them.

CE466 COMPUTATIONAL FLUID DYNAMICS

Course objectives

- To understand the basic concepts in turbulence modelling.
- To provide fundamental knowledge on finite difference / element and volume methods.
- To describe the solution methodologies for discretized equations.
- To develop models using structured and unstructured grids.

Course content

Derivation of flow governing equations; turbulence modeling; modeling approaches for multiphase flow; initial and boundary conditions; wellposedness.

Discretization of the governing equations using finite difference/volume/element methods; concepts of consistency, stability and convergence; template for the discretization of a generic unsteady transport equation.

Solution of discretized equations; direct methods; classical iterative methods; advanced methods for structured matrices; conjugate gradient techniques; multigrid methods.

Solution of coupled equations: methods for compressible flows; evaluation of pressure in incompressible flows; pressure-velocity coupling algorithms.

Structured and unstructured grids; structured grid generation; unstructured grid generation. Benchmarking; calibration.

References

1. John Anderson, Computational Fluid Dynamics, McgrawHill Education, 1999

2. Pieter Wesseling, Principles of Computational Fluid Dynamics, Springer series,2009

3. Anil W. Date, Introduction to Computational Fluid Dynamics, Cambridge, 2005

4. Charles Hisch, Numerical computation of internal and external flows, Elsevier, 2007

Course outcomes

By the end of this course, the students will be able to

- Develop knowledge on non linear problems.
- Improve knowledge on finite element, difference and volume methods.
- Provide solution methodologies for real time problems.
- Develop hydrological and hydrodynamic models.

CE467 FREE SURFACE FLOW

Course objectives

- To understand the behaviour free surface flow conditions under varying depths of flow in open channel
- To analyse the inland navigation behaviour in water way
- To design suitable channel sections by understanding the river behaviour
- To describe the steady and unsteady flows in open channels

Course content

Derivation of the general one-dimensional equations of continuity, momentum and energy used in open channel flow analysis.

Steady non-uniform flows, channel transitions and controls, hydraulic jumps surges.

Surface profile for gradually varied flow.

Unsteady flow in open channels, method of characteristics, surge formation. Kinematics of waves, flood routing and overhead flow.

Inland navigation: Introduction, Various Requirements of Navigable Waterways, Various Measures Adopted for Achieving Navigability, India's Navigable Waterways.

River Engineering: Classification of Rivers, Causes of Meandering, The Aggrading type of River, Degrading type of River, Cutoffs, river Training, Types of Training Works.

References

1. *F.M. Henderson, Open Channel Flow, Macmillan publishing company.*
2. *Ven Te Chow, Open channel hydraulics, Mcgrawhill publishers, 2009*
3. *Irrigation Engineering and Hydraulic Structures – Santhosh Kumar Garg.*
4. *Irrigation and Water Power Engineering – DR. B.C. Punmia, Dr. Pande B.B. Lal.*

Course outcomes

By the end of this course, the students will be able to

- Develop understanding of open channel flows.
- Design different channel regimes due to hydraulic jump, surges and any kind of unsteady conditions.
- Provide solutions for real time problems in river engineering.
- Determine the surface profile for steady and varying flows.

CE651 THEORY OF ELASTICITY AND PLASTICITY

Course objectives

- To understand the deformations and strains in a body when subjected to stresses
- To learn about stress and strain transformations in a 3D field
- To understand the results using theory of elasticity approach and compare with SOM approach for different types of structural problems.
- To understand the fundamentals of plasticity theory

Course content

Basic concepts of deformation of bodies - Notations of stress and strain in 3D field- Transformation of stress and strain in a 3D field.- Equilibrium equations in 2D and 3D Cartesian coordinates. Plane stress and plane strain problems- 2D problems in Cartesian coordinates as applied to beam bending using Airy's stress function- Problems in 2D -Polar coordinate- Equations of equilibrium and compatibility- Curved beam bending- stress concentration in holes- Circular disc subjected to diametral compressive loading- Semi-infinite solid subjected to different types of loads. Energy principle - Theorem of minimum potential energy and complementary energy. Torsion of non-circular sections- St. Venant's theory – Torsion of elliptical sections - Torsion of triangular sections - Prandtl's membrane analogy - Torsion of rolled profiles- Stress concentration around re-entrant corners - Torsion of thin walled tubes-Stress concentration Plasticity – Introduction - Plastic stress strain relations - Different hardening rules - Yield criteria for metals - Graphical representation of yield criteria - Application to thin and thick cylinders under internal pressure.

