Master of Technology

SYLLABUS

CREDIT BASED CURRICULUM

(2013 - 2015)

DEPARTMENT OF CIVIL ENGINEERING
NATIONAL INSTITUTE OF TECHNOLOGY
TIRUCHIRAPPALLI - 620 015, 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 IS TO ACHIEVE INTERNATIONAL RECOGNITION BY:

- Developing Professional Civil Engineers
- Offering Continuing Education
- Interacting with Industry with emphasis on R&D

M. Tech. (TRANSPORTATION ENGINEERING AND MANAGEMENT)

The total minimum credits required for completing the M. Tech. (Transportation Engineering and Management) Course is 66.

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
CE603	Pavement Analysis and Design	3	1	0	4
	Elective – I	3	0	0	3
	Elective – II	3	0	0	3
	Elective – III	3	0	0	3
CE609	Traffic and Pavement Engineering Laboratory	0	0	6	2
		18	**1**	**3**	**21**

SEMESTER – II

Code	Course of Study	L	T	P	C
CE602	Road Transport Management and Economics	3	0	0	3
CE604	Transportation Planning	3	1	0	4
CE606	Computational Techniques in Transportation Engineering	3	0	0	3
	Elective – IV	3	0	0	3
	Elective – V	3	0	0	3
	Elective - VI	3	0	0	3
CE610	CAD in Transportation Engineering	1	0	3	2
		19	**1**	**3**	**21**

SUMMER TERM

Code	Course of Study	L	T	P	C
	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

Sl. No.	Code	Course of Study	L	T	P	C
1.	CE611	Geospatial Techniques	3	0	0	3
2.	CE612	Intelligent Transportation Systems	3	0	0	3
3.	CE613	Pavement Materials	3	0	0	3
4.	CE614	Ground Improvement Techniques	3	0	0	3
5.	CE615	Bridge Engineering	3	0	0	3
6.	CE616	Traffic Flow Theory	3	0	0	3
7.	CE617	Transportation Network Analysis and Optimization	3	0	0	3
8.	CE618	Advanced Highway Materials	3	0	0	3
9.	CE619	Transportation Systems	3	0	0	3
10.	CE714	Environmental Impact Assessment	3	0	0	3
11.	HM712	Human Resource Management	3	0	0	3
12.	MB794	Project Management	3	0	0	3
13.		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.

CE601 HIGHWAY TRAFFIC ANALYSIS AND DESIGN

Elements of Traffic Engineering - road user, vehicle and road way and driver characteristics. - Design speed, volume. Passenger Car Units - Static and Dynamic- Highway capacity and level of service - capacity of urban and rural roads - Road user facilities - Parking facilities - Cycle tracks - 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. Traffic regulation and control - Signs and markings - Traffic System Management.

Design of intersections – 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 – Area raffic Control System. Grade separated interchanges - Geometric elements for divided and access controlled highways and expressways.

Traffic Safety – Principles and Practices – Safety along links - Safety at intersections. Road Safety Audit – Countermeasures, evaluation of effectiveness of counter-measures– Road safety programmes.

References

1. ITE Hand Book, *Highway Engineering Hand Book*, Mc Graw - Hill.
2. AASHTO *A Policy on Geometric Design of Highway and Streets*
3. Pignataro, L.J., *Traffic Engineering – Theory & Practice*, John Wiley, 1985
4. R. J. Salter and N. B. Hounsel, *Highway Traffic Analysis and Desig*n, Macmillan Press Ltd, 1996.
5. Relevant IRC codes

CE603 PAVEMENT ANALYSIS AND DESIGN

Types and component parts of pavements, Factors affecting design and performance of pavements. Highway and airfield pavements, Requirements and desirable properties of aggregates, bitumen, emulsion and modified bitumen, Characterisation of different pavement materials
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, Mechanistic –Empirical design, 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 Distresses in pavements, maintenance of highways, structural and functional condition evaluation of pavements, performance prediction models, ranking and optimization in pavement management.

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

CE609 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, Origin Destination (O-D) Surveys, Roadside and Household 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

SEMESTER II

CE602 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 terminal facilities – Bus terminal, bus stops and bus bays, Freight Terminal Design
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 Design-Build-Operate-Transfer Schemes – Risk Analysis – Value for Money 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

CE604 TRANSPORTATION PLANNING

Urban morphology - Urbanization and travel demand – Urban activity systems and travel patterns – Systems approach – Trip based and Activity based approach - Urban Transportation Planning – Goals, Objectives and Constraints - Inventory, Model building, Forecasting and Evaluation - Study area delineation – Zoning - UTP survey
Trip generation models – Trip classification - productions and attractions – Trip rate analysis - Multiple regression models - Category analysis - Trip distribution models – Growth factor models, Gravity model and Opportunity modes.
Modal split models – Mode choice behavior – Trip end and trip interchange models - Probabilistic models - Utility functions - Logit models - Two stage model. Traffic assignment – Transportation networks – Minimum Path Algorithms - Assignment methods – All or Nothing assignment, Capacity restrained assignment and Multi path assignment - Route-choice behavior.
Landuse transportation models – Urban forms and structures - Location models - Accessibility – Landuse models - Lowry derivative models - Quick response techniques - Non-Transport solutions for transport problems.
Preparation of alternative plans - Evaluation techniques - Plan implementation - Monitoring - Financing of Project – urban development planning policy - 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, NJ, 2007.
3. Papacostas C.S. and Prevedouros, P.D., *Transportation Engineering & Planning*, PHI, New Delhi,2002.

CE606 COMPUTATIONAL TECHNIQUES IN TRANSPORTATION ENGINEERING

Introduction to systems approach - Typical transportation systems - Mathematical models. Fundamentals of simulation - Monte Carlo method - Continuous and discrete models - Simulation languages. Probability concepts - Random numbers - Pseudo random generators - Arrival patterns - Service time distributions – Manual simulation of simple queuing system

GPSS Fundamentals - Creating and moving transactions - Queues and facilities - Event scheduling – Standard numerical attributes – Parameters and savevalues - Functions - Priority - Preemption - Collection of statistics - Report preparation. Internal logic of GPSS processor - Program control statements.

