M.E. Civil Engineering (Computer Aided Structural Engineering)

Semester I

Core-I			MCSE 111 -COMPUTATIONAL STRUCTURAL MECHANICS			
Hours per week			Scheme of Examination			
L	T	P	Theory (Hrs)	Marks /Credits		
				Theory	IA	Total/Credits
4	-	-	2.5	75	25	100/4

Course Objectives:

1. To provide the students with the fundamental concepts and operating tools to solve structural engineering problems.
2. To introduce the concept and applications of the Finite element method.

Course Outcomes:

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

CO 1	Understand the concept of Matrix methods and FEM
CO 2	Apply stiffness matrix method and analyze 2-D structures
CO 3	Analyze structural elements using FEM.
CO 4	Understand the concept to develop programs for structural analysis

Course content:

Sr. No.	Content	Hours
1	**Introduction to Matrix methods of structural Analysis**: Degrees of Static and Kinematic indeterminacies, Concepts of Stiffness and Flexibility, Local and Global Coordinate System, Force Transformation matrix, Displacement transformation matrix	12
2	**Analysis of indeterminate Trusses**: Trusses with and without initial strains for different types of boundary conditions such as Fixed, Hinged, Roller, Slider, Elastic (Spring) supports and support settlement using Stiffness method.	12

3	**FE Analysis of Bars and trusses:** Shape Functions for linear and higher order elements, FE formulation for bars and trusses.	**12**
4	**FE Analysis of Beams, Frames and Grids:** Derivation of Shape Function for two nodded beam element, Hermitian Interpolation, Element Stiffness matrix, Consistent Nodal loads. Analysis of 2D beams and frames using FEM, Grid analysis using FEM	**12**
5	**Computer Applications:** Flowchart, Algorithm, Computer logic and concept of development of programs to analyze trusses, beams and frames.	**12**

Texts and Reference books (latest editions of the books to be referred)

1. Rajasekaran, S. and Shankarsubramanian, G., Computational Structural Mechanics, PHI New Delhi.

2. Weaver, W. and Gere, J. M., Matrix analysis of framed structures, CBS Publishers and Distributors Pvt. Ltd.

3. Reddy. C. S, Basic Structural Analysis, TMH, New Delhi

4. Robert D Cook, Malkas, D. S. and Plesha., M. E., Concepts and Applications of Finite Element Analysis, John Wiley and Sons, New York.

5. Bathe. K. J., Finite element procedures in Engineering Analysis. PHI. NewDelhi.

6. Rubinstein M.F, Matrix Computer Analysis of structures. Prentice-Hall, Eaglewood Cliffs, New Jersey.

7. M. Asghar Bhatti, Fundamental finite element analysis and applications, John Wiley & Sons.

Core-II			MCSE 112 – PYTHON PROGRAMMING			
Hours per week			Scheme of Examination			
L	T	P	Theory (Hrs)	Marks /Credits		
				Theory	IA	Total/Credits
4	-	-	2.5	75	25	100/4

Course Objectives:

1. Learn the syntax and semantics of Python Programming Language.

2. Write Python functions to facilitate code reuse and manipulate strings.

3. Illustrate the process of structuring the data using lists, tuples and dictionaries.

4. Demonstrate the use of built-in functions to navigate the file system.

Course Outcomes:

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

CO 1	Demonstrate the concepts of control structures in Python.
CO 2	Implement Python programs using functions and strings.
CO 3	Implement methods to create and manipulate lists, tuples and dictionaries.
CO 4	Apply the concepts of file handling and using packages.

Course content:

Sr. No.	Content	Hours
1	**Introduction to Python**: Python variables, Python basic Operators, Understanding python blocks. Python Data Types, Declaring and using Numeric data types: int, float etc.	12
2	**Python Program Flow Control Conditional blocks**: if, else and else if, Simple for loops in python, For loop using ranges, string, list and dictionaries. Use of while loops in python, Loop manipulation using pass, continue, break and else. Programming using Python conditional and loop blocks.	12
3	**Python Complex data types**: Using string data type and string operations, Defining list and list slicing, Use of Tuple data type. String, List and Dictionary, Manipulations Building blocks of python programs, string	12

	manipulation methods, List manipulation. Dictionary manipulation, Programming using string, list and dictionary in-built functions. Python Functions, Organizing python codes using functions.	
4	**Python File Operations**: Reading files, Writing files in python, Understanding read functions, read(), readline(), readlines(). Understanding write functions, write() and writelines() Manipulating file pointer using seek Programming, using file operations. Database Programming: Connecting to a database, Creating Tables,INSERT, UPDATE, DELETE and READ operations, Transaction Control,Disconnecting from a database, Exception Handling in Databases.	**12**
5	**Python packages**: Simple programs using the built-in functions of packages matplotlib, numpy, pandas etc. GUI Programming: Tkinter introduction, Tkinter and PythonProgramming, Tk Widgets, Tkinter examples. Python programming with IDE.	**12**

Text and reference books (latest editions of the books to be referred):

1. Wesley J. Chun, Core Python Applications Programming, Pearson Education.
2. Charles Dierbach, Introduction to Computer Science using Python, Wiley.
3. Jeeva Jose &P.SojanLal, Introduction to Computing and Problem Solving with PYTHON, Khanna Publishers, New Delhi.
4. Downey, A. et al., How to think like a Computer Scientist: Learning with Python, John Wiley.
5. Mark Lutz, Learning Python, Orelly Publication
6. John Zelle, Python Programming: An Introduction to Computer Science Course Technology Cengage Learning Publications
7. Michel Dawson, Python Programming for Absolute Beginners, Course Technology Cengage Learning Publications
8. David Beazley, Brian Jones., Python Cookbook, Orelly Publication
9. Dr. R. Nageswar Rao, Core Python Programming, Dreamtech Press

Program Elective I			MCSE 121- THEORY OF DEFORMABLE BODIES			
Hours per week			Scheme of Examination			
L	T	P	Theory (Hrs)	Marks /Credits		
				Theory	IA	Total/Credits
4	-	-	2.5	75	25	100/4

Course Objectives:

1. To make students understand the principles of elasticity.

2. To familiarize students with basic equations of elasticity.

3. To expose students to two dimensional problems in Cartesian and polar coordinates.

Course Outcomes:

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

CO 1	Apply elastic analysis to study mechanics of deformable bodies
CO 2	Demonstrate the application of plane stress and plane strain in a given situation
CO 3	Formulate and solve planar problems using Airy stress function for two dimensional problems
CO 4	Solve specific three-dimensional problems like torsion, bending of non-circular prismatic bar, membrane analogy and simple plate bending

Course content:

