Master of Technology

SYLLABUS

CREDIT BASED CURRICULUM

(2012 - 2014)

DEPARTMENT OF CIVIL ENGINEERING
NATIONAL INSTITUTE OF TECHNOLOGY
TIRUCHIRAPPALLI - 620 015, INDIA.

M. Tech. (TRANSPORTATION ENGINEERING AND MANAGEMENT)

The total minimum credits required for completing the M. Tech (Transportation Engineering and Management) Course is 64.

SEMESTER I

Code	Course of Study	L	T	P	C
MA601	Numerical Methods and Applied Statistics	3	0	0	3
CE601	Highway Traffic Analysis and Design	3	0	0	3
CE602	Pavement Analysis and Design	3	0	0	3
CE603	Transportation Systems	3	0	0	3
	Elective – I	3	0	0	3
	Elective – II	3	0	0	3
CE604	Traffic and Pavement Engineering Laboratory	0	0	3	2
		18	**0**	**3**	**20**

SEMESTER II

Code	Course of Study	L	T	P	C
CE605	Road Transport Management and Economics	3	0	0	3
CE606	Transportation Planning	3	0	0	3
CE607	Computer Simulation Applications in Transportation Engineering	3	0	0	3
	Elective – III	3	0	0	3
	Elective – IV	3	0	0	3
	Elective - V	3	0	0	3
CE608	CAD in Transportation Engineering	1	0	3	2
		19	**0**	**3**	**20**

SUMMER TERM

CE605	Practical Training (4 weeks)	-	-	-	-

SEMESTER III

Code	Course of Study	L	T	P	C
CE647	Project Work – Phase I	0	0	24	12

SEMESTER IV

Code	Course of Study	L	T	P	C
CE648	Project Work – Phase II	0	0	24	12

ELECTIVES

Code	Course of Study	L	T	P	C
CE611	Geographical Information Systems and Remote Sensing	3	0	0	3
CE612	Intelligent Transportation Systems	3	0	0	3
CE613	Pavement Materials	3	0	0	3
CE614	Ground Improvement Techniques	3	0	0	3
CE615	Bridge Engineering	3	0	0	3
CE616	Theory of Traffic Flow	3	0	0	3
CE714	Environmental Impact Assessment	3	0	0	3
HM712	Human Resource Management	3	0	0	3
MB794	Project Management	3	0	0	3
	Any other elective				

MA601 NUMERICAL METHODS AND APPLIED STATISTICS

Linear system – Gaussian elimination and Gauss – Jordan methods – matrix inversion – Gauss seidel method – Nonlinear equations – Regula falsi and Newton- Raphson methods – interpolation – Newton's and Lagrange's interpolation

Linear Programming – Graphical and Simplex methods – Measures of central tendency, dispersion, skewness and Kurtosis – Probability – conditional probability – Bayes' theorem

Random variable – two dimensional random variables – standard probability distributions – Binomial Poisson and normal distributions - moment generating function

Sampling distributions – confidence interval estimation of population parameters – testing of hypotheses – Large sample tests for mean and proportion – t-test, F-test and Chi-square test – curve fitting-method of least squares

Regression and correlation – rank correlation – multiple and partial correlation – analysis of variance-one way and two way classifications – experimental design – Latin square design – Time series analysis.

References

1. Bowker and Liberman, *Engineering Statistics,* Prentice-Hall, 1972.
2. Venkatraman, M.K., *Numerical Methods in Science and Engineering*, National Publisher Company.

CE601 HIGHWAY TRAFFIC ANALYSIS AND DESIGN

Elements of Traffic Engineering - road user, vehicle and road way. Vehicle characteristics - IRC standards - Design speed, volume. Highway capacity and levels of service - capacity of urban and rural roads - PCU concept and its limitations - Road user facilities - Parking facilities - Cycle tracks and cycleways - Pedestrian facilities.

Traffic volume studies, origin destination studies, speed studies, travel time and delay studies, Parking studies, Accident studies.

Elements of design - Alignment - Cross sectional elements - Stopping and passing sight distance. Horizontal curves - Vertical curves. Design problems – Hill Roads.

Traffic regulation and control - Signs and markings - Traffic System Management - Design of at-grade intersections – Principles of design – Channelization - Design of rotaries - Traffic signals - pre-timed and traffic actuated. Design of signal setting - phase diagrams, timing diagram – Signal co-ordination.

Grade separated intersections - Geometric elements for divided and access controlled highways and expressways – Road furniture - Street lighting. Traffic Safety – Principles and Practices – Road Safety Audit.

References

1. ITE Hand Book, *Highway Engineering Hand Book*, Mc Graw - Hill.
2. AASHTO *A Policy on Geometric Design of Highway and Streets*
3. R. J. Salter and N. B. Hounsel, *Highway Traffic Analysis and Desig*n, Macmillan Press Ltd, 1996.

CE602 PAVEMENT ANALYSIS AND DESIGN

Introduction: Types and component parts of pavements, Factors affecting design and performance of pavements. Highway and airport pavements, functions of pavement components

Pavement Design Factors: Design wheel load, strength characteristics of pavement materials, climatic variations, traffic - load equivalence factors and equivalent wheel loads, aircraft loading, gear

configuration and tyre pressure. Drainage – Estimation of flow, surface drainage, sub-surface drainage systems, design of sub-surface drainage structures

Flexible Pavement Design: Empirical, semi-empirical and theoretical approaches, design of highway and airport pavements by IRC, AASHTO Methods, applications of pavement design software

Rigid Pavement Design: Types of joints and their functions, joint spacing; design of CC pavement for roads, highways and airports as per IRC, AASHTO, design of joints. Design of continuously reinforced concrete pavements. Reliability; Use of software for rigid pavement design

Pavement Management: Pavement failures, maintenance of highways, structural and functional condition evaluation of pavements, pavement management system.

References

1. Yoder and Witczak, *Priniciples of Pavement Design*, John Wiley and Sons
2. Yang. H. Huang, *Pavement Analysis and Design*, Second Edition, Prentice Hall Inc.
3. Rajib B. Mallick and Tahar El-Korchi, *Pavement Engineering – Principles and Practice*, CRC Press (Taylor and Francis Group)
4. W.Ronald Hudson, Ralph Haas and Zeniswki , *Modern Pavement Management*, Mc Graw Hill and Co
5. Relevant IRC Codes

CE603 TRANSPORTATION SYSTEMS

Historical development of transport in India - 20 year Road Plans, National Transport Policy Recommendations, IRC, CRRI, Vision 2021, NHDP, PMGSY. Characteristics of different modes of transport and their integration and interactions - impact on environment.

Planning of railway - Passenger and goods terminals - layout - passenger facilities - traffic control.

Airport Planning, requirements and components. Design of runway and taxiway - Apron - parking configuration - terminal requirements - Airport marking and lighting - Air traffic control.

Planning of Harbours and ports - cargo handling - Containerization - Navigation aids - Inland waterways - Pipeline transportation.

Urban transportation systems - Mass rapid transit system - Light rail transit - Personal rapid transit, guided way systems, cabin taxi, dual mode bus - Para transit systems - Demand responsive system - Intermediate public transport.

References

1. Paquette, R.J., et al, *Transportation Engineering Planning and Design,* John Wiley & Sons, New York, 1982.
2. Alan Black, *Urban Mass Transportation Planning*, McGraw-Hill, 1995.

CE604 TRAFFIC AND PAVEMENT ENGINEERING LABORATORY

Traffic Surveys: Volume count, Speed study, Parking study, Intersection turning movements, Speed and Delay study, Moving observer survey, Traffic noise measurement, Vehicle emission testing, Road lighting, User perception surveys, Road side and house hold interviews

Tests on sub grade soil, aggregates, bitumen, modified binders - Soil stabilization - Pavement evaluation.

Mix Design: Granular Sub-base, Bituminous – DBM, SDBC, BC, etc., Cement concrete.

Mini project report based on field and laboratory studies and data collected

CE605 ROAD TRANSPORT MANAGEMENT AND ECONOMICS

Motor Vehicles Act - statutory provision for road transport and connected organizations. Route scheduling, Freight transport, Vehicle scheduling, Optimum fleet size, Headway control strategies, Crew scheduling.
Depots and Terminals - Principles and types of layout, Depot location, Twin depot concept, Crew facilities. Design of parking facilities – Bus terminal, bus stops and bus bays
Transportation costs - Supply and demand - elasticity of demand; Supply of transport services - Economics of traffic congestion - Pricing policy. Vehicle operating costs - Fuel costs - Maintenance and spares - Depreciation - Crew costs - Value of travel time savings - Accident costs.
Economic analysis of projects - Methods of evaluation - Cost-benefit ratio, first year rate of return, net present value, and internal-rate of return methods; Indirect costs and benefits of transport projects.
Financing of road projects - methods – Private Public Partnership (PPP) - Toll collection - Economic viability of Build-Operate-Transfer Schemes – Risk Analysis - Case Studies.

References

1. Winfrey, *Economic analysis for Highways,* International Textbook Company, Pennsylvania, 1969.
2. CRRI, *Road User Cost Study in India*, New Delhi, 1982
3. IRC, *Manual on Economic Evaluation of Highway Projects in India*, SP30, 2007

CE606 TRANSPORTATION PLANNING

Urban Transportation Planning - Goals and objectives - Hierarchical levels of transportation planning - Forecast - Implementation - Constraints. UTP survey - Inventory of land use

Trip generation - Trip classification - productions and attractions - Multiple regression models - Category analysis - Trip production models - Trip distribution models - Linear programming approach.
Modal split models - Behavioral models - Probabilistic models - Utility functions - logit models - Two stage model. Traffic assignment - Assignment methods - Route-choice behavior - Network analysis.
Landuse and its interaction - Lowry derivative models - Quick response techniques - Non-Transport solutions for transport problems. Characteristics of urban structure. Town planning concepts.
Preparation of alternative plans - Evaluation techniques - Plan implementation - Monitoring - Financing of Project – Case studies.