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.
Genetic Algorithm - Terminology in GA – Strings, Structure, Parameter string - Data Structures – Operators - Algorithm – Application in Transportation. Fuzzy Logic.
Artificial Neural Networks - Basics of ANN – Topology - Learning Processes - Supervised and unsupervised learning. Least mean square algorithm, Back propagation algorithm - Applications.

References

1. Gordon, G., *System Simulation,* Prentice-Hall of India, 2005
2. GPSS/PC, *User Manual, Minuteman Software,* USA, 2005
3. David E. Goldberg, Genetic Algorithms in Search, Optimisation and Machine Learning, Addison-Wesley, 1989
4. J.M. Zurada, .Introduction to artificial neural systems., Jaico Publishers, 2006

CE610 CAD IN TRANSPORTATION ENGINEERING

Transportation Software – Mx Road, REI heads, HDM4, KENPAVE, M-E design of pavements as per AASHTO, TRIPS, MIGRAN, VISSIM, CUBE
GIS and Remote Sensing Packages – ArcGIS, Geo-Concept, GRAM++, ENVI, ERDAS Imagine, GPS
Computer Aided Drafting - DBMS concepts - Civil Engineering Databases – Data entry & Reports. Spreadsheet concepts – Worksheet calculations in Civil Eng, - Regression & Matrix Inversion, SPSS.
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 GEOSPATIAL TECHNIQUES

Concepts and foundations of remote sensing – energy source EMS – Remote Sensing System – EMR interaction with particulate matter – Spectral Signature curves – Data Acquisition and interpretation – Visual Image Interpretation – Photogrammetry – Radar, LIDAR, SAR systems
Platform/Sensors – Classification – satellite system/sensor parameters – earth resources and meteorological satellites – microwave remote sensing techniques – Data Processing – Digital Image processing – Characteristics of Digital Satellite Image – ground truthing.
History of Development – Maps – Types of Maps, Projections – Components/Architecture of GIS – Data – Spatial and Non–Spatial – Data Input Sources – Raster and Vector data structures – DBMS – Data Output – Data quality – Sources/ types of errors
Data handling in GIS –processing, analysis and Modelling – Raster and Vector spatial analysis – Density analysis – Spatial autocorrelation – network analysis – nearest neightbour analysis – Surface modeling – DTM – Introduction to Geodesy – Space Geodetic Techniques – GPS

Application of Remote Sensing, GIS and GPS – Survey, mapping and monitoring – Transportation planning – Infrastructure development – Structural engineering – Geotechnical Engineering – Earthquake Engineering – Environmental studies – Water resources

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.
4. Joseph G., *Fundamentals of Remote Sensing,* University Press, 2005.
5. Panigrahi, N., *Geographical Information systems,* University Press, 2005.

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. 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.

CE616 TRAFFIC FLOW THEORY

Course Content

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 - Queue discipline - 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.
4. Sussman, J. M., *Perspective on ITS*, Artech House Publishers, 2005.

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 – Behaviour – 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.
Reclaimed / 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.

CE619 TRANSPORTATION SYSTEMS

Historical development of transport in India - Road Development Plans, National Transport Policy Recommendations, Vision 2021, NHDP, PMGSY - IRC, CRRI. 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 – Harbour infrastructures - Port facilities - 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. Horenjeff Robert; *The planning & Design of Airports*, McGraw Hill Book Co., 2007
3. Alan Black, *Urban Mass Transportation Planning*, McGraw-Hill, 1995.

M. Tech. (STRUCTURAL ENGINEERING)

The total minimum credits required for completing the M. Tech. (Structural Engineering) course is 66.

SEMESTER – I

Code	Course of Study	L	T	P	C
MA751	Applied Mathematics	3	1	0	3
CE651	Theory of Elasticity and Plasticity	3	0	0	3
CE653	Matrix Methods of Structural Analysis	3	0	0	4
	Elective – I	3	0	0	3
	Elective – II	3	0	0	3
	Elective – III	3	0	0	3
CE659	Structural Engineering Laboratory	1	0	3	2
		19	1	3	21

SEMESTER – II

Code	Course of Study	L	T	P	C
CE652	Stability of Structures	3	0	0	3
CE654	Finite Element Methods	3	1	0	4
CE656	Theory of Plates	3	0	0	3
	Elective – IV	3	0	0	3
	Elective – V	3	0	0	3
	Elective – VI	3	0	0	3
CE660	CAD in Structural Engineering	1	0	3	2
		19	1	3	21

SUMMER TERM

Code	Course of Study	L	T	P	C
	Practical Training (4 Weeks)	-	-	-	-

SEMESTER III

Code	Course of Study	L	T	P	C
CE697	Project Work **Phase-I**	0	0	24	12

SEMESTER IV

Code	Course of Study	L	T	P	C
CE698	Project Work **Phase-II**	0	0	24	12

ELECTIVES

Sl. No.	Code	Course of Study	L	T	P	C
1.	CE661	Structural Dynamics	3	0	0	3
2.	CE662	Theory of Shells	3	0	0	3
3.	CE663	Stochastic Processes In Structural Mechanics	3	0	0	3
4.	CE664	Random Vibrations and Structural Reliability	3	0	0	3
5.	CE665	Fracture Mechanics	3	0	0	3
6.	CE666	Structural Optimization	3	0	0	3
7.	CE667	Failure Analysis of Structures	3	0	0	3
8.	CE668	Advanced Concrete Structures	3	0	0	3
9.	CE669	Advanced Steel Structures	3	0	0	3
10.	CE670	Advanced Steel and Concrete Composite Structures	3	0	0	3
11.	CE671	Seismic Design of Structures	3	0	0	3
12.	CE672	Prefabricated Structures	3	0	0	3
13.	CE673	Smart Structures and Applications	3	0	0	3
14.	CE674	Pre-stressed Concrete structures	3	0	0	3
15.	CE675	Design of Tall Buildings	3	0	0	3
16.	CE676	Structures in Disaster Prone areas	3	0	0	3
17.	CE677	Design of Boiler Structures	3	0	0	3
18.	CE678	Structures for Power Plants	3	0	0	3
19.	CE679	Forensic Engineering and Rehabilitation of Structures	3	0	0	3
20.	CE680	Soil Structure Interaction	3	0	0	3
21.	CE681	Advanced Concrete Technology	3	0	0	3
22.	CE682	Special Concrete	3	0	0	3
23.	CE683	Hydraulic Structures	3	0	0	3
24.	CE684	Analysis of Deep Foundation	3	0	0	3
25.	HM712	Human Resource Management	3	0	0	3
26.		Any other elective	3	0	0	3

