SCHEME FOR M.TECH. CIVIL (STRUCTURAL ENGINEERING) P G DEGREE COURSE

SEMESTER -I

S.No.	Course No.	Subject	Examination Schedule				Teaching Schedule				Time of Exams(Hrs.)
			L	T	P/D	Total	Theory	Sessional	Practical	Total	
1	MCS-101	Advanced Structural Analysis	3	1	-	4	60	40	-	100	3
2	MCS-102	Advanced R.C.C. Design	3	1	-	4	60	40	-	100	3
3	MCS-103	Structural Dynamics	3	1	-	4	60	40	-	100	3
4		**Departmental Elective-I**	3	1	-	4	60	40	-	100	3
5	MCS-104	Advanced Material Testing Lab	-	-	4	4	-	40	60	100	3
		Total	12	4	4	20	240	200	60	500	

SEMESTER- II

S.No.	Course No.	Subject	Examination Schedule				Teaching Schedule				Time of Exams(Hrs.)
			L	T	P/D	Total	Theory	Sessional	Practical	Total	
1	MCS-201	Design of Bridges	3	1	-	4	60	40	-	100	3
2	MCS-202	Advanced Design of Steel Structures	3	1	-	4	60	40	-	100	3
3	MCS-203	Finite Element Method in Structural Engineering	3	1	-	4	60	40	-	100	3
4		**Departmental Elective-II**	3	1	-	4	60	40	-	100	3
5	MCS-204	Computational Lab for Structural Engineering	-	-	4	4	-	40	60	100	3
		Total	12	4	4	20	240	200	60	500	

SEMESTER -III

S.No.	Course No.	Subject	Examination Schedule				Teaching Schedule				Time of Exams(Hrs.)
			L	T	P/D	Total	Theory	Sessional	Practical	Total	
1	MCS-301	Earthquake Analysis and Design of Structures	3	1	-	4	60	40	-	100	3
2		**Departmental Elective-III**	3	1	-	4	60	40	-	100	3
3	MCS-302	Seminar	-	-	1	1		100	-	100	1
4		Dissertation /Project starts									
		Total	6	2	1	9	120	180		300	

SEMESTER -IV

1	Dissertation/Project Evaluation & Viva Voce

DISSERATION GRADE

A > 85%
B = 76% - 85%
C = 61% - 75%
D = 50% - 60%

* **List of Electives for M. Tech. Civil (STRUCTURAL ENGINEERING)**

1.	MCS-401	Design of Pre-stressed concrete structures
2.	MCS-402	Reliability Analysis and Design of Structures
3.	MCS-403	Composite Materials
4.	MCS-404	High Rise Buildings
5.	MCS-405	Rehabilitation of Structures
6.	MCS-406	Advanced Numerical Analysis
7.	MCS-407	Stability Theory in Structural Engineering
8.	MCS-408	Expert Systems, Neural Networks and Fuzzy Systems
9.	MCS-409	Construction and Maintenance Management

* The candidates will opt for one of these electives in I, II, III semesters so as not to opt for the elective paper more than once.

MCS-101 **Advanced Structural Analysis**

L	T	P/D	Total
3	1	-	4

Max. Marks: 100
Theory: 60
Sessional: 40
Duration: 3 Hours

1. **Stiffness Method (Systems Approach):** Basis of stiffness method, Degrees of freedom, Force-displacement relationships, Nodal stiffness.

2. **Flexibility Method (Systems Approach):** Flexibility coefficients, Basis of the method, Application to various types of structures.

3. **Introduction to Element Approach:** Member stiffness matrix, Local or Member co-ordinate system, Global or Structural co-ordinate system, Rotation of axes etc, Structure stiffness matrix.

4. **Structural Stability Analysis:** Elastic Instability, Introduction to stability problem, Energy methods, buckling of axially loaded members for different end conditions, Concept of effective length, approximate techniques, Stability analysis of beam-column and frames.

5. **Plastic Analysis:** Concept of Limit load analysis, Upper and lower bonds, Plastic analysis of beams and multi-storey frames using mechanism method.

6. **Non Linear Analysis:** Introduction to geometric and material non-linearity.

