

SCIA5101	ADVANCED REINFORCED CONCRETE STRUCTURES	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVE

- To make the students be familiar with the limit state design of RCC beams.
- To design special structures, Shear walls, Bunkers, Silos and Earth quake Engineering.

UNIT 1 LIMIT STATE DESIGN OF BEAMS FOR FLEXURE**9 Hrs.**

Review of Basic Concepts - Behaviour and Design of Reinforced Concrete members considering flexure, Torsion, combined with flexure and flexural shear, deflection and crack width as per IS456.

UNIT 2 DESIGN OF SHEAR WALLS AND DEEP BEAMS**9 Hrs.**

Shear walls – Types of shear walls – Design of shear walls. Simply Supported and Continuous Deep beams.

UNIT 3 DESIGN OF SPECIAL RCC MEMBERS**9 Hrs.**

Flat slabs, Flat plates, Grid floor and Corbel.

UNIT 4 BUNKERS AND SILOS**9 Hrs.**

Introduction to Limit state design of Bunkers and Silos - Rectangular and Circular types.

UNIT 5 DESIGN OF EARTHQUAKE ENGINEERING**9 Hrs.**

Response of RCC buildings to seismic loads – Ductility and its importance – Rehabilitation of existing buildings.

Max. 45 Hrs.**TEXT / REFERENCE BOOKS**

1. Ashok. K. Jain, "Reinforced concrete – Limit state design", Nemchand & Bros, Roorkee, 1983.
2. Park and Pauley. T. "Reinforced concrete structures", John Wiley & Sons, Newyork, 1975.
3. Varghese, P.C. "Limit State Design of Reinforced Concrete", Prentice Hall of India Ltd, New Delhi, 2007.
4. Varghese, P.C, "Advanced Reinforced Concrete Design", Prentice Hall of India, 2005.
5. IS 456 -2000 – Code of practice for plain and reinforced concrete.
6. SP 16 (1980) - Design Aids for Reinforced concrete.
7. SP 34(1987) – Hand book on Concrete reinforcement and Detailing.
8. IS 1893:2002 – Indian Standard criteria for earthquake resistant design of structures.
9. IS 13920:1993 Code of practice for ductile detailing of reinforced concrete structures subjected to seismic forces.
10. IS 4326:1993 – Code of practice for earthquake resistant design and construction of buildings.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN**Max. Marks: 100****Exam Duration: 3 Hrs.****PART A:** 5 Questions of 6 Marks each – No choice**30 Marks****PART B:** 2 Questions from each unit of internal choice, each carrying 14 Marks**70 Marks**

SCIA5104	EXPERIMENTAL STRESS ANALYSIS AND TECHNIQUES	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVE

- To learn the principles of measurements of static and dynamic response of structures and carryout the analysis of results.

UNIT 1 STRAIN MEASUREMENT**9 Hrs.**

Methods of Measurement -Calibration-Load calibration of testing machines-I.S. Code provisions - Measurement system - Strain measurement - Strain gauges - Principle, Types, Performance, Uses - Strain Rosettes- Wheatstone Bridge- Photo elasticity- Principle, Application-Moire fringe- Electronic load cells-Proving rings.

UNIT 2 MEASUREMENT OF VIBRATION AND WIND FLOW**9 Hrs.**

Measurement of Vibration- Vibration Galvanometers- Vibrometer-Characteristics of Structural vibration- Pressure gauges- Velocity transducers- Seismic transducers – Linear Variable Differential Transformer- Cathode ray oscilloscope – X Y Plotter- Wind Tunnels-Flow meters- Venturimeter- Digital Data Acquisition systems.

UNIT 3 DISTRESS MEASUREMENT AND CONTROL**9 Hrs.**

Diagnosis of distress in structures-Cracks in structures-Formation of cracks- Types of cracks-Causes of cracks- Crack measurement- Monitoring and measurement of crack movement- Corrosion of reinforcement in RCC- Half cell-Construction and use-Damage assessment-Controlled blasting for demolition.

UNIT 4 N.D.T.METHODS**9 Hrs.**

Load testing on structures-In situ load testing-Ultimate load testing-Rebound hammer-Principle and Applications-Limitations- Ultrasonic testing- Principles and Applications- Brittle coating- Principle and Applications- Stress coat- All Temp- Comparison of brittle coatings- Evaluation of the coating.

UNIT 5 MODEL ANALYSIS**9 Hrs.**

Model laws- Laws of similitude-Model materials- Model testing- Necessity for Model analysis-Advantages- Applications- Types of similitude- Scale effect in Models- Indirect model study- Direct model study- Limitations of model investigations- Structural problems that may demand model studies- Usage of influence lines in model studies.