References

1. Hutchinson, B.G., *Principles of Urban Transport Systems Planning*, Scripta, McGraw-Hill, NewYork, 1974.
2. Khisty C.J., *Transportation Engineering - An Introduction*, Prentice Hall, India, 2002.

CE607 COMPUTER SIMULATION APPLICATIONS IN TRANSPORTATION ENGINEERING

Introduction to systems approach - Typical transportation systems - Mathematical models. Fundamentals of simulation - Monte Carlo method - Analog and digital simulation - Continuous and discrete models - Simulation languages - Introduction to CSMP.
Probability concepts - Random numbers - Pseudo random generators - Arrival patterns - Service time distributions, Queue discipline – Manual simulation of simple queuing system
Creating and moving transactions - Queues and facilities - Event scheduling - Internal logic of GPSS

processor - Program control statements.
Priority - Preemption - Functions – Parameters and save values – Standard numerical attributes - Collection of statistics - Report preparation.
Applications of GPSS - Simple queuing problems - Inventory problems - Simulation of ports - Railway platforms and level crossings - Traffic signals. Analysis of simulation results - Model validation - Replication of random conditions - Time series analysis.

References

1. Gordon, G., *System Simulation,* Prentice-Hall of India, 1992
2. GPSS/PC, *User Manual, Minuteman Software,* USA, 1985

CE608 CAD IN TRANSPORTATION ENGINEERING

Transportation Software – Mx Road, REI heads, HDM4, TRIPS, MIGRAN
GIS and Remote Sensing Packages – ArcGIS, Geo-Concept, GRAM++, ENVI, ERDAS Imagine
Computer Aided Drafting - DBMS concepts - Civil Engineering Databases – Data entry & Reports. Spreadsheet concepts – Worksheet calculations in Civil Eng, - Regression & Matrix Inversion.
Development of C programs to solve problems using numerical techniques

a. Roots of an equation using Newton – Raphson method.
b. Solution of linear simultaneous equations using Gauss elimination.
c. Matrix inversion using Gauss Jordan method
d. Linear regression line of given points.

References

1. Rajaraman, V., *Computer Oriented Numerical Methods*, Prentice – Hall of India, 1995
2. Chapra S.C., and Canale R.P., *Numerical Methods for Engineers*, McGraw – Hill, 2004
3. Software Manuals

ELECTIVES

CE611 GEOGRAPHICAL INFORMATION SYSTEMS AND REMOTE SENSING

GIS Definition – Map and map analysis – Automated cartography – History and development of GIS – Hardware requirement – Type of data – Spatial and non- spatial data – Data structure – Vector and raster – Files and data formats – Data compression.
Spatial analysis – Data retrieval – Query – Overlay – Vector data analysis – Raster data analysis – Modelling in GIS – Digital Elevation Model – DTM – Types of output data – Output devices – Sources of errors – Types of errors – Elimination – Accuracies - The Global Positioning system and its applications.
Concepts and foundations of remote sensing - electromagnetic spectrum - EMR interaction with atmosphere, water vapour, ozone - Basic principles of photogrammetry – Spectral Signature and Spectral Signature curves - Remote sensing platforms and sensors.
Satellite system parameters, sensor parameters, earth resources and meteorological satellites, microwave sensors, Data Acquisition and interpretation - Visual Image Interpretation – Visual Image Interpretation Equipment - Digital Image Processing – Classification.
Applications in Survey, mapping and monitoring of land use/land cover - Transportation planning - Infrastructure development - Natural resources management - Urban Planning, Environment - Coastal Zone Management – Air Quality - 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.

CE612 INTELLIGENT TRANSPORTATION SYSTEMS

Introduction to Intelligent Transportation Systems (ITS) – Definition of ITS and Identification of ITS Objectives, Historical Background, Benefits of ITS - ITS Data collection techniques – Detectors, Automatic Vehicle Location (AVL), Automatic Vehicle Identification (AVI), Geographic Information Systems (GIS), video data collection.

Telecommunications in ITS – Importance of telecommunications in the ITS system, Information Management, Traffic Management Centres (TMC). Vehicle – Road side communication – Vehicle Positioning System
ITS functional areas – Advanced Traffic Management Systems (ATMS), Advanced Traveler Information Systems (ATIS), Commercial Vehicle Operations (CVO), Advanced Vehicle Control Systems (AVCS), Advanced Public Transportation Systems (APTS), Advanced Rural Transportation Systems (ARTS).
ITS User Needs and Services – Travel and Traffic management, Public Transportation Management, Electronic Payment, Commercial Vehicle Operations, Emergency Management, Advanced Vehicle safety systems, Information Management.
Automated Highway Systems - Vehicles in Platoons – Integration of Automated Highway Systems. ITS Programs in the World – Overview of ITS implementations in developed countries, ITS in developing countries.

References

1. ITS Hand Book 2000: *Recommendations for World Road Association (PIARC)* by Kan Paul Chen, John Miles.
2. Sussman, J. M., *Perspective on ITS*, Artech House Publishers, 2005.
3. National ITS Architecture Documentation, US Department of Transportation, 2007 (CD-ROM).

CE613 PAVEMENT MATERIALS

Subgrade soil - Soil composition and structure - Soil classification for engineering purposes - Origin, Classification, requirements, properties and tests on road aggregates
Origin, preparation, properties and tests, constitution of bituminous road binders, requirements - Bituminous Emulsions and Cutbacks: Preparation, characteristics, uses and tests
Bituminous Mixes: Mechanical properties - Resilient modulus, dynamic modulus and fatigue characteristics of bituminous mixes.
Weathering and Durability of Bituminous Materials and Mixes - Performance based Bitumen Specifications - Superpave mix design method
Cement Concrete for Pavement Construction: Requirements, design of mix for CC pavement, joint filler and sealer materials.

References

1. RRL, DSIR, *Bituminous Materials in Road Construction*, HMSO Publication, 1955
2. IS and IRC Publications on relevant topic.

CE614 GROUND IMPROVEMENT TECHNIQUES

Introduction: Engineering properties of soft – weak and compressible deposits – problems associated with weak deposit – Requirements of ground improvements – introduction to engineering ground modification, need and objectives.
Soil Stabilization: Science of soil stabilization – Mechanical modification – Hydraulic modification – Dewatering systems – Chemical modification – Modification by admixtures like lime, Cement, Bitumen etc. – Grouting – Deep jet mixing methods
Recent Ground improvement techniques: stabilization using industrial waste – modification by inclusion and confinement – soil nailing – stone column – compaction piles – dynamic compaction – prefabricated vertical drains – preloading – electro – osmosis – soil freezing vacuum consolidation – deep explosion – dry powdered polymers - enzymes
Soil reinforcement: Historical background, RCC – Vidalean concept of reinforced earth – Mechanisms – Types of reinforcements – Soil – Reinforcement – Interaction studies – Internal & External stability criteria – Design Principles of steep reinforced soil slops – pavements – Embankments on soft soils.
Geo-Synthetics: Geo-synthetic clay liner – Construction details – Geo Synthetic Materials – Functions – Property characterization – Testing Methods for Geo – Synthetics – Recent research and Developments. Control of Improvement – Field Instrumentation – design and analysis for bearing capacity and settlement of improved deposits.

References

1. Hausmann, M.R., *Engineering Principles of Ground Modification*, McGraw – Hill International Editions, 1990.
2. Purushotham Raj, *Ground Improvement Techniques*, Laxmi Publications, New Delhi
3. Sharma.S.K., Priniciples, *Practice and Design of Highway Engineering*, S.Chand & Co. New Delhi,1985.
4. Jones C. J. F. P, *Earth Reinforcement and Soil Structures*, Butterworths, London.

CE615 BRIDGE ENGINEERING

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. Ponnu swamy, 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 Super structure*, Narosa Publishing House, New Delhi, 2006.

CE616 THEORY OF TRAFFIC FLOW

Traffic stream parameters - Fundamental diagram of volume-speed-density surface. Discrete and continuous probability distributions. Merging manoeuvres - critical gaps and their distribution.
Macroscopic models - Heat flow and fluid flow analogies - Shock waves and bottleneck control approach.
Microscopic models - Application of queuing theory - regular, random and Erlang arrival and service time distributions - Waiting time in single channel queues and extension to multiple channels.
Linear and non-linear car following models - Determination of car following variables - Acceleration noise.
Geographical Information System – Global Positioning System – Intelligent Transportation Systems - Area Traffic Control – Automatic Toll Collection – Smart Cards – Collision Detection System.

References

1. Drew, D.R., *Traffic Flow Theory and Control*, McGraw Hill., 1978.
2. TRB, *Traffic Flow Theory* - A Monograph, SR165, 1975.
3. Burrough P.A. and Rachel A. McDonell, *Principles of Geographical Information Systems*, Oxford Publication, 2004.

CE617 TRANSPORTATION NETWORK ANALYSIS AND OPTIMIZATION

Network flows: Applications, definitions, graphs, paths, trees, cycles, loops, walk, network representation (adjacency list and matrices) and basic network transformations; Network algorithms; Complexity, Search Algorithms, Strategies for designing polynomial algorithms.
Shortest Path Algorithms: Label setting, Dijkstra's and Dial's algorithms, Optimality conditions, label correcting algorithms and optimality conditions, detecting negative cycles, all-pair shortest path algorithms; pre-flow push polynomial time algorithms, capacity scaling techniques.
Minimum cost network assignment: optimality conditions, cycle-canceling algorithm, Successive shortest path algorithm, other polynomial time variants; Network equilibrium analysis; principles and optimisation formulations, Frank-Wolfe algorithm; Special cases and variants.
Applications: Applications of min-cost, max-flow, and shortest path algorithms to transportation and infrastructure networks: transportation networks, airline, freight, facility location, logistics, network design, project scheduling, reliability of distribution systems, telecommunication/power networks etc.
Computer Software: Principles of TRIPS, SATURN, EMME/2, CUBE; Demo Versions, Case studies

References

1. Ahuja, R.., Magnanti, T.L., and Orlin, J.B., *Network Flows: Theory, Algorithms and Application,* Prentice Hall, New Jersey, 1993.
2. Bell, M.G., *Transportation Networks,* Elsevier Science Publishers, 1999.