References

1. Timoshenko and Goodier : Theory of Elasticity and Plasticity, McGraw-Hill, 2006

2. Mohammed Amin : Computation Elasticity, Narosa Publications,2005

3. Chen and Han : Plasticity for Structural Engineers, Springer Verlag,1998.

4. K. Bhaskar, T.K. Varadan: Theory of Isotropic/Orthotropic Elasticity, An Introductory Primer, Anne books Pvt Ltd,2009.

Course outcomes

By the end of this course, the students will be able to

- Understand the concepts of deformations and strains in a body when subjected to stresses
- Learn about stress and strain transformations in a 3D field
- Understand the results using theory of elasticity approach and compare with SOM approach for different types of structural problems.
- Understand the fundamentals of plasticity theory

CE656 THEORY OF PLATES

Course objectives

- To understand the basics of deformations and strains in a plate subjected to lateral loads.
- To learn about analysis of thin plates subjected to different types of loads and boundary conditions.
- To understand the energy methods used in plate analysis
- To understand the fundamentals of orthotropic plate theory.

Course content

Thin Plates with small deflection. Laterally loaded thin plates, governing differential equation, various boundary conditions. Rectangular plates. Simply supported rectangular plates, Navier solution and Levy's method, Rectangular plates with various edge conditions, plates on elastic foundation. Special and Approximate Methods. Energy methods, Finite difference and Finite element methods. Analysis of orthotropic plates and grids, moderately thick plates, Analysis and behavior of folded plates.

References

1. *Timoshenko, S. and Krieger S.W. "Theory of Plates and Shells", McGraw Hill Book Company, New York, 1990.*
2. *Bairagi, "Plate Analysis", Khanna Publishers, 1996.*
3. *Reddy J N, "Theory and Analysis of Elastic Plates and Shells", McGraw Hill Book Company, 2006.*
4. *Szilard, R., "Theory and Analysis of Plates", Prentice Hall Inc., 1995.*

Course outcomes

By the end of this course, the students will be able to

- understand the basics of deformations and strains in a plate subjected to lateral loads.
- know about analysis of thin plates subjected to different types of loads and boundary conditions.
- understand the energy methods used in plate analysis
- understand the fundamentals of orthotropic plate theory.

CE666 STRUCTURAL OPTIMISATION

Course objectives

- To understand the basics of formulation of structural optimization problems.
- To learn about different linear and nonlinear programming methods(NLP)
- To understand the application of NLP to optimal structural design problems
- To understand the various stochastic optimisation methods.

Course content

Formulation of Structural Optimization problems: Design variables - Objective function - constraints. Fully stressed design.

Review of Linear Algebra: Vector spaces, basis and dimension, canonical forms. Linear Programming: Revised Simplex method, Application to structural Optimization. Nonlinear Programming: Deterministic Methods - Unconstrained and constrained Optimization - Kuhn-Tucker conditions, Direct search and gradient methods - One dimensional search methods - DFP and BFGS algorithms, constrained Optimization - Direct and Indirect methods - SLP, SQP and SUMT

Application of NLP methods to optimal structural design problems. Optimality criteria based methods, Reanalysis techniques - Approximation concepts - Design sensitivity Optimization of sections, steel and concrete structures - framed structures, bridge structures.

Stochastic Optimization Methods: Genetic Algorithms - Binary coding- Genetic Operators - Simple Genetic Algorithm (SGA) and variable length Genetic Algorithm (VGA). Simulated annealing.

Applications to discrete size, Configuration and shape optimization problems. Artificial Intelligence and Artificial Neural Networks based approaches for structural optimization problems.

