Credit Courses Syllabus

Civil Engineering

S. No.	Credit Courses
1	Finite Element Method
2	Stability Of Structures
3	Design of offshore structures
4	Principles and Applications of Remote Sensing & GIS
5	Foundation Engineering
6	Ground Improvement Techniques
7	Traffic Engineering
8	Advanced Concrete Technology
9	Theory of Elasticity and Plasticity
10	Design of Masonry structures
11	Experimental Stress Analysis
12	Structural Dynamics & Earthquake Resistant Design
13	Pavement Analysis and Design
14	Expansive Soil
15	Fracture Mechanics of concrete structures
16	Repair & Rehabilitation of Concrete Structures
17	Computational And Statistical Methods
18	Neuro-Fuzzy Techniques And Computer Programming
19	Solid & Hazardous Waste Management
20	Physico-Chemical Process For Water And Wastewater Treatment

S. No.	Credit Courses
1	**Finite Element Method**

FINITE ELEMENT METHOD

Unit I:

Introduction: Review of stiffness method- displacement field - Integral form-differential form - "Rayleigh-Ritz method" of functional approximation - variational approaches -weighted residual methods- concept of FEM. Bar and torsional elements: Degree of freedom –simple element- higher order element-nodal displacement vector- shape functions- FE formulation-discrimination- stiffness matrix of element- element nodal load vector-assembling- total potential in terms of FEM formulation- boundary conditions- strain, stress and force in element-reaction- torsional element. trusses-Iso-parametric element. –natural coordinates.

Unit II:

Beam, frame and grid elements: Degree of freedom - displacement vector - simple element- higher order element-nodal displacement vector - shape functions- discrimination- stiffness matrix of element- element nodal load vector-assembling-total potential in terms of FE formulation- boundary conditions- strain, stress and forces in elements-reactions- frame element-Grid element-Beams - frames- Grid structures. Iso-parametric element –natural coordinates.

Unit III:

Membrane element: 2 Dimensional structures- Plane stress-plane strain- triangular elements-CST element-LST element-rectangular elements-Legrangian family of elements-Serendipity family of elements Shape functions – nodal displacement vector-FEM formulation-element stiffness matrix-element nodal load vector due to body forces, traction and concentrated loads- Iso-parametric element- Area coordinates- strain vector and stress vector in element. Axisymmetric solids: Modelling as 2D problem: stress-strain relations- material stiffness matrix-dof - Triangular element-rectangular element-shape functions- Displacement function- FE formulation -stiffness matrix of element- nodal loads- strain vector, stress vector in elements- reactions. Iso-parametric element-Area coordinates.

Unit IV:

3 Dimensional stress analysis: dof – types of elements- simple elements – higher order elements-displacement function- shape functions- nodal displacement verctor- Nodal load vector- stiffness matrix of element- FE formulation – volume coordionates- isoparametric elements- strain vector and stress vector in element. Plate structures & shell structures: dof- displacement field – nodal displacement vector- shape function- Finite Element Formulation of plate structures- types elements-strain vector and stress vector in element-types of elements.

Unit V:

Introduction to Non-linear Finite Element Methods- types of nonlinear problems-Introduction to dynamic analysis using Finite Element Method - Development of simple programs for simple structures- Introductio of FEM package(only class work)

REFERENCES:

1. Concepts and applications of Finite Element Analysis – Robert D. Cook, Michael E Plesha, John Wiley & sons Publications
2. A first course in the Finite Element Method – Daryl L. Logan, Thomson Publications.
3. Introduction to Finite Elements in Engineering- Tirupati R. Chandrupatla, Ashok D. Belgunda, PHI publications
4. Fundamentals of Finite Element Analysis- David V. Hutton, Tata McGraw-Hill
5. Finite element Analysis- Theory and programming – C.S. Krishna Murthy, Tata Mc Gra Hill.
6. Finite element Analysis – P.Seshu, PHI
7. Finite element method – O.C. Zeinkiewicz, Tata Mc Gra Hill, 2007

2	**Stability Of Structures**

STABILITY OF STRUCTURES

UNIT-I

Beam columns: Differential equation for beam columns – Beams column with concentrated loads – continuous lateral load – couples – Beam column with built in ends – continuous beams with axial load – application of Trigonometric series – Determination of allowable stresses.

UNIT-II

Elastic buckling of bars : Elastic buckling of straight columns – Effect of shear stress on buckling – Eccentrically and laterally loaded columns –Sway & Non Sway mode - Energy methods – Buckling of a bar on elastic foundation – Buckling of bar with intermediate compressive forces and distributed axial loads – Buckling of bars with change in cross section – Effect of shear force on critical load – Built up columns – Effect of Initial curvature on bars – Buckling of frames – Sway & Non Sway mode.

UNIT-III

In Elastic Buckling: Buckling of straight bars – Double modulus theory Tangent modulus theory.

UNIT-IV

Experiments and design formulae: Experiments on columns – Critical stress diagram – Empirical formulae of design – various end conditions – Design of columns based on buckling. Mathematical Treatment of stability problems: Buckling problem orthogonality relation – Ritz method – Timeshinko method, Galerkin method.

UNIT-V

Torsional Buckling: Pure torsion of thin walled bars of open cross section – Non uniform torsion of thin walled bars of open cross section - Torsional buckling – Buckling of Torsion and Flexure. Lateral Buckling of simply supported Beams: Beams of rectangular cross section subjected for pure bending, Buckling of I Section subjected to pure bending.