Max. 45 Hrs.**TEXT / REFERENCE BOOKS**

1. Dally J.W. and Riley W.F., "Experimental stress Analysis", McGraw Hill, Inc. New York, 1991.
2. Srinath L.S. et al, "Experimental Stress Analysis", Tata McGraw Hill Publishing Co. Ltd., New Delhi, 1984.
3. Rangan C.S., "Instrumentation – Devices and Systems", Tata McGraw Hill Publishing Co. Ltd., New Delhi, 1983.
4. Sadhu Singh, "Experimental Stress Analysis", Khanna Publishers, New Delhi, 1996.
5. Sirohi R.S., Radhakrishna H.C., "Mechanical Measurements", New Age International Pvt. Ltd., 1997.
6. Bray D.E. and Stanley R.K., "Course Material on Non-destructive Evaluation", McGraw Hill Publishing Company, New York, 1989.
7. Ravisankar K. and Chellappan A., "Advanced course on Non-Destructive Testing and Evaluation of Concrete Structures", SERC, Chennai, 2007.
8. Ganesan T.P., "Model Analysis of Structures", University Press, India, 2000.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN**Max. Marks: 100****Exam Duration: 3 Hrs.****PART A:** 5 Questions of 6 Marks each – No choice**30 Marks****PART B:** 2 Questions from each unit of internal choice, each carrying 14 Marks**70 Marks**

SCIA5201	FINITE ELEMENT ANALYSIS	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVE

- To study the basics of the Finite Element Technique, a numerical tool for the solution of different classes of problems.

UNIT 1 INTRODUCTION**9 Hrs.**

Boundary Value Problems – Approximate Solutions – Variational and Weighed Residual Methods – Ritz and Galerkin Formulations – Concept of Piecewise Approximation and Finite Element – Displacement and Shape Functions –Weak Formulation – Minimum Potential Energy – Generation of Stiffness Matrix and Load Vector.

UNIT 2 STRESS ANALYSIS**9 Hrs.**

Two Dimensional problems – Plane Stress, Plane Strain and Axisymmetric Problems – Triangular and Quadrilateral Elements –Natural Coordinates – Isoparametric Formulation - Numerical Integration – Plate Bending and Shell Elements — Brick Elements –Elements for Fracture Analysis.

UNIT 3 MESHING AND SOLUTION PROBLEMS**9 Hrs.**

Higher Order Elements – p and h Methods of Mesh Refinement – ill conditioned Elements – Discretisation Errors – Auto and Adaptive Mesh Generation Techniques -Error Evaluation.

UNIT 4 NONLINEAR, VIBRATION AND THERMAL PROBLEMS**9 Hrs.**

Material and Geometric Nonlinearity – Methods of Treatment – Consistent System Matrices – Dynamic Condensation – Eigen Value Extraction - thermal analysis.

UNIT 5 DYNAMIC ANALYSIS AND SOFTWARE APPLICATION**9 Hrs.**

Dynamic equations – Consistent and lumped mass matrices - 1-D bar element - Formulation of element stiffness, mass and force matrices - Example problems. Natural frequencies - 1-D bar element - Formulation of element stiffness, mass matrices. Modeling and analysis using recent softwares.

Max. 45 Hrs.**TEXT / REFERENCE BOOKS**

1. Bhavikatti S.S., "Finite Element Analysis", New Age Publishers, 2007.
2. Krishnamoorthy C.S., "Finite Element Analysis: Theory and Programming", Tata McGraw-Hill, 1995.
3. David Hutton, "Fundamentals of Finite Element Analysis", Tata McGraw Hill Publishing Company Limited, New Delhi, 2005.
4. Bathe, K.J., "Finite Element Procedures in Engineering Analysis", Prentice Hall Inc., 1996.
5. Zienkiewicz, O.C. and Taylor, R.L., "The Finite Element Method", McGraw Hill, 1987.
6. Chandrupatla, R.T. and Belegundu, A.D., "Introduction to Finite Elements in Engineering", Prentice Hall of India, 1997..
7. Moaveni, S., "Finite Element Analysis Theory and Application with ANSYS", Prentice Hall Inc., 1999.
8. <http://www.mech.port.ac.uk/sdalby/mbm/CTFRProg.htm>.
9. <http://www.me.mtu.edu/~bettig/MEEM4405>.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN**Max. Marks: 100****Exam Duration: 3 Hrs.****PART A:** 5 Questions of 6 Marks each – No choice**30 Marks****PART B:** 2 Questions from each unit of internal choice, each carrying 14 Marks**70 Marks**

SCIA5202	STRUCTURAL DYNAMICS	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

- To expose the students the principles and methods of dynamic analysis of structures.
- To prepare them for designing the structures for wind, earthquake and other dynamic loads.

UNIT 1 INTRODUCTION TO STRUCTURAL DYNAMICS**9 Hrs.**

Formulation of equation of motion by different methods – Single degree of freedom – Free vibration – Forced response to harmonic – Periodic and impulsive loads – Response to general dynamic loading – Effect of damping – Methods of evaluation of damping.

UNIT 2 MUTI-DEGREE-OF FREEDOM SYSTEMS**9 Hrs.**

Formulation of MDOF equations of motion – Evaluation of structural property matrices – Analysis of vibration frequency of motion – orthogonality conditions – approximate methods of extraction of eigen values.

UNIT 3 DYNAMIC RESPONSE OF MDOF SYSTEMS**9 Hrs.**

Normal co-ordinates – Mode super position technique – Numerical integration process.

UNIT 4 CONTINUOUS SYSTEMS**9 Hrs.**

Modeling – Analysis of free and forced response of beams and bars.

UNIT 5 APPLICATIONS**9 Hrs.**

Idealization and mathematical model of multistory building frames, towers, examples of wind, earthquake and impact excitations.