Sr. No.	Content	Hours
1	**Introduction:** Definition of stress and strain at a point, components of stress and strain at a point of Cartesian and polar co-ordinates, Constitutive relations, equilibrium equations, compatibility equations and boundary conditions in 2-D and 3-D cases.	12
2	**Transformation of stress and strain at a point:** Principal stresses and principal strains, invariants of stress and strain, hydrostatic and deviatory stress, spherical and deviatory strains, maximum shear strain	12
3	**Plane stress and plane strain:** Airy's stress function approach to 2 dimensional problems of elasticity, simple problems of bending beams. Solution of axi-symmetric problems, stress concentration due to presence of	12

	circular hole in plates.	
4	**Elementary problems on elasticity in 3 dimensions:** Stretching of a prismatical bar by its own weight, twist of circular shafts, torsion of non-circular sections, membrane analogy, propagation of waves in solid media, application of finite difference equations in elasticity.	**12**
5	**Torsion of various shaped bars:** Prandtl's membrane analogy- energy method- Torsion of rolled Profiles- Stress concentration at re-entrant corners.	**12**

Texts/References

1. S. Timoshhenko and J. N. Goodier, Theory of Elasticity, McGraw Hill
2. Srinath L. S., Advanced Mechanics of Solids, 10th Print, Tata McGraw Hill, New Delhi
3. Sadhu Singh, Theory of Elasticity, Khanna Publishers
4. Verma P. D. S., Theory of Elasticity, Vikas Publishing Pvt. Ltd.
5. Xi Lu, Theory of Elasticity, John Wiley
6. Sadhu Singh, Applied Stress Analysis, Khanna Publishers

Program Elective- I			MCSE 122 NUMERICAL TECHNIQUES IN STRUCTURAL ENGINEERING			
Hours per week			Scheme of Examination			
L	T	P	Theory (Hrs)	Marks /Credits		
				Theory	IA	Total/Credits
4	-	-	2.5	75	25	100/4

Course Objectives:

1) To Provide basic understanding of numerical methods
2) To enhance the problem-solving skills using numerical methods

Course Outcomes:

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

CO 1	Solve first order initial value problems of Ordinary Differential Equations using appropriate Numerical methods.
CO 2	Understand the implementation of numerical techniques for polynomial interpolation and numerical integration.
CO 3	Apply numerical techniques to Solve an algebraic and transcendental equation and system of equations to the desired accuracy.
CO 4	Apply numerical techniques to solve real life structural engineering problems.

Course content:

Sr. No.	Content	Hours
1	**Solution of linear system of equations :**Gaussian Elimination Method, Cholesky's factorisation, Crout's Reduction, Matrix inversion method, solution of Eigen value Problems, Gauss Jacobi Iteration, Gauss Seidel	10
2	**Solution of Nonlinear Equations** :Newton Raphson's Method, Regula-Falsi Method.	8
3	**Solution of ordinary Differential equations:**Euler 's Method , Modified Euler's Method, Fourth order Runge – Kutta method, Taylor series Method.	8
4	**Numerical Integration:** Trapezoidal and Simpson's Rule, Weddle's Rule, Gauss Quadrature technique	8
5	**Finite Difference Method:** Expression of derivatives by finite differences, Finite Difference Method, Boundary value problems of exact differential equations limited to second order only, PDE's-Parabolic-explicit. Hyperbolic equations, Elliptic equations. statically determinate and	8

	Indeterminate Problems, Buckling of Columns, Vibration of beams, bending of laterally loaded thin plates.	
6	**Interpolation and Extrapolation:** Newton's Interpolation-forward and backward, Lagrange's Interpolation, Hermite Interpolation, Spline Interpolation- Cubic, Inverse Interpolation, Extrapolation, Interpolation functions for axially loaded bar elements.	**8**
7	**Curve Fitting and Errors :** Curve fitting (Interpolation, function that fits given values - approximate and exact, find function where reaches min/max or a specific value, linear regression, higher order polynomial, Gaussian, quantifying errors in curve fitting). Structural Engineering Applications.	**10**

Text and reference books (latest editions of the books to be referred):

1. Hamming R. W., Numerical Methods for Scientists and Engineers, McGraw Hill.
2. Scarborough J. B., Numerical Mathematical Analysis, Oxford & IBH Publishing Co. Pvt. Ltd.
3. Jain K. K., Iyengar S. R. K and Jain R. K., Numerical Methods - Problem and Solutions, Wiley India Pvt. Ltd
4. Mathews J. H. and Fink K. D., Numerical Methods using MATLAB, Pearson Education
5. Capri S. C. and Canale R. P., Numerical Methods for Engineers, McGraw Hill
6. Hildebrand F. B., Introduction to Numerical Analysis, Dover Publications
7. Rajasekaran S., Numerical Methods in Science and Engineering, A Practical Approach. S. Chand & Company Ltd., New Delhi
8. Sastry S. S., Introductory Methods for Numerical Analysis, Prentice Hall of India Private Ltd., New Delhi
9. Akai T. J., Applied Numerical Methods for Engineers, John Wiley & Sons.
10. Krishna Raju., Numerical Techniques and Computer Programming for Engineering Problems, CBS Publishers & Distributors Pvt. Ltd.
11. Dr. B.S. Grewal, Numerical Methods in Engineering and Science with programs in C and C++, Khanna Publishers.

Program Elective I			MCSE 123- STRUCTURAL HEALTH MONITORING			
Hours per week			Scheme of Examination			
L	T	P	Theory (Hrs)	Marks /Credits		
				Theory	IA	Total/Credits
4	-	-	2.5	75	25	100/4

Course Objectives:

1. To gain knowledge of technologies used in structural health monitoring.

2. To understand the Structural health monitoring using static and Dynamic field testing.

Course Outcomes:

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

CO 1	Diagnose the distress in the structure
CO 2	Assess the health of the structure using static field methods
CO 3	Assess the health of the structure using dynamic field tests
CO 4	Understand Remote Data Acquisition Systems

Course content:

Sr. No.	Content	Hours
1	**Introduction** - Definition of SHM - Motivation for structural health monitoring - Assessment by NDT equipment's.	12
2	**Static Testing** - Static field testing- types of static tests- loading methods - Behavioural / Diagnostic tests - Proof tests - Static response measurement – strain gauges, LVDTs, dial gauges - case study.	12
3	**Dynamic field testing** - Types of dynamic tests - Stress history data Dynamic load allowance tests - Ambient vibration tests - Forced Vibration Method - Dynamic response methods - Impact hammer testing - Shaker testing - Periodic and continuous monitoring.	12
4	**Data Acquisition** - Static data acquisition systems - Dynamic data acquisition systems - Components of Data acquisition system - Hardware for Remote data acquisition systems.	12
5	**Remote Structural health monitoring** - Remote Structural Health Monitoring - Importance and Advantages – Methodology - RF/PSTN/GSM/Satellite Communications - Networking of sensor - Data compression technique - Case Studies	12

Text and reference books (latest editions of the books to be referred):

1. Daniel Balageas, Claus-Peter Fritzen, Alfredo Güemes, Structural Health Monitoring, John Wiley and Sons

2. Douglas E Adams, Health Monitoring of Structural Materials and Components - Methods with Applications, John Wiley and Sons

3. J.P. Ou, H. Li and Z.D. Duan, Structural Health Monitoring and Intelligent Infrastructure Vol-1,Taylor and Francis Group, London, U.K