References

1. *Haftka, R.T. and Gürdal, Z., Elements of Structural Optimization, 3rd edition , Springer, 1992 (Covered sections will be distributed at the class).*
2. *Gürdal, Z, Haftka, R.T., and Hajela, P., Design and Optimization of Composite Materials, Wiley, 1998 (Covered sections will be distributed at the class).*
3. *K. K. Choi and N. H. Kim, Design Sensitivity Analysis for Linear and Nonlinear Structures, Springer, 2005 by (Covered sections will be distributed at the class)*
4. *Arora, J.S., Introduction to Optimum Design, 2nd Edition, Elsevier, 2004.*

Course outcomes

By the end of this course, the students will be able to

- Understand the basics of formulation of structural optimization problems.
- Know about different linear and nonlinear programming methods(NLP)
- Understand the application of NLP to optimal structural design problems
- Understand the various stochastic optimisation methods.

CE468 SOIL DYNAMICS AND MACHINE FOUNDATIONS

Prerequisite: Geotechnical Engineering I & II

Course objectives

- To explain the significance of dynamic load in machine foundation analysis
- To explain theory of vibration for different field conditions
- To explain the principles of machine foundation design for reciprocating and impact machines
- To explain the concept and method of foundation isolation

Course content

Introduction - nature of dynamic loads - stress conditions on soil elements under earthquake loading - dynamic loads imposed by simple crank mechanism - type of machine foundations - special considerations for design of machine foundations.

Theory of vibration: general definitions - properties of harmonic motion - free vibrations of a mass- spring system - free vibrations with viscous damping - forced vibrations with viscous damping - frequency dependent exciting force - systems under transient forces - Raleigh's method - logarithmic decrement - determination of viscous damping - principle of vibration measuring instruments - systems with two degrees of freedom.

Criteria for a satisfactory machine foundation - permissible amplitude of vibration for different type of machines - methods of analysis of machine foundations - methods based on linear elastic weightless springs - methods based on linear theory of elasticity (elastic half space theory) - methods based on semi graphical approach - degrees of freedom of a block foundation - definition of soil spring constants - nature of damping - geometric and internal damping - determination of soil constants – methods of determination of soil constants in laboratory and field based on IS code provisions.

Vertical, sliding, rocking and yawing vibrations of a block foundation - simultaneous rocking, sliding and vertical vibrations of a block foundation - foundation of reciprocating machines - design criteria - calculation of induced forces and moments - multi-cylinder engines - numerical example (IS code method).

Foundations subjected to impact loads - design criteria - analysis of vertical vibrations - computation of dynamic forces - design of hammer foundations (IS code method) - vibration isolation - active and passive isolation - transmissibility - methods of isolation in machine foundations.

References

1. Shamsher Prakash, Soil Dynamics, McGraw-Hill, 1981.

2. Alexander Major, Dynamics in Soil Engineering, A kademiai,1980.

3. Sreenivasalu and Varadarajan, Handbook of Machine Foundations, Tata McGraw Hill, 2007.

4. IS 2974 - Part I and II, Design Considerations for Machine Foundations

5. IS 5249: Method of Test for Determination of Dynamic Properties Of Soils

Course outcomes

Upon completion of this course, the students will be able to

- Understand the influence of dynamic load in the machine foundation analysis and design.
- Use vibration theory in soil dynamics and ascertain soil behviour accordingly
- Do machine foundation analysis and design for reciprocating and impact machines.
- Understand foundation isolation and its significance in machine foundation.

CE469 NUMERICAL MODELLING IN GEOTECHNICAL ENGINEERING

Prerequisite: Geotechnical Engineering I & II

Course objectives

- To explain modeling of soil behaviour considering field aspects
- To explain constitutive relations in soil modeling
- To explain material modeling with respect to soil behaviour
- To give an exposure to numerical methods in geotechnical problems
- To give hand on experience using geotechnical software

Course content

Modelling of Soil Behaviour: Critical state theory; stress paths within and on the state boundary surface; shear strength of clays related to the critical state concept.

Basic Concept of Continuum Mechanics: Notations; stresses and strains in three dimensions; equations of equilibrium, geometric conditions and constitutive relations.

Material modeling: Elastic models; perfect plasticity models-Coulomb model-Drucker-Prager model; Hardening plasticity models; generalized stress-strain relations and stiffness formulations; cap model in isotropic consolidation test and triaxial shear test; simulation of pore pressure; case studies on implementing the models.