REFERENCES:

1. Theory of Elastic stability by Timshenko & Gere-Mc Graw Hill
2. Stability of Metal Structures by Bleinch – Mc Graw Hill
3. Theory of beam columns Vol I by Chem. & Atsute Mc. Graw Hill.
4. Theory of Stability of Structures by Alexander Chases.

3	**Design of Offshore Structures**

DESIGN OF OFFSHORE STRUCTURES

UNIT-I

Introduction- Physical Environmental aspects of Marine and offshore construction- Materials and offshore construction equipment – Marine operations – Sea floor modification and improvements. Marine and Offshore construction equipment- Basic motions in sea- Buoyancy, Draft and freeboard- Stability- Damage control- Barges - Crane - offshore Derrick – Catamaran and Semi submersible Barges- Jack up Barges- launch barges- offshore Dredges- Floating Concrete Plant .

UNIT-II

Installation of Piles in marine and offshore Structures- Fabrication of tubular steel piles- Transportation- Installation- Methods of increasing penetration – Inserting and anchoring into rock and hardpan- Prestressed concrete piles for marine construction- Handling and Positioning of Piles Review of Basic Concepts.

UNIT-III

Offshore Platforms: Steel Jackets and Pin piles- Fabrication- Land out, tie down and transportation- Removal of jacket from transportation barge – Lifting – launching-Installation at Sea floor- Pile and conductor Installation- Deck Installation- Concrete Platforms- Construction stages- Sub base

	construction. **UNIT-IV** Submarine Pipelines- Types of barges- Controlled underwater floating- Bundles pipes- Directional drilling- protection of pipelines- burial and covering with rock- support of pipelines . Underwater repairs- Repairs to steel Jacket- type structures- Repairs to steel piling- Repairs to Concrete offshore structures- repairs to foundations- Fie damage- Pipeline repairs. **UNIT-V** Strengthening Existing structures- Strengthening of offshore Platforms and terminals, members or assembles- Increasing capacity of piles for axial loads- Increasing lateral capacity of piles and structures in interaction- seismic retrofitting. Constructability - Construction stages- Principles- Assembly and Jointing procedures- access- tolerances- survey control- quality control and assurance- safety- risk and reliability evaluation **REFERENCES:** 1. Construction of Marine and offshore Structures- 2e- Ben-C. Gerwick, Jr CRC press 2. Basic Coastal Engineering by R. M. Sorensen, published by Chapman & Hall, 1997 3. Port and Marine Structure Quin
4	**Principles and Applications of Remote Sensing & GIS**
	PRINCIPLES AND APPLICATIONS OF REMOTE SENSING & GIS UNIT I Introduction to aerial Photogrammetry: Principles of Optics, Types of Aerial Photographs, Stereoscopy, Photoscale, Map vs Mosaic, Mosaic-Kinds of Mosaic, Construction of Mosaic, Ground Control, Parallax measurements for height determinations. Remote Sensing: Basic Concepts and foundation of remote sensing, Elements involved in Remote Sensing, Electromagnetic spectrum, Remote Sensing terminology, Energy Sources, Energy interactions with Earth Surface features and atmosphere, Resolution, Sensors and Satellites, Visual Interpretation techniques-Basic elements. Interpretation for Terrain Evaluation, Spectral properties of water bodies, Introduction to digital data analysis. Unit II Geographic Information Systems: Introduction, GIS definition and Terminology, GIS categories, Components of GIS, Fundamental Operations of GIS, A theoretical Framework for GIS, GIS types of data representation, Raster Data Structures, Vector Data Structures, Comparisons between Data Structures. Unit III Data Acquisition and Data Input: Introduction, exisiting data sets, developing own data, digitization and scanning. Preprocessing: Format conversion, data reduction and generalisation, error detection and editing, merging, edge matching, rectification and registration, interpolation. Unit IV Data Management: Basic principles of data management: Efficiency, conventional database management systems, Spatial database management product generation: Types of output products, hardware components, Integrated analysis of Spectral and attribute data. Data Quality: Introduction, Components of data quality, Sources of error, Introduction to GPS Unit V Remote Sensing & GIS Applications: Land Use/Land cover in water resources, Rainfall-Runoff modelling, Flood plain zoning, Drought assessment and monitoring, Cropping patterns, condition of crops, irrigation system performance, Watershed Management for sustainable development, watershed characteristics, erosion and deposition, catchment area treatment, Estimation of Sediment

load.

TEXT BOOKS:

1. Elements of Photogrammetry by Paul Wolf
1. Remote Sensing and Image Interpretation by T.M. Lilles and R.W. Kifer.
2. Geographic Information Systems – A Management Perspective by Stan Aronoff
3. Elements of Photogrammetry by K.K. Rampal
4. Principles and Applications of Photogeology by R.W. Shiv Pandey
5. Remote Sensing in Hydrology by E.T. Engman and R.J. Curney
6. Geographic Information Systems by David Martin.
7. Remote sensing and Image Interpretation by LILESAND and KIEFER, Published by john Wiley and sons.
8. Fundamental of GIS by MICHAEL N DEMERS Published by John Wiley & Sons Inc.

5 **Foundation Engineering**

FOUNDATION ENGINEERING

UNIT- I

Soil Exploration – Importance, Terminology, planning - Geophysical methods. Borings, location, spacing and depth, methods of boring including drilling, stabilization of boreholes, boring records.

UNIT- II

Soil sampling – Methods of sampling -Types of samples and samplers- cleaning of bore holes, preservation, labeling and shipment of samples - Design considerations of open drive samplers.