4. Victor Giurglutiu, Structural Health Monitoring with Wafer Active Sensors, Academic Press Inc.

Program Elective II			MCSE 131- STRUCTURAL OPTIMIZATION			
Hours per week			Scheme of Examination			
L	T	P	Theory (Hrs)	Marks /Credits		
				Theory	IA	Total/Credits
4	-	-	2.5	75	25	100/4

Course Objectives:

1. To learn principles of optimization
2. To implement the optimization concepts for structures
3. To evaluate different methods of optimization techniques

Course Outcomes:

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

CO 1	Classify optimization and various techniques
CO 2	Apply linear programming methods to solve problems
CO 3	Apply non- linear programming methods to solve problems
CO 4	Solve a problem by applying the concept of constrained optimization techniques

Course Content:

Sr. No.	Content	Hours
1	**Introduction:** Introduction to optimization, engineering applications of optimization, formulation of structural optimization problems as programming problems.	12
2	**Optimization techniques:** Classical optimization techniques, single variable optimization, multivariable optimization with no constraints, unconstrained minimization techniques and algorithms constrained optimized solutions by penalty function techniques, Lagrange multipliers techniques and feasibility techniques.	12
3	**Linear programming:** Linear programming, standard form of linear programming, geometry of linear programming problems, solution of system of linear simultaneous equations, pivotal production of general	12

	systems of equations, simplex algorithms, revised simplex methods, duality in linear programming.	
4	**Non- linear programming:** Non- linear programming, one dimensional minimization methods, elimination methods, Fibonacci method, golden section method, interpolation methods, quadratic and cubic methods, unconstrained optimization methods, direct search methods, descent methods	**12**
5	**Constrained optimization techniques:** Direct and complex methods, cutting plane method, exterior penalty function methods for structural engineering problems, formulation and solution of structural optimization problems by different techniques.	**12**

Text and reference books (latest editions of the books to be referred):

1. Spunt, Optimum Structural Design, Prentice Hall

2. S. S. Rao, Optimization: Theory and Practice, Wiley Eastern Ltd.

3. Uri Krisch, Optimum Structural Design, McGraw Hill

4. Richard Bronson, Operation Research- Schaum's Outline Series

5. S. S. Bhavikatti, Structural Optimization using sequential linear programming, Vikas publishing house

PROGRAM ELECTIVE III			MCSE 132- STABILITY OF STRUCTURES			
Hours per week			**Scheme of Examination**			
L	**T**	**P**	**Theory (Hrs)**	**Marks /Credits**		
				Theory	**IA**	**Total/Credits**
4	**-**	**-**	**2.5**	**75**	**25**	**100/4**

Course Objectives:

1. To learn principles of stability of structures.

2. To study the stability of structures for different boundary conditions.

3. To evaluate the use of strain energy in plate bending and stability.

Course Outcomes:

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

CO 1	Analyze the buckling of columns, beam-columns for various boundary conditions
CO 2	Analyze the buckling of frames and continuous beams for various boundary conditions
CO 3	Analyze the lateral buckling of beams and stability analysis of structural elements by finite element approach
CO 4	Analyze the buckling of rectangular plates and find critical compressive loads for various boundary conditions

Course content:

Sr. No.	Content	Hours
1	**Beam - Column:** Differential equation, beam column subjected to lateral concentrated load, several concentrated loads, continuous lateral load, application of trigonometric series, Euler's formulation using fourth order differential equation for pinned-pinned, fixed-fixed, fixed-free and fixed-pinned column.	**12**
2	**Buckling of frames and continuous beams:** Elastic, energy method-approximate calculation of critical loads for cantilever, exact critical load for hinged-hinged column using energy approach, buckling of bar on elastic foundation, buckling of cantilever column under distributed loads,	**12**

	determination of critical loads by successive approximation, bars with varying cross section, effect of shear force on critical load.	
3	**Stability analysis by finite element approach:** Finite element formulation for buckling, Calculation of critical loads for a discretized (two elements) column (both ends built in), buckling of pin jointed frames (maximum of two active dof).	**12**
4	**Lateral buckling of beams:** Differential equations, pure bending, cantilever beam with tip load, simply supported beam of I section subjected to central concentrated load, pure torsion of thin-walled bars of open cross section, non-uniform torsion of thin walled bars of open cross section.	**12**
5	**Buckling of rectangular plates:** Buckling of simply supported rectangular plate- uniaxial load and biaxial load, buckling of uniformly compressed rectangular plate simply supported along two opposite sides perpendicular to the direction of compression and having edge condition along the other two sides.	**12**

Text and reference books (latest editions of the books to be referred):

1. Stephen P. Timoshenko and James M. Gere, Theory of Elastic Stability, McGraw Hill, New Delhi

2. Robert D. Cook et.al., Concepts and Application of Finite Element Analysis, John Wiley and Sons, New York

3. H. Zeiglar, Principles of Structural Stability, Blaisdall Publications

Program Elective II			MCSE 133- STRUCTURAL RELIABILITY			
Hours per week			Scheme of Examination			
L	T	P	Theory (Hrs)	Marks /Credits		
				Theory	IA	Total/Credits
4	-	-	2.5	75	25	100/4

Course objectives:

1. To understand the concepts and techniques of reliability and probability distributions

2. To define safety format or failure surface for a given actions and response along with their statistics.

3. To use simulation techniques to arrive at the probability distributions of design variables

Course Outcomes

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

CO 1	Apply statistical principles for analyzing randomness in variables.
CO 2	Test goodness of fit of distribution in the data.
CO 3	Adopt different acceptance and rejection tests for strength and other parameters of measurement.
CO 4	Carry out reliability analysis and compute reliability index, for the given design details.

Course Content:

Sr. No.	Content	Hours
1	**Concept of variability**: Applications of Statistical principles to deal with randomness in basic variables, statistical parameters and their significance, Description of various probability distributions – Binomial, Poisson, Normal, Log-Normal, Beta, Gama, distributions. Testing of goodness– of – fit of distributions to the actual data using chi square method and K - S Method	12

2	**Statistical regression and correlation:** Operation on one Random variable, expectation, multiple random variables, reliability distributions – basic formulation.	**12**
3	**Statistical Quality control in Structural Engineering:** Characteristic strength and characteristic load, probability modeling of strength, geometrical dimensions, material properties and loading. Application problems on Mean value method and its applications in structural designs.	**12**
4	**Safety assessment of structures:** Reliability analysis using mean value theorem – Ist , IInd and IIIrd order Reliability formats.	**12**
5	**Simulation Techniques and Reliability based design:** Monte Carlo method**,** Reliability index - reliability formulation in various limit states, application to design of RC, PSC and steel structural elements – LRFD Concept.	**12**

Text and reference books (latest editions of the books to be referred):

1.Ang A.H.S and W.H. Tang, Probability concepts in Engineering planning and Design, John Wiley and sons, New York, Vol.I and II.