Books recommended:

1. Przemieniecki, J.S., 'Theory of Matrix Structure Analysis', Tata McGraw Hill Book Co.
2. Martin, H.C. ' Introduction to Matrix Methods of Structural Analysis' McGraw Hill Book Co.
3. Meghre & Deshmukh, 'Matrix Methods of Structural Analysis' Charotar Publishing House, Anand.
4. Pandit & Gupta, Matrix Analysis of Structures, Tata McGraw Hill Publications (2003). Iyengar, N.G.R., Elastic Stability of Structural Elements, Macmillan India Ltd (1980).
5. Gere, G. M. and Weaver, Jr. W., Matrix Analysis of Framed Structures, CBS Publishers (1987).
6. McCormac, J. C. & Nelson, J. K., Structural Analysis: A Classical and Matrix Approach, John Wiley and Sons (1997).

MCS-102

Advanced R.C.C. Design

L	T	P/D	Total
3	1	-	4

Max. Marks: 100
Theory: 60
Sessional: 40
Duration: 3 Hours

1. **Yield Line Theory:** Assumptions, location of yield lines, methods of analysis, analysis of one way and two way slabs.
2. **Flat slab:** Limitations of Direct Design Method, shear in flat slabs, equivalent frame method, opening in flat slabs.
3. **Redistribution of moments in beam:** conditions for moment redistribution, single span beams, multi-span beams and design of sections.
4. **Deep Beam:** minimum thickness, design by IS-456. Design as per British and American practice, beam with holes.
5. **Shear walls:** classification of shear wall, classification according to behavior and design of rectangular and flanged shear wall.
6. **Cast-in-situ Beam-column joint**, Force acting on joints, strength requirement of column, anchorage, confinement of core, shear strength of joint, corner joint and procedure for design.
7. **Computation of deflection and crack-width:** short term and long term deflection of beam and slab, calculation of deflection as per IS-456, Factors effecting crack width in beams, calculation of crack width in beams, calculation of crack width as per IS-456, shrinkage and thermal cracking.

Books recommended:

1. Varghese, P.C. (2001), 'Advanced Reinforced Concrete Design' , Prentice Hall of India, New Delhi.
2. Jain, A.K. (1999), 'Reinforced Concrete Limit State Design' Nem Chand & Bros, Roorkee.
3. Krishna Raju (1986), 'Advanced Reinforced Concrete Design', C.B.S. Publication , New Delhi.
4. Ferguson P.M., Breen J.E. and Jirsa J.O. (1988), 'Reinforced Concrete Fundamentals', Johan wiley & sons, New York.

MCS-103 **Structural Dynamics**

L T P/D Total
3 1 - 4

Max. Marks: 100
Theory: 60
Sessional: 40
Duration: 3 Hours

1. **Introduction:** Objective, difference between static and dynamic analysis, loading, essential characteristics of a dynamic problem, principles of dynamics, formulation of equation of motion.
2. **Single Degree Of Freedom System:** analysis for free and forced vibration, Duhamels integral, Damping – types and evaluation, Response of SDOF system to harmonic excitation, Periodic excitation, Impulsive loading, arbitrary, step, pulse excitation, Response to General Dynamic loading, Numerical evaluation of dynamic response-superposition and step by step methods, generalized SDOF system.
3. **Multi degree of freedom:** equation of motion, equation of structural property matrices, problem statement and solution methods, free vibration, forced harmonic vibration, damped motion for MDOF, Generalized co-ordinates, principle of orthogonality of modes, Eigenvalue problem, model response, approximate methods: Stodalla-Vanaello, Modified Reyleigh's method, Holzer's Method, Holzer Myklested method, Matrix method, Energy method, Lagrange's equation, model analysis, stochastic response of linier SDOF and MDOF system to Gaussian inputs.

Books recommended:

1. Clough and Penzien, 'Dynamics of Structures' McGraw Hill Book co.
2. Chopra, A.K., Dynamics of Structures', Theory and Application to Earthquake Engineering', Prentice Hall of India, New Delhi. 1995.
3. Glen V. Berg, 'Element of Structural Dynamic', Prentice Hall, Engewood Cliffs, NJ.
4. Grover L. Rogers, 'Dynamics of Framed Structures', John Wiley and Sons Inc., New York.

MCS-104

Advanced Material Testing Lab

L	T	P/D	Total
-	-	4	4

Max. Marks: 100
Practical 60
Sessional: 40
Duration: 3 Hours

List of experiments/assignments

1. Concrete Mix Design as per IS-10262 for various grades of concrete mixes.
2. Special concretes.
3. Durability studies on concrete.
4. Effect of super plasticizer on properties of concrete in fresh and hardened stages.
5. Measurement of air content of concrete.
6. Fineness of cement by Air Permeability method.
7. Non Destructive Testing of Concrete.
8. To determine the modulus of elasticity of concrete.
9. Effect of replacement of fly ash on properties of concrete.
10. Testing of structural steel reinforcement and steel sections.