Finite element modeling: Introduction to numerical methods - FEM, FDM, BEM; FEM for 1D and 2D problems; FEM for non-linear problems.

Application of Finite element modeling: Effective stress analysis, seepage and consolidation problems; practical aspects related to foundations, embankments and retaining structures; application examples-use of ABAQUS, PLAXIS, FLAC, MIDAS_GTS programs etc.

References

1. *Chen, W. F. and Mizuno, E., Nonlinear analysis in Soil Mechanics: theory and Implementation, Elsevier science publishers, 1990*
2. *Fethi Azizi, Applied Analyses in Geotechnics, E andN Spon of Taylor and Francis group, 2000*
3. *Desai, C. S., Elementary Finite Element Method, Prentice-Hall, 1979.*
4. *Owen, D. R. J., Hinton, E, Finite Element in Plasticity: Theory and Practice, Pineridge Press Limited, 1980*
5. *Helwany, S, Applied Soil Mechanics with ABAQUS Applications, John Wiley and Sons, 2007.*
6. *Lewis, R. W., Schrefler, B. A., The Finite Element Method in the Deformation and Consolidation of Porous Media, John Wiley and Sons, 1984*
7. *Zienkiewicz, O. C., Chan, A. H. C., Paster, M., Schrefler, B. A., Shiomi, T., Computational Geomechanics with special reference to earthquake engineering, John Wiley and Sons, 1999.*

Course outcomes

Upon completion of this course, the students will be able to

- Do proper soil modeling with respect to the soil behaviour
- Understand the constitute relations
- Select proper material modeling for the FE analysis
- Use geotechnical software like PLAXIS, FLAC etc.

CE702 BIOLOGICAL PROCESS DESIGN FOR WASTEWATER TREATMENT

Course objectives

- To provide an understanding of the design principles, practice and operational experience of biological treatment processes.
- To study about various treatment processes and its operations for the wastewater treatment.
- The course will provide an understanding of the kinetic theory of biological growth and apply it to typical aerobic processes, and an appreciation of the purpose and practice of sludge treatment.
- To integrate the principles of biochemical processes with applications in the real world-communicating approaches to the conception, design, operation, and optimization of biochemical unit operations.

Course content

Constituents of wastewaters-Sources-Significant parameter-Fundamentals of Process Kinetics, Zero order, First order, Second order Reactions, Enzyme reactions –Bio reactors- Types- Classification- Design principles.

Design of wastewater treatment systems-Primary, secondary and tertiary treatments-Evaluation of Biokinetic Parameters -Activated Sludge and its process- Modifications, Biological Nitrification and denitrification.

Attached Growth Biological Treatment Systems-Trickling Filters- Rotating Biological Contactors.

Waste stabilization ponds and Lagoons: Aerobic pond, facultative pond, anaerobic ponds- polishing ponds, aerated Lagoons.

Anaerobic processes-Process fundamentals-Standard, high rate and hybrid reactors, Anaerobic filters-Expanded /fluidized bed reactors-Upflow anaerobic sludge blanket reactors, - Expanded granular bed reactors- Two stage/phase anaerobic reactors-Sludge Digestion, Sludge disposal.

References

1. *Benefield, L.D. and Randall C.W. Biological Processes Design for wastewaters, Prentice-Hall, Inc. Eaglewood Cliffs, 1982.*
2. *Grady Jr. C.P.L and Lin H.C. Biological wastewater treatment: Theory and Applications, Marcel Dekker, Inc New York, 1980.*
3. *Metcalf & Eddy, Inc. Wastewater Engineering, Treatment and Reuse. 3rd Edition, Tata McGraw-Hill, New Delhi, 2003.*

Course outcomes

On successful completion of this course the students will be able to:

- Identify the range of conventional and advanced biological treatment processes for the treatment of bulk organics, nutrients and micropollutants.
- Understand the underlying biological principles on which the processes are based, and be able to apply these principles to unit process design and operation.
- Select appropriate processes for specific applications, and have some knowledge of practical design considerations.
- Execute and asses laboratory work for wastewater quality analysis

CE703 PHYSICO CHEMICAL PROCESS FOR WATER AND WASTEWATER TREATMENT

Course objectives

- To learn the physical chemical and biological parameters of water and potable water standards.
- To examine the physical and chemical treatment processes used for the removal of undesirable constituents (contaminants) from water and wastewaters
- To evaluate the treatment processes including all of the major processes used in domestic and industrial water and wastewater treatment.
- To examine the mechanisms that are responsible for contaminant removal and the quantitative representation (theoretical and empirical formulations) of these

processes that have been developed to predict treatment performance and are used in process design.