CE618 ADVANCED HIGHWAY MATERIALS

Aggregate: Nature and properties – aggregate requirements – types and processing – aggregates for pavement base – aggregate for bituminous mixture – aggregate for Portland Cement Concrete – light weight aggregate – tests on aggregate – specification.
Bituminous Materials: conventional and modified binders – production – types and grade – physical and chemical properties and uses – types of asphalt pavement construction – principles of bituminous pavement construction – tests on bituminous materials. Bituminous Mix design – modified mixtures – temperature susceptibility and performance.
Cement /concrete based materials: Cement – properties – PCC mix design and properties – modified PCC – Mix Design – Behavior – Performance – Tests on Cement and Concrete mixes. High Performance Concrete – low shrinkage – increased strength.
Composites, Plastics and Geosynthetics: Plastics and polymerization process – properties – durability and chemical composition – Reinforced Polymer Composites – Geosynthetics – Dry Powdered Polymers – Enzymes.
Reclamed/Recycled Waste Products: Reclaimed Materials – waste products in civil engineering applications – effect of waste products on materials, structure and properties – self healing and smart materials – locally available materials.

References

1. P. T. Sherwood, *Alternative Materials in Road Construction*, Thomas Telford Publication, London, 1997.
2. RRL, DSIR, *Soil Mechanics for Road Engineers,* HMSO, London , 1995
3. Koerner, R. M. *Designing with Geosynthetics,* Prentice Hall, Englewood Cliffs, New Jersey, U.S.A.
4. Shan Somayaji, *Civil Engineering Materials*, second edition, Prentice Hall Inc., 2001.

M. Tech. (STRUCTURAL ENGINEERING)

The total minimum credits required for completing the M. Tech. Programming in Structural Engineering is 64.

SEMESTER I

Code	Course of Study	L	T	P	C
MA751	Applied Mathematics	3	0	0	3
CE651	Theory of Elasticity and Plasticity	3	0	0	3
CE652	Matrix Methods of Structural Analysis	3	0	0	3
CE653	Structural Dynamics	3	0	0	3
	Elective – I	3	0	0	3
	Elective – II	3	0	0	3
CE654	Structural Engineering Laboratory	0	0	3	2
		18	**0**	**3**	**20**

SEMESTER II

Code	Course of Study	L	T	P	C
CE655	Stability of Structures	3	0	0	3
CE656	Finite Element Methods	3	0	0	3
CE657	Theory of Plates and Shells	3	0	0	3
	Elective – III		0	0	3
	Elective – IV	3	0	0	3
	Elective – V	3	0	0	3
CE658	CAD in Structural Engineering	1	0	3	2
		19	**0**	**3**	**20**

SEMESTER III

Code	Course of Study	L	T	P	C
CE697	Project	0	0	24	12

SEMESTER IV

Code	Course of Study	L	T	P	C
CE698	Project	0	0	24	12

ELECTIVES

Code	Course of Study	L	T	P	C
CE661	Advanced Concrete Technology	3	0	0	3
CE662	Analysis of Deep Foundation	3	0	0	3
CE663	Maintenance of Structures	3	0	0	3
CE664	Advanced Steel Structures	3	0	0	3
CE665	Failure Analysis of Structures	3	0	0	3
CE666	Seismic Design of Structures	3	0	0	3
CE667	Prefabricated Structures	3	0	0	3
CE669	Smart Structures and Applications	3	0	0	3
CE671	Prestressed Concrete	3	0	0	3
CE672	Design of Tall Buildings	3	0	0	3
CE673	Fracture Mechanics	3	0	0	3
CE674	Structures in Disaster Prone areas	3	0	0	3
CE675	Advanced Concrete Structures	3	0	0	3
CE676	Soil Structure Interaction	3	0	0	3
CE677	Random Vibrations and Structural Reliability	3	0	0	3
CE678	Design of Boiler Structures	3	0	0	3
CE615	Bridge Engineering	3	0	0	3
CE679	Hydraulic Structures	3	0	0	3
CE680	Forensic Engineering and Rehabilitation of Structures	3	0	0	3
CE681	Advanced Steel and Concrete Composite Structures	3	0	0	3
CE682	Special Concrete	3	0	0	3
MT614	Corrosion Engineering	3	0	0	3
ME774	Safety in Construction	3	0	0	3
	Any other elective				

SEMESTER I

MA751 APPLIED MATHEMATICS

Polar co-ordinates - Expressions of gradient of scalar point function -divergence and curllof a vector point function in orthogonal curvilinear co-ordinates - Summation convention tensors - Quotient law - Chrioleffel symbols - Inverse of a matrix - Eigen values and Eigen vectors of matrix - Quadratic form - Hermition form - Canonical form.

Maxima and minima of functions of two variables - Lagrange Multipliers - Functional - Externals -Euler-Lagrange Equation - Solution in power series by the method of Frobenious - Legendre and Bessel equations

Fourier, Bessel and Legendre series and functions - Two dimensional wave equations - Transverse vibrations of rectangular and circular membranes

Two dimensional heat flow in transient state - Three dimensional heat flow in transient state - Laplace equations - Steady state temperature distribution in solid spheres and spherical shells.

References

1. Grewal B.S, Higher Engineering Mathematics, Khanna publishers, 1997.
2. Venkataraman, M.K., Higher Mathematics for Engineers, National Publishing Co., 1986.

CE 651 THEORY OF ELASTICITY AND PLASTICITY

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 2 and 3 dimensions in 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. Wang: Applied Elasticity, Dover publications Inc.,1985
4. Chen and Han : Plasticity for Structural Engineers, Springer Verlag,1998.

CE652 MATRIX METHODS OF STRUCTURAL ANALYSIS

Generalized Measurements - Degrees of freedom - Constrained Measurements - Behavior of structures - Principle of superposition- Stiffness and flexibility matrices in single, two and n-co-ordinates - Structures with constrained measurements.

Stiffness and flexibility matrices from strain energy - Betti's law and its applications- Determinate and indeterminate structures - Transformation of element matrices to system matrices - Transformation of

system vectors to element vectors.
Flexibility method applied to statically determinate and indeterminate structures – Choice of redunants - Transformation of redundants-Internal forces due to thermal expansion and lack of fit.
Displacement method - Internal forces due to thermal expansion and lack of fit - Application to symmetrical structures - Code system in the stiffness methods - Computer program for the code system - Comparison between stiffness and flexibility methods.
Analysis by substructures using the stiffness method and flexibility method with tridiagonalization- Analysis by Iteration method - frames with prismatic members - non-prismatic members.

References

1. Moshe, F., Rubenstein, Matrix Computer Analysis of Structures, Prentice Hall, New York, 1966.
2. Kanchi, Matrix Structural Analysis, Wiley Eastern Ltd., Newdelhi 1981.
3. Rajasekaran S, Computational Structural Mechanics, Prentice Hall of India. New Delhi, 2001.

CE653 STRUCTURAL DYNAMICS

Introduction to 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 methods - Expression for generalized system properties - vibration analysis Rayleigh's method - Rayleigh - Ritz method.
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
Differential equation of motion - Beam flexure including shear deformation and rotatory inertia - Vibration analysis using finite element method for beams and frames

References

1. Mario Paz, and William Leigh, 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" Pcarson Education, 2001.

CE654 STRUCTURAL ENGINEERING LABORATORY

Model Analysis - Use of various types of strain gauges - Mechanical and Electrical strain gauges - Casting and testing of R.C. and pre-stressed concrete beams and study of their behavior-Experiments in 2-D photo elasticity - properties of concrete ingredients – concrete mix design - strength tests on concrete.

SEMESTER – II

CE655 STABILITY OF STRUCTURES

Buckling of columns – introduction – concepts of stability – methods of Neutral Equilibrium – Euler column – Eigen value problem – Axially loaded column – Eccentrically loaded column

Energy principle – Raleigh Ritz method – Galerkin method – Numerical methods (New mark's difference and matrix methods)
Beams and Beam columns – introduction – lateral buckling of beams – beam column with concentrated and distributed loads – effect of axial load on bending stiffness
Buckling of frames – introduction – modes of buckling – critical load using various methods Neutral equilibrium – slope deflection equations, matrix method.
Buckling of plates – Differential equation of plate buckling – critical loan on plates for various boundary conditions – Energy method – Finite difference method.

References

1. Timoshenko and Gere. Theory of elastic stability, McGraw Hill Book Company, 1981
2. Alexandar Chajes, Principles of Structural Stability Theory, Prentice Hall, New Jersey, 1980
3. Iyenger, N.G.R. Structural Stability of columns and plates, Affiliated East west press Pvt Ltd., 1990.
4. Bleich F. Buckling Strength of metal structures, McGraw Hill 1991.

CE656 FINITE ELEMENT METHOD

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 LDL^T decomposition- Basic steps in finite element anlaysis.
Analysis of framed Structures- 2D truss element - 2D beam element. Analysis of plate bending: Basic theory 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. NewDelhi 2000.