SEMESTER I

MA751 APPLIED MATHEMATICS

Polar co-ordinates - Expressions of gradient of scalar point function -divergence and curlof a vector point function in orthogonal curvilinear co-ordinates - Summation convention tensors - Quotient law - Christoffel symbols.
Maxima and minima of functions of two variables - Lagrange Multipliers - Functional -Externals -Euler-Lagrange Equation-Fourier Analysis and Transformation.
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, 42nd edition, 2012.
2. Venkataraman, M.K., Higher Mathematics for Engineers, National Publishing Co., 1986.

CE651 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 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. Baskar, T.K. Varadan: Theory of Isotropic/Orthotropic Elasticity, An Introductory Primer, Anne books Pvt Ltd,2009.

CE653 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 redundant - Transformation of redundant-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-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. Rajasekaran S, Computational Structural Mechanics, Prentice Hall of India. New Delhi, 2001.
3. McGuire, W., and Gallagher, R.H., Matrix Structural Analysis, John Wiley and Sons, 1979.
4. John L.Meek., Matrix Structural Analysis, Mc Graw Hill Book Company, 1971.
5. Devdas Menon., Advanced Structural Analysis, Narosa Publishers in India and Alpha Science International, UK, 2009.

CE659 STRUCTURAL ENGINEERING LABORATORY

Properties of concrete ingredients – concrete mix design ACI/ IS method for M45 to M60 grade(IS), upto M80 grade (ACI), Design of Special Concrete likes fibres, SCC, HPC - strength tests on concrete – Non destructive tests on concrete. Use of various types of strain gauges - Mechanical and Electrical strain gauges - Casting and testing of R.C. beams and study of their behavior.

References

1. C.B.Kukreja, K.Kishore and Ravi Chawla, Material Testing Laboratory Manual, Standard Publishers Distributors, New Delhi.
2. L.S.Srinath, Experimental Stress analysis, Tata McGraw-Hill Publishing Company Limited.
3. Colin. D.Johnston, Fibre Reinforced Cements and Concrete, Taylor and Francis Publishers.
4. Geert De Schutter, Peter J.M. Bartos, Peter Domone, John Gibbs, Self Compacting Concrete, Whittles Publishing, 2008.

SEMESTER II

CE652 STABILITY OF STRUCTURES

Course Content

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 Finite 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.

CE654 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 LDLT decomposition- Basic steps in finite element analysis.

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.
3. V.K.Manikkaselvam, Rudiments of Finite Element Method, Dhanpat Rai & Sons, New Delhi – 110 006.
4. T.R.Chandrupatla and A.D.Belegundu, Introduction to Finite Element in Engineering, PHI Learning pvt ltd. NewDelhi.

CE656 THEORY OF PLATES

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.

CE660 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.
2. Krishnamoorthy C.S and Rajeev S., "Computer Aided Design", Narosa Publishing House, New Delhi, 1991.
3. Groover M.P.and Zimmers E.W. Jr.," CAD/CAM, Computer Aided Design and Manufacturing ", Prentice Hall of India Ltd, New Delhi, 1993.
4. Harrison H.B., "Structural Analysis and Design Vol.I and II", Pergamon Press,1991.

ELECTIVES

CE661 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.
4. Clough and Penzien, Dynamics of Structures, 5th Edition, McGraw Hill, 1975.

CE662 THEORY OF SHELLS

Structural behaviour of shells-classification of shells-translational and rotational shells-ruled surfaces-methods of generating the surface of different shells-hyperbolic paraboloid-elliptic paraboloid-conoid-Gaussian curvature-synclastic and anticlastic surfaces.
Classical theories of shells-thin shell-thick shell-small deflection theory-stress resultants and deformations of shells without bending.
Membrane theory of singly curved shells - cylindrical shells-free body diagram of a cylindrical shell element-formulation of equilibrium equation-doubly curved shells- shells of revolution.
Bending theory of cylindrical shells-stresses and deformation of circular cylindrical shells-pressure vessels-cylindrical shells with uniform internal pressure-free body diagram of a differential cylindrical shell element- formulation of equilibrium equation.
Bending theory of doubly curved shells- Hyperbolic parabolic shells subjected to external loads and gravity loads- shells of revolution.

References

1. Timishenko, S.P. and S. Woinowsky-Krieger, 1970. "*Theory Plates and Shells*," McGraw-Hill.
2. J Ramachandran, Thin shells theory and problems, Universities press.
3. Novoshilov V V,Theory of thin elastic shells, P Noordoff, Groningen,1959.
4. Ramaswamy G S, Design and construction of concrete shell roofs, Mc Graw Hill, New York.

CE663 STOCHASTIC PROCESSES IN STRUCTURAL MECHANICS

Basic Theory of Random variables Probability distribution of a random variable, multiple random variables, main descriptors of a random variable – Moments, expectation, covariance, correlation, conditional mean and variance. Functions of random variables, moments of functions of random variables.
Basic Theory of Stochastic Processes Introduction, Statistics of stochastic processes, Ergodic processes, Some properties of the correlation functions, Spectral analysis, Wiener-Khintchine equation.
Some Important Random Processes Normal processes, Poisson processes, Markov processes.
Properties of Random Processes Level crossing peaks, Fractional occupation time, Envelopes, First-Passage time, Maximum value of a Random Process in a time interval.
Some Models of Random Processes in Nature Earthquake, Wind, Atmosphere turbulence, Random Runways, Road Roughness, Jet Noise, Ocean wave turbulence.
Fourier analysis and Data Processing.