UNIT- III

Shallow Foundations –Bearing capacity – General bearing capacity equation, Meyerhof's, Hansen's and Vesic's bearing capacity factors - Bearing capacity of stratified soils - Bearing capacity based on penetration resistance- safe bearing capacity and allowable bearing pressure. (Ref: IS -2131 & IS 6403)

UNIT- IV

Types and choice of type. Design considerations including location and depth, Proportioning of shallow foundations- isolated and combined footings and mats - Design procedure for mats. Floating foundation- Fundamentals of beams on Elastic foundations. .(Ref: IS -456 & N.B.C. relevant volume)

UNIT- V

Pile foundations-Classification of piles-factors influencing choice-Load -carrying capacity of single piles in clays and sands using static pile formulae- α - β - and λ - methods –Dynamic pile formulae- limitations- Monotonic and cyclic pile load tests – Under reamed piles. Pile groups -Efficiency of pile groups- Different formulae-load carrying capacity of pile groups in clays and sands – settlement of pile groups in clays and sands – Computation of load on each pile in a group.

REFERENCES:

1. Principles of Foundation Engineering by Braja M. Das.
2. Soil Mechanics in Engineering Practice by Terzagi and Peck
3. Foundation Design by Wayne C. Teng, John Wiley & Co.,

	4. Foundation Analysis and Design by J.E. Bowles McGraw Hill Publishing Co., 5. Analysis and Design of sub structures by Swami Saran 6. Design Aids in Soil Mechanics and Foundation Engineering by Shanbaga R. Kaniraj,Tata Mc. Graw Hill. 7. Foundation Design and Construction by MJ Tomlinson – Longman Scientific 8. A short course in Foundation Engineering by Simmons and Menzes - ELBS
6	**Ground Improvement Techniques**
	GROUND IMPROVEMENT TECHNIQUES **UNIT – I** **Introduction to Ground Modification:** Need and objectives of Ground Improvement, Classification of Ground Modification Techniques – suitability and feasibility, Emerging Trends in ground improvement. **UNIT –II** **Mechanical Modification:** Methods of compaction, Shallow compaction, Deep compaction techniques – Vibro-floatation, Blasting, Dynamic consolidation, pre-compression and compaction piles, Field compaction control. **UNIT –III** **Hydraulic Modification:** Methods of dewatering – open sumps and ditches, Well-point system, Electro-osmosis, Vacuum dewatering wells; pre-loading without and with sand drains, strip drains and rope drains. **Physical and Chemical Modification:** Stabilization with admixtures like cement, lime, calcium chloride, fly ash and bitumen, Grouting: categories of grouting, Art of grouting, Gout materials, Grouting techniques and control. **UNIT –IV** **Reinforced Earth Technology:** Concept of soil reinforcement, Reinforcing materials, Backfill criteria, Art of reinforced earth technology, Design and construction of reinforced earth structures. **Soil Confinement Systems:** Concept of confinement, Gabbion walls, CRB walls, Sand bags, Evergreen systems and fabric formwork. **UNIT –V** **Miscellaneous Techniques:** Design, Construction and applications of stone columns lime columns and cofferdams. Types of Geo-textiles and their applications in various constructions. **References:** 1. Engineering, principles of ground modification – Manfred R.Hansmann Mc Graw-Hill pub. Co., New York. 2. Construction and Geotechnical methods in Foundation Engineering – Robert M.Koerner McGraw-Hill Pub. Co., New York. 3. Foundation Engineering Hand book – Winterkorn and Fang Van Nostrand Reinhold Co., New York. 4. Aris C.Stamatopoulos & Panaghiotis C.Kotzios – Soil Improvement by Preloading – John Wiley & Sons Inc. Canada. 5. Ground Improvement Techniques – P. Purushothama Raj Laxmi Publications (P) Limited.
7	Traffic Engineering **and** Transportation Planning
	TRAFFIC ENGINEERING AND TRANSPORTATION PLANNING **UNIT – I** **TRAFFIC STUDIES:** Basic Traffic Parameters – Speed, Volume and Density – Definitions and