CE 657 THEORY OF PLATES AND SHELLS

Simple bending of Plates- Assumptions in thin plate theory- Different relationships-Different boundary conditions for plates- Plates subjected to lateral loads- Naviers method for simply supported plates- Levy's method for general plates- Example problems with different types of loading.
Circular plates subjected to axi-symmetric loads- Concentrated load at centre-udl and uvl-Annular plates with different types of loads and different boundary conditions- Circular plates with end moments-method of superposition
Rayleigh- Ritz method for plate analysis-Applications to different plate problems with different boundary conditions-Finite difference schemes- Finite Element methodology for plates

Orthotropic plates- material orthotropy and structural orthotropy – Solution methods.
Shells- Classification of shells- Membrane theory for axi-symmetric shells- Equilibrium equations- Solution for some special cases of axi-symmetric shells – Analysis of folded plates

References

1. Timoshenko and Krieger :Theory of Plates and Shells, McGraw Hill, 1984
2. Rudolph Szilard: Theory and Analysis of Plates, Prentice Hall 1986
3. K. Chandrasekhara: Theory of Plates, Universities Press,2001

CE658 CAD IN STRUCTURAL ENGINEERING

Computer Aided Drafting **-** Basic 2D objects – line, polyline, circle, ellipse – Dimensioning – Preparation of plan, elevation and section drawings of simple structural objects – Introduction to 3D - DBMS concepts - Civil Eng. Databases – Data entry & Reports. Spreadsheet concepts – Worksheet calculations in Civil Engineering - Regression & Matrix Inversion. Development of C programs to solve problems using numerical techniques

1. Roots of an equation using Newton – Raphson method.
2. Solution of linear simultaneous equations using Gauss elimination.
3. Matrix inversion using GJ method
4. Linear regression line of given points.
5. Curve fitting using Polynomial Regression.
6. Eigen value extraction power method

Computer methods of structural analysis - Finite Element programming - Analysis through application packages. Design of steel and RC Structural elements.

References

1. Rajaraman, V., Computer Oriented Numerical Methods, Prentice – Hall of India, 2004.

ELECTIVES

CE661 ADVANCED CONCRETE TECHNOLOGY

Introduction to concrete – Mineral and chemical admixtures – Structure of hydrated cement paste – Transition zone in concrete - Design of concrete mix proportions by ACI and IS 10262:2009 method – Rheological behavior of fresh concrete - Properties of hardened concrete and their significance.
Strength-Porosity relationship – Failure modes in concrete – Behavior of concrete under various stress states – Elastic behavior in concrete - Creep, shrinkage and thermal properties of concrete.
Classification of causes of concrete deterioration – Permeability of concrete – Chloride penetration – Acid attack - Sulfate attack – Alkali-aggregate reaction – Concrete in sea water – AC impedance test - Corrosion of embedded steel in concrete – Case histories..
Non-Destructive testing: Rebound hammer – Windsor probe – Ultrasonic pulse velocity – Acoustic emission – Pulse-echo method – Initial surface absorption – Radar technique – Infrared Thermogaphy – Quantab test – Portable crack measuring microscope – Cover meter –Resistivity of concrete – Semi-destructive testing.
Concreting under special circumstances – Special materials in construction – Concreting machinery and equipments – Future trends in concrete technology.

References

1. P.Kumar Metha and Paulo J.M.Monteiro., Concrete: Microstructure, Properties and Materials, Third edition, Mc Graw Hill, 2006.
2. IS: 10262-2009, Recommended Guidelines for Concrete Mix Design, BIS, NewDelhi.
3. *ACI 211.1-91*, Reapproved 2002, Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass concrete based on a report published by the American Concrete Institute (ACI), Committee 211.
4. Adam. M. Nevillie., Properties of Concrete, Fourth and Final edition, Wiley Publications, 1996.
5. A.R. Santhakumar, Concrete Technology" Oxford University Press, 2006
6. P.-C.Aïtcin, High Performance Concrete, E &FN SPON, 1998

CE662 ANALYSIS OF DEEP FOUNDATION

Functions and requisites of a foundation - Different types - Choice of foundation type – Types of deep foundation – Types of pile foundations- Factor governing choice of type of pile – Choice of pile materials.

Load carrying capacity of piles by static formulae- Introduction: IS code method- API method-Piles in cohesive and cohesionless soils – Piles in layered cohesive and cohesionless soils – Settlement of single pile – Piles bearing on rock – Piles in fill and Negative skin friction.

Load carrying capacity of piles by static formulae: Introduction- Pile driving formulae- selection of pile hammers- Determination of temporary elastic compression- Driving stresses in piles- Field measurement- Wave equation analysis.

Group action in piled foundations: Introduction- Minimum spacing of piles- group efficiency- Estimation of group bearing capacity- Effect of pile arrangement- Effect on pile groups of installation methods-precaution against heave effect in pile group-Settlement of pile group-Reduce differential settlement in pile group.

Pile subjected to lateral load: Introduction- Lateral resistance of single pile-IS 2911 method for lateral resistance of pile- Broms charts for lateral load analysis- Elastic analysis-p-y curves, use of p-y curves-improving lateral resistance of piles- field test on piles.

References

1. J.E. Bowles, "Foundation Analysis and Design", McGraw Hill, 1996.
2. M.J. Tomlinson, "Foundation Design and Construction", Addison Wesley, 2001.
3. M.J. Tomlinson, "Pile Design and Construction Practice", E & FN Spon, 1987.
4. Braja M. Das., "Principles of Foundation Engineering", Thomson Asia Pte , 1987, London Ltd., Singapore, 2005, A viewpoint publication.
5. P.C. Varghese, "Foundation Engineering", Prentice-Hall of India, New Delhi, 2005.

CE663 MAINTENANCE OF STRUCTURES

Quality assurance for concrete construction as built concrete properties strength, permeability, thermal properties and cracking.

Effects due to climate, temperature, chemicals, wear and erosion, Design and construction errors, corrosion mechanism, Effects of cover thickness and cracking, methods of corrosion protection

Definitions: Maintenance, repair and rehabilitation, Facets of and importance of Maintenance Preventive measures on various aspects Inspection, Assessment procedure for evaluating a damaged structure causes of deterioration-testing techniques.

Special concretes and mortar, concrete chemicals, special elements for accelerated strength gain,

Expansive cement, polymer concrete, sulphur infiltrated concrete, ferro cement, Fiber reinforced concrete.
Rust eliminators and polymers coating for rebars during foamed concrete, mortar repair for cracks, shoring and underpinning.

References

1. Raikar, R.N., Learning from failures – Deficiencies in Design, Construction and Service – R&D Centre (SDCPL), Raikar Bhavan, 1987.
2. Allen R.T., and Edwards S.C, Repairs of Concrete Structures, Blaike and Sons, U.K.1987.

CE 664 ADVANCED STEEL STRUCTURES

Estimation of wind load - Design of industrial stacks - Self supporting and guyed stacks lined and unlined – along wind and across wind vibration.
Principles of analysis and design of Industrial buildings and bents - Gantry girders and crane columns.
Lattice tower configurations and types – loads in tower – Analysis and design of steel towers – micro wave towers - Transmission line towers – analysis of tower foundation.
Types of connections, Design of framed beam connections, Seated beam connection, Un-stiffened, Stiffened Seat connections, Continuous beam – to - beam connections and continuous beam–to–column connection both welded and bolted.
Cold formed Steel Sections - Types of cross sections - Local buckling and post buckling - Design of compression and Tension members - Beams - Deflection of beams - Combined stresses and connections.

Reference

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, Design and Drawing,
4. IS 800-2007, Code of practice for general construction in steel, Bureau of Indian Standards, New Delhi.
5. 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.
6. SP6 (1)-1964, IS hand book for structural Engineers. Bureau of Indian Standards, New Delhi.

CE665 FAILURE ANALYSIS OF STRUCTURES

Causes of failure – Types of failure – why, what, how – durability of materials – Landmark case – Performance and shape inadequacy – statistics and reliability – life cycle assessment.
Structural failure –material and load effects – environment effect - Non-structural and structural repairs –Biocidal treatment and use of preservatives –deterioration of wood
Macro micro level failures – component and sub-system failures - failure theories – analytical models – cases and type of problem in components –safety evaluation.
Structural systems–case studies – pin-jointed steel systems – rigid jointed frames – concrete walls arches – reinforced concrete beams and frames – shells –repair of concrete bridge and water retaining structures.
Bridge maintenance techniques –The refurbishment of buildings, legal responsibilities – Case studies – Definition of smartness –sensors – automatic and adaptive systems – smart components

References

1. Rasnom, W.H., Building Failures, E&F, N. SPON Ltd., 1980.
2. Moskvin V, Concrete and Reinforced Structures – Deterioration and Protection, Mir Publishers, Moscow, 1980.

CE666 SEISMIC DESIGN OF STRUCTURES

Engineering seismology – rebound theory – plate tectonics – seismic waves – earthquake size and various scales – local site effects – Indian seismicity – seismic zones of India – theory of vibration – near ground and far ground rotation and their effects.
Seismic design concepts – EQ load on simple buildings – load path – floor and roof diaphragms – seismic resistant building architecture – plan configuration – vertical configuration – pounding effects – mass and stiffness irregularities – torsion in structural system
Provision of seismic code (IS1893 & IS 13920) – Building systems – frames – shear wall – braced frames – layout design of Moment Resisting Frames (MRF) – ductility of MRF – Infill walls – Non-structural elements
Calculation of EQ load – 3D modelling of building systems and analysis (theory only) Design and detailing of frames, shear wall, and frame walls
Cyclic loading behaviour of RC steel and pre-stressed concrete elements - modern concepts – base isolation – Adoptive systems – case studies

References

1. Pankaj Agarwal and Manish ShriKhande, Earthquake Resistant Design of Structures, Prentice- Hall of India, 2007, New Delhi
2. Bullen K.E., Introduction to the Theory of Seismology, Great Britain at the University Printing houses, Cambridge University Press 1996.
3. Relevant code of practices.

CE667 PREFABRICATED STRUCTURES

Types of prefabrication, prefabrication systems and structural schemes- Disuniting of structures- Structural behavior of precast structures. Handling and erection stresses- Application of prestressing of roof members; floor systems two way load bearing slabs, Wall panels, hipped plate and shell structures.
Dimensioning and detailing of joints for different structural connections; construction and expansion joints.
Production, Transportation & erection- Shuttering and mould design Dimensional tolerances- Erection of R.C. Structures, Total prefabricated buildings.
Designing and detailing prefabricated units for 1) industrial structures 2) Multistorey buildings and 3) Water tanks, silos bunkers etc., 4) Application of prestressed concrete in prefabrication.

References

1. Hass, A.M. Precast Concrete Design and Applications, Applied Science Publishers, 1983.
2. Promyslolw, V Design and Erection of Reinforced Concrete Structures, MIR Publishers, Moscow 1980.