Reference

1. Papoulis, A., Probability, Random Variables and Stochastic Processes, McGraw Hill.
2. Lin, Y. K., Probabilistic Theory in Structural Dynamics, McGraw Hill.
3. Nigam N. C., Introduction to Random Vibrations, MIT Press, Cambridge, USA.
4. Crandall, S. H. & Mark, W. D., Random Vibration in Mechanical Systems, Academic Press.

CE664 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.
4. O. Ditlevsen ,H. O. Madsen, Structural Reliability Methods, Wiley, 1 edition ,1996.

CE665 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.
3. Prashant Kumar, Elements of Fracture Mechanics, Tata McGraw Hill, New Delhi, India, 2009.
4. K. Ramesh, e-Book on Engineering Fracture Mechanics, IIT Madras, 2007.
   URL: http://apm.iitm.ac.in/smlab/kramesh/book_4.htm

CE666 STRUCTURAL OPTIMIZATION

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.

CE667 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.
3. Kenneth and L. Carper, Forensic Engineering, 2nd Edition, CRC Press, 2001.
4. V K Raina, Concrete Bridge Practice Construction, Maintenance and Rehabilitation, 2nd Edition, Shroff Publishers and Distributors, August, 2010.

CE668 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. Varghese, P.C, Advanced Reinforced Concrete Design, Prentice Hall of India, 2005.
3. Unnikrishna Pillai and Devdas Menon ,Reinforced concrete Design, Tata McGraw Hill Publishers Company Ltd., New Delhi, 2006.
4. N. Krishna Raju, R.N. Pranesh, Reinforced Concrete Design: Principles and Practice, New Age International Pvt Ltd Publishers,2009.

CE669 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.

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. Punmia B.C., Comprehensive design of steel structures, Lakshmi Publications, Newdelhi 2000.
4. IS 800-2007, Code of practice for general construction in steel, Bureau of Indian Standards, New Delhi.

CE670 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.

CE671 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. S K Duggal, "Earthquake Resistant Design of Structures", Oxford University Press, 2007.
4. Paulay,T and Priestly, M.N.J., "A seismic Design of Reinforced Concrete and Masonry buildings", John Wiley and Sons, 1991.

CE672 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.
3. Koncz.T., Manual of Precast Concrete Construction, Vol.I II and III, Bauverlag, GMBH, 1971.
4. Structural Design Manual, Precast Concrete Connection Details, Society for the Studies in the use of Precase Concrete, Netherland Betor Verlag, 1978.

CE673 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.
3. Brian Culshaw, Smart Structures and Materials , Artech House, Boston, 1996.
4. M.V.Gandhi and B.S.thompson, Smart Materials and Structures , Chapman and Hall 1992.

CE674 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 pre-stressing - 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. Raja Gopalan N. Prestressed Concrete, Narosa Publishing House, New Delhi, 2002.
3. Krishna Raju, “Prestressed Concrete”, Tata McGraw Hill Publishing Co,2000.
4. Sinha.N.C.and.Roy.S.K, “Fundamentals of Prestressed Concrete”, S.Chand and Co., 1998.

CE675 DESIGN OF TALL BUILDINGS

Design philosophy – Loading - Sequential loading, materials.
High risk behavior, rigid frames, braced frames, in filled 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, pre-stressing, 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.
2. Taranath B.S., Structural Analysis and Design of Tall Buildings, McGraw Hill, 1988.

3. Lin T.Y and Stotes Burry D, Structural Concepts and systems for Architects and Engineers, John Wiley, 1988.
4. Beedle.L.S., Advances in Tall Buildings, CBS Publishers and Distributors, Delhi, 1986.

CE676 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.
3. A K Jain, Practical Guide to Disaster Management, Pragun Publication,2008.
4. Denison Campbell, Allen and Harold Roper, Concrete Structures, Materials,Maintenance and Repair, Longman Scientific and Technical, UK, 1991.

CE677 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. Bhavikatti, S.S., Design of Steel Structures, I.K. International Publishing House Pvt. Ltd., New Delhi, 2010.
3. Punmia B.C., Comprehensive design of steel structures, Lakshmi Publications, Newdelhi 2000.
4. IS800:2007 – Code of Practice for general construction in steel.

CE678 STRUCTURES FOR POWER PLANTS

Planning, Analysis and design of different types of power plants - Chimneys, Induced draught and Natural draught cooling towers, Turbo generator Foundation, Material handling structures, Intake towers, storage structures and other supporting structures for equipments.

References

1. Kam W.Li and A.Paul Priddy., Power Plant System Design by John and Willey Sons Inc. ISBN No - 9780471888475.
2. E.E. Khalil., Power Plant Design An abacus book Energy and Engineering Science Series, ISSN 1042 – 1939. ISBN0856265101, 9780856265105 by Abacus Press 1990.
3. P.C. Sharma ., Power Plant Engineering by S.K.Kataria and Sons 01 Jan 2009.

CE679 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, NewDelhi, 2001.
3. Shen-En Chen, R. Janardhanam, C. Natarajan, Ryan Schmidt, Ino-U.S. Forensic Practices - Investigation Techniques and Technology, ASCE, U.S.A., 2010.
4. C. Natarajan, R. Janardhanam, Shen-En Chen, Ryan Schmidt, Ino-U.S. Forensic Practices - Investigation Techniques and Technology, NIT, Tiruchirappalli, 2010.
5. Gary L. Lewis, Guidelines for Forensic Engineering Practice, ASCE, U.S.A., 2003.

CE680 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.
4. J.W. Bull, Soil-Structure Interaction: Numerical Analysis and Modelling, CRC Press, 1st edition , 1994.

CE681 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. Adam. M. Nevillie., Properties of Concrete, Fourth and Final edition, Wiley Publications, 1996.
3. A.R. Santhakumar, Concrete Technology" Oxford University Press, 2006
4. P.-C.Aïtcin, High Performance Concrete, E &FN SPON, 1998.