	their interrelationship – Traffic Volume Studies: Types, Methods and Analysis of Traffic Volume Data; Speed and Delay Studies: Types of Speeds, Speed Study Methods, Data Collection, analysis and Presentation; Use of Statistical Methods in Traffic Volume and Speed Data Analysis. **UNIT – II** **HIGHWAY CAPACITY**: Highway Capacity and Level of Service; Factors affecting Highway Capacity and Level of Service; Concept of PCU Factors; Capacity of Rural Highways and Basic freeways ; Capacity of Urban Roads; Capacity of Intersections and Factors influencing; Capacity of Rotary Intersections. **UNIT – III** **TRANSPORTATION PLANNING PROCESS**: Definition of Study Area; Zoning Principles; Types of Surveys: Home Interview Studies, Commercial Vehicle Surveys, Road Side Interview Methods, Public Transport Studies, Land Use Inventory; O-D Matrix and Desire Line Diagram. **TRIP GENERATION**: Four Stage UTP Process; Travel Demand Models; Sequential Models and Direct Demand Models; Factors affecting Travel Demand; Trip Generation; Multiple Regression Analysis; Category Analysis; Aggregate and Disaggregate Models. **UNIT- IV** **TRIP DISTRIBUTION**: Trip Distribution Models- Growth Factor Models: Uniform Growth Factor, Average Growth Factor, Fratar Method and Furness Method; Limitations of Growth factor Models; Gravity Model – Calibration of Gravity Model.; Opportunity Models. **TRAFFIC ASSIGNMENT**: Purpose of Traffic Assignment; Assignment Techniques-All-or-Nothing Assignment, Multiple Route Assignment, Capacity restraint assignment; Use of Diversion Curves in Assignment. **UNIT –V** **MODE SPLIT**: Factors affecting Mode Split; Pre–distribution Mode Split; Post-Distribution Mode Split; Advantages and Disadvantages; Probit, Logit and Discriminate Analysis in Mode Split. Syllabi for Pre-Ph.D/Civil (2009-2010) **ECONOMIC EVALUATION OF TRANSPORT PLANS**: Need for Economic Evaluation; Principles of Economic Evaluation; Costs and Benefits of Transportation Projects; Methods of Economic Analysis- Benefit Cost Ratio Method; Net Present Value Method; Internal Rate of Return Method; Comparison of various methods and their suitability. **REFERENCES:** 1. **Traffic Engineering and Transport Planning**, L.R.Kadiyali, Khanna Publishers,New Delhi. 2. **Fundamentals of Transportation Engineering**, C.S.Papacostas, Prentice Hall India Ltd 3. **Transportation Engineering**-An Introduction, C.J.Khisty and B.Kent Lall, Prentice Hall India Ltd
8	**Advanced Concrete Technology**
	ADVANCED CONCRETE TECHNOLOGY **UNIT-I** Materials- Cement, Aggregates, mixing water soundness of aggregate- Fresh and hardened concrete: Admixtures- types of admixtures- purposes of using admixtures- chemical composition- effect of admixtures on fresh and hardened concretes- Natural admixtures. Non destructive evaluation: Importance- Concrete behavior under corrosion, disintegrated mechanisms- moisture effects and thermal effects – Visual investigation- Acoustical emission methods- Corrosion activity measurement- chloride content – Depth of carbonation- Impact echo methods- Ultrasound pulse velocity methods- Pull out tests **UNIT-II** Repair and rehabilitation of structural elements: Analysis, strategy and design- Material requirement- Material selection- Surface preparation- Reinforcing steel cleaning, repair and protection- Bonding repair materials to existing concrete- placement methods-

UNIT-III

Strengthening and stabilization- Techniques- design considerations- Beam shear capacity strengthening- Shear Transfer strengthening- stress reduction techniques- Column strengthening- flexural strengthening- Connection stabilization and strengthening Crack stabilization

UNIT-IV

Fiber-reinforced concrete- Properties of constituent materials- Mix proportions, mixing and casting methods-Mechanical properties of fiber reinforced concrete- applications of fibre reinforced concretes. Light weight concrete- Introduction- properties of light weight concrete- No fines concrete- design of light weight concrete

UNIT-V

Fly ash concrete- Introduction- classification of flyash- properties and reaction mechanism of flyash- Properties of flyash concrete in fresh state and hardened state- Durability of flyash concretes. High performance concretes- Introduction- Development of high performance concretes- Materials of high performance concretes- Properties of high performance concretes.

REFERENCE:

1. Concrete technology- Neville & Brooks
2. Special Structural concrete- Rafat Siddique
3. Concrete repair and maintenance illustrated- Peter H Emmons
4. Concrete technology-M S Shetty
5. Special Structural concretes by Rajat Siddique, Galgotia Publications.
6. Design of Concrete Mixes by N.Krishna Raju, CBS Publications.
7. Concrete: Micro Structure by P.K.Mehta, ICI, Chennai.

9 Theory of Elasticity and Plasticity

THEORY OF ELASTICITY AND PLASTICITY

1. **Introduction:** Elasticity – Notation for Forces and Stresses – Components of Stresses – Components of Strain – Hooke's Law. Plane Stress and Plane Strain analysis – Plane Stress – Plane strain – Differential Equations of equilibrium – Boundary conditions – Compatibility equations - Stress function – Boundary Conditions.

2. **Two Dimensional Problems:** in Rectangular Co-Ordinates – Solution by polynomials – Saint – Venant's Principle – Determination of Displacements – Bending of Simple beams – Application of Fourier Series for two dimensional problems for gravity Loading. Two Dimensional problems in Polar Co-ordinates General Equations in polar Co-ordinates – Stress Distribution Symmetrical about an axis – Pure bending of curved bars - Strain Components in Polar Co-ordinates – Displacements for Symmetrical stress Distributions – Circular discs- Stresses on plates with circular holes

3. **Three Dimensional Problems:** Analysis of Stress and Strain in Three Dimension Principal Stress – Stress Ellipsoid and stress director surface – Determination of Principal stresses Maximum shear stresses – Homogeneous Deformation – Principle Axes of Strain.
   General Theorems: Differential equations of equilibrium – Conditions of Compatibility Determination of Displacement – Equations of Equilibrium in Terms of Displacements – Principle of Superposition – Uniqueness of Solution –Reciprocal theorem.