Max. 45 Hrs.**TEXT / REFERENCE BOOKS**

1. Mario Paz, "Structural dynamics", Academic Press, 1985.
2. Anderson R.A., "Fundamentals of vibration", Amerind Publishing Co., 1972.
3. Ray W. Clough and Joseph Penzien, "Dynamics of structures", McGraw Hill, New York, 1993.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN**Max. Marks: 100****Exam Duration: 3 Hrs.****PART A:** 5 Questions of 6 Marks each – No choice**30 Marks****PART B:** 2 Questions from each unit of internal choice, each carrying 14 Marks**70 Marks**

SCIA5203	ADVANCED DESIGN OF STEEL STRUCTURES	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

- To study the behaviour of members and connections, analysis and design of Industrial buildings and roofs, chimneys.
- To Study the design of with cold formed steel and plastic analysis of structures.

UNIT 1 STRUCTURAL CONNECTIONS**9 Hrs.**

Types of connections- Bolted and welded connections – Seated Connections – Unstiffened and Stiffened – Moment Resistant Connections – Clip angle Connections – Split beam Connections – Framed Connections.

UNIT 2 PRE ENGINEERED INDUSTRIAL BUILDING**9 Hrs.**

Design of members subjected to lateral loads and axial loads, Analysis and design of Industrial Buildings and bents, Sway and non-sway frames, Design of Purlins, Louver rails, Gable column and Gable wind girder - Design of Moment Resisting Base Plates – Analysis of Gable Frames.

UNIT 3 PLASTIC ANALYSIS OF STRUCTURES**9 Hrs.**

Introduction, Shape factor, Moment redistribution, Combined mechanisms, Analysis of portal frames, Effect of axial force - Effect of shear force on plastic moment, Connections - Requirement – Moment resisting connections. Design of Straight Corner Connections – Haunched Connections – Design of continuous beams.

UNIT 4 ANALYSIS AND DESIGN OF SPECIAL STRUCTURES**9 Hrs.**

Design of self supporting chimney and guyed steel stacks- Stresses due to wind and earthquake forces – Design of foundation –Gust factor method. Towers- Basic structural configurations – free standing and guyed towers – loads on towers – wind loads – foundation design.

UNIT 5 DESIGN OF COLD FORMED STEEL STRUCTURES**9 Hrs.**

Behaviour of Compression Elements - Effective width for load and deflection determination – Behaviour of Unstiffened and Stiffened Elements – Design of webs of beams – Flexural members – Lateral buckling of beams – Shear Lag – Flange Curling – Design of Compression Members – Wall Studs.

Max. 45 Hrs.**TEXT / REFERENCE BOOKS**

- Owens G.W. and Cheal B.D., "Structural Steelwork Connections", Butterworths, London, 1989.
- Dayaratnam P., "Design of Steel Structures", A.H. Wheeler & Co. Ltd., Allahabad, 1996.
- Subramanian N., "Design of Steel Structures", Oxford University Press, 2008.
- Murthy S.S. and Santhakumar A.R., "Transmission Line Structures", McGraw Hill Publishing Co. Ltd., 1990.
- Wie Wen Yu, "Design of Cold Formed Steel Structures", McGraw Hill Book Company, New York, 1996.
- Punmia B.C., Ashok Kumar Jain and Arun Kumar Jain, "Design of Steel Structures" Vol. I and II, Arihant Publications, Mumbai, 1998.
- Duggal S.K., "Limit State design of steel structures", Tata McGraw Hill Publishing Company, New Delhi, 2010.
- IS: 800-2007, Indian Standard for General Construction in Steel, Code of Practice.
- IS:801-1975, : Code of practice for use of cold – formed light gauge steel structural members in general building construction.
- SP 6(1) – 1964 Hand book for Structures Engineers.
- IS 811 - 1987, "Specification for cold formed light gauge structural steel sections.
- IS 875-1987 part 3 Code of practice for design loads.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN**Max. Marks: 100****Exam Duration: 3 Hrs.****PART A:** 5 Questions of 6 Marks each – No choice**30 Marks****PART B:** 2 Questions from each unit of internal choice, each carrying 14 Marks**70 Marks**

SCIA6101	STRUCTURAL ANALYSIS LAB - I	L	T	P	Credits	Total Marks
		0	0	4	3	100

COURSE OBJECTIVE

- To learn analysis and design of RCC, Steel Structures by using software.

SUGGESTED LIST OF EXERCISES

1. Carryout the analysis and design of RCC structures & Steel structures (single storey & Multi storey buildings).
2. Analysis of truss
3. Typical modeling of berthing structure(IS 4651)
4. P-delta analysis of G+12 building.
5. Bridge modeling
 - i) Modeling of road bridges (load calculation as per IRC)
 - ii) Modeling of railway bridges using load calculation as per IRS

SCIA6201	STRUCTURAL ANALYSIS LAB – II	L	T	P	Credits	Total Marks
		0	0	4	2	100

COURSE OBJECTIVE

- To learn Advanced analysis of Structures by using software.