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 – Fiber reinforced HPC – Confined HPC – Roller Compacted HPC – Ultra High Performance Concrete – Reactive powder Concrete-Bio concrete-Geopolymer 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.

CE683 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. P. Novak , A.I.B. Moffat , C. Nalluri , R. Narayanan , Hydraulic Structures, CRC Press, 4 edition, 2007.
4. Ken Weaver and Donald Bruce ,Dam Foundation Grouting, American Society of Civil Engineers, Rev Exp edition , 2007.

CE684 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 dynamic 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, “Pile Design and Construction Practice”, E & FN Spon, 1987.
3. Braja M. Das., “Principles of Foundation Engineering”, Thomson Asia Pte , 1987. London Ltd., Singapore, 2005, A viewpoint publication.
4. P.C. Varghese, “Foundation Engineering”, Prentice-Hall of India, New Delhi, 2005.

M. Tech. (ENVIRONMENTAL ENGINEERING)

The total credits required for completing the M.Tech. Programme in Environmental Engineering is 66.

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
CE703	Physico-chemical Process for Water and Wastewater Treatment	3	1	0	4
	Elective I	3	0	0	3
	Elective II	3	0	0	3
	Elective III	3	0	0	3
CE709	Environmental Quality Measurements Laboratory	0	0	3	2
		18	**1**	**3**	**21**

SEMESTER – II

Code	Course of Study	L	T	P	C
CE702	Biological Process Design for Wastewater Treatment	3	1	0	4
CE704	Transport of Water and Wastewater	3	0	0	3
CE706	Air Quality Management	3	0	0	3
	Elective IV	3	0	0	3
	Elective V	3	0	0	3
	Elective VI	3	0	0	3
CE710	Environmental Microbiology and Engineering Laboratory	1	0	3	2
		19	**1**	**3**	**21**

SUMMER TERM

Code	Course of Study	L	T	P	C
	Practical Training (4 Weeks)	-	-	-	-

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

Sl. No.	Code	Course of Study	L	T	P	C
1.	CE711	Solid and Hazardous Waste Management	3	0	0	3
2.	CE712	Industrial Wastewater Management	3	0	0	3
3.	CE713	Environmental Impact Assessment	3	0	0	3
4.	CE714	Water and Air Quality Models	3	0	0	3
5.	CE715	Contaminant Transport Modeling	3	0	0	3
6.	CE716	Environmental Systems Analysis	3	0	0	3
7.	CE717	Design of Air Pollution Control Systems	3	0	0	3
8.	CE718	Indoor Air Quality	3	0	0	3
9.	CE719	Ecological and Ecosystems Engineering	3	0	0	3
10.	CE720	Process chemistry for water and wastewater treatment	3	0	0	3
11.	CE721	Membrane Technology for Water and Wastewater Treatment	3	0	0	3
12.	CE722	Biodegradation and Bioremediation Techniques	3	0	0	3
13.	CE723	Environmental Policies and Legislations	3	0	0	3
14.	CE724	Cleaner Production and Environmental Sustainable Management	3	0	0	3
15.	CE725	Environmental Health and Eco-Toxicology	3	0	0	3
16.	CE726	Analytical Methods for Environmental Monitoring	3	0	0	3
17.	CE727	Environmental Biotechnology	3	0	0	3
18.	CE728	Environmental Geotechnology	3	0	0	3
19.	CE729	River Engineering	3	0	0	3

20.	CE730	Surface and Ground water modeling	3	0	0	3
21.	CE731	Water Resources Systems Management	3	0	0	3
22.	CE732	Environmental Engineering Structures	3	0	0	3
23.	CE733	Remote Sensing and GIS for Environmental Applications	3	0	0	3
24.	EE778	Analysis and Design of Artificial Neural Networks	3	0	0	3
25.		Any other elective				

SEMESTER I

MA701 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 spectroscopy – Principles and applications – Principles of green chemistry – Error Analysis of Environmental Data

Transport and transformation of chemicals – DO, BOD and COD – Photobcatalysis – 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 microoraganisms- Environmental factors influencing miribial growth.
Distribution of microrganisms- Water, Air and Soil, Indicatorborganisms, 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,bioaccumulation, biomagnification, bioassay, biomonitoring.

References

1. *C.N. Sawyer, P.L. McCarty, and G.F Parkin, Chemistry for Environmental Engineering, Tata McGraw-Hill, New Delhi, 2003.*
2. *G. W. Vanloon and S. J. Duffy Environmental chemistry – a global perspective, Oxford University press, Newyork., 2000.*
3. *Tortora. G.J, B.R. Furke, and C.L.Case, Microbiology- An introduction (4th Ed.), Benjammin/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.*

CE703 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- 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.*

CE709 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, Suspendd

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

CE702 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.
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.*

CE704 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.
Rapson 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 – Waste water 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.*

CE706 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.*

CE710 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 SOLID AND HAZARDOUS WASTE MANAGEMENT

Types and Sources of solid and hazardous wastes - Need for solid and hazardous waste management

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 – closure of landfills – landfill remediation

Legislations on management and handling of municipal solid wastes, hazardous wastes, and biomedical wastes.

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.*

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 – Photocatalysis – Wet Air Oxidation – Evaporation – Ion Exchange – Membrane Technologies - Individual and Common Effluent Treatment Plants – Zero effluent discharge systems - Wastewater reuse – Disposal of effluent on land.
Industrial manufacturing process description, wastewater characteristics, source reduction options and waste treatment flow sheet for Textiles – Tanneries – Pulp and paper – Metal finishing – Petroleum Refining – Pharmaceuticals – Sugar and Distilleries – Food Processing – Fertilizers – Thermal Power Plants and Industrial Estates, 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 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.*

CE714 WATER AND AIR QUALITY MODELS

Modeling approaches to water quality - classification – Mathematical Models for water quality- Conservation of mass- mass balance- steady state system- time variable response system
Mass transport mechanisms - Advective and diffusive mass transport - DO and BOD models for Streams – Point source and multiple point sources Streeter Phelps model - oxygen 'sag' curve - deoxygenation and reaeration coefficients – anaerobic condition-Benthal oxygen demand