4. **Torsion of Prismatic Bars:**
   Torsion of Prismatic Bars – Bars with Elliptical Cross Section – Other elementary Solution – Membrane Analogy – Torsion of Rectangular Bars – Solution of Torsional Problems by Energy

	method – use of soap Films in Solving Torsional problems – Hydro dynamical Analogies – Torsion of Bars. 5. **Theory of Plasticity:** Introduction – Concepts and Assumptions – Yield criteria. **References:** 1.Theory of Elasticity- Timoshenko & Goodier 2.Theory of Elasticity – Sadhu Singh
10	Design of Masonry structures
	DESIGN OF MASONRY STRUCTURES **Unit I:** Properties of materials of masonry- Bricks, mortar, and factors influencing strength of masonry. **Unit II:** Properties of masonry, **Unit III** : Masonry under axial, flexure and shear, **Unit IV:** Theories of failure of masonry **Unit V:** Design of unreinforced masonry structures. **REFERENCES:** 1. Hendry, A.W., Structural Masonry, MacMillan Press, 1998. 2. Duggal, S.K., Earthquake resistant design of structures, Oxford University Press, 2007 3. Current literature.
11	Experimental Stress Analysis
	EXPERIMENTAL STRESS ANALYSIS **UNIT-I** **Strain measurement methods:** Definition of strain and its relation to experimental determinations - properties of strain – Gauge systems – Mechanical, Optical, Acoustic and Pneumatic types. **UNIT-II** **Electrical resistance strain gages:** Introduction – gauge construction – strain gauge adhesives - mounting methods – gauge sensitivities and gage factor – performance characteristics of wire and foil strain gauges – environmental effects. Analysis of strain gauge data: Introduction – the three element rectangular rosette – the delta rosette – correction for transverse sensitivity. **UNIT-III** **Non-Destructive Testing (NDT):** Introduction – objective of non destructive testing. Ultrasonic pulse velocity method – Rebound Hardness method (Concrete hammer) application to assessment of concrete quality. Brittle coating methods: Introduction – coating stresses – failure theories – brittle coating crack patterns – crack detection – types of brittle coatings – test procedures for brittle coating analysis – calibration procedures – analysis of brittle coating, data interpretation **UNIT-IV** **Theory of photo elasticity:** Introduction – temporary double refraction – Index ellipsoid and stress ellipsoid – the stress optic law – effects of stressed model in a polariscope for various arrangements - fringe sharpening. Two dimensional photo elasticity: iso-chromatic fringe patterns – isoclinic fringe patterns – compensation techniques – calibration methods – separation methods – materials for

	photo-elasticity – properties of photo-elastic materials. **UNIT-V** **Model design:** Introduction – Model & Prototype - Factors influencing model design – scale factors and Model material properties – Methods of model design. **REFERENCES:** 1. Experimental Stress Analysis- Riley and Dally 2. Experimental Stress Analysis – Lee 3. Experimental Stress Analysis- Sadhu Singh
12	**Structural Dynamics And Earthquake Resistant Design**
	STRUCTURAL DYNAMICS AND EARTHQUAKE RESISTANT DESIGN 1. Introduction to Structural Dynamics: Fundamental objective of Dynamic analysis – Types of prescribed loadings – methods of Discretization – Formulation of the Equations of Motion. Theory of Vibrations: Introduction – Elements of a Vibratory system – Degrees of Freedom of continuous systems - Oscillatory motion – Simple Harmonic Motion – Free Vibrations of Single Degree of Freedom (SDOF) systems – Undamped and Damped – Critical damping – Logarithmic decrement – Forced vibrations of SDOF systems – Harmonic excitation – Dynamic magnification factor – Band width. 2. Single Degree of Freedom System: Formulation and Solution of the equation of Motion – Free vibration response – Response to Harmonic, Periodic, Impulsive and general dynamic loadings – Duhamel integral. 3. Multi Degree of Freedom System: Selection of the Degrees of Freedom – Evaluation of Structural Property Matrices – Formulation of the MDOF equations of motion - Undamped free vibrations – Solution of Eigen value problem for natural frequencies and mode shapes – Analysis of dynamic response - Normal coordinates – 4. Continuous Systems: Introduction – Flexural vibrations of beams – Elementary case – Equation of motion – Analysis of undamped free vibration of beams in flexure – Natural frequencies and mode shapes of simple beams with different end conditions. 5. Introduction to Earthquake Analysis: Introduction – Excitation by rigid base translation – Lumped mass approach of SDOF and MDOF systems – I.S. Code methods of analysis. Terminology- general principles of design criteria- Seismic coefficient method- Design criteria for various applications- Multistoried buildings- Bridges - Dams and Embankments- Retaining walls. Sesmic Evaluation of RC buildings – Condition assessment Field Evaluation Identification and assessment of concrete -. Sesmic retrofitting R.C.C and masonary building – Ductile detailing for earth quake resistant construction. I.S. Codal Provisions REFERENCES: 1. Dynamics of Structures by Claugh & Penzien. 2. Structural Dynamics A K Chopra 3. Earth quake resistant Design of Structure – P. Agarwal, M. Shikhande 4. IS:1983-1984 Code of Practice for Earthquake Resistant Design of Structure

13	**Pavement Analysis and Design**

PAVEMENT ANALYSIS DESIGN AND EVALUATION

1. Pavement Types, Wheel Loads and Design Factors: Definition of Pavement Types, Comparison of Highway pavements, Wheel Loads, Tyre pressure, Contact pressure, Design Factors: Traffic and Loading, Environment, Materials, Failure criteria, Reliability.
2. Stresses in Pavements: Layered System Concepts: One Layer System: Boussinesq Theory. Two Layer Theory: Burmister's Theory. Three Layer System. Stresses in Rigid Pavements. Relative Stiffness of Slabs, Modulus of Subgrade Reaction, Stresses due to Warping, Stresses due to Friction, Stresses due to Load, IRC Recommendations.
3. Pavement Design: IRC Method of Flexible Pavement Design, AASHTO Method of Flexible Pavement Design, IRC Method for Rigid Pavements, use of Geosynthatics in pavements.
4. Pavement Inventories: Serviceability Concepts, Visual Rating, Pavement Serviceability Index, Roughness Measurements, Measurement of Distress Modes Cracking, Rutting, Rebound Deflection using Benkleman Beam Deflection Method, Load Man Concept, Skid Resistance Measurement.
5. Pavement EvaluationFunctional Pavement Performance Evaluation: AASHTO Method, Psycho Physical and Psycho Metric Scaling Techniques, Deduct Value Method.
   Structural Conditional Evaluation Technique: Benkelman Beam Deflection Method, Pavement Distress Rating Technique. Design of Overlays by Benkelmen Beam Deflection Methods as per IRC – 81 - 1997 – pavements on problematic soils.