MCS-201

Design of Bridges

L	T	P/D	Total
3	1	-	4

Max. Marks: 100
Theory: 60
Sessional: 40
Duration: 3 Hours

1. **Types of bridges super structure:** introduction and types, temporary bridge superstructures, military bridges, other temporary bridges, permanent bridges, R.C.C. bridges, Pre-stressed concrete bridges, steel bridges, movable steel bridges.
2. **Consideration of loads and stress in road bridges:** introduction, loads, forces and stresses, dead loads, bridge loading as per relevant IRC and IRS specifications, traffic lanes, foot way, kerb, railing and parapet loading, impact, wind load, longitudinal forces, Temperature effects, secondary stresses, erection stresses, earth pressure, effect of live load on backfill and on the abutment.
3. **Design OF R.C. Bridges:** Slab culvert, box culvert, pipe culvert, T-beam bridge superstructure, design examples, brief introduction to rigid frame, arch and bow string girder bridges.
4. **Design of prestressed concrete bridges:** Pre-tensioned and Post tensioned concrete bridges, analysis and design of multi lane pre stressed concrete T-beam bridge superstructure.
5. **Pier, Abutment and wing walls:** Introduction, types of piers, design of piers, forces On piers, stability, abutments, bridge code provisions for abutments, wing walls, design examples.
6. **Bearings:** Introduction, function of bearings, bearings for steel bridges and concrete bridges, bearings for continuous span bridges, I.R.C. provision for bearings, fixed bearings, expansion bearings, materials and specifications, permissible stresses in bearings, design consideration for rocker and roller-cum-rocker bearings, sliding bearings.

7. **Foundations:** Types of foundations and general design criteria, design of well and
Pile foundations for piers and abutments.

Books recommended:

1 Victor, D.J., 'Essential of bridge Engineering' Oxford & IBH Pub.Co
2 Rower, R.E., 'Concrete bridge Design' C.R. Books Ltd., London.
3 Krishna Raju, N., 'Design of bridges' Oxford & IBH Pub. Co., New Delhi.
4 Krishna Raju, N. 'Prestressed Concrete' Tata McGraw Hill, New Delhi.
5 Bakht, B and Jaeger, L.C., 'Bridge Analysis Simplified' McGraw Hill Int. Ed., New Delhi.

MCS-202 **Advanced Design of Steel Structures**

L	T	P/D	Total
3	1	-	4

Max. Marks: 100
Theory: 60
Sessional: 40
Duration: 3 Hours

1. **Introduction to Limit States:** Introduction, standardization, allowable stress design limit state design, partial safety factors, concept of section classification: Plastic, compact, semi-compact & slender.
2. **Columns:** Basic concepts, strength curve for an ideal strut, strength of column member in practice, effect of eccentricity of applied loading, effect of residual stresses, concept of effective lengths, no sway & sway columns, torsional and torsional flexural buckling of column, Robertson design curve, modification to Robertson approach, design of column using Robertson approach.
3. **Laterally restrained beams:** Flexural& shear behavior, web buckling & web crippling, effect of local buckling in laterally restrained plastic or compact beam combined bending & shear, unsymmetrical bending.
4. **Unrestrained beam:** Similarity of column buckling & lateral buckling of beams lateral torsional buckling of symmetric section, factor affecting lateral stability, buckling of real beam, design of cantilever beams, continuous beam.
5. **Beam columns:** Short & long beam column, effect of slenderness ratio and axial force on modes of failure, beam column under biaxial bending, strength of beam column, local section failure & overall member failure.
6. **Beam subjected to torsion and bending:** Introduction, pure torsion and warping, combined bending and torsion, capacity check, buckling check, design method for lateral torsional buckling.
7. **Connection design:** Complexities of steel connections, type of connection, connection design philosophies, welded and bolted connection: truss connection, portal frame connection, beam& column splices, beam to beam and beam to column connections.

Books recommended:

1 Teaching resource for Structural Steel Design Vol. 1 to 3, Institute for steel development & growth (INSDAG), Calcutta.
2 Morsis L.J., Plum, D.R "Structural Steel Work Design".
3 Yu,W.W.,"Cold Formed Steel Structures Design".
4 Arya A.S. and Ajmani, J.L., "Design of Steel Structures".
5 Sihna D.A. "Design of Steel Structures".