Models for Estuary-Estuary transport -Estuary Streeter Phelps -dispersion coefficient-Models for lakes – eutrophication-thermal stratification - physical chemical and biological processes - water quality distribution – temperature models.
Models for microorganisms decay- bacterial growth- microbial kinetics- batch reactor- CSTR reactor
Air quality models - Micrometeorological processes – lapse rate - wind rose – dispersion – stability classes - Gaussian dispersion model - Regional air quality models- Line source models- area source models- An Indoor air quality model

References

1. *Davis, M.L., and Cornell, D.A. Introduction to Environmental Engineering, Mc Graw Hill International Editions, 1998.*
2. *Pevy, Rowe, and Techobanoglous, Environmental Engineering, Mc Graw Hill Publishing company, Newyork.*
3. *Gilbert M. Masters, Introduction to Environmental Engineering and Science, Prentice- Hall of India Pvt. Ltd., Newdelhi.*
4. *Bibbero. R.J, and I.G.Young, Systems approach to Air pollution control, John wiley & Sons, Newyork, 1974.*
5. *Chapra, Steven C., Surface water quality modeling, McGraw Hill International Edition, 1997.*

CE715 CONTAMINANT TRANSPORT MODELING

Transport phenomenon – advection - diffusion – dispersion — adsorption - conservative and non-conservative pollutants- Extrinsic and Intrinsic properties- laws of conservation- Reynolds Transport Theorem.
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 – Model input parameters- Initial and boundary conditions -calibration – sensitivity analysis - application and evaluation of environmental control – bioremediation.
Numerical models: FDM- explicit vs. implicit methods - numerical errors - High resolution techniques - Finite volume techniques
Stream quality modeling using QUAL2K - Groundwater transport modeling using VISUAL 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.
3. Zheng, C. and Bennett, G. D., Applied contaminant Transport Modeling, A John wiley & sons, inc, publication, Newyork, 2002.
4. Sun, N. Z., Mathematical modeling of groundwater Pollution, Springer –Verlac Newyork Inc., and Geological publishing house, 1996.

CE716 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.*

CE717 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.

CE718 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- odors and sick-building syndrome- Humidity- Bio aerosols- infectious disease transmission- Special indoor environments- A/C units in indoor- Measurement methods- Control technologies- Control strategies.

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*.

CE719 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 720 PROCESS CHEMISTRY FOR WATER AND WASTEWATER TREATMENT

Environmental Chemistry Basic concepts from general chemistry: chemical equations, types of chemical reactions, calculations from chemical equations, solutions, activity and activity coefficients, chemical equilibria, chemical thermodynamics, factors affecting chemical equilibrium. Gas laws.
Acid Base Equilibria: fundamentals, equilibrium diagrams, alkalinity and acidity, the carbonic acid system, buffering in water systems, measuring alkalinity.
Solubility Equilibria: Solubility equlilibria for slightly soluble salts, effect of other solutes on salt solubility, removal of heavy metals from complex water and wastewater systems.
Oxidation reduction Equlilibria: oxidation reduction processes galvanic cell and chemical thermodynamics, stability diagrams measuring redox potentials.
Water Stabilization: Electrochemical aspects of corrosion, water stabilization, Langelier saturation index, Caldwell Lawrence diagrams, Water softening and neutralization: chemical precipitation, ion exchange Application of Redox Chemistry:

References

1. Benfield, L.D.; Weand, B.L.; Judkins, J.F. (1982) *Process chemistry for water and wastewater*. Prentice Hall Inc Englewood Cliffs New Jersey.
2. Weber Jr., W.J. (1972) *Physico-chemical Process for Water Quality Control*. Wiley Inc. Newyork.

CE721 MEMBRANE TECHNOLOGY FOR WATER AND WASTEWATER TREATMENT

Principles of Membrane processes- Types and Classification- Theory of Membrane separation- Types and choice of membranes– Liquid Membranes- Characterization of membranes-Recent development in membranes-Modules and washing process.
Electrodialysis- principles- Electro dialysis stack and its various components- ion exchange capacity- Electrical resistance of ion exchange membrane-Donnon dialysis- Reverse osmosis- theory and principle- membrane materials- design considerations.
Filtration- theory- Nanofiltration- Ultrafiltration- Microfiltration- Membrane Module/Element designs- Design of Membrane systems- Membrane bioreactors- Biotreatment Fundamentals, Biomass Separation MBR Principles- MBR Design Principles – Submerged anaerobic membrane bioreactors.
Fouling- Pretreatment methods and strategies – Langlier and Silt indexes- cleaning methods- Foulants analysis- disposal of RO concentrate- rejects in membranes.
Synthetic Membranes- preparation methods- composite membranes- preparation methods and applications- immersion precipitation preparation techniques- phase inversion membranes- Introduction to module and process design -zero Liquid effluent discharge Plants.

References

1. R.D. Noble and S.A. Stern, Membrane Separations Technology: Principles and Applications, Elservier, 1995.
2. E.D. Schroeder, Water & Wastewater Treatment, McGraw Hill, 1977.
3. J.G. Crespo and K.W. Boddekes, Membrane Processes in Separation and Purification, Kluwer Academic Publications, 1994.
4. R. Rautanbach and R.Albrecht, Membrane Process, John Wiley & Sons, 1989.

CE722 BIODEGRADATION AND BIOREMEDIATION TECHNIQUES

Bioremediation and biodegradation- Historical perspectives of biodegradation and bioremediation - contaminant bioavailability- microbial catabolism of organic pollutant - catabolic enzymes- properties- designing of microorganisms- biodegradation measurement potential-impediments to microbial biodegradation.

Biodegradation Detoxication Reactions – Principles of biodegradation- Biodegradation kinetics- Effect of pollutant chemical structure on biodegradation- Fate and transport of contaminants in soils and water bodies- Requirements of biodegradation- nutritional factors- Chemical structure- environmental factors- biological factors- Bioavailability and aging

Bioremediation monitoring and assessment methods- conventional plating and microbial enumeration- biochemical and physiological methods- BIOLOG- soil enzyme assay- immunochemical methods- phospholipids fatty acid analysis- molecular biology based methods- bacterial biosensors- molecular techniques- Toxicological risk assessments.