SUGGESTED LIST OF EXERCISES

1. Analysis of Structures using Finite element Package – ANSYS.
2. Problem Formulation – input parameters – modeling – material properties – boundary conditions.
3. Mesh generation – Solution and post processing.
4. Modal Analysis, Buckling Analysis, Non-linear analysis, Non-linear material analysis and Contact Analysis of beam, column, beam-column, frames and plate elements.

SCIA6301	STRUCTURAL ENGINEERING LAB	L	T	P	Credits	Total Marks
		0	0	4	2	100

COURSE OBJECTIVE

- To learn about various tests on RC Beams and Steel Beams

SUGGESTED LIST OF EXPERIMENTS

1. Fabrication, casting and testing of simply supported reinforced concrete beam for Strength and deflection behavior.
2. Testing of simply supported steel beam for strength and deflection behavior.
3. Testing of Reinforcement using Mechanical and electrical strain gauges.
4. Bending test of steel Flat
5. Determination of Young's modulus of concrete
6. Determination of Tensile and flexural strength of concrete.
7. Determination of in-situ strength and quality of concrete using i) rebound hammer ii) Ultrasonic Pulse Velocity Tester
8. Torsion on open and closed sections
9. Lateral torsional buckling of beams.

SCIA7001	ADVANCED CONCRETE TECHNOLOGY	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVE

- To study the properties of concrete making materials, tests, mix design, special concretes and various methods for making concrete.

UNIT 1 CONCRETE MAKING MATERIALS**9 Hrs.**

Aggregates classification, IS Specifications, Properties, Grading, Methods of combining aggregates, specified gradings, Testing of aggregates. Cement, Grade of cement, Chemical composition, Testing of concrete, Hydration of cement, Structure of hydrated cement, special cements. Water Chemical admixtures, Mineral admixture.

UNIT 2 CONCRETE**9 Hrs.**

Properties of fresh concrete, Hardened concrete, Strength, Elastic properties, Creep and shrinkage, Variability of concrete strength, durability of concrete.

UNIT 3 MIX DESIGN**9 Hrs.**

Principles of concrete mix design, Methods of concrete mix design, testing of Concrete. Statistical quality control- sampling and acceptance criteria.

UNIT 4 SPECIAL CONCRETE**9 Hrs.**

Light weight concrete, Fly ash concrete, Fibre reinforced concrete, Sulphur impregnated concrete, Polymer Concrete, Super plasticised concrete, hyper plasticized concrete, Epoxy resins and screeds for rehabilitation - properties and applications - high performance concrete. High performance fiber reinforced concrete, self- compacting-concrete.

UNIT 5 CONCRETING METHODS**9 Hrs.**

Process of manufacturing of concrete, methods of transportation, placing and curing. Extreme weather concreting, special concreting methods. Vacuum dewatering - underwater concrete, special form work.

Max. 45 Hrs.**TEXT / REFERENCE BOOKS**

1. Neville, A.M., "Properties of Concrete", Prentice Hall, 1995, London.
2. Shetty M.S., "Concrete Technology", S.Chand and Company Ltd., New Delhi, 2003.
3. Santhakumar, A.R., "Concrete Technology", Oxford University Press, 2007.
4. Rudhani G., "Light Weight Concrete Academic Kiado", Publishing Home of Hungarian Academy of Sciences, 1963.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN**Max. Marks: 100****Exam Duration: 3 Hrs.****PART A:** 5 Questions of 6 Marks each – No choice**30 Marks****PART B:** 2 Questions from each unit of internal choice, each carrying 14 Marks**70 Marks**

SCIA7003	MAINTENANCE AND REHABILITATION OF STRUCTURES	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVE

- To study the damages, repair and rehabilitation of structures.

UNIT 1 MAINTENANCE AND REPAIR STRATEGIES**9 Hrs.**

Maintenance, repair and rehabilitation, facets of maintenance and importance of maintenance, various aspects of inspection, Assessment procedures for evaluating damaged structures, causes of deterioration – Testing techniques, NDT, Rebound Hammer, types of failures in foundation, floors, roofs, walls etc., Safety evaluation of existing buildings.

UNIT 2 SERVICEABILITY AND DURABILITY OF CONCRETE**9 Hrs.**

Quality assurance for concrete construction, concrete properties strength, workability, permeability, thermal properties and cracking. Effects due to climate, temperature, chemicals, wear and erosion, design and construction errors, corrosion mechanism, effects of cover thickness and cracking of corrosion protection, corrosion inhibitors, corrosion resistant steels, coatings, cathodic protection.

UNIT 3 MATERIALS AND TECHNIQUES FOR REPAIR**9 Hrs.**

Special concrete and mortars, concrete chemicals, special elements for accelerated strength gain, expansive cement, polymer concrete, sulphur infiltrated concrete, Ferro-cement, fibre reinforced concrete, water-proofing materials, Admixtures. Polymer coating for rebars, vacuum concrete, gunite, shotcrete, Epoxy injection, Mortar repairs of cracks, Shoring & Underpinning.

UNIT 4 REPAIR OF STRUCTURES**9 Hrs.**

Repair of structures distressed due to Earthquake. Strengthening using FRP, Strengthening and Stabilization techniques for repair. Strengthening of bridge pier.