2. Ranganthan R, Reliability Analysis and Design of Structures, Tata McGraw Hill publishing Co. Ltd., New Delhi

3. John B. Kennedy and Adam M.Neville, Basic Statistical Methods for Engineers and Scientists,

4. Harperand Row Publishers, New York. Robert E. Melchers, Structural Reliability Analysis and Prediction, John Wiley and Sons

5. Haldar, A., and Mahadevan, S. Probability, reliability and statistical methods in engineering design. John Wiley and Sons, New York.

LAB 1			MCSE 141- COMPUTER AIDED STRUCTURAL ENGINEERING LAB I (CASE LAB I)			
Hours per week			Scheme of Examination			
L	T	P	Theory (Hrs)	Marks /Credits		
				Theory	Orals	Total/Credits
-	-	4	0	0	50	50/2

Course Objective:

1. To introduce software and programming tools for finding solutions of Engineering problems

Course Outcomes:

The student after undergoing this course will be able to:

CO 1	Write algorithms and programs to solve Engineering problems

Course content:

Sr. No.	Content	Hours
1	**Any three experiments from** 1. Implementation of factorial of a given number 2. Implementation of basic calculator as a menu driven program 3. Implementation of list and various operations on it 4. Program to implement string manipulation functions. 5. Program to find Factorial of a Number Using Recursion.	60
2	**Any three experiments from** 6. Implementation of dictionary and basic operations in Python 7. Implementation of functions in Python 8. Implementation of file I/O in Python 9. Implementation of basic database operations 10. Exception handling in database	

3	**Any one experiment from** 11. Implementation of built- in functions from matplotlib package. 12. Implementation of arrays using numpy package	
4	**Any two experiments from** 13. Structural engineering application of Interpolation techniques 14. Structural engineering application of numerical integration 15. Structural engineering applications of curve fitting and errors	

LAB II			MCSE 142 LAB - II COMPUTER AIDED STRUCTURAL ENGINEERING (CASE LAB II)			
Hours per week			Scheme of Examination			
L	T	P	Theory (Hrs.)	Marks /Credits		
				Theory	orals	Total/Credits
-	-	4	-	-	50	50/2

Course Objective:

1. To acquaint the students with the tests to be carried out to assess concrete quality.

Course Outcomes:

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

CO 1	Assess the quality of existing concrete.
CO 2	Design the concrete mix for various grades by using Indian and ACI Code.

Course Content:

Sr. No.	Content	Hours
1	**Minimum of 8 experiments to be conducted:** 1. Assess the quality of concrete with Rebound Hammer and Ultrasonic Pulse Velocity equipment. 2. To detect reinforcement details in concrete elements using Profometer. 3. Design concrete mix based on IS code and ACI code. 4. Carbonation Test on Concrete. 5. Rapid Chloride Permeability Test on Concrete. 6. Flow Characteristics of Self Compacting concrete. 7. Strain measurement – electrical resistance, strain gauges. 8. Short- and long-term durability tests and analysis using software 9. Shrinkage and Creep of concrete 10.Thermal imaging test	60

GENERAL TOPIC / ELECTIVE			MCSE 151- RESEARCH METHODOLOGY & IPR			
Hours per week			**Scheme of Examination**			
L	**T**	**P**	**Theory (Hrs.)**	**Marks /Credits**		
				Theory	**IA**	**Total/Credits**
2	**-**	**-**	**2**	**50**	**-**	**50/2**

Course Objectives:

1. Understand the nature of a problem and identify the related area of knowledge.
2. Demonstrate the ability to choose appropriate research aims and objectives.
3. Use appropriate analytical techniques to arrive at meaningful conclusions.

Course Outcomes:

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

CO1	Understand and formulate the research problem.
CO2	Analyse the problem using suitable analytical tools on the collected data.
CO3	Evaluate the solutions obtained using various analytical tools, comparative methods and arriving at logical conclusions.
CO4	Present the findings of research through a well written report and publications.

Course Content:

Sr. No.	Content	Hours
1	Research Methodology: Meaning of research problem, Sources of research problem, criterion, characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, Plagiarism, Research ethics.	**6**
2	Results and Analysis: Importance and scientific methodology in recording results, importance of negative results, different ways of recording, industrial requirement, artifacts versus true results, types of analysis (analytical, objective, subjective), outcome as new idea, hypothesis, concept, theory, model etc.	**6**
3	Technical Writing: Effective technical writing, how to write a manuscript/ response to reviewer's comments, preparation of research article/ research report, Writing a Research Proposal - presentation and assessment by a review committee.	**6**
4	Intellectual Property Rights: Nature of Intellectual Property: Patents, Designs, Trademark and Copyright. Process of Patenting and Development: technological research, innovation, patenting & development. Procedure for grants of patents, Patenting underPCT.	**6**

5	Patent Rights and New Developments in IPR: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System.	**6**

Text and reference books (latest editions of the books to be referred):

1. Cooper, D. R., Schindler, P. S. and Sharma, J. K.: Business Research Methods, Tata McGraw Hill Publishers.

2. Bryman, A. and Bell, E.: Business Research Methods, Oxford University Press.

3. Kothari, C. R. and Garg, G.: Research Methodology, New Age International Publishers, New Delhi.

4. Ranjit Kumar, Research Methodology a step-by step guide for beginners. SAGE Publications Ltd.

5. Trochim, Research Methods: the concise knowledge base, Atomic Dog Publishing.

SKILL / ABILITY ENHANCEMENT			MCSE 161- BUILDING INFORMATION MODELLING			
Hours per week			Scheme of Examination			
L	T	P	Theory (Hrs)	Marks /Credits		
				Theory	IA	Total/Credits
2	-	-	-	-	50	50/2

Course Objectives:

1.To understand the applications of Building information modeling in Construction Industry.

2.To demonstrate the ability to create structural elements in Revit

Course Outcomes:

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

CO1	To understand the framework of BIM and use of its various components.
CO2	To create architectural and structural elements in Revit
CO3	To understand the interportability of CAD interfaces and its use in Construction Management

Course content:

Sr. No.	Content	Hours
1	Introduction to BIM: Overview, Need for BIM in Architecture, Engineering and Construction Industry, Transition from traditional lifecycle to BIM lifecycle	**7**
2	Introduction to Information Modelling: Introduction to modeling tools like Revit Architecture, Revit Structure and Revit MEP and AUTOCAD	**8**
3	Basics of Information modeling: Modelling in BIM environment, Creating and editing elements in the model.	**7**
4	Advanced modeling applications in Revit Structure: Modelling of steel connections, Structural Reinforcement and Precast Concrete.	**8**

Text and reference books (latest editions of the books to be referred):

1. Harshul Savla, Chandrahauns Chavan, Pallavi Patil, Building Information Modeling: Global & Indian Perspective, Notion Press Pvt.Ltd.

2. Chunk Eastman, Paul Teicholz, Rafael Sacks and Kathleen Liston. BIM Handbook: A guide to building information modeling for Owners, Managers, Designers, Engineers and Contractors.