REFERENCES:

1. Yoder and Witzorack, "Principles of Pavement Design", John Willey and Sons.
2. Yang, H. Huang, "Pavement Analysis and Design", Prentice Hall Publication, Englewood Cliffs, New Jersy.
3. Sargious, M.A. Pavements and Surfacings for Highways and Airports – Applied science Publishers limited
4. Ralps Hass and Hudson, W.R. " Pavement Management System" Mc-Graw Hill Book Company.
5. IRC codes of practice.

14	**Expansive Soil**

EXPANSIVE SOILS

Unit-I

Origin and occurrence of expansive soils-problems associated with expansive clays-identification and classification based on mineralogical composition. X-Ray diffraction, differential thermal analysis and electron microscopy-identification by index properties .

Unit-II

Clay-water system – Ion distribution in clay –water systems-diffuse double layer-Gouy Chapman theory-cation exchange. Mechanisms of swelling-osmotic pressure concept-Importance of mineralogical details in swelling-soil suction-measurement in laboratory and field

Unit-III

Swell potential-swelling pressure-factors affecting-direct measurement from laboratory testing-stresses in an in-situ soil mass-factors affecting heave-methods of heave prediction

Unit-IV:

Shear strength of expansive clays-Katti's concept of bilinear stress- state variables-Fredlund's three dimensional approach to shear strength and swelling behaviour of expansive clays

Unit-V

Foundation practices in expansive clays-sand cushion-belled piers-under reamed piles-CNS layer technique. Expansive soil stabilization with lime-lime soil columns and lime slurry pressure injection-stabilization with admixtures.

REFERENCES:

	1. Foundations on expansive soils – F.H. Chen, Elsevier Publishing Co. 2. Search for solutions to problems in black cotton soils – R.K. Katti, Indian Goe.Tech.Journal, Volume 1, 1971 3. Fundamentals of soil behaviour – J.K. Mitchell, John Wiley&Sons
15	**Fracture Mechanics of Concrete Structures**
	FRACTURE MECHANICS OF CONCRETE STRUCTURES 1. Introduction: Fundamentals of elastic and plastic behaviour of materials- stresses in a plate with a hole – Stress Concentration factor- modes of failure- Brittle fracture and ductile fracture- history of fracture mechanics-Griffiths criteria of cracks- mode I, mode II and mode III failure. 2. Principles of Linear Elastic Fracture Mechanics: SOM vs Fracture Mechanics -stressed based Criteria for fracture- Stress Intensity Factors- K_I K_{II} and K_{III} – Critical stress Intensity Factors, K_{Ic} K_{IIc} and K_{IIc} – crack tip plastic zone – Erwin's plastic zone correction -Critical crack length-Load carrying capacity of a cracked component- Design of components based on fracture mechanics. 3. Griffith's criteria- Criteria for crack propagation -Energy release rate , G_I G_{II} and G_{III} - Critical energy release rate G_{Ic} , G_{IIc} and G_{IIIc} – surface energy - R curves – compliance- J-Integrals: 4. Material characterisation by Crack Tip Opening Displacements (CTOD)- Crack Mouth Opening Displacement (CMOD)- Critical crack tip opening displacement ($CTOD_c$) –critical Crack Mouth Opening Displacement ($CMOD_c$)-Determination of fracture parameters. Experimental determination of fracture parameters- K_{Ic} , G_{Ic}, $CTOD_c$ and critical J-Integral.-for brittle and quasi brittle materials like concrete and rock- Specimen geometry . 5. Nonlinear Fracture Mechanics for mode I quasi- brittle fracture(Concrete): General quasi-brittle fracture-Ficticious crack approach - Hillerborg's Fictitious crack model-Bazanth's crack band model- Effective elastic crack approach-Two Parameter model- Bazanth' Size effect model-effective crack model-softening- Applications of Fracture Mechanics to Concrete structures: Size effect on nominal strength-Tension ,Bending, Shear and torsion of RRC members-Concrete dams- Interfacial fracture mechanics- **REFERENCES :** 1. Engineering Fracture Mechanics- S.A. Meguid, Elsevier Applied Science Publications. 2. Elementary engineering fracture mechanics – David Broek – Sijthoff & Noordhoff – Alphenaan den Rijn – Netherlands. 3. Elements of Fracture Mechanics – Prasanth Kumar, wiley Eastern Publications 4. Fracture Mechanics: Fundamentals and applications – T. L. Andrason, PhD, CRC publications 5. Fracture Mechanics of Concrete: Applications of fracture mechanics to concrete, Rock, and other quasi-brittle materials, Surendra P. Shah, Stuart E. Swartz, Chengsheng Ouyang, John Wiley & Son publications. 6. Fracture mechanics of concrete structures – Theory and applications – Rilem Report – Edited by L. Elfgreen – Chapman and Hall – 1989. 7. Fracture mechanics – applications to concrete – Edite
16	Repair & Rehabilitation of Concrete Structures
	REHABILITATION AND RETRO FITTING OF STRUCTURES **UNIT – I** **General:** Quality assurance for concrete construction, As built concrete properties, strength, permeability, volume changes, thermal properties, cracking. **UNIT – II** **Influence on serviceability and Durability:-** Effects due to climate, temperature, chemicals, wear and erosion, design and construction errors, corrosion mechanism, Effects of cover thickness and cracking methods of corrosion protection, inhibitors, resistant steels, coatings cathode protection. **UNIT – III**