MCS-203 Finite Element Method in Structural Engineering

L	T	P/D	Total
3	1	-	4

Max. Marks: 100
Theory: 60
Sessional: 40
Duration: 3 Hours

Introduction to Finite Elements: Introduction, Direct formulation of finite element characteristics, Energy approach, Convergence criteria, Displacement functions with discontinuity between elements, Solution bounds, Extension of variational approach.

Plane Stress and Plane Strain: Introduction, Element characteristics, Assessment of accuracy, Some practical applications.

Axis-Symmetric Stress Analysis: Introduction, Element characteristics, Practical applications, Non-symmetrical loading.

Some Improved Elements in 2–D Problems: Introduction, Quadrilateral element, Characteristics derived from triangular elements, Conforming shape functions for a rectangle, Conforming shape functions for an arbitrary quadrilateral, Triangular element with size nodes.

Nodes Dimensional Stress Analysis: Introduction, Tetrahedral element characteristics, Composite elements with eight nodes, Improved displacement functions an element with eight arbitrary nodes, Tetrahedral element with ten nodes, Introduction to rectangular elements, Quadrilateral elements, Conforming functions for quadrilateral elements, Plate-bending elements, Introduction to non-linear Analysis-Material non-linearity and Performance non-linearity.

Books recommended:

1. Bhavikati S. S., "Finite Element Analysis" New Age International Publishers, New Delhi (2005)
2. Desai C. S. and Abel J. F.; Introduction To The Finite Element Method : A Numerical Method For Engineering Analysis, CBS Publisher (2005)
3. O.C. Zienkiewicz & R.L. Taylor, "The Finite element method", Butterworth Heinemann (Vol I and Vol II), (2000).
4. J. N. Reddy, An introduction to the finite element method, McGraw Hill Inc. (1993).
5. C.S. Krishnamoorthy, "Finite Element Analysis, Theory and programming", Tata McGraw Hill, (1994).

MCS-204 **Computational Lab for Structural Engineering**

L	T	P/D	Total
-	-	4	4

Max. Marks: 100
Practical 60
Sessional: 40
Duration: 3 Hours

1. Analysis and design of Multi-storey building frames using STAAD. Pro., SAP, Ansys
2. Analysis and design of Elevated Water Tank using STAAD.Pro., SAP, Ansys
3. Analysis and design of bridge decks and other structures using STAAD.Pro., SAP, Ansys
4. Analysis and design of steel trusses using STAAD-Pro., SAP, Ansys
5. Dynamic response of structures using PULSE software.

Books recommended:

1. Software related manuals.

MCS-301 Earthquake Analysis and Design of Structures

L	T	P/D	Total
3	1	-	4

Max. Marks: 100
Theory: 60
Sessional: 40
Duration: 3 Hours

1. **Engineering Seismology:** Basic terms, seismic waves, earthquake magnitude and intensity, ground motion, dynamic response of structures, normalized response spectra, seismic coefficients and seismic zone coefficients.
2. **Torsion and Rigidity:** Rigid diaphragms, torsional moment, centre of mass and centre of rigidity, torsional effects.
3. **Lateral Analysis of Building Systems:** Lateral load distribution with rigid floor diaphragms, moment resisting frames, shear walls, lateral stiffness of shear walls, shear-wall frame combination, Examples.
4. **Concept of Earthquake Resistant Design:** Objectives of seismic design, ductility, hysteric response & energy dissipation, response modification factor, design spectrum, capacity design, classification of structural system, IS codal provisions for seismic design of structures, multistoreyed buildings, design criteria, P-Δ effects, storey drift, design examples, ductile detailing of RCC structures.
5. **Seismic Design of Special Structures:** Elevated liquid storage tanks, hydrodynamic pressure in tanks, stack like structures; IS-1893 codal provisions for bridges: Superstructure, sub-structure, submersible bridges.
6. **Seismic Strengthening of Existing Buildings:** Seismic strengthening procedures.
7. **Seismic Design of Brick Masonry Construction:** Shear walls and cross walls, opening in bearing walls, brick infills in Framed buildings, strengthening arrangements as per IS-4326, Design of bands.

Books recommended:

1. Chopra A.K., 'Dynamics of Structures- Theory & Applications to Earthquake Engineering' Prentice Hall, India.
2. Clough & Penzien, 'Dynamic of Structures' McGraw Hill Co.
3. Paz, M., 'International Handbook of Earthquake Engineering', Chapman & Hall, Newyork.
4. IS 1893-1984 Indian Standard Criteria for Earthquake Resistant Design of Structures, B.I.S., New Delhi.
5. IS 4326-1993 Indian Standard Code of Practice for Earthquake Resistant Design and Construction of Buildings, B.I.S., New Delhi.