Biodegradation of organic compounds- anaerobic biodegradation of benzene and ethyl benzene- polyaromatic transformation and degradation- co-metabolic process for polychlorinated biphenyl degradation- aerobic hexachlorocyclohexane biodegradation- co posting of contaminated soil.

Improved bioremediation by engineering microbes- Bioadsorbents- metal precipitation- enzymatic transformation of metals- strains for enhanced biodegradation-improved biodegradation by protein

References

1. A. Singh and O.P. Ward Biodegradation and bioremediation, Springer-Verlag Berlin Heidelberg New York, 2004.
2. K.H. Baker and D.S. Herson, Bioremediation, McGraw-Hill, Inc., New York, 1994.
3. M. Alexander, Biodegradation and Bioremediation, Academic Press, 1999.

CE723 ENVIRONMENTAL POLICIES AND LEGISLATIONS

Common environmental laws-Role of judiciary in environmental protection- Criminal law, Common law-Criminal procedure Code-Indian Penal Code-Fundamental Rights and Fundamental Duties-International and national efforts at environmental protection-Green funding and taxes-National Environmental policies-Framework for environmental impact assessment.

Pollution control acts for water and air pollution-Water Prevention and Control of Pollution) Act, 1974-Water (Prevention and Control of Pollution) Cess Act, 1977 - Air (Prevention & Control of Pollution) Act, 1981.

Other environmental protection acts-Environmental (Protection) Act, 1986; Forest Conservation Act, 1980 - National Forest Policy 1988 - Wild Life (Protection) Act, 1972, Public Insurance & Liabilities Act, 1991- Biomedical wastes (management and handling)- Noise pollution, Eco - labeling, and E.I A. Coastal zone Notification (1991).

International laws- Stockholm Conference- The Rio Earth Summit, 1992 - Rio+5 and the Rio+10- Montreal Protocol, Kyoto Summit, 1997 - Nairobi Declaration, World Summit on sustainable development, 2002- Role of UN authorities in protection of Global Environment - Global environmental issues and International laws: to control Global warming, Ozone depletion, Acid rains, hazardous waste. Sustainable developments and environmental movements-Sustainable development principles, indicators of sustainability - sustainable development models- national and international sustainable development scenarios

References

1. S. Divan and A. Roseneranz, Environmental law and policy in India, Oxford University Press, New Delhi, 2001.
2. R. K. Sapru, Environmental Management in India Vol. I & II): Ashish Publishing House, 2004.
3. Gupta, K.R., Environmental Legislation of India, Atlantic Publishers, 2006.

CE724 CLEANER PRODUCTION AND ENVIRONMENTAL SUSTAINABLE MANAGEMENT

Concepts of Sustainable Development – Indicators of Sustainability – Sustainability Strategies, Barriers to Sustainability – Resource degradation - Industrialization and Sustainable development – Industrial Ecology – Socio economic policies for sustainable development - Clean development mechanism, cleaner Production (CP) in Achieving Sustainability.
Principles and concepts of Cleaner Production- Definition – Importance – Historical evolution – Benefits – Promotion – Barriers – Role of Industry, Regulations to Encourage Pollution Prevention and Cleaner Production – Regulatory versus Market-Based Approaches – Environmental Management Hierarchy – Source Reduction Techniques – Process and equipment optimization, reuse, recovery, recycle, raw material substitution – Internet Information & Other CP Resources.
Overview of CP Assessment Steps and Skills- Preparing for the Site visits-Information Gathering - Process Flow Diagram- Material Balance- CP Option Generation – Technical and Environmental Feasibility analysis – Economic valuation of alternatives - Total Cost Analysis – CP Financing – Establishing a Program – Organizing a Program – Preparing a Program Plan – Measuring Progress – Pollution Prevention and Cleaner Production Awareness Plan – Waste audit – Environmental Statement- green house gases and carbon credit- carbon sequestration- Sustainable development through trade - carbon trading.
Elements of Life Cycle Assessment (LCA) – Life Cycle Costing – Eco Labelling – Design for the Environment – International Environmental Standards – ISO 14001 – Environmental audit, Green building & green energy concepts and management.
Industrial applications of CP, LCA, EMS and Environmental Audits- green energy and green process management in Pharmaceutical, Construction, Textiles, Petroleum Refineries, Iron and Steel industries.

References

1. J. Kirkby, P. O'Keefe and Timberlake, Sustainable Development, Earthscan Publication,London, 1996.
2. P.L. Bishop, Pollution Prevention: Fundamentals and Practice, McGraw Hill International, 2000.
3. P. Modak, C. Visvanathan and M. Parasnis, Cleaner Production Audit, Environmental System Reviews, Asian Institute of Technology, Bangkok, 1995.

CE725 ENVIRONMENTAL HEALTH AND ECO-TOXICOLOGY

Need for developing Environment- Health and Safety systems in work places- Extent of industrial pollution- Public exposure from industrial sources- Major chemical contaminants at workplace- Hazards

by industry and its environmental effects- Status and relationship of Acts- Regulations and Codes of Practice.
The relationship of occupational hygiene/ safety and disease-Occupational Safety and Health Administration- Principles and methods of occupational health- Occupation Health and Safety Policy- OH & SMS Documentation- Health problem due to industrial dust, heat, chemicals, noise, toxic gases and metals- Health hazard in agriculture - Pesticides and environment- Pesticides and human health- Right to know Laws.
Overview, planning, hazard identification and risk assessment- Biological, chemical, physical and psychological health hazard- Health risk assessment and management in Tanneries, Pharmaceutical, Construction, Textiles, Petroleum Refineries, Iron and Steel industries.
Toxic substances in the environment- their sources and entry roots- Routes of toxicants to human body – entry through inhalation, skill absorption, indigestion and injection- Eco-system influence on the fate and transport of toxicants; Transport of toxicants by air and water-Transport through food chain - bio-transformation and bio-magnification
Accident Causation - Need for Accident Investigation, Accident investigation plan, Methods of Acquiring Accident Facts, Response to toxic exposures – Dose response, Frequency response and cumulative response- Lethal and sub-lethal doses; Dose- Response relationships between chemical and biological reactions. Detoxification in human body - detoxification mechanisms, organs of detoxification. Education and Training in health Hygiene.