UNIT 5 NDT OF STEEL**9 Hrs.**

Correlating ASTM tensile test (or IS:1608) for rebar with chemical composition results with respect to IS:2062, use of digital thickness gauges and weld gauges, use of hardness testers – Correlation with fire damaged and virgin specimens simple surface NDT tests – Penetration tests, Magnetic particle tests, use of coating gauges for metallic and Non-Metallic coating and identification of details for corrosion (durability aspects) simple techniques in visual inspection of weldments.

Max. 45 Hrs.**TEXT / REFERENCE BOOKS**

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. Shetty, M.S., "Concrete Technology – Theory and Practice", S. Chand and Company, New Delhi, sixth edition, 2008.
4. Santhakumar, A.R., "Training Courses notes and damage assessment and repair in low cost housing", "RHDC-NBO" Anna University, 1992.
5. Raikar, R.N. "Learning from Failures – Deficiencies in Design, Construction and Service (SDCPL)", Raikar Bhavan, Bombay, 1987.
6. B.Raj, T.Jayakumar and M.Thavasimuthu, "Practical Non-destructive testing", Wood Head Publishing Ltd., 2002.
7. IS:1608(1995) Mechanical Testing of metals.
8. IS: 2062(1999) Steel for general structural purposes.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN**Max. Marks: 100****Exam Duration: 3 Hrs.****PART A:** 5 Questions of 6 Marks each – No choice**30 Marks****PART B:** 2 Questions from each unit of internal choice, each carrying 14 Marks**70 Marks**

SCIA7007	DESIGN OF SUB STRUCTURES	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

- To gain familiarity and design of different types of foundation like shallow foundations and deep foundations.
- To understand the concept of designing well, machine and special foundations.

UNIT 1 SITE INVESTIGATION, SELECTION OF FOUNDATION AND BEARING CAPACITY 9 Hrs.

Objectives – **Methods of exploration** – Depth of exploration – Sample disturbance – Factors governing location and depth of foundation – Insitu testing of Soils – Plate load test – Geophysical methods – Selection of foundation – Bearing capacity of shallow foundations by Terzaghi's theory, Meyerhof's theory, and codal provisions – Bearing capacity of footing subjected to inclined and eccentric loading – problems – Types of shear failure – General principles of foundation design.

UNIT 2 DESIGN OF SHALLOW FOUNDATIONS 9 Hrs.

Types of shallow foundations – **General principles of design of reinforced concrete shallow foundations** – Structural design of isolated and combined footing – Structural design of rafts by conventional method – Principles of design of buoyancy raft and basement (no design problems).

UNIT 3 PILE FOUNDATION 9 Hrs.

Pile foundations – Types – **General principles of design – Estimation of load capacity of piles by static and dynamic formulae – Detailing of reinforcement as per IS 2911 – Design of pile caps – Settlement analysis of pile groups – Negative skin friction – Pile load tests.**

UNIT 4 WELL AND CAISSON FOUNDATIONS 9 Hrs.

Well and caisson foundations – Structural elements of Caisson and Well foundations – Elements of well foundation – Forces acting on Caisson and well foundations – Design of individual components of Caisson and well foundation (only forces acting and design principles) – Sinking of well – Shifts and tilts in Well foundations – Preventive measures.

UNIT 5 TOWER FOUNDATION 9 Hrs

Types of Foundations – **Design of foundation for transmission towers.**

Max. 45 Hrs.**TEXT / REFERENCE BOOKS**

1. Tomlinson M.J. and Boorman R., "Foundation design and construction", 6th Edition, ELBS Longman, 1995.
2. Nayak N.V., "Foundation design manual for practicing engineers", Dhanpat Rai and Sons, 1982.
3. Arora, K.R., "Soil Mechanics & Foundation Engineering", Standard Publishers & Distributors, 2005.
4. Winterkorn. H.F. and Fang H.Y., "Foundation Engineering Hand Book, Van Nostrand, Reinhold, 1976.
5. Swami Saran, "Analysis and Design of Substructures Limit State Design", Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, 2010.
6. Barken, "Dynamics of Bases and Foundations", McGraw Hill Company, 1962.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN**Max. Marks: 100****Exam Duration: 3 Hrs.****PART A:** 5 Questions of 6 Marks each – No choice**30 Marks****PART B:** 2 Questions from each unit of internal choice, each carrying 14 Marks**70 Marks**

SCIA7014	INDUSTRIAL STRUCTURES	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVE

- To study the requirements, planning and design of Industrial structures.

UNIT 1 PLANNING AND FUNCTIONAL REQUIREMENTS**9 Hrs.**

Classification of Industries and industrial structures – planning for layout requirements regarding Lightning, Ventilation and Fire safety – Protection against Noise and Vibration – Guidelines from Factories Act.

UNIT 2 INDUSTRIAL BUILDINGS**9 Hrs.**

Components of Industrial Structure -Roofs for Industrial buildings – Design of Gantry girder – Design of Corbels.

UNIT 3 POWER PLANT STRUCTURES**9 Hrs.**

Chimneys and Cooling Towers – high-pressure boilers and piping design – Nuclear Contaminant structures.

UNIT 4 POWER TRANSMISSION STRUCTURES**9 Hrs.**

Cables – Transmission Line Towers – Substation structures – Tower foundations – Testing Towers.