MCS-401 **Design of Pre-stressed Concrete Structures**

L	T	P/D	Total
3	1	-	4

Max. Marks: 100
Theory: 60
Sessional: 40
Duration: 3 Hours

1. **Prestressing System and Losses of Prestress:** Introduction, various systems of prestressing, types of losses and their analysis.

2. **Working Stress Design of Simple Beams:** Critical load conditions; allowable stresses; Flexural design criteria; axially prestressed members; design of prestressing cable for a given cross-section; design procedure based on flexure, design by load balancing method and multiple stage prestressing.

3. **Continuous Beams:** Analysis of two span beam, analysis of two span beam with eccentricities at outer supports; continuous beams with variable section; design of continuous beam.

4. **Limit State Design of Beams:** Limit state of strength in flexure, shear and torsion; permissible stresses, Limit state of serviceability against deflection, cracking and durability; Design of simply supported and continuous beams.
   Limit State Design of partially pre-stressed Beams, Moment Capacity of rectangular and flanged section; design for shear and serviceability.

5. **Bond and Anchorage of prestressing cables:** bond in pre-tensioned and post-tensioned construction, prestressing cable at centroidal axis; symmetric multiple cables causing axial thrust; cable eccentricity; inclined prestressing cable, spalling stresses, end zone reinforcement.

Books recommended:

1. N. Krishna Raju, Prestressed Concrete, Tata-McGraw Hill, Delhi.
2. P. Dayaratram, prestressed Concrete Structures, Oxford & IBH Co., Delhi.
3. Jain & Jai Krishna, Plain & Reinforced Concrete, Vol-II, Nem Chand & Co., Roorkee.
4. IS 1343-1980 code of Practice for Prestressed Concrete, Bureau of standards, New Delhi.

MCS-402 **Reliability Analysis and Design of Structures**

L	T	P/D	Total
3	1	-	4

Max. Marks: 100
Theory: 60
Sessional: 40
Duration: 3 Hours

1. **Probability Theory :** Mutually exclusive events , set theory, sample points and sample spaces, laws of probability, total probability theorem, Baye's rule, random variables-discrete and continuous, jointly distributed discrete variables, marginal distribution, condition distribution, jointly distributed continuous variables, functions of random variables, moments and expectations, common probability distribution-normal, lognormal, gamma and beta distributions, external distributions.

2. **Resistance Distribution and Parameters:** Statistics of properties of concrete and steel, statistics of strength of bricks and mortar, characterization of variables, allowable stresses based on specified reliability.

3. **Probabilistic Analysis of Loads:** Loads as a stochastic process, dead load, stastical analysis of live loads-maximum sustained load intensity model, maximum total load model, wind load-probability model for wind load.

4. **Structural Reliability:** General expression for reliability, expression for probility of failure, reliability when strength(S) and load (L) follow normal distribution, lognormal distribution, exponential distribution, extreme value distributions, F.O.S corresponding to a given reliability

5. **Monte Carlo Study of Reliability:** Monte Carlo Method-Inverse transformation technique, Application to columns, beams and frames.

6. **Level 2 Reliability Methods:** Basic variables and failure surface, first-order second moment methods-Hasofer and Lind's method, non-normal disributions, determinnation of reliability index beta of structural elements.

7. **Reliability Based Design:** Determination of partial safety factors, safety checking formats, development of reliability based criteria, optimal safety factors, calibration of IS456 and IS800.

8. **Reliability of Structural System:** System reliability, modeling of srtuctural systems, bounds on system reliability, automatic generation of a mechanisms, reliability analysis of R.C.C and steel frames.

Books recommended:

1. Raganathan, R(1990), 'Reliability Analysis and Design of Structures' Tata McGraw Hill pub., New Delhi.
2. Rao, S.S. (1992), 'Reliability Based Design' McGraw Hill Co. New York
3. Ghosh, D.L(1989),'A Primer of Reliability Theory', John Wiley, New York
4. Lewis, E.E (1987),'Introduction to Reliability Engineering',John Wiley, New ,John Wiley, New York

MCS-403 **Composite Materials**

L	T	P/D	Total
3	1	-	4

Max. Marks: 100
Theory: 60
Sessional: 40
Duration: 3 Hours

1. Fibre Reinforced Concrete: Properties of Constituent Materials, Mix Proportions, Mixing and Casting Procedures, Properties of Freshly mixed FRC, Mechanics and properties of Fibre reinforced concrete, Composite Material approach, Application of fibre reinforced concrete.