	Maintenance and Repair Strategies:- Inspection, Structural Appraisal, Economic appraisal, components of quality assurance, conceptual bases for quality assurance schemes. **UNIT – IV** **Materials for Repair-1: -** Special concretes and mortar, concrete chemicals, special elements for accelerated strength gain, Expansive cement. Polymer concrete, sulphur infiltrated concrete, ferro-cement, Fibre reinforced concrete, Slurry Infiltrated Fibrous Concrete **UNIT – V** **Techniques for Repair-** Rust eliminators and polymers coating for re-bars during repair, foamed concrete, mortar and dry pack, vacuum concrete - Gunite and shotcrete - Epoxy injection, Mortar repair for cracks, shoring and underpinning. Examples of repairs to structures:- Repairs to overcome low member strength, Deflection, cracking, chemical disruption, weathering, wear, fire, leakage, marine exposure. Syllabi for Pre-Ph.D/Civil (2009-2010) **References:** 1. Dension Campbell, Allen and Harold Roper, Concrete Structures, Materials, Maintenance and Repair, Longman Scientific and Technical, U.K, 1991. 2 Repair of concrete Structures, . RT. Allen and S.C. Edwards, Blakie and sons, UK, 1987. 3. Concrete Technology – Theory and practice, MS. Shetty S.Chand and company, New Delhi, 1992. 4. Training course notes on damage assessment and Repair in low cost housing Santhakumar, S.R. RHDC-NBO Anna University, Madras, July, 1992. 5. Raikar, R.N. learning from failures – deficiencies in Design, construction and service– R & D centre (SDCPL), Raikar Bhavan, Bombay, 1987. 6. Estate Management, N. Palaniappan, Anna Institute of Management, Madras Sep. 1992. 7. Structural Assessment, F.K. Garas, J.L. Clarke, GST Armer Butterworths, UK April 1987. 8. Concrete chemicals – Theory and applications, A.R. Santhakumar, Indian society for construction Engineering and Technology, Madras. 1993 (In press)
17	Computational And Statistical Methods
	COMPUTATIONAL AND STATISTICAL METHODS **Unit I** Numerical Solution of Ordinary: Differential Equations – Solution by Taylor's Series – Euler's Method- Runge Kutta Methods – Simultaneous and Higher Order Equations – Boundary Value Problems – Applications. **Unit II** Partial differential equations: Variable Separable Method – Wave, Heat and Laplace Equation (Two dimensions only) **Unit III** Regression Analysis – Simple Linear Regression, Evaluation of Regression – Confidence Intervals and Tests of Hypotheses – Multiple Linear Regression – Correlation and Regression Analysis. **Unit IV** Finite Difference Method : Construction of finite difference approximations – Taylor series, Forward, Backward and central difference approximations, Finite difference approximations of boundary value and initial value problems, One dimensional and two dimensional problems, Explicit, Implicit, and Crank – Nicolson Schemes, Convergence and stability, Alternating Direction Implicit (ADI) method for two space dimensions, simple examples. **Unit V** Finite Element Method: General Principles, types of elements, interpolation functions, Development of basis functions for one-dimensional and two dimensional elements, Linear interpolation, local co-ordinate system, variational formulation, Galerkin formulation, development of element matrices. Posting into Global locations, treatment of initial and boundary conditions, solution of Linear algebraic equations, simple examples.

	TEXT BOOKS: 1. Advanced Engineering Mathematics by B.S. Grewal 2 .Engineering Mathematics by Jaggi & Mathur 3. Calculus by Shantinarayan 4. GLEN. E. MYERS – Analytical Methods in Conduction Heat Transfer Mc Graw Hill, New York (1977) 5.REMSON. I. G.M. HORNBERGER AND F.J. MOLIZ – Numerical Methods in Subsurface Hydrology. 6. PINDER G.F. and GRAY – Finite Element Simulation in Sub Surface Hydrology, Academic Press, New York (1971).
18	Neuro-Fuzzy Techniques And Computer Programming
	NEURO-FUZZY TECHNIQUES AND COMPUTER PROGRAMMING **Unit I** Introduction: Basic concepts of Neural Networks and Fuzzy Logic, Differences between conventional computing and Neuro-Fuzzy computing, Characteristics of Neuro-Fuzzy computing. Fuzzy Set Theory: Basic definitions and terminology and membership functions – formulation and parameters, basic operations of fuzzy sets – complement, intersection, vision, T-norm and T-conorm **Unit II** Fuzzy Reasoning and Fuzzy Inference: Fuzzy relations, Fuzzy rules, Fuzzy reasoning, Fuzzy Inference Systems, Fuzzy modelling, Applications of Fuzzy reasoning and modelling in Water Resources Engineering Problems. **Unit III** Fundamental concepts of Artificial Neural Networks: Model of a neuron, activation functions, neural processing, Network architectures, learning methods. Neural Network Models: Feed forward Neural Networks, Back propagation algorithm, Applications of Feed forward networks, Recurrent networks, Hopfield networks, Hebbian learning, Self organising networks, Unsupervised learning, competitive learning. **Neuro-Fuzzy Techniques:** Hydrologic Modelling Time Series Analysis and Modelling, Remote Sensing , Environmental Modelling and Water Management, **Unit IV** Introduction to C and important Concepts. Beginning with C ++ : What is C ++., Applications of C ++, A S imple C ++ programme, More C ++ Statement, An Example with Class, Structure of C++ Program, Creating the Source File, Compiling and Linking. **Unit V** Tokens, Expressions and Control Structures in C ++ : Introduction, Tokens, Keywords, Identifiers, Basic Data Types, User-Defined Data Types, Symbolic Constants. Type Compatibility, Declaration of Variables, Dynamic Initialization of Variables, Reference Variables, Operators in C++ , Scope Resolution Operator, Member Dereferencing Operators, Memory Management Operators, Manipulators, Type Cast Operator, Expressions and Implicit Conversions, Operator Overloading, Operator Precedence, Control Structures **TEXT BOOKS:** 1. Jang, JSR, C.T. Sun and E. Mizutan (1997), "Neuro-Fuzzy and Soft Computing", Prentice Hall, NJ 2. Simon Haykin, (1994), "Neural Networks, A Comprehensive Foundation", Mc Millan College Publishing Company 3. Kosko, B. (1997), "Neural Networks and Fuzzy Systems", Prentice Hall of India Pvt. Ltd. , New Delhi. 4. Klir, George J., T.A. Forger, (1995), "Fuzzy Sets, Uncertainty and Information", Prentice Hall of