CE669 SMART STRUCTURES AND APPLICATIONS

Introduction to passive and active systems – need for active systems – smart systems – definitions and implications - active control and adaptive control systems – examples.
Components of smart systems– system features and interpretation of sensor data – pro active and reactive systems – demo example in component level – system level complexity
Materials used in smart systems – characteristics of sensors – different types smart materials – characteristics and behavior of smart materials – modelling smart materials – examples.
Control Systems – features – active systems – adaptive systems – electronic, thermal and hydraulic type actuators – characteristics of control systems – application examples.
Integration of sensors and control systems – modelling features – sensor-response integration – processing for proactive and reactive components – FE models – examples.

References

1. Srinivasan, A.V. and Michael McFarland, D., Smart Structures: Analysis and Design, Cambridge University Press, 2000.
2. Yoseph Bar Cohen, Smart Structures and Materials 2003, The International Society for Optical Engineering 2003.

CE671 PRESTRESSED CONCRETE STRUCTURES

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.

CE672 DESIGN OF TALL BUILDINGS

Design philosophy – Loading - Sequential loading, materials.
High risk behavior, rigid frames, braced frames, infilled frames; shear walls, coupled shear walls, wall – frames, tubulars, cores, futrigger - braced and hybrid mega system.
Approximate Analysis, Accurate Analysis and Reduction Techniques - Analysis of building for member forces - drift and twist - Computerized general three dimensional analysis.
Structural elements- design, deflection, cracking, prestressing, shear flow-Design for differential movements, creep and shrinkage effects, temperature effects and fire.
Overall buckling analysis of frames, wall – frames–second order effects of gravity of loading– simultaneous first order and P-delta analysis Translational - torsional instability, out of plum effects

References

1. Bryan Stafford smith and Alex coull, Tall Building Structures – Analysis and Design, John Wiley & sons, 2006.

CE673 FRACTURE MECHANICS

Definition of stress intensity factor, Fracture toughness Energy release rate, Critical Energy release rate Crack mouth opening displacement, R-Curve and J integral Basic reasons for fracture mechanics approach for concrete, Limitations of linear elastic fracture mechanics for concrete. Non linear fracture method Fracture energy and size effect.

References

1. David Broek, Elementary Engineering Fracture Mechanics, Sijthoff and Noordhaff, Alphen Aan Den Rijn, The Netherlands, 2001.
2. Analysis of Concrete Structure by Fracture Mechanics, Ed L. Elfgren and S.P. Shah, Proc of Rilem Workshop, Chapman and Hall, London, 2001.

CE674 STRUCTURES IN DISASTER PRONE AREAS

Philosophy for design to resist Earthquake, Cyclone and flood –By-laws of urban and Semi-Urban areas-Traditional and modern structures
Response of dams, bridges, buildings – Strengthening - Testing and evaluation – Classification of structures for safety point of view
Methods of strengthening for different disasters – Qualification test.
Use of modern materials their impact on disaster reduction – Use of modern analysis, design and construction techniques optimization for performance.
Damage surveys – Maintenance and modifications to improve hazard resistance – Different types of foundation and its impact on safety – Ground improvement techniques.

References

1. Allen, R.T. and Edwards, S.C., Repair of Concrete Structures, Blakie and Sons, 1980.
2. Moskvin V, Concrete and Reinforced Structures – Deterioration and Protection, Mir Publishers, Moscow, 1980.

CE675 ADVANCED CONCRETE STRUCTURES

The nature of concrete, stress-strain relationships of concrete, stress-strain relationships of reinforcing steel, stress block parameters. Failure criteria for concrete.
Behavior of concrete flexural members, general equations for calculation of moment capacities at ultimate limit state and at limit state of local damage, flexural rigidity, calculation of deflection, redistribution of moments, design examples.
Axially loaded compression members combine axial load and uniaxial bending. Interaction diagrams, combined axial load and biaxial bending, slender compression members, design example using I.S.456-2000.
Shear cracking of ordinary reinforced concrete members, web reinforcement, design examples, shear in tapered beams. Development length of reinforcement, anchorage. Significance of Torsion, Torsional resistance of concrete beams, reinforcement for torsion, design examples.

General principles, effective depths, detailing of reinforcement, design of main reinforcement, design of transverse reinforcement, conditions at loads and at supports. Yield line theory.

References

1. Varghese P.C, Design of Reinforced Concrete Structures, Prentice hall of India, 2004.
2. Krishnamurthy, K.T, Gharpure S.C. and A.B. Kulkarni – Limit design of reinforced concrete structures, Khanna Publishers, 1985.

CE676 SOIL-STRUCTURE INTERACTION

Soil-Foundation Interaction: Introduction to soil-foundation interaction problems, Soil behavior, Foundation behavior, Interface behavior, Scope of soil foundation interaction analysis, soil response models, Winkler, Elastic continuum, two parameter elastic models, Elastic plastic behavior and Time dependent behavior.
Beam on Elastic Foundation- Soil Models: Infinite beam, two parameters, Isotropic elastic half space, Analysis of beams of finite length, Classification of finite beams in relation to their stiffness. Plate on Elastic Medium: Thin and thick plates, Analysis of finite plates, Numerical analysis of finite plates, simple solutions.
Elastic Analysis of Pile: Elastic analysis of single pile, Theoretical solutions for settlement and load distributions, Analysis of pile group, Interaction analysis, Load distribution in groups with rigid cap.
Laterally Loaded Pile: Load deflection prediction for laterally loaded piles, Subgrade reaction and elastic analysis, Interaction analysis, Pile-raft system, Solutions through influence charts. An introduction to soil-foundation interaction under dynamic loads

References

1. Selva durai, A. P. S, Elastic Analysis of Soil-Foundation Interaction, Elsevier, 1979.
2. Poulos, H. G., and Davis, E. H., Pile Foundation Analysis and Design, John Wiley, 1980.
3. J.E. Bowles, “Foundation analysis and design”, McGraw Hill 1996.

CE677 RANDOM VIBRATIONS AND STRUCTURAL RELIABILITY

Review of probability: probability space, random variables, functions of random variables, sequence of random variables and limit theorems for sums, products and extremes. Review of random processes: stationarity, ergodictiy, power spectrum and autocovariance. Calculus of random processes. Input-output relations for linear systems. Stochastic steady state. Level crossing and first passage problems. Extreme value distributions. Reliability index based analyses: FORM and SORM. Monte Carlo simulations and variance reduction. Reliability of existing structures.

References

1. N C Nigam, 1983, Introduction to random vibrations, MIT Press, Boston.
2. A Papoulis, 1993, Probability, random variables and stochastic processes, McGraw-Hill, NY.
3. R E Melchers, 1999, Structural reliability analysis and prediction, John Wiley, Chichester.

CE678 DESIGN OF BOILER STRUCTURES

Type of boilers: Top supported - Utility boilers- Tower type- Two pass system- Once through boiler- Bottom supported - Industrial boilers-Bi drum

Layout configuration-Front mill layout-Rear mill layout- Side mill layout-column configuration for 210MW-250MW-500MW and lower capacity boilers.
Boiler Structure Structural components- Columns-beams-vertical bracings- ceiling structure including ceiling girders-girder pin connection-horizontal truss work-platforms- weather protection structure-stair ways-mid landing plat forms-handrails - floor grills-post and hangers -inter connection platforms- lift structure-mill maintenance plat form structure-duct supports-furnace guide supports-Eco coil handling structure-ID system structure-Fan handling structure.
Drum lifting Structure: Design loads: Dead loads – pressure parts-ducts-fuel pipe-platform-critical pipe - lining and insulation- silencer- weather protection roof-side cladding-cable tray and pipe rack
Live load-wind load-seismic load-guide load-temperature load-customer load- handling loads-contingency load etc.,
Foundation analysis-Foundation materials-main columns-auxiliary columns-horizontal beams-vertical bracings-MBL concept-horizontal truss work-girder-pin connection- ceiling main girders-cross girders-pressure parts support beams-ceiling truss work- drum floor-stairs-mid landing plat forms-hand rails-floor grills-fasteners
Platform Structure: Access platforms required for ducts, equipment, and furnace etc-Air heater supports-Fuel pipe support-Duct support- Primary & Secondary air ducts - Bus duct- SCAPH-Flue gas duct supports.
Buck stay beams-key channel - leveller guides-vertical buckstay-furnace guide- corner connections-link ties-hanger tie rods-hanger spring - hopper truss work -goose neck truss work -wind box truss work-expansion measurement instrument

References

1. Subramanian N, Design of Steel Structures, Oxford University Press, New Delhi 2008.
2. Arya A.S., Design of Steel Structures, Newchand & Brothers, Newdelhi 1982.
3. Punmia B.C., Comprehensive design of steel structures, Lakshmi Publications, Newdelhi 2000.
4. IS800 – Code of Practice for general construction in steel
5. IS875 (Part 1 -5) Code of Practice for design loads for buildings and structures
6. IS1893 – Criteria for earthquake resistance design of structures.

CE679 HYDRAULIC STRUCTURES

Investigation and Planning -Preliminary investigations and preparation of reports, Layout of projects, Geological and hydrological investigations.
Analysis and Design of Dams - Earthen Dam and Gravity Dam.
Analysis and Design of Arch Dam, Infiltration Gallery, Collector wells.
Construction of Dams - Masonry, Concrete and Earthen Dams, Foundation for Dams –Principles of Foundation treatment, grouting methods.
Design of Weirs on Permeable foundation - Creep theory, Potential theory, Flow nets, design of weirs - Khosla's theory.