UNIT 5 MACHINE FOUNDATIONS**9 Hrs.**

Types – Design Principles – Foundation for Turbo generators.

Max. 45 Hrs.**TEXT / REFERENCE BOOKS**

1. Process of Advanced course on Industrial structures, Structural Engineering Research Centre, Chennai 1982.
2. Srinivasalu P. and Vaidyanathan C.V., "Handbook on foundations", Tata McGraw Hill 1976.
3. Manohar S.N., "Tall Chimneys – Design and Construction", Tata McGraw Hill 1985.
4. Santhakumar A.R. and S.S. Murthy, "Transmission Line Structures", Tata McGraw Hill, 1992.
5. Jakkula & Stephenson, "Fundamentals of Structural Analysis", Von Nostrand, East West Press, 1953.
6. Arya & Ajmani, "Design of Steel Structures", Nemchand Publishers, 1974.

CODE BOOKS

1. IS 4998 (PART 1) : 1992 Criteria For Design of Reinforced Concrete Chimneys.
2. IS 2974 (PART 1 to PART 5) : Design and Construction of Machine Foundations.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN**Max. Marks: 100****Exam Duration: 3 Hrs.****PART A:** 5 Questions of 6 Marks each – No choice**30 Marks****PART B:** 2 Questions from each unit of internal choice, each carrying 14 Marks**70 Marks**

SCIA7017	PREFABRICATED STRUCTURES	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVE

- To Study the design principles, analysis and design of elements.

UNIT 1 GENERAL PRINCIPLES OF FABRICATION**9 Hrs.**

Comparison with monolithic construction – Types of prefabrication – site and plant prefabrication – Economy of prefabrication – Modular coordination – Standardization – Planning for Components of prefabricated structures – Disuniting of structures – Design of simple rectangular beams and I beams – Handling and erection stresses – Elimination of erection stresses – Beams, columns – Symmetrical frames.

UNIT 2 PREFABRICATED ELEMENTS**9 Hrs.**

Roof and floor panels, ribbed floor panels – wall panels – footings – Joints for different structural connections – Effective sealing of joints for water proofing – Provisions for non-structural fastenings – Expansion joints in pre-cast construction.

UNIT 3 PRODUCTION TECHNOLOGY**9 Hrs.**

Choice of production setup – Manufacturing methods – Stationary and mobile production – Planning of production setup – Storage of precast elements – Dimensional tolerances – Acceleration of concrete hardening.

UNIT 4 HOISTING TECHNOLOGY**9 Hrs.**

Equipments for hoisting and erection – Techniques for erection of different types of members like Beams, Slabs, Wall panels and Columns – Vacuum lifting pads.

UNIT 5 MAINTENANCE**9 Hrs.**

Designing and detailing of precast unit for factory structures – Purlins, Principal rafters, roof trusses, lattice girders, gable frames – Single span single storeyed frames – Single storeyed buildings – slabs, beams and columns.

Max. 45 Hrs.**TEXT / REFERENCE BOOKS**

1. Mokr L., "Prefabricated Concrete for Industrial and Public Structures", Publishing House of the Hungarian Academy of Sciences, Budapest, 1964.
2. Glover C.W., "Structural Precast Concrete", Asia Publishing House, India, 1965.
3. Koncz I.T., "Manual of Precast Concrete Construction", Vol.I,II,III & IV, Berlin, 1968.
4. Lewicki B., "Building with Large Prefabricates", Elsevier Publishing Company, Amsterdam/London/New York, 1966.
5. "Structural Design Manual, Precast Concrete Connection Details", Society for the Studies in the use of Precast Concrete, Netherland Beton Verlag, 1978.

CODE BOOKS

1. IS 4998 (PART 1) : 1992 Criteria For Design Of Reinforced Concrete Chimneys.
2. IS 2974 (PART 1 to PART 5): Design And Construction of Machine Foundations.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN**Max. Marks: 100****Exam Duration: 3 Hrs.****PART A:** 5 Questions of 6 Marks each – No choice**30 Marks****PART B:** 2 Questions from each unit of internal choice, each carrying 14 Marks**70 Marks**

SCCA9501	INDUSTRY 4.0	L	T	P	Credits	Total Marks
		2	0	2	2	100

UNIT1 TRANSFORMING TECHNOLOGIES IN BIOENGINEERING**9 Hrs.**

Establishment of smart biotechnology factory, Artificial intelligence in Bioprocess technology, Omics – Big data analysis through automation, 3D bio printing for tissue engineering. Simulation tools, RSM and Box model. Cyber physical system based telemedicine, diagnosis and therapeutics through real time biosensors. Bionanotechnology. Intellectual Property rights (IPR): Case Studies.