References

1. H. Koren, Handbook of Environmental Health and Safety – principle and practices, Lewis Publishers, 1991.
2. I. C. Shaw and J. Chadwick, Principles of Environmental Toxicology, Taylor & Francis ltd, 1998.

CE726 ANALYTICAL METHODS FOR ENVIRONMENTAL MONITORING

Classification of instrumental methods- Performance characteristics of instruments (static and dynamic)- errors and uncertainties in performance parameters- noise reduction- Sensitivity and detection limit- Errors-types- expression of errors- Precision and accuracy- Calibration of instrumental methods.
Spectophotometry - Electromagnetic radiation -Atomic absorption and emission spectrometry - Ultraviolet-visible spectrophotometry principle and instrumentation- Atomic adsorption spectroscopy principle and instrumentation- Flame photometer- Fluorimetry- nephelometry and turbidimety- principles
Chromatography- principle and classification- column efficiency and resolution- quantitative determination- Column Chromatography- Thin Layer Chromatography- Principle and application of Ion-chromatography- Application Gas Chromatography(GC)- Principle and application of high precision liquid chromatography (HPLC)- Ion Chromatography- Mass Spectroscopy-GC-MS.
Electro chemical methods- electrochemical cell- reference electrodes- Cyclic votametry-Polarograph-Oscilloscopi Polarography- Ion Selective Electrodes- Conductomety- electrolytic conductivity specific-equivalent and molar conductance- working principles of pH, EC, TDS meters.
Material characterization techniques- SEM, TEM, XRD, FTIR, thermal analysis- working principles and applications.

References

1. D.A. Skoog, D.M. West and T.A. Nieman, Principles of Instrumental Analysis,5th Ed. Thomson Asion (P) Ltd. Singapore, 2004
2. H.H, Willard, L.L. Merit, J.A. Dean and F.A. Settle, Instrumental Methods of Analysis, 7th Ed. CBP Publishers and Distributors, New Delhi, 1986

CE727 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*

CE 728 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: Diffused 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.
Concept of waste containment facilities; desirable properties; 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.*

CE729 RIVER ENGINEERING

Classification of free surface flow, velocity and pressure distribution, Uniform flow.
Dynamics equation for gradually variedd 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 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. *Santhosh Kumar Garg., "Irrigation Engineering & Hydraulic structures", Khanna Publishers, 2006.*
3. *Subramanya., "Flow in Open Channels", Tata McGraw Hill, 2001.*

CE730 SURFACE AND GROUNDWATER MODELLING

Land Processes – Subsurface and channel processes – Precipitation – Rain gauge network – Abstractions, Infiltration, Evaporation, Transpiration, Process and Models.
Unit Hydrograph and S curve hydrograph, Dimensionless unit hydrograph, GUIH, Watershed model and Conceptual model.
Occurrence and movement of ground water- Properties of aquifer, Ground water flow equation, Dupuit Forchheimer assumptions, Well hydraulics, Partial penetration of wells, Interference of wells, Collector wells and Infiltration galleries.
Pumping tests, Analysis of unconfined and non leaky and leaky confined aquifer and water table aquifer, locating hydrogeologic boundaries, well design criteria.
Natural and artificial recharge of groundwater - 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*

CE731 WATER RESOURCES SYSTEMS MANAGEMENT

Reservoir planning, Management, Multireservoir 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.
Rain water Harvesting and Management- different types and methods of harvesting in urban and agricultural areas.
Drought 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 and practices)", Prentice Hal of India (P). Ltd., 2004.*
2. *Water Resources Systems, "Vedula & Mujumdar", Mc Graw Hill, 2005.*
3. *Daniel P. Loucks, "Water resources systems Planning and Management (Studies and Reports in hydrology)", 2006.*

CE732 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.*

CE733 REMOTE SENSING AND GIS FOR ENVIRONMENTAL APPLICATIONS

Fundamentals of geographic information system, geo-data type, Input Sources, Raster and Vector data structures, Comparison of Raster and Vector data structure, Analysis using Raster and Vector data, Projection and transformation, Retrieval, Reclassification, Overlaying, Buffering.
Electro-magneticenergy, spectrum, EMR interaction with atmosphere, Scattering, Atmospheric Windows and its Significance, EMR interaction with Earth Surface Materials, Spectral Signature EMR interaction with water, soil and Earth Surface. Introduction to image processing, Pre-processing and corrections, Visual Interpretation of Satellite Images, Environmental Satellites: GOES, NOAA, AVHRR, CZCR, OCM and MODIS.
Data base creation and quality modeling using GIS, Water supply and sewage network using GIS, Eutrophication in lakes and reservoir, Groundwater vulnerability, DRASTIC model, Remote Sensing application of reservoir and coastal water quality modeling,
Remote Sensing application on soil salinity mapping, soil erosion-land degradation, Impact of agricultural and industrial activity on soil properties, Catchment nutrients transport modeling, Monitor and mapping of atmosphere constituents, aerosol using MODIS satellite.
Modeling of land slides, suitable site for disposal of solid waste using Multi Criterion Analysis, GIS for health and emergency management, Impact analysis.

References

1. Sabins, F., Remote Sensing Principles and Interpretation, W. H. Freeman and Company, New York, Third edition, 2007.
2. Allan Brimicombe., GIS Environmental Modeling and Engineering, Taylor &Francis, 2003.
3. Lai, Poh C., Mak, Ann S.H. (Eds.)GIS for Health and Environment, Springer Publication, 2007.
4. Uzair M.S., GIS Tools for Water, Wastewater, and Storm water Systems, ASCE Press, 2002.
5. George Joseph, Fundamentals of Remote sensing, University Press, Second edition, 2005.