2. Fly Ash Concrete: Classification of Indian Flyashes, Properties of Flyash, Reaction Mechanism, Proportioning of Flyash concretes, Properties of Flyash concrete in fresh and hardened state, Durability of flyash concrete.

3. Polymer Concrete: Terminology used in polymer concrete, Properties of constituent materials, Polymer impregnated concrete, Polymer modified concrete, Properties and applications of polymer concrete and polymer impregnated concrete.

4. Ferro Cement: Constituent materials and their properties, Mechanical properties of ferro cement, Construction techniques and application of ferro cement.

5. High Performance Concrete: Materials for high performance concrete, Supplementary cementing materials, Properties and durability of high performance concrete, Introduction to silica fume concrete, Properties and applications of silica fume concrete.

6. Sulphur Concrete And Sulphur Infiltrated Concrete: Process technology, Mechanical properties, Durability and applications of sulphur concrete, Sulphur infiltrated concrete, Infiltration techniques, Mechanical properties, Durability and applications of sulphur infiltrated concrete.

7. Light Weight Concrete: Properties of light weight concretes, Pumice concrete, Aerated cement mortars, No fines concrete, Design and applications of light weight concrete.

Books recommended:

1. Concrete Technology-A.M. Nevillie
2. Concrete Technology-M.L. Gambhir.

MCS-404 **High Rise Buildings**

L	T	P/D	Total
3	1	-	4

Max. Marks: 100
Theory: 60
Sessional: 40
Duration: 3 Hours

1. **Principles of Planning of Tall Buildings:** Technological Planning, Mechanical systems, Fire rating, local considerations, Structures elements, Types of structural systems for tall buildings, Shear Walls and their arrangement.
2. **Loads on Tall Buildings:** Gravity loads, Live loads, Wind loads and seismic loading, Code Provisions, Discussion of relevant codes of practices and loading standards.
3. **Analysis of Tall Buildings (With and Without Shear Walls):** Approximate analysis for gravity loads, Lateral loads, Analysis of tube-in-tube constructional and 3-Dimensional analysis of shear core buildings, Stability, Stiffness and fatigue, Factor of safety and load factor.
4. **Design of Tall Buildings:** Procedures of elastic design, Ultimate strength design and Limit state design of super structures including structural connections, soil structure interaction.

Books recommended:

1. Structural Analysis and design of Tall Buildings by Tara Nath Bungale
2. Advances in tall buildings by Beedle L.S.
3. Analysis of Shear walled buildings
4. Design of multistory reinforced concrete buildings for earthquake motion by J.A. Blume, N.M. Newmark.

MCS-405 **Rehabilitation of Structures**

L	T	P/D	Total
3	1	-	4

Max. Marks: 100
Theory: 60
Sessional: 40
Duration: 3 Hours

1. **Maintenance and repair strategies:** Maintenance, repair and rehabilitation, Facets of Maintenance, importance of Maintenance various aspects of Inspection, Assessment procedure for evaluating a damaged structure, causes of distress and deterioration of concrete- Evaluation of existing buildings through field investigations, Seismic evaluation of existing buildings
2. **Serviceability and durability of concrete:** Quality assurance for concrete construction concrete properties – strength, permeability, thermal properties and cracking. – Effects due to climate, temperature, chemicals, corrosion – design and construction errors – Effects of cover thickness and cracking.
3. **Materials and techniques for repair:** Special concretes and mortar, concrete chemicals, special elements for accelerated strength gain, Expansive cement, polymer concrete, sulphur infiltrated concrete, ferro cement, Fibre reinforced concrete. Rust eliminators and polymers coating for rebars during repair, foamed concrete, mortar and dry pack, vacuum concrete, Gunite and Shotcrete, Epoxy injection, Mortar repair for cracks, shoring and underpinning - Methods of corrosion protection, corrosion inhibitors, corrosion resistant steels, coating and cathodic protection.
4. **Repairs, rehabilitation and retrofitting of structures:** Repairs to overcome low member strength, Deflection, Cracking, Chemical disruption, weathering corrosion, wear, fire, leakage and marine exposure - Special techniques for structural Retrofitting (Bracing, Shear walls, Base isolation etc).
5. **Demolition techniques:** Engineered demolition techniques for Dilapidated structures – case studies - Case Studies on Restoration of fire damaged buildings, Case study on repairs and strengthening corrosion damaged buildings; Case study on use of composite fibre wraps for strengthening of building components.