References

1. Creager, W.P. Justin D, and Hinds, J., Engineering for Dams Vol. I, II and III.
2. Kushalani, K.B., Irrigation (practice and design) Vol. III and IV.
3. Nalluri C., " Hydraulic Structures" Taylor & Francis,2001

CE680 FORENSIC ENGINEERING AND REHABILITATION OF STRUCTURES

Failure of Structures: Review of the construction theory – performance problems – responsibility and accountability – case studies – learning from failures – causes of distress in structural members – design and material deficiencies – over loading

Diagnosis and Assessment of Distress: Visual inspection – non- destructive tests – ultrasonic pulse velocity method – rebound hammer technique – ASTM classifications – pullout tests – Bremor test – Windsor probe test – crack detection techniques – case studies – single and multistorey buildings – Fibreoptic method for prediction of structural weakness

Environmental Problems and Natural Hazards: Effect of corrosive, chemical and marine environment – pollution and carbonation problems – durability of RCC structures – damage due to earthquakes and flood- strengthening of buildings – provisions of BIS 1893 and 4326

Modern Techniques of Retrofitting: Structural first aid after a disaster – guniting - jacketing – use of chemicals in repair – application of polymers – ferrocement and fiber concretes as rehabilitation materials – rust eliminators and polymer coating for rebars- foamed concrete- mortar repair for cracks- shoring and underpinning -strengthening by pre-stressing.

Case studies – buildings - heritage buildings- high rise buildings- water tanks – bridges and other structures

References

1. Raikar, R.N., Learning from failures – Deficiencies in Design, Construction and Service – R&D Centre (SDCPL), Raikar Bhavan, 1987.
2. Dovkaminetzky, *Design and Construction Failures*, Galgotia Publication, New Delhi,2001
3. Jacob Feld and Kenneth L Carper, *Structural Failures*, Wiley, Europe.
4. Shen-En Chen, R. Janardhanam, C. Natarajan, Ryan Schmidt, Ino-U.S. Forensic Practices - Investigation Techniques and Technology, ASCE, U.S.A., 2010.
5. C. Natarajan, R. Janardhanam, Shen-En Chen, Ryan Schmidt, Ino-U.S. Forensic Practices - Investigation Techniques and Technology, NIT, Tiruchirappalli, 2010.
6. Gary L. Lewis, Guidelines for Forensic Engineering Practice, ASCE, U.S.A., 2003.
7. Norbert J. Delatte Jr. Beyond Failure – Forensic Case Studies for Civil Engineers, ASCE, U.S.A., 2009.

CE681 ADVANCED STEEL-CONCRETE COMPOSITE STRUCTURES

Introduction – limit states of composite sections - shear connectors – types of shear connectors – degree of shear connection – partial and complete shear connections – strength of shear connectors – Analysis and design of composite beams without profile sheet.
Design of composite beam – propped condition – un-propped condition – deflection of composite beams – beam with profile sheeted deck slab – 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.
Types of Composite columns – design of encased columns – design of in-filled columns – axial, uni-axial and bi-axially loaded columns.
Temperature – shrinkage and creep – vibration of composite beams – Cyclic behavior of composite section – case studies.

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

CE682 SPECIAL CONCRETE

High Performance Concrete (HPC) Introduction – Principles of HPC – Ingredients used for HPC – Production of HPC – Curing of HPC – Mechanism of HPC – Properties of HPC during the fresh and hardened state.

Durability of HPC **-** Acid Attack – Permeability – Scaling resistance – Chloride penetration – Resistance to sea water – sulfate attack – Alkali-aggregate reaction – Fire resistance – Mix design methods of HPC.

Special High Performance Concrete**-**Air-entrained HPC – Light weight HPC – Heavy weight HPC – Fibre reinforced HPC – Confined HPC – Roller Compacted HPC – Ultra High Performance Concrete – Reactive powder Concrete

Self Compacting Concrete**-**Introduction – Principles of SCC – Ingredients used for SCC – Mix design methods – Production and curing of SCC – Behavior of SCC under fresh and hardened state.

Various Case Histories on HPC and SCC

References

1. P.-C.Aïtcin, High Performance Concrete, E &FN SPON, 1998
2. E.G.Nawy, Fundamentals of High Performance Concrete, John Wiley & Sons., 2nd edition, 2000
3. High Performance Concrete Structural Designers Guide published by FHWA, USA, 2005.
4. Geert De Schutter**,** Peter J.M. Bartos**,** Peter Domone**,** John Gibbs**,** Self Compacting Concrete, Whittles Publishing, 2008.

M. Tech. (ENVIRONMENTAL ENGINEERING)

The total minimum credits required for completing the M. Tech. Programming in Environmental Engineering is 64.

SEMESTER I

Code	Course of Study	L	T	P	C
MA601	Numerical Methods and Applied Statistics	3	0	0	3
CE701	Environmental Chemistry and Microbiology	3	0	0	3
CE702	Physico-chemical Process for Water and Wastewater Treatment	3	0	0	3
CE703	Solid and Hazardous Waste Management	3	0	0	3
	Elective I	3	0	0	3
	Elective II	3	0	0	3
CE704	Environmental Quality Measurements Laboratory	0	0	3	2
		18	**0**	**3**	**20**

SEMESTER II

Code	Course of Study	L	T	P	C
CE705	Biological Process Design for Wastewater Treatment	3	0	0	3
CE706	Transport of Water and Wastewater	3	0	0	3
CE707	Air Quality Management	3	0	0	3
	Elective III	3	0	0	3
	Elective IV	3	0	0	3
	Elective V	3	0	0	3
CE708	Environmental Microbiology and Engineering Laboratory	1	0	3	2
		19	**0**	**3**	**20**

SEMESTER III

Code	Course of Study	L	T	P	C
CE747	Project Work	0	0	24	12

SEMESTER IV

Code	Course of Study	L	T	P	C
CE748	Project Work	0	0	24	12

ELECTIVES

Code	Course of Study	L	T	P	C
CE611	Geographical Information Systems and Remote Sensing	3	0	0	3
CE711	Water and Air Quality Models	3	0	0	3
CE712	Industrial Wastewater Management	3	0	0	3
CE713	Environmental Systems Analysis	3	0	0	3
CE714	Environmental Impact Assessment	3	0	0	3
CE715	Indoor Air Quality	3	0	0	3
CE716	Ecological and Ecosystems Engineering	3	0	0	3
CE717	Contaminant Transport Modeling	3	0	0	3
CE718	Environmental Engineering Structures	3	0	0	3
CE719	Environmental Geotechnology	3	0	0	3
CE720	Environmental Biotechnology	3	0	0	3
CE721	Design of Air Pollution Control Systems	3	0	0	3
CE722	Surface and Ground Water Modeling	3	0	0	3
CE723	River Engineering	3	0	0	3
CE724	Water Resource Systems Management	3	0	0	3
EE778	Analysis and Design of Artificial Neural Networks	3	0	0	3
EN601	Environmental Engineering and Pollution	3	0	0	3
	Any other elective				

SEMESTER I

MA601 NUMERICAL METHODS AND APPLIED STATISTICS

Linear system – Gaussian elimination and Gauss – Jordan methods – matrix inversion – Gauss seidel method – Nonlinear equations – Regula falsi and Newton- Raphson methods – interpolation – Newton's and Lagrange's interpolation

Linear Programming – Graphical and Simplex methods – Measures of central tendency, dispersion, skewness and Kurtosis – Probability – conditional probability – Bayes' theorem

Random variable – two dimensional random variables – standard probability distributions – Binomial Poisson and normal distributions - moment generating function

Sampling distributions – confidence interval estimation of population parameters – testing of hypotheses – Large sample tests for mean and proportion – t-test, F-test and Chi-square test – curve fitting-method of least squares

Regression and correlation – rank correlation – multiple and partial correlation – analysis of variance-one way and two way classifications – experimental design – Latin square design – Time series analysis.

References

1. Bowker and Liberman, *Engineering Statistics,* Prentice-Hall, 1972.
2. Venkatraman, M.K., *Numerical Methods in Science and Engineering*, National Publisher Company.

CE701 ENVIRONMENTAL CHEMISTRY AND MICROBIOLOGY

Colloids – Redox potentials – partition co-efficient – Beer – Lambert's Law – Limitations – UV visible spectroscopy – basic principles – application – Atomic absorption spectroscopy –

Principles – applications Gas chromatograph – Principles and applications – Principles of green chemistry – Error Analysis of Environmental Data

Transport and transformation of chemicals – DO, BOD and COD – Photo catalysis - Degradation of food stuffs, detergents, pesticides and hydrocarbons. Soil chemistry- acid-base and ion-exchange reactions in soil - salt affected soil and its remediation. Classification of microorganisms- prokaryotic, eukaryotic, structure, characteristics, nucleic acids-DNA, RNA, replication. Culturing of microorganisms-Environmental factors influencing microbial growth

Distribution of microorganisms—Water, Air and Soil, Indicator organisms, coliforms—fecal coliforms, E. coli, Streptococcus, Clostridium, Significance in water. Algae in water supplies—problems and control.MPN and MFT.

Ecotoxicology—toxicants and toxicity, factors influencing toxicity, effects—acute, chronic, concentration response relationships, test organisms, toxicity testing, bio concentration, bioaccumulation, bio magnification, bioassay, bio monitoring.

References

1. C.N. Sawyer, P.L. MacCarty and G.F. Parkin, Chemistry for Environmental Engineering and Science, Tata McGraw-Hill, Fifth edition, New Delhi, 2003.
2. G.W. Vanloon and S.J. Duffy 'Environmental chemistry – a global perspective, Oxford University press, New York., 2000.
3. Tortora. G.J, B.R. Furke, and C.L. Case, "Microbiology-An Introduction" (4th Ed.), Benjamin/Cummings Publ. Co., Inc., California, 1992.
4. Pelczar,M.J.,Chan E.C.S. and Krieg,N.R.Microbiology,Tata Mcgraw Hill,New Delhi,1993

CE702 PHYSICO-CHEMICAL PROCESS FOR WATER AND WASTEWATER TREATMENT

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- transport of colloidal particles, Clariflocculation.
Filtration - theory of granular media filtration; Classification of of filters; slow sand filter and 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.