Semester II

Core - III			MCSE 211- COMPUTATIONAL STRUCTURAL DYNAMICS			
Hours per week			Scheme of Examination			
L	T	P	Theory (Hrs)	Marks /Credits		
				Theory	IA	Total/Credits
4	-	-	2.5	75	25	100/4

Course Objectives:|

1. To define various dynamic properties and dynamic loads acting on the structure

2. To Introduce modeling of free and forced vibration systems

3. To formulate fundamental equation of motion for SDOF and MDOF systems

4. To identify the behavior of structure especially buildings to various dynamic loads such as wind, earthquake, and machine vibration

Course Outcomes:

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

CO 1	Evaluate the effect of structural vibrations on structural systems.
CO 2	Develop and solve equations of motion for free and forced response of structural systems.
CO 3	Analyze damping and its influence on structural response.
CO 4	Apply modal method to compute forced response of SDOF and MDOF systems.
CO 5	Carry out dynamic analysis of beams using FEM.

Couse Content:

Sr. No.	Content	Hours
1	**Single Degree of Freedom System subjected to free vibration**: Degrees of freedom, undamped system, springs in parallel, in series. Newton's laws of motion, free body diagrams. D'Alembert's principle, solution of the differential equation of motion, frequency and period, amplitude of motion. Damped Single degree of freedom system –	10

	viscous damping, equation of motion, critically damped system, over damped system, under damped system, and logarithmic decrement.	
2	**Response of single degree of freedom system to harmonic loading**: Undamped harmonic excitation, damped harmonic excitation, evaluation of damping at resonance, bandwidth method (Half power) to evaluate damping, response to support motion, force transmitted to the foundation, seismic instruments.	**10**
3	**Response to General Dynamic Loading**: Impulsive loading and Duhamel's integral, numerical evaluation of Duhamel's integral, un-damped system, numerical evaluation of Duhamel's integral, damped system. Numerical Evaluation of dynamic response using Newmark's methods.	**10**
4	**Multiple degrees of Freedom system:** Dynamics of Multi-degree freedom systems: Mathematical models of multi-degree-of- freedom systems, Shear building concept, free vibration of undamped multi-degree-of- freedom systems – Natural frequencies and mode shapes – Orthogonality of modes.	**10**
5	**Dynamics of continuous systems:** Dynamics of Continuous systems: Flexural vibration of beams with different end conditions	**7**
6	**Dynamic Analysis of Beams:** Stiffness matrix, mass matrix (lumped and consistent); equations of motion for the discretized beam in matrix form and its solutions.	**7**
7	**Computer Applications:** Flowchart, Algorithms Computer logic for development of computer Programs for solution of Single and multiple degree of freedom system subjected to forced and free vibration.	**6**

Text and reference books (latest editions of the books to be referred):

1. Anil K. Chopra, Dynamics of structures – Theory and Applications, Pearson Education.

2. Mario Paz, Structural dynamics - Theory and computations, 2nd Edition, CBS Publisher and Distributors, New Delhi.

3. Mukhopadyaya, Vibration, Dynamics and structural problems, Oxford IBH Publishers.

4. Clough, Ray W and Penzien J, Dynamics of Structures, McGraw-Hill, New York.

5. Roy R. Craig, Andrew J. Kurdila, Fundamentals of Structural Dynamics, John Wiley & Sons.

6. Timoshenko, S., Vibration Problems in Engineering, Van Nostrand Co., New York.

CORE IV			MCSE 212- ADVANCED DESIGN OF REINFORCED CONCRETE AND PRESTRESSED STRUCTURES			
Hours per week			Scheme of Examination			
L	T	P	Theory (Hrs)	Marks /Credits		
				Theory	IA	Total/Credits
4	-	-	2.5	75	25	100/4

Course Objectives:

1. To provide detailed treatment of fundamental concepts for the design of flat slabs, grid floors and chimneys
2. To understand the concepts of flexure, shear and torsion in prestressed concrete

Course Outcomes:

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

CO 1	Analyze, Design and detail various RCC structures like flat slabs and grid floors.
CO 2	Analyze and design Chimney
CO 3	Analyze and design prestressed concrete structures
CO 4	Understand the concept of post tensioning of structural elements

Course Content:

Sr. No.	Content	Hours
1	**Flat Slabs**: Direct design method: Distribution of moments in column strips and middle strip-moment and shear transfer from slabs to columns. Shear in Flat Slabs-Check for one way and two-way shears. Introduction to Equivalent frame method. Limitations of Direct design method, Distribution of moments in column strips and middle strip sketch showing reinforcement details.	14
2	**Grid Floor**: Concept, Design and detailing of grid floors	10
3	**Chimneys**: Introduction, Design factors, Stresses due to self-weight, wind and temperature, Combinations of stresses.	12

4	**Design of Prestressed Concrete Sections using Limit State Method**: General philosophy of design, permissible stresses in concrete and steel, suitability of section, safe cable zone, design of rectangular and Flange sections using limit state method. Calculation of principal tension under working load, permissible principal tension, shear strength calculation under limit state of collapse for both sections cracked and uncracked in flexure. Design of end block.	**14**
5	Design of Post tensioned slabs	**10**

Text and reference books (latest editions of the books to be referred):

1. Advanced RCC by Krishnam Raju, CBS Publishers & distributors, New Delhi.
2. Advanced RCC by Varghese, PHI Publications, New Delhi.
3. Structural Design and drawing (RCC and steel) by Krishnam Raju, Univ. Press, New Delhi
4. R.C.C Structures by Dr. B. C. Punmia, Ashok Kumar Jain, Arun Kumar Jain, Laxmi Publications, New Delhi.

PROGRAM ELECTIVE III			MCSE 221- OFFSHORE STRUCTURES			
Hours per week			**Scheme of Examination**			
L	**T**	**P**	**Theory (Hrs)**	**Marks /Credits**		
				Theory	**IA**	**Total/Credits**
4	**-**	**-**	**2.5**	**75**	**25**	**100/4**

Course Objectives:

The course aims to provide the students with

1. An understanding of various components of an offshore structure.
2. An understanding of various loads on offshore structures.
3. An introduction to the design philosophy of offshore structures.

Course Outcomes:

The student after undergoing this course will be able to:

CO1	Illustrate the components of offshore structure.
CO2	Calculate loads on components of offshore structures.
CO3	Get acquainted to design principles of tubular members and joints.
CO4	Calculate submarine pipeline dimensions and stability.