Books recommended:

1. Denison Campbell, Allen and Harold Roper, Concrete Structures, Materials, Maintenance and Repair, Longman Scientific and Technical UK, (1991).
2. R.T. Allen and S.C. Edwards, Repair of Concrete structures, Blakie and Sons, UK, (1987)
3. M. S. Shetty, Concrete Technology – Theory and Practice, S. Chand and Company, New Delhi, (1992).
4. Santhakumar, A.R., Training Course notes on Damage Assessment and repairs in Low Cost Housing, "RHDC – NBO" Anna University, July (1992).
5. Raikar, R.., Learning from failures – Deficiencies in Design, Construction and Service – R & D centre (SDCPL), Raikar Bhavan, Bombay, (1987).
6. N. Palaniappan, Estate Management, Anna Institute of Management, Chennai, (1992).
7. Lakshmipathy, M. et al. Lecture notes of Workshop on Repairs and Rehabilitation of Structures, 29 -30th October 1999, (1999).

MCS-406 **Advanced Numerical Analysis**

L	T	P/D	Total
3	1	-	4

Max. Marks: 100
Theory: 60
Sessional: 40
Duration: 3 Hours

1. Introduction of Programming Language 'C'.
2. Error analysis, significant digits, inherent errors, numerical errors, absolute and relative error, error propagation, conditioning & stability.
3. Solution of linear simultaneous equation, direct and iterative algorithms based on Gauss elimination, Gauss Jordan method, Gauss Seidel method.
4. Numerical solution to non-linear system of equations, bisection method, false position method, Newton-Raphson method, Secant method, fixed point method.
5. Interpolation formulae, Polynomial forms, linear interpolation, Lagrange interpolation polynomial, Newton interpolation polynomial, forward and backward differences.
6. Numerical differentiation by forward difference quotient. Central difference quotient, Richardson extrapolation and numerical integration by Trapezoidal rule, Simpson's 1/3 rule, Romberg integration, Gaussian integration.
7. Numerical solution of ordinary differential equation by Taylor series method, Euler's method, Runge-kutta method, Picard's method, Heun's method, Polygon method.

Books recommended:

1. Terrence J.Akai, 'Numerical Methods', John Wiley & sons Inc,Singapore,1994.
2. S.S Shastry, 'Introductory Method of Numerical Analysis', PHI Pvt. Ltd.,1997.
3. H.C Saxena, 'Finite Differences and Numerical', S.Chand & CO.Delhi,2001.
4. Baron M.L & Salvadori M.G., 'Numerical Methods in Engineering', PHI Pvt. Ltd.,1963.
5. Curtis F.Gerald & Patricks.O.Wheately, 'Applied Numerical Analysis', 5th Ed.,Addison Wesley,1994.
6. Balagurusamy E., 'Numerical Methods', TMH Pub.CO.Ltd.,2001.

MCS-407 **Stability Theory in Structural Engineering**

L	T	P/D	Total
3	1	-	4

Max. Marks: 100
Theory: 60
Sessional: 40
Duration: 3 Hours

1. Plane Stress &Plane strain: Plane stress, plane strain, stress and strain at a point. Differential equations of equilibrium, constitutive relations: anisotropic materials, yield criterion, flow rule, boundary conditions, compatibility equation ,stress function.

2. Two-Dimensional problems in rectangular coordinates: Solutions by polynomials, Saint-Venant's Principle, determination of displacements, bending of beams, solution of two dimensional problem in Fourier series.

3 .Two-Dimensional problems in polar coordinates: general equations in polar coordinates, pure bending of curved bars, displacements for symmetrical stress distributions, bending of curved bar, distribution in plates with circular holes, stress in a circular disc, general solution.

4. Analysis of stress &strains in three Dimensions: Principal stress and strain, shearing stresses and strains ,elementary equations, compatibility conditions, problems of elasticity involving pure bending of prismatic bars.

5. Buckling of columns: Analysis of columns with various end conditions by differential equations ,initially curved members, eccentrically loaded column, secant formulae, p-delta effect, energy methods applied to buckling, stability of columns, beam columns, tie roads with lateral bending.