CE703 SOLID AND HAZARDOUS WASTE MANAGEMENT

Types and Sources of solid and hazardous wastes - Need for solid and hazardous waste management - Legislations on management and handling of municipal solid wastes, hazardous wastes, and biomedical wastes.
Waste generation rates – Composition - Hazardous Characteristics – TCLP tests – waste sampling- Source reduction of wastes – Recycling and reuse.
Handling and segregation of wastes at source – storage and collection of municipal solid wastes – Analysis of Collection systems - Need for transfer and transport – Transfer stations - labeling and handling of hazardous wastes.
Waste processing – processing technologies – biological and chemical conversion technologies – Composting - thermal conversion technologies - energy recovery – incineration – solidification and stabilization of hazardous wastes - treatment of biomedical wastes.
Disposal in landfills - site selection - design and operation of sanitary landfills- secure landfills and landfill bioreactors – leachate and landfill gas management – landfill closure and environmental monitoring – landfill remediation
Elements of integrated waste management

References

1. George Tchobanoglous, Hilary Theisen and Samuel A, Vigil, Integrated *Solid Waste Management,* McGraw- Hill, New York, 1993
2. CPHEEO, *Manual on Municipal Solid waste management, Central Public Health and Environmental Engineering Organization*, Government of India, New Delhi, 2000.

CE704 ENVIRONMENTAL QUALITY MEASUREMENT LABORATORY

Physical and chemical characteristics of water – pH, Electrical conductivity, Turbidity, Alkalinity, Acidity, Hardness, Sulphates, Fluorides, Nitrates. Analysis of solids content of water: Total solids, suspended solids, volatile solids, non volatile solids, Residual chlorine analysis, Optimum coagulant dose, Break point Chlorination.

Test on dissolved oxygen, BOD and COD
Ambient air quality Analysis: Determination of SPM, CO, NO_x and SO_x.
Soil Analysis**:** pH, Conductivity, Cation exchange capacity, Sodium Adsorption ratio

SEMESTER II

CE705 BIOLOGICAL PROCESS DESIGN FOR WASTEWATER TREATMENT

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.
Aeration- Fundamentals of gas transfer- Attached Growth Biological Treatment Systems-Trickling Filters- Rotating Biological Contactors- Activated Biofilters.
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-Up flow 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.

CE706 TRANSPORT OF WATER AND WASTEWATER

Water storage – Impounding reservoirs – Intakes – pressure conduits – pumps – Economic design of pumps and pumping mains – Pipes – Pipe appurtenances – Water hammer.
Water Distribution systems – Hardy cross, Equivalent pipe and Newton Raphson methods, Distribution network analysis- methods of control and prevention of corrosion.
Sanitary sewage flow estimation – Sewer materials – Hydraulics of flow in sanitary sewers – Partial flow – Sewer designs – Sewer layouts – Storm drainage.
Storm runoff estimation – Hydraulics of flow in storm water drains – hydraulics of flow in storm water drains-storm water drain materials and section-design of storm water drains.
Maintenance of sanitary sewerage and storm drainage – equipments – corrosion in sewers –

prevention and control – Wastewater pumping networks, Application of software in design of water supply networks.

References

1. *Manual on water supply and Treatment,* CPHEEO, Ministry of Urban Development, GOI, New Delhi, 2000.
2. *Manual on Sewerage and Sewage Treatment,* CPHEEO, Ministry of Urban Development, GOI, New Delhi, 2000.

CE707 AIR QUALITY MANAGEMENT

Air pollutants – Sources and classification of pollutants and their effect on human health vegetation and property- Effects - Reactions of pollutants and their effects-Smoke, smog and ozone layer disturbance - Greenhouse effect – Ambient and stack sampling.
Atmospheric diffusion of pollutants - Transport, transformation and deposition of air contaminants - Air sampling & pollution measurement methods - Ambient air quality and emission standards - Air pollution indices - Air Act
Control principles – Removal of gaseous pollutants by adsorption, absorption, reaction and other methods.
Particulate emission control- settling chambers, cyclone separation, Wet collectors, fabric filters, electrostatic precipitators and other removal methods like absorption, adsorption, precipitation.
Biological air pollution control technologies - bioscrubers, biofilters, and Indoor air quality.

References

1. Wark Kenneth and Warner C.F, *Air pollution its origin and control.* Harper and Row Publishers, New York, 1981.
2. Rao C.S., *Environmental pollution control Engineering*, New age international Ltd, New Delhi, 1995.
3. Peavy, H.S., Rowe, D.R., Tchobanoglous, G. *Environmental Engineering*, McGraw Hills, New York 1985.

CE708 ENVIRONMENTAL MICROBIOLOGY AND ENGINEERING LABORATORY

Microscopic Examination of Microorganisms: Preparation of bacterial smear - staining - Hanging drop technique - plate count test, MPN tests and MFT Tests. Determination of MLSS and MLVSS in ASP - Coagulation and flocculation of water – Optimization of dose / pH / time of flocculation. Color removal from wastewater by adsorption - Estimation of suspended particulate matter / SPM, NO_x, SO_x.

ELECTIVES

CE711 WATER AND AIR QUALITY MODELS

Modelling approaches to water quality - classification – Mathematical Models for water quality.
DO. Models for Streams - Streeter Phelps model - oxygen 'sag' curve - deoxygenation and reaeration coefficients - Benthal oxygen demand - mass transport mechanisms –
Advective and diffusive mass transport - Models for Estuary and Lakes - Physical chemical and biological processes - water quality distribution - dispersion coefficient - temperature models.
Models for microorganisms decay.

Air quality models – Point Source – Line Source – Multiple source models - Micrometeorological processes - wind rose – dispersion - stability classes - Gaussian dispersion model - Regional air quality models, Line source models, Noise – Decibel – Decibel Addition – Octave band spectrum.

References

1. Chapra, Steven C., *Surface water quality modeling*, McGraw Hill International Edition, 1997.

CE712 INDUSTRIAL WASTEWATER MANAGEMENT

Sources and types of industrial wastewater – Environmental impacts – Regulatory requirements – generation rates – characterization – Toxicity and Bioassay tests.

Prevention vs. Control of Industrial Pollution– Source reduction techniques – Waste Audit- Evaluation of pollution prevention options.
Waste minimization - Equalization - Neutralization – Oil separation – Flotation – Precipitation – Heavy metal Removal – adsorption – Aerobic and anaerobic biological treatment – Sequencing batch reactors – High Rate reactors - Chemical oxidation – Ozonation – Photo catalysis – Wet Air Oxidation – Evaporation – Ion Exchange – Membrane Technologies – Nutrient removal
Individual and Common Effluent Treatment Plants – Zero effluent discharge systems - Wastewater reuse – Disposal of effluent on land – Quantification, characteristics and disposal of Sludge.
Industrial manufacturing process description, wastewater characteristics, source reduction options and waste treatment flow sheet for Textiles – Tanneries – Pulp and paper – metal finishing – Petrochemical -Pharmaceuticals – Sugar and Distilleries – Food Processing – fertilizers – Thermal Power Plants and Industrial Estates, ISO 14000:2003 – Waste Audit.

References

1. Eckenfelder, W.W., *Industrial Water Pollution Control*, McGraw-Hill, 1999.
2. Arceivala, S.J., *Wastewater Treatment for Pollution Control*, McGraw-Hill, 1998.
3. Frank Woodard, *Industrial waste treatment Handbook*, Butterworth Heinemann, New Delhi, 2001.

CE713 ENVIRONMENTAL SYSTEMS ANALYSIS

Systems Engineering – Analysis - Design – synthesis - applications to environmental engineering Systems.
Role of optimization models - Deterministic models/Linear programming, Dynamic programming, Separable and Nonlinear programming models.
Formulation of objective functions and constraints for environmental engineering planning and design.
Probabilistic models - fuzzy models - Simulation models.
Modern tools - Expert systems - Neural networks - Genetic Algorithm - Case studies.

References

1. Rich L.G., *Environmental Systems Engineering*, McGraw Hill, 1973.
2. Thoman R.V., *Systems Analysis & water Quality control*, McGraw Hill, 1978.

CE714 ENVIRONMENTAL IMPACT ASSESSMENT

Evolution of EIA – Concepts – Methodologies – Screening – Scoping – Base line studies - Mitigation –

Matrices – Check list.
Rapid and Comprehensive EIA – Legislative and Environmental clearance procedures in India – Prediction tools for EIA.
Assessment of impacts – Air – Water – Soil – Noise – Biological.
Socio cultural environment – Public participation – resettlement and rehabilitation.
Documentation of EIA – Environmental Management plan – Post project monitoring – Environmental Audit – Life cycle assessment – EMS - Case studies in EIA.

References

1. Canter R.L., *Environmental Impact Assessment*, Mc Graw Hill International Edition, 1997.
2. John G. Rau and David C. Wooten (Ed), *Environmental Impact Analysis Handbook*, McGraw Hill Book Company.

CE716 ECOLOGICAL AND ECO SYSTEMS ENGINEERING

Development and evolution of ecosystems – Principles and concepts – Energy flow and material cycling – productivity – Classification of ecotechnology – ecological engineering.

Classification of systems – Structural and functional interactions of environmental systems – Mechanisms of steady-state maintenance in open and closed systems.
Modeling and ecotechnology – Classification of ecological models – Applications- Ecological economics- Self-organizing design and processes – Multi seeded microcosms.
Interface coupling in ecological systems – Concept of energy – Determination of sustainable loading of ecosystems.
Ecosanitation – soil infiltration systems – Wetlands and ponds – Source separation systems – Aqua cultural systems – Agro ecosystems – Detritus based treatment for solid wastes – marine systems- Case studies.

References

1. Kangas, P.C. and Kangas, P., *Ecological Engineering: Principles and Practice*, Lewis Publishers, New York, 2003.
2. Etnier, C. and Guterstam, B., *Ecological Engineering for Wastewater Treatment*, Lewis Publishers, New York, 1997.