UNIT 2 ADVANCEMENTS IN SUSTAINABLE BUILT ENVIRONMENT**9 Hrs.**

Introduction – Technological developments in Architectural, Engineering and Construction (AEC) - **Building Information Modelling (BIM) using Cloud computing technology and Internet of things (IoT)** – Unmanned Aerial Vehicles, sensors – Additive manufacturing in construction – **Concrete 3D printing** - Materials used - Lightweight and functionally graded structures - Net Zero Energy buildings, Bioswales, Biofiltration pond, Ecosan systems- Recent developments in Waste water Management, Air pollution control, **waste disposal** - Integration of energy, water and environmental systems for a sustainable development- Emerging Technologies: Robot Highway- Vertical farming - Intellectual Property rights: Case studies

UNIT 3 SMART MANUFACTURING**9 Hrs.**

Smart factories and interconnection, Smart Manufacturing – automation systems, Additive Manufacturing, Smart grids, Micro Electro Mechanical Systems (MEMS), Stealth technology, Metal Finishing, Self propelled vehicles, e mobility, Green fuels, drones – unmanned aerial vehicles(UAVs), aerodynamics. Robotic Automation and Collaborative Robots – Augmented reality and haptics, engineering cybernetics and artificial intelligence (AI), Disruptive Technologies – Frugal Innovations – Emerging Technologies- Autonomous Robots, Swam Robot, Modular Robotics, Space craft, Intellectual Property Rights (IPR): Case Studies.

UNIT 4 SMART WORLD**9 Hrs.**

Smart Sensors and IIOT, Smart grid, Hybrid renewable energy systems, Electronics in Smart city, Integration of Sensors in Robots and Artificial Intelligence, **5G Technology**, Communication protocols, Human-Machine Interaction, Virtual Reality, Quantum Computing: Changing trends in transistor technology: Processor, Emerging Trends: Deep Space, Swarm Robots, Cyborg, Geofencing, Pervasive Computing, **Intellectual Property Rights- Case Studies.**

UNIT 5 CYBER PHYSICAL SYSTEMS**9 Hrs.**

Introduction to Cyber Physical Systems (CPS), Architecture of CPS, Data science and technology for CPS, Prototypes of CPS, Emerging applications in CPS including social space, crowd sourcing, healthcare and human computer interactions, Industrial Artificial Intelligence, Deep Learning, Gamification, Networking systems for CPS applications, Wearable cyber physical systems and applications, Domain applications of CPS: Agriculture, Infrastructure, Disaster management, Energy, Transportation, Intellectual Property Rights (IPR) : Case Studies.

Max. 45 Hrs.**TEXT / REFERENCE BOOKS**

1. William D. Callister, "Materials Science and Engineering, An Introduction", John Wiley and Sons Inc. Singapore, 2001.
2. V. Raghavan, "Physical Metallurgy: Principle and Practice", Prentice Hall India Pvt. Ltd, 2006.
3. Flavio Craveiro, Jose Pinto Duarte, Helena Bartolo and Paulo JorgeBartolo, "Additive manufacturing as an enabling technology for digital construction: A perspective on Construction 4.0", Automation in Construction, Vol. 103, 2019.
4. Klaus Schwab, "Fourth Industrial Revolution", Random House USA Inc, New York, USA, 2017.
5. Oliver Grunow, "Smart Factory and Industry 4.0. The current state of Application Technologies", Studylab Publications, 2016.
6. Alasdair Gilchrist, "INDUSTRY 4.0: Industrial Internet of Things", Apress, 2016.
7. Sang C. Suh, U. John Tanik, John N. Carbone, Abdullah Eroglu, "Applied Cyber-Physical Systems", Springer Publications, New York, 2013.

SCI5201	SEISMIC DESIGN OF STRUCTURES	L	T	P	Credits	Total Marks
		3	1	0	4	100

COURSE OBJECTIVE

To study the effect of earthquakes, analysis and design of earthquake resistant Structures.

UNIT 1 INTRODUCTION**12 Hrs.**

Elements of Engineering Seismology – Theory of vibrations – Response Spectrum. Seismo tectonics and Seismic Zoning of India, Earthquake Monitoring and Seismic Instrumentation, Characteristics of Strong Earthquake Motion, Estimation of Earthquake Parameters.

UNIT 2 EARTHQUAKE HISTORY**12 Hrs.**

Indian Seismicity – Earthquake History – Earthquake occurrence in the world- causes of earthquake. Behaviour of structures in the past Earthquakes.

UNIT 3 DESIGN CONCEPT & BEHAVIOR OF STRUCTURES**12 Hrs.**

Philosophy and Principle of Earthquake Resistant Design, Guidelines for Earthquake Resistant Design Seismic Design Concepts – Cyclic load behaviour of RCC, Steel and Pre-stressed Concrete Elements – Design spectrum – Principles of capacity design.

UNIT 4 FRAMES AND SHEAR WALLS**12 Hrs.**

Provisions of Seismic Code (IS 1893) – Building systems frames, Shear Wall, Braced frames, combinations – Torsion. Design and Detailing of Frames – Shear Walls and Frame Walls.

UNIT 5 COMPUTATIONAL ANALYSIS, MODERN CONCEPTS**12 Hrs.**

Performance of Regular buildings 3D Computer Analysis of building Systems (Theory only) – Structural Configuration – Seismic performance – Irregular Buildings – Soil performance, Modern Concepts – Base Isolation – Adaptive systems – Case Studies.