Course content

Water Quality - Physical, chemical and biological parameters of water - Water Quality requirement - Potable water standards-Wastewater Effluent standards - Water quality indices.

Water purification systems in natural systems - Physical processes - chemical processes and biological processes - Primary, Secondary and tertiary treatment - Unit operations - unit processes.

Mixing, clarification – sedimentation; Types; Aeration and gas transfer – Coagulation and flocculation, coagulation processes-stability of colloids- destabilization of colloids-destabilization in water and wastewater treatment-transport of colloidal particles, 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.

Adsorption, adsorption equilibria- adsorption isotherms, Disinfection – chlorine dioxide; chloramines; ozonation; UV radiation.

Ion Exchange-processes, Application Membrane Processes, Reverse osmosis, Ultrafiltration, Electrodyalisis.

References

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, McGraw Hills, New York 1985.*
3. *Metcalf and Eddy, Wastewater engineering, Treatment and Reuse, Tata McGraw-Hill, New Delhi, 2003.*

Course outcomes

On successful completion of this course the students will be able to:

- Understand various physical and chemical treatment options for treatment of water and wastewater.
- Understand the mechanism behind the treatment processes their advantages and disadvantages.
- Discover how quantitative relationships based on theory can be integrated with actual situations in water and wastewater treatment systems.

CE477 ADVANCED REMOTE SENSING TECHNIQUES

Prerequisite: CE441 GIS and Remote Sensing or equivalent.

Course objectives

- To provide knowledge of the principles and applications of Lidar / Radarand Microwave applications
- To provide Knowledge to advanced Remote Sensing techniques of Hyperspectral Remote sensing.
- To provide knowledge on ANN, Advanced Image processing techniques.

Course content

Advanced Image processing: Data Fusion, Spectral Indices and Texture Analysis, object oriented image classification, Band differencing, Pattern recognition, linear and non-linear classifiers, Application of ANN and SVM techniques, Change Detection analysis.

Hyperspectral remote sensing: Introduction, sensors, data capture and analysis, SAM, Linear spectral unmixing, Applications and case studies will include environmental, disaster response assistance, agricultural, soil science.

Li DAR and RADAR Remote Sensing: LiDAR techniques, Sensor, Applications of terrain mapping, Corridor Mapping and Forest, Principles of Radar techniques, Altimetry, Scatterometry, Radar Interferometry Polarimetry, Synthetic Aperture Radar (SAR), Understanding SAR Images, SAR intensity Processing, TOPSAR data and DEM ,Shuttle Radar Topographic Mission (SRTM) data, Sea surface Roughness.

Microwave Remote Sensing: Principles, Properties of Microwaves, sensors, Microwave interactions with natural objects Active and Passive microwaves, Principles of data assimilation, Microwave Soil moisture mapping Flood mapping, Assessment of data assimilation in improving weather forecasting.

Remote sensing of atmospheric chemistry: Aerosol remote sensing products, Cloud remote sensing products (MODIS and ISCCP), Remote sensing for mapping of SO_2, CO and O_3 mapping.

References

1. *Sabins, F., Remote Sensing Principles and Interpretation, W. H. Freeman and Company, New York, 3rd edition, 2007.*
2. *George Joseph, Fundamentals of Remote sensing, University Press, Second edition, 2005.*
3. *Thomas. M. Lillesand and Ralph. W. Kiefer, Remote Sensing and Image Interpretation, John Wiley and Sons, 2003.*

Course outcomes

On successful completion of this course the students will be able to:

- Understand the theory behind Hyperspectral remote sensing observations and be able to select suitable data sources to investigate conditions in the land, vegetation, and atmosphere.
- Describe the applications of LiDAR and Microwave radar for various civil engineering applications.
- Understand how the Advanced remote sensing techniques will be used in the future extraction.