CE 719 ENVIRONMENTAL GEOTECHNOLOGY

Soil as a multiphase system; Soil-environment interaction; Properties of water in relation to the porous media; Water cycle with special reference to soil medium.
Soil mineralogy; significance of mineralogy in determining soil behavior; Mineralogical characterization.
Mechanisms of soil-water interaction: Diffuse double layer models; Force of attraction and repulsion; Soil-water-contaminant interaction; Theories of ion exchange; Influence of organic and inorganic chemical interaction.
Introduction to unsaturated soil mechanics; water retention property and soil-water characteristic curve; flow of water in unsaturated soil.
Concepts of waste containment facilities; desirable properties of soil; contaminant transport and retention; contaminated site remediation.
Introduction to advanced soil characterization techniques; volumetric water content; gas permeation in soil; electrical and thermal properties; pore-size distribution; contaminant analysis.

References

1. Mitchell, J. K and Soga, K Fundamentals of Soil Behavior, John Wiley and Sons Inc., 2005.
2. Fang, H-Y, Introduction to Environmental Geotechnology, CRC Press, 1997.
3. Daniel, D. E, Geotechnical Practice for Waste Disposal, Chapman and Hall, 1993.
4. Rowe, R. K., Quigley, R. M. and Booker, Clay Barrier Systems for Waste Disposal Facilities, J. R., E & FN Spon, 1995.
5. Rowe, R. K, Geotechnical and Geoenvironmental Engineering Handbook, Kluwer Academic Publishers, 2001.
6. Reddi, L. N. and Inyang, H. F, Geoenvironmental Engineering - Principles and Applications, Marcel Dekker Inc, 2000.
7. Sharma, H. D. and Lewis, S. P, Waste Containment Systems, Waste Stabilization and Landfills: Design and Evaluation, John Wiley & Sons Inc., 1994

ELECTIVES (To be substituted whenever needed)

CE715 INDOOR AIR QUALITY

Indoor activities of inhabitants - Levels of pollutants in indoor and outdoor air- Design and operation of buildings for improvements of public health- IAQ policy issues- sustainability.
Air pollutants in indoor environments- private residences- offices- schools-public buildings- ventilation.

Control of several pollutant classes- radon- toxic organic gases- combustion byproducts- microorganisms such as molds and infectious bacteria.
Concepts and tools- exposure- material balance models- statistical models.
Indoor air pollution from outdoor sources- particulate matter and ozone- Combustion byproducts- Radon and its decay products- Volatile organic compounds- odours and sick-building syndrome- Humidity- Bio aerosols- infectious disease transmission- Special indoor environments- A/C units in indoor- Measurement methods- Control technologies- Control strategies.

References

1. Thaddes Godish, *Indoor air and Environmental Quality*, CRC press, 2000.
2. Nazaroff W.W. and L. Alvarez-Cohen, *Environmental Engineering Science*, Wiley sons, Newyork, 2001.

CE717 CONTAMINANT TRANSPORT MODELING

Transport phenomenon – diffusion – dispersion – advection – adsorption - conservative and non-conservative polluants.
Governing Equations for flow and transport in surface and subsurface waters - chemical and biological process models - simplified models for lakes, streams, and estuaries.
Model complexity - model resolution - coupled and uncoupled models - linear and nonlinear models - Solution techniques – calibration - application and evaluation of environmental control – bioremediation –
Numerical models: FDM, FEM and Finite volume techniques - explicit vs. implicit methods - numerical errors - High resolution techniques –
Stream quality modeling using QUAL2K - Groundwater transport modeling using VISULA MODFLOW.

References

1. Martin, L.J. and McCucheon, S.C, *Hydrodynamics of transport for water quality modeling*, Lewis Publishers, Boca Raton, 1999.
2. Freeze, R.A. and Cherry. J.A. *Groundwater*, Prentice Hall, 1979.

CE718 ENVIRONMENTAL ENGINEERING STRUCTURES

Structural design of Concrete- Prestressed Concrete - anchorage for pipes - massive outfalls.
Design of concrete roofing systems a) Cylindrical b) Spherical and c) Conical shapes using membrane theory.
Design of water retaining structures- Design of circular, rectangular, spherical and Intze type of tanks- Design of prestressed concrete cylindrical tanks.

Underground reservoirs and swimming pools- Intake towers- Structural design of settling tanks- clarifloculators- aeration tanks - effect of earth pressure and uplift considerations.

Identification of different types of structural and non-structural cracks – repair and rehabilitation methods for Masonry, Concrete and Steel Structures.

References

1. Krishna Raju, *Prestressed Concrete*, Tata McGraw Hill, 1988.
2. Sinha N.C., Roy S.K., *Reinforced Concrete*, S. Chand and Co, 1985.

CE720 ENVIRONMENTAL BIOTECHNOLOGY

Environmental Biotechnology -Principles and concepts - usefulness to mankind.

Degradation of high concentrated toxic pollutants- halogenated, non halogenated, petroleum hydrocarbons, metals - Mechanisms of detoxification – oxidation - dehalogenation - biotransformation of metals - biodegradation of solid wastes.
Biotechnological remedies for environmental pollution - decontamination of groundwater – bioremediation - Production of proteins – biofertilizers - Physical, chemical and microbiological factors of composting – health risk – pathogens – odor management – Microbial cell/enzyme technology – adapted microorganisms – biological removal of nutrients – algal biotechnology– extra cellular polymers - Biogas technology.
Concept of rDNA technology – expression vectors – cloning of DNA – mutation – construction of microbial strains - radioactive probes - protoplast fusion technology – applications.
Environmental effects and ethics of microbial technology – genetically engineered organisms- Microbial containment-Risk assessment.

References

1. Chaudhury, G.R., *Biological degradation and Bioremediation of toxic chemicals*, Dioscorides Press, Oregon, 1994.
2. Martin.A.M, *Biological degradation of wastes*, Elsevier Applied Science, London, 1991.
3. Blaine Metting.F (Jr.,) *Soil Microbiology Ecology*, Marcel Dekker Inc., 1993

CE721 DESIGN OF AIR POLLUTION CONTROL SYSTEMS

Industrial sources of air pollution- Emission factors-regulations- control strategies-policies.
Particulate Pollutant Control: Settling chambers - laminar and turbulent flow- Filtration – interception- Impaction- Convective diffusion- Collection of particles by cylindrical fibres and granular beds- Electrostatic precipitation - Cyclones - Wet collectors.
Gaseous Pollutant Control: Gas absorption in tray and packed towers- Absorption with/without chemical reaction- Removal of SO_2 - Adsorption in fixed beds- Breakthrough.
Removal of HCs/ VOCs- NO_X removal - Wet scrubbers.
Integrated air pollution control systems.

References

1. Lawrence K.Wang, Norman C Perelra, Yung-Tse Hung, *Air pollution control Engineering*, Tokyo.
2. Noel de Nevers, *Air pollution control Engineering*, McGraw Hill, New York.

CE722 SURFACE AND GROUND WATER MODELLING

Land Processes – Subsurface and Channel Processes- Precipitation – Rain gauge network, Abstractions, Infiltration, Evaporation, Transpiration, Process and models
Unit Hydrograph & S curve hydrograph, Dimensionless unit hydrograph, GUIH, Watershed Model and Conceptual Models.
Occurrence and Movement of Ground water, Properties of aquifer, Groundwater flow equations, Dupuit Forchheimer assumptions, Well hydraulics, Partial penetration of wells, Interference of wells, Collector wells and Infiltration galleries.
Pumping tests, Analysis for unconfined and non leaky and leaky confined aquifer and water table aquifer, locating hydro geologic boundaries, Well design criteria.
Natural and Artificial Recharge of Ground water- Salt water intrusion, Application of Finite Difference in ground water.

References

1. Ven Te Chow, “Applied Hydrology”, Mc GrawHill Science Publishers, 1988
2. Singh, Vijay ., “Elementary Hydrology”, Prentice Hall,1994
3. Raghunath. “Ground Water”, Mc Graw Hill, 2007
4. Bear, J., Hydraulics of Ground water, Mc Graw Hill, 2007

CE723 RIVER ENGINEERING

Classification of free surface flow, velocity and pressure distributions, Uniform flow.
Dynamic equation for gradually varied flow – Classification of flow profiles, Computational methods, Prismatic channels.
Energy and Momentum principles in open channel flow, Rapidly Varied Flow, Hydraulic jump – Analysis.
River Hydrology & Distribution of water quality in Rivers, Estuaries, Physical and Hydrological Characteristics of Lakes.
Sediment Transport, Properties, Initiation of Sediment Transport, Bed load, Bed forms, Bed roughness, Suspended load, total load, Meandering of Rivers, Scouring at different structures.

References

1. Garde, R.J.Rangaraju, K.G. "Mechanics of Sediment Transportation And Alluvial Stream Problems",1978
2. Santosh Kumar Garg., "Irrigation Engineering & Hydraulic Structures" Khanna Publishers, 2006
3. Subramanya., "Flow in Open Channels", Tata Mc Graw Hill,2001

CE724 WATER RESOURCES SYSTEMS MANAGEMENT

Reservoir planning, Management, Multi reservoir systems, Real time operation, River basin planning, water logging, soil salinity, salinity control.
Design of Dams, Non gravity dams, Weirs and Barrages, Conjunctive use of Irrigation water, Quality of Irrigation water, Contaminants and their effects on various crops
Rainwater Harvesting and Management – Different Types and Methods of Harvesting in urban and agricultural areas.
Draught analysis, NCA classification, Direct and Indirect losses, Drought severity assessment, Drought Monitoring, Drought Management
Introduction to systems approach, Linear programming, Problem formulation, Solution by simplex method, Application to design and operation of reservoir, Non Linear Programming, Sensitivity analysis, Monte Carlo simulation.

References

1. Dilip Kumar Majumdar, "Irrigation Water Management (Principles & Practices)", Prentice Hall of India (P), Ltd, 2004
2. Water Resources Systems, "Vedula & Mujumdar", McGrawHill, 2005.
3. Daniel P. Loucks "Water Resources systems Planning and Management(Studies and Reports in Hydrology) ", 2006