Max. 60 Hours**Course Outcomes**

At the end of the course, student will be able to:

- CO 1 - Construct design spectrum, site specific, probabilistic and uniform hazard spectrums.
- CO 2 - Understanding of earthquake hazards: sources, magnitude, seismic intensity and site effects
- CO 3 - Utilize various IS Codal provisions for seismic design
- CO 4 - Understand the principles of performance based seismic design, failure mode control and capacity design
- CO 5 - Design RC shear wall frame systems
- CO 6 - Design buildings for seismic using various software packages.

TEXT / REFERENCE BOOKS

1. Bungalow S. Taranath "Structural Analysis and Design of Tall Buildings" - McGraw Hill Book company, New York, 1999.
2. Course Notes "Design of Reinforced Concrete Buildings", IIT, Kanpur, June 1999.
3. S.K. Duggal, "Earthquake Resistant Design of Structures" – Oxford University Press, 2007.
4. Pankaj Agarwal and Manish Shrikhande, "Earthquake Resistant Design of Structures", Prentice Hall, 2007.
5. IS 13920-1993, Ductile Detailing of Reinforced Concrete Structures Subjected to Seismic Forces-Code of Practice.
6. IS 1893 (2002): Criteria for Earthquake Resistant Design of Structures
7. Anil K. Chopra "Dynamics of Structures" Prentice Hall, 2012.

END SEMESTER EXAM QUESTION PAPER PATTERN**Max. Marks: 80****Exam Duration : 3 Hrs.****PART A** : 6 Questions of 5 marks each – No choice - uniformly distributed**30 Marks****PART B** : 2 Questions from each unit of internal choice, each carrying 10 marks**50 Marks**

SCI5607	PRESTRESSED CONCRETE STRUCTURES	L	T	P	Credits	Total Marks
		3	1	0	4	100

COURSE OBJECTIVE

To learn The Principles of prestressing, analysis and design of prestressed concrete structures.

UNIT 1 PRINCIPLES OF PRESTRESSING**12 Hrs.**

Basic concepts of Prestressing - Types and systems of prestressing - Need for High Strength materials, Analysis methods, losses of prestress – Short and Long term deflections – Cable layouts.

UNIT 2 DESIGN FOR FLEXURAL MEMBERS**12 Hrs.**

Behaviour of flexural members, determination of ultimate flexural strength – Various Codal provisions - Design of flexural members, Design for shear, bond and torsion. Transfer of prestress – Block design and cantilever beams.

UNIT 3 TRANSFER OF PRE STRESS AND DESIGN OF CANTILEVER BEAMS**12 Hrs.**

Transmission of Prestressing force by Bond – Transmission length – factors affecting transmission length – check for Transmission length – Anchorage Zone stresses in Post tensioned members – Methods of achieving continuity - concept of linear transformations, concordant cable profile and gap cables – Analysis and design of cantilever beams.

UNIT 4 DESIGN OF TENSION AND COMPRESSION MEMBERS**12 Hrs.**

Design of tension members - application in the design of prestressed pipes and prestressed concrete cylindrical water tanks - Design of compression members with and without flexure - its application in the design piles, flag masts and similar structures.

UNIT 5 DESIGN OF COMPOSITE MEMBERS AND CIRCULAR PRESTRESSING**12 Hrs.**

Composite members - analysis and design, ultimate strength - applications. Partial prestressing - advantages and applications – Circular prestressing in liquid retaining tanks – Analysis for stresses – Design of tank wall incorporating recommendations of IS: 3370 Part III Code – Types of Prestressed Concrete Pipes – Design of Pipes.

Max. 60 Hours**COURSE OUTCOME**

On the end of the course, student will be able to:

- CO1 - Analyse a composite section
- CO2 - Evaluate the losses in different types of prestressed flexural beams
- CO3 - Analyse and design of Tension and compression members
- CO4 - Analysis of stresses in flexural member
- CO5 - Design of prestressing concrete pipes
- CO6 - Understand behavior of flexural members subjected to external loads

TEXT / REFERENCE BOOKS

1. Krishna Raju. N, "Design of Prestressed Concrete Structures", Fourth Edition, Tata Mc Graw Hill Publishing Company Ltd., New Delhi, 1995.
2. Sinha & Roy, "Prestressed Concrete", S Chand & Company Ltd., New Delhi, 1994.
3. Ramamurtham. S., "Prestressed Concrete", 3rd Edition, Dhanpat Rai & Sons., New Delhi, 1995.
4. Pandit. G.S. and Gupta. S.P., Prestressed Concrete, CBS Publishers and Distributors Pvt. Ltd., 1993
5. Arthur H. Nilson, "Design of Prestressed Concrete", John Wiley and Sons Inc, New York, 2004.
6. Lin. T.Y., and Burns. H "Design of Prestressed Concrete Structures", John Wiley and Sons Inc, New York, 2009.
7. Rajagopalan. N, "Prestressed Concrete", Narosa Publications, New Delhi, 2008.
8. "IS 1343, Indian Standard Code of Practice for Pre-stressed Concrete", Indian Standard Institution, New Delhi 2012.

END SEMESTER EXAM QUESTION PAPER PATTERN**Max. Marks: 80****Exam Duration : 3 Hrs.****PART A : 6 Questions of 5 marks each – No choice - uniformly distributed****30 Marks****PART B : 2 Questions from each unit of internal choice, each carrying 10 marks****50 Marks**