	India, Pvt. Ltd., New Delhi. 5. Rao V and H. Rao , (1996), "C++ Neural Networks and Fuzzy Logic, BPB Publications, New Delhi.
19	**Solid & Hazardous Waste Management**
	SOLID & HAZARDOUS WASTE MANAGEMENT **Unit I Solid Waste Collection, Segregation and Transport:** Definition of solid wastes – types of solid wastes – Sources - Industrial, mining, agricultural and domestic – Characteristics. Solid waste Problems - impact on environmental health – Concepts of waste reduction, recycling and reuse. Handling and segregation of wastes at source. Collection and storage of municipal solid wastes; Analysis of Collection systems. Transfer stations. **Unit II Municipal Solid Waste Management:** Solid waste processing technologies. Mechanical and thermal volume reduction. Biological and chemical techniques for energy and other resource recovery: composting, vermi-composting, termi-gradation, fermentation. Incineration of solid wastes. Disposal in landfills: site selection, design, and operation of sanitary landfills; Leachate and landfill gas management; landfill closure and post-closure environmental monitoring; landfill remediation. Regulatory aspects of municipal solid waste management. **Unit III Hazardous Wastes:** Hazardous waste definition. Physical and biological routes of transport of hazardous substances – sources and characterization categories and control. Sampling and analysis of hazardous wastes – analytical approach for hazardous waste characterization – proximate analysis – survey analysis – directed analysis – analytical methods. **Unit IV Hazardous Wastes Management:** Sources and characteristics: handling, collection, storage and transport, TSDF concept. Hazardous Waste treatment technologies - Physical, chemical and thermal treatment of hazardous waste: solidification, chemical fixation, encapsulation, pyrolysis and incineration. Hazardous waste landfills - Site selections, design and operation. Hazardous waste reduction and Recycling - Regulatory aspects of HWM. **Unit V Biomedical, Radioactive and e-Waste Management:** Biomedical waste: Definition, sources, classification, collection, segregation Treatment and disposal. Radioactive waste: Definition, Sources, Low level and high level radioactive wastes and their management, Radiation standard by ICRP and AERB. Waste characteristics, generation, collection, transport and disposal. **Books:** Hazardous waste management by Prof. Y. Anjaneyulu. Hazardous waste management Charles A. Wentz. Second edition 1995. McGraw Hill International. Integrated solid waste management, George Tchobanoglous, Hilary Theisen & Sammuel A. Vigil. Criteria for hazardous waste landfills – CPCB guidelines 2000. Environmental Science by Daniel B. Botkin and Edward A. Keller, Wiley student, 6th edition-2009.
20	**Physico-Chemical Process For Water And Wastewater Treatment**
	PHYSICO-CHEMICAL PROCESS FOR WATER AND WASTEWATER TREATMENT UNIT-I 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. UNIT-II Mixing, Clarification - Sedimentation; Types; Aeration and gas transfer – Coagulation and flocculation, coagulation processes - stability of colloids - destabilization of colloidstransport of colloidal particles, Clariflocculation. UNIT-III

	Filtration - theory of granular media filtration; Classification of of filters; slow sand filter and rapid sand filter; mechanism of filtration; modes of operation and operational problems; negative head and air binding; dual and multimedia filtration. UNIT-IV Adsorption, adsorption equilibria- adsorption isotherms, Disinfection - chlorine dioxide; chloramines; ozonation; UV radiation. UNIT-V Ion Exchange-processes, Application Membrane Processes, Reverse osmosis, Ultrafiltration, Electrodyalisis. **REFERENCE BOOKS** 1. Weber, W.J. *Physicochemical processes for water quality control*, John Wiley and sons, Newyork, 1983. 2. Peavy, H.S., Rowe, D.R., Tchobanoglous, G. *Environmental Engineering*, McGraw Hills, New York 1985. 3. Metcalf and Eddy, *Wastewater engineering, Treatment and Reuse*, Tata McGraw-Hill, New Delhi, 2003.