Sr. No.	Content	Hours
1	**Components of Offshore Structure:** Functional and Structural Requirements of an Offshore Platform, Components of a Fixed Jacket Steel Platform, Steel Jack-Up Platform, Concrete Gravity Platform, Ship Structure.	**12**
2	**Loads on Offshore Structures:** Wind Loads; Wave and Current	**12**

	Loads; Calculation based on Maximum base Shear and Overturning Moments; Design Wave heights and Spectral Definition; Hydrodynamic Coefficients and Marine growth; Fatigue Load Definition and Joint Probability distribution; Seismic Loads.	
3	**Concepts of Fixed Platform Jacket and Deck** : Jacket concepts, redundant framing arrangement; Launch and Lift jackets; Simple Deck configurations for Lift and float-over installations; In-service and Pre-service Loads and analysis.	**12**
4	**Steel Tubular Member Design:** Principles of WSD and LRFD; Allowable stresses and Partial Safety Factors; Tubular Members, Slenderness effects; Column Buckling, Design for Hydrostatic pressure; Design for combined axial and bending stresses (API RP 2A guidelines). **Tubular Joint Design for Static and Cyclic Loads:** Simple tubular joints, design using allowable loads; stress concentration factors; S-N curves and fatigue damage calculations.	**12**
5	**Submarine Pipelines and Risers:** Route selection and Diameter / wall thickness calculations; Pipeline stability, free span calculations; Concrete coated pipelines and pipe-in-pipe insulated pipelines.	**12**

Texts/References:

1. Hydrodynamics of Offshore Structures by S.K. Chakrabarti, SpringerVerlag
2. Handbook of Offshore Engineering by S.K. Chakrabarti, Elseviers.
3. Offshore pipelines by B. Gou, S. Song, J. Chacko and A. Ghalambor, GPP Publisher.
4. Structural Stability - Theory and Implementation by W.F.Chen and E.M.Lui by Elsevier

Programme Elective III			MCSE 222- RC DESIGN OF SUB STRUCTURES			
Hours per week			Scheme of Examination			
L	T	P	Theory (Hrs)	Marks /Credits		
				Theory	IA	Total/Credits
4	-	-	2.5	75	25	100/4

Course Objectives:

The course aims to provide the students with

1. To gain familiarity with different types of foundation.
2. To explore the students to design shallow foundations and deep foundations.
3. To understand the concept of designing well, machine and special foundations.

Course Outcomes:

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

CO1	Select appropriate foundations type based on available soil conditions.
CO2	Analyze the load carrying capacity of each type of foundation.
CO3	Design of reinforced concrete shallow foundations, pile foundations, well foundations, and machine foundations.
CO4	Understand the design concepts of Special Foundations

Course Content:

Sr. No.	Content	Hours
1	**Shallow Foundations:** Soil investigation – Basic requirements of foundation – Types and selection of foundations. Bearing capacity of soil - plate load test – Design of reinforced concrete isolated, strip, combined and strap footings – mat foundation.	12
2	**Pile Foundation:** Introduction – Types of pile foundations – load carrying capacity - pile load test – structural design of straight piles – different shapes of piles cap – structural design of pile cap, Design of end bearing and frictional piles.	12
3	**Well Foundation:** Types of well foundation – Grip length – load carrying capacity – construction of wells – Failures and Remedies – Design of well foundation – Lateral stability.	12

4	**Machine Foundation:** Introduction – Types of machine foundation – Basic principles of design of machine foundation – Dynamic properties of soil – vibration analysis of machine foundation – Design of foundation for Reciprocating machines and Impact machines – Reinforcement and construction details – vibration isolation.	**12**
5	**Special Foundations**: Foundation on expansive soils – choice of foundation – under-reamed pile foundation. Foundation for concrete Towers, chimneys – Design of anchors- Reinforced earth retailing walls.	**12**

Text and reference books (latest editions of the books to be referred):

1. Bowles .J.E., Foundation Analysis and Design, McGraw Hill Publishing co., New York,

2. Swamy Saran, Analysis and Design of substructuresford and IBH Publishing Co. Pvt. Ltd.

3. Tomlinson.M.J, Foundation Design and Construction, Longman, New Delhi,

4. Varghese.P.C, Design of Reinforced Concrete Foundation – PHI learning private limited, New Delhi

Programme Elective III			MCSE 223- COMPOSITE AND SMART MATERIALS			
Hours per week			Scheme of Examination			
L	T	P	Theory (Hrs)	Marks /Credits		
				Theory	IA	Total/Credits
4	-	-	2.5	75	25	100/4

Course objectives:

1. To understand the basic properties and their application in various industries for different types of composites.

2. Familiarize with different classes of ceramic and polymeric smart materials; development of actuators and sensors and their integration into a smart structure

3. Generate controllable force and response of a system.

4. Monitor the response of the system.

Course Outcomes:

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

CO 1	Carry out classification and application of various types of fibres.
CO 2	Understand thermo-mechanical properties of materials.
CO 3	Analyze environmental effects and failure theories of composite materials.
CO 4	Familiarize with smart materials and structures.
CO 5	Carry out the analysis of a beam model with induced strain actuation.

Course Content:

Sr. No.	Content	Hours
1	**Introduction to Composite materials:** Classifications and applications of fibers, volume fraction and load distribution among constituents, minimum & critical volume fraction, compliance & stiffness matrices, coupling.	12

2	**Anisotropic elasticity:** Unidirectional and anisotropic lamina, thermo-mechanical properties, micro- mechanical analysis, classical composite lamination theory, Cross and angle–play laminates, symmetric, antisymmetric and general asymmetric laminates, mechanical coupling, laminate stacking	**12**
3	**Analysis of simple laminated structural elements:** Ply-stress and strain, lamina failure theories - first fly failure, environmental effects, manufacturing of composites.	**12**
4	**Smart materials:** Introduction, Types of smart structures, actuators & sensors, embedded & surface mounted, piezoelectric coefficients, phase transition, piezoelectric constitutive relation.	**12**
5	**Beam modelling**: Beam modelling with strain actuator, bending extension relation	**12**

Text and reference books (latest editions of the books to be referred):

1. Robart M Jones, Mechanic of Composite Materials, McGraw Hill Publishing Co.

2. Bhagwan D Agarawal, and Lawrence J Brutman, Analysis and Performance of Fiber Composites, John Wiley and Sons.

3. Madhujit Mukhopadyay, Mechanics of composite materials and structures, University Press.

4. Mercedes C. Reaves and Lucas G. Horta, Piezoelectric actuator modeling using MSC/NASTRAN and MATLAB. NASA/TM-2003-212651, Langley Research Center, Hampton, Virginia.

5. Inderjith Chopra, Lecture notes on Smart Structures, Department of Aerospace Engg., University of Maryland.

6. Crawley E F. and deLuis J, Use of piezoelectric actuators elements of intelligent structures, A journal Vol 25, No 10 Oct 1987, Pp 1373-1385.

7. Ceawley E. and Anderson E., Detailed models of piezo-ceramics actuation of beams, Proceedings of the 30th AIAA/ASME/ASCE/ASC – Structural dynamics and materials conference, Washington DC.