6.Torsion of Prismatic Bars: Torsion of prismatic bars, membrane analogy, torsion of a bar of narrow rectangular cross section, torsion of rectangular bars, solution of torsional problems, torsion of rolled sections, torsion of hallow shaft and thin tubes, torsional buckling, torsional-flexural buckling.

7. Buckling of frames: Triangular frames, rigid jointed frames-Analysis of beams columns, method of moment equations, geometrial approach, Multistoreyed-multibay frames.

Books recommended:

1. Timoshenko ,S.P.., Theory of Elasticity"
2. Timoshenko ,S;P, Theory of Elatsic Stability"
3. Lyenger N.G.R..; Structural Stability of Columns &Plates'

MCS-408 Expert Systems, Neural Networks and Fuzzy Systems

L	T	P/D	Total
3	1	-	4

Max. Marks: 100
Theory: 60
Sessional: 40
Duration: 3 Hours

1. Introduction to Expert System: Knowledge representation, Structure of an expert system, organization and representation of knowledge in an expert system, basic activities of an expert system, Expert system shells, development of a an expert system in civil engg.

2. Introduction to Artificial Neutral Network: Feed-forward and Feed-backward network, Neutral network learning rules.

3. Perceptrons and the LMS Algorithm: Rosen blatt's Perceptron, Definition, Linear seperability of training patterns, Perceptron learning Algorithms, Derivation of the Perceptron algorithm as Gradient Descent, The perceptron convergence Theorem, The Widrow-Holf LMS Algorithm,.

4. Multilayer Networks: Exact and approximate representation using Feed forward Networks, Fixed-Multilayer Feed forward network Training by Backpropagation.

5. Complexity of Learning Using Feed forward Network: Generalizability of learning, VC dimension and generalizabilty, Sufficent conditions for valid generalizability in Feef forward Networks, discussion and ways to improve generalizabilt , space complexity of feed forward networks, order of a function and the complexity of a network.

6. Recurrent Network: Symmetric networks and associative Memory, Bi-directional Associative Memory, Analog Hopfield networks, simulated Annealing in optimization.

7. Introduction to Fuzzy logic: Statistics and random Processes, Uncertainty in Information.

8. Classical Sets and Fuzzy Sets: Classical sets, operation on classical sets, properties of classical sets, Mapping of classical sets to functions, Fuzzy sets, fuzzy set operations, properties of Fuzzy sets, sets as points in Hypercubes.

9. Classical Relations and Fuzzy Relations: Cartesian product, crisp relations, Cardinality of crisp relations, properties of crisp relations, composition, fuzzy relations, Cardinality of fuzzy relations, operations on fuzzy relations, cardinality of fuzzy relations, operations on fuzzy relations, properties of fuzzy relations and equivalence relations, Value Assignments.

Books recommended:

1. Zurada, J.M. Introduction to Artificial Neural Network system, "Jaico publicating house.
2. Haykin,S, `ANN a comprehensive foundation' .Macmillan College Publishing company, New York.
3. Bose, N.K and Liang, P..`Neural Network Fundamentals with Graphs, Algorithms and Applications..`Tata McGraw Hill.
4. Ross, J. Timothy.` Fuzzy logic with engineering Applications. McGraw Hill.
5. Asai , k.` Fuzzy systems for information processing."IOS press.
6. Jackson, p. `Introduction to expert. Addison Wesley.
7. Clocksin and Mellish.`programming in prolog. Springer verlag

MCS-409

Construction and Maintenance Management

L	T	P/D	Total
3	1	-	4

Max. Marks: 100
Theory: 60
Sessional: 40
Duration: 3 Hours

1. Services in Residential, Commercial and Medical buildings

(A) Sanitation, water supply, electric wiring, rain water disposal, lighting & illumination, calculation methods for these services.

(B) Air Conditioning & Ventilation: Natural ventilation, control cooling systems, modern systems of air conditioning, ducting systems, different mechanical means of air conditioning.

(C) CCD-CS: General principles of transmission and passage of sound reverberation, absorption, reflection, acoustic materials and their coefficiency, principles of good acoustic design.

(D) Thermal Insulation: Behavior of various building materials & thermal conductivity. Thermal insulation for air conditioned interior spaces, working out air conditioning loads for different spaces.

(E) Fire Safety Dye.

2. Architectural controls and building byelaws: Role of building byelaws in a city, local byelaws and architectural controls, façade control and zoning plans.

3. Regional planning: Understanding of physical, social and economical parameters for regional planning.

4. **Landscaping:** Forces of man and nature, their relationship and effect on shaping landscape, site analysis, site and.