Programme Elective IV			MCSE 231- ANALYSIS OF PLATES AND SHELLS			
Hours per week			Scheme of Examination			
L	T	P	Theory (Hrs)	Marks /Credits		
				Theory	IA	Total/Credits
4	-	-	2.5	75	25	100/4

Course Objectives:

1. To introduce the concept of plate theory.
2. To study the behavior and analysis of thin plates.
3. To study the behavior and analysis of rectangular plates and circular plates.
4. To study the classification of shell surfaces

Course Outcomes:

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

CO 1	Analyse plates using the concept of Navier's and Levy's solution for various boundary conditions
CO 2	Apply energy methods for plates with various boundary conditions
CO 3	Apply membrane theory for shells of different shapes
CO 4	Analyse singly curved shells, doubly curved shells and cylindrical shells

Course content:

Sr. No.	Content	Hours
1	**Introduction to plate theory:** Introduction to plate theory, small deflection of laterally loaded thin rectangular plates for pure bending, Navier's and Levy's solution for various lateral loading and boundary conditions, Numerical examples.	12
2	**Energy methods for plates:** Energy methods for rectangular and circular plates with clamped edges subjected to symmetric loadings.	12
3	**Introduction to curved surfaces:** Introduction to curved surfaces and classification of shells, membrane theory of spherical shells, cylindrical shells, hyperbolic paraboloids, elliptic paraboloid and conoids.	12

4	**Axially symmetrical bending:** Axially symmetrical bending of shells revolution, closed cylindrical shells, water tanks, spherical shells and Geckeler's approximation, bending theory of doubly curved shallow shells	**12**
5	**Finite Element Approach:** Finite element formulation for Plates and shells.	**12**

Text and reference books (latest editions of the books to be referred):

1. S. Timoshenko and Woinowsky-Kreiger W., Theory of Plates and Shells, McGraw Hill Co, New York

2. A. C. Ugural, Stresses in Plates and Shells, McGraw Hill

3. R. Szilard, Theory and Analysis of Plates: Classical and Numerical Methods, Prentice Hall

4. B. K. Chatterjee, Theory and Design of Concrete Shell, Chapman and Hall

Programme Elective IV			MCSE 232 - EXPERIMENTAL TECHNIQUES IN STRUCTURAL ENGINEERING			
Hours per week			Scheme of Examination			
L	T	P	Theory (Hrs)	Marks /Credits		
				Theory	IA	Total/Credits
4	-	-	2.5	75	25	100/4

Course Objectives:

The course aims to provide the students with

1.To understand the overall behavior of the structure by experimental methods
2. To conduct experiments and interpret data

Course Outcomes:

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

CO1	Understand the working of Instruments and sensors
CO2	Use strain gauges for strain measurement
CO3	Determine stress using Photoelasticity
CO4	Carry out Non Destructive testing of Structures to access quality of structures

Course content:

Sr. No.	Content	Hours
1	**Introduction to General Experimentation:** Role and limitations, properties of engineering materials, failure due to excessive stresses, buckling, fatigue, creep, impact, testing machines for standard tests.	15
2	**Force and Strain Measurement:** Strain measurements, types of strain gauges, electrical resistance strain gauges, cross sensitivity factor, gauge indicators, analysis of strains at a point, measurement of dynamic strains, galvanometer and oscilloscope, basic concept of model analysis, model materials and their properties, dimensional analysis, means of application of forces, means of measurement of forces and displacements, calculation of displacement in prototypes.	15
3	**Photo Elasticity:** Basic concepts, Optics of Photoelasticity, Isoclinic's, Isochromatics, Material fringe value, application to determination of stress in beams, rings and discs.	15
4	**Non-Destructive Methods of Testing of Concrete:** Basic concepts in Ultrasonic Testing, Schmidt Hammer, Magnetometer. Determination of strength and quality of concrete using above mentioned method. Determination of corrosion/ carbonation in R.C	15

	member, reviews of various other Non-destructive techniques for determining quality of concrete, concept of condition survey of a structure, load testing of structures, Acoustic Emission, Holography, use of Lase or structural testing codal provisions for load testing and Non-destructive testing of concrete structures.	

Text and reference books (latest editions of the books to be referred):

1. Frocht M. M., Photoelasticity, John Wiley.
2. Dally J. W. and Riley W. F., Experimental Stress Analysis, McGraw Hill Book Co.
3. Srinath L., Raghavan. M., Ingaiah K., Gargesha G, Pant B. and Ramachandra K., Experimental Stress Analysis, Tata McGraw Hill Company, New Delhi,.
4. Singh S., Experimental Stress Analysis, Khanna Publishers, New Delhi.
5. Bungy J. H. and Millard S. G., Testing of Concrete in Structures, Blackie Academic and Professional Glasglow
6. Ramesh K., Digital Photoelasticity- Advanced Techniques and Applications, Springer-Verlag, Heidelberg, New York.
7. Ramesh K., Experimental Stress Analysis, IIT Madras, India.
8. Ganesan T. P., Model Analysis of Structures, Universities Press (India) Ltd., Hyderabad.
9. Ramesh, K., Digital Photoelasticity: advanced techniques and applications, Volume 1, Springer-Verlag.
10. Ramarutham, Experimental Stress Analysis, Dhanpatrai and Publishers.
11. Malhotra V. M., and Carin Nicholas J., Handbook on Nondestructive Testing of Concrete, CRC Press, New York.
12. Bray and Stanley, Non Destructive evaluation, Mcgraw hill Publishing Company, New York
13. Guideline for Structural Condition Assessment of Existing Buildings: An ASCE Standard: SEI/ASCE 11-19, By American Society of Civil Engineers, Structural Engineering Institute. New York.

Programme Elective IV			MCSE 233 – LIMIT STATE DESIGN OF STRUCTURAL STEEL ELEMENTS			
Hours per week			**Scheme of Examination**			
L	**T**	**P**	**Theory (Hrs)**	**Marks /Credits**		
				Theory	**IA**	**Total/Credits**
4	**-**	**-**	**2.5**	**75**	**25**	**100/4**

Course Objectives:

1. To enhance and strengthen knowledge on detailed design methods for steel structures in compliance with Indian codes

2. To Analyze and design various structural steel members

3. To learn advanced design concepts for structural steel applicable to various types of steel structures.

Course Outcomes:

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

CO1	Apply unified code philosophy to steel structure design
CO2	Apply plastic methods for design of beams and frames
CO3	Design suitable connections for steel structures
CO4	Design Steel structural components for gravity and lateral loads as per IS code

Course Content:

Sr. No.	Content	Hours
1	**Introduction**: Properties of Structural Steel, Corrosion, Fire Protection, Indian Standard Specifications and Sections, Design Requirements & Design Process, Analysis Procedures & Design Philosophy, Introduction to Limit State Design, Other Design Requirements.	**12**
2	**Moment Connections**: Simple, Semi-rigid and Rigid Connections, Connection Configurations, Angle Cleat Connections, End-plate	**12**

	Connections, Semi-rigid Connections, Moment-rotation Characteristics.	
3	**Industrial Buildings**: Structural Configurations, Functional and Serviceability Requirements, Industrial Floors, Roof Systems, Plastic Analysis and Design of Portal Frames, Crane Gantry Girders, Design for Wind Actions, Design for Earthquake Actions	**12**
4	**Multi-Storeyed Buildings**: Structural Configurations, Steel-Concrete Composite Floor Systems, Loading, Analysis for Gravity Loads, Lateral Load Resisting Systems, Analysis for Lateral Loads, Dual Systems, Advanced Structural Forms.	**12**
5	**Tanks**: Introduction- Types of Tanks, Load and Load Combination, Design Aspects of cylindrical Tanks, Design Aspects of Rectangular Tanks Wind and Earthquake effects, Staging Design	**6**
6	**Towers**: Classification of Types of Towers, Loads and Load Combinations, Wind Effects on Towers, Methods of Analysis. Design Approaches. Economy and Optimisation.	**6**

Text and reference books (latest editions of the books to be referred): 1. Lynn S. Beedle, Plastic Design of Steel Frames, John Wiley and Sons, 1990.

2. Narayanan.R.et.al., Teaching Resource on Structural steel Design, INSDAG, Ministry of Steel Publishing, 2000.

3. Subramanian N., Design of Steel Structures, Oxford University Press, 2008.

4. Wie Wen Yu.2000, Design of Cold Steel Formed Structures, Steel Structures, Me Graw Hill Book Company, 1996

5. M L Gambhir, Design of Steel Structures

Lab III			MCSE 241- Computer Aided Structural Engineering Lab III (CASE Lab III)			
Hours per week			Scheme of Examination			
L	T	P	Theory (Hrs)	Marks /Credits		
				Theory	orals	Total/Credits
-	-	4	-	-	50	50/2

Course Objective:

1. To use industry standard software in a professional set up.

2. To understand the elements of finite element modeling, specification of loads and boundary condition, performing analysis and interpretation of results for final design

3. To develop customized design automation tools

Course Outcomes:

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

CO 1	Carry out Finite element analysis of various structural elements
CO 2	Develop programs for Analysis of structural elements

Course Content:

Sr. No.	Content	Hours
1	1. Finite Element modelling and analysis of Truss. 2. Finite Element modelling and analysis of steel Beam. 3. Finite Element modelling and analysis of steel Frame. 4. Finite Element modelling and analysis of RC Beam. 5. Finite Element modelling and analysis of RC Frame. 6. Program Development for Analysis of truss, beams and frames by direct stiffness method.	60

	7. Finite Element analysis of plane stress and plane strain problems. 8. Finite Element analysis of Plates and shells. 9. Finite Element modelling and analysis of Framed structures due to Gravity, Seismic and Wind loads. 10. Dynamic modelling and analysis of a two-dimensional Frame structures. (Any Industry standard software can be used for analysis)	

Lab IV			MCSE 242 - LAB IV: COMPUTER AIDED STRUCTURAL ENGINEERING (CASE LAB IV)			
Hours per week			Scheme of Examination			
L	T	P	Theory (Hrs)	Marks /Credits		
				Theory	Oral	Total/Credits
-	-	4	-	-	50	50/2

Course Objective:

1. To use industry standard software in a professional set up.
2. To understand the elements of finite element modeling, specification of loads and boundary condition, perform analysis and interpret results for final design
3. To develop customized design automation tools

Course Outcomes:

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

CO 1	Perform Finite element analysis of various structural elements
CO 2	Develop programs for design of structural elements

Course content:

Sr. No.	Content	Hours
1	1. Design and detailing of Truss. 2. Design and detailing of steel Beam. 3. Design and detailing of steel Frame. 4. Design and detailing of RC Beam. 5. Design and detailing of RC Frame. 6. Program Development for Design of RC Structural Elements 7. Design of Framed structures due to Gravity, Seismic and Wind loads. 8. Design of two-dimensional Frame structures subjected to Dynamic load. (Design using Standard software and detailing using AutoCAD)	60

Mini Project			MCSE 251- Mini Project /Seminar			
Hours per week			Scheme of Examination			
L	T	P	Theory (Hrs)	Marks /Credits		
				IA	orals	Total/Credits
-	-	4	-	50	50	100/2

Course Objectives:

1. To familiarize the students to select site related/design/research problem/case study from the field, prepare report and presentation, so as to enable them to choose dissertation topic and understand the requirements for dissertation.

Course Outcomes:

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

CO 1	Select small site related/design/research problem/case study, collect literature, prepare report and presentation
CO2	Able to choose suitable topic for dissertation and carry out literature survey, design, testing, etc. and prepare report and presentation.

Course content:

Students are required to choose a small site related/design/research problem and :

- Collect relevant literature, prepare literature review, critical appraisal of literature and identify gaps.
- Plan suitable testing scheme in the lab and execute lab work /collect data from the site/use computer programs or softwares for design, depending upon the nature of the problem selected
- Prepare project report and presentation.

SKILL/ ABILITY ENHANCEMENT			MCSE 261 – APPLICATIONS OF IOT IN CIVIL ENGINEERING			
Hours per week			Scheme of Examination			
L	T	P	Theory(Hrs)	Marks /Credits		
				Theory	IA	Total/Credits
2	-	-	-	-	50	50/2

Course objectives:

1. To learn basics of Internet of Things (IoT) and sensors.

2. To study applications of IoT and sensors and Basics of networking in civil engineering & construction industry

Course Outcomes:

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

CO 1	Understand the basics of IoT, types of sensors & devices used.
CO2	Apply IoT in enhancing various aspects of construction projects.

Sr. No.	Content	Hours
1	Internet of Things, promises, definition, scope, sensors for IoT applications, structure of IoT, IoT Map device Industry Sensors: Definitions and Characteristics of first generation sensors, advanced generation sensors, Integrated IoT sensors, Polytronics systems, Sensor Swarm, Printed Electronics and IoT generation Road Map	10
2	Basics of Networking, Communication Protocols, Sensor Networks, Machine to Machine Communications, Interoperability in IoT.	10
3	Internet of Things devices and sensors for collecting job site data, construction crew management, construction equipment management, IoT adoption to enhance productivity, maintenance, safety and security	10

	in construction industry.	

Text and reference books (latest editions of the books to be referred):

1. Ashwin Pajankar, Internet of Things with Arduino and Bolt, BPB Publications

2. Krishnan Saravanan, Implementation and Deployment of IoT Projects in Smart Cities, IGI Global

3. Qusay F Hassan, Internet of Things A to Z: Technologies and Applications, Wiley-IEEE Press

4. Handbook of Research on Implementation and Deployment of IoT Projects in Smart Cities

(Advances in Civil and Industrial Engineering)

Semester III

Internship			MCSE 311-INTERNSHIP (14 WEEKS)			
Hours per week			Scheme of Examination			
L	T	P	Theory (Hrs)	Marks /Credits		
				IA	Orals	Total/Credits
-	-	16	-	100	100	200/8

Course Content:

An internship is an integral part of M.E. in Computer aided Structural Engineering. It provides real world experience in the profession, enables correlation of classroom learning with its application in industry. It Broadens understanding of the types of employment available in the field; Helps students discover their individual interests it enables Build resume credentials for the students and develops relationships between college and industries.

The internship course requires that a student be employed in the field of Engineering for a minimum of 20 hours per week for at least 14 weeks. However, it is preferred that a student be employed for 40 hours per week during the entire semester he/she is off track. The student will be registered for the internship course/exam after completing the "Internship" and other requirements mandated by the University. The internship formalities be completed and started within the first month of the semester.

As a result of the internship, it is expected that the student will

1. Develop practical engineering skills and judgment
2. Communicate effectively
3. Discover their own interests within the field of Civil/Structural Engineering
4. Build resume credentials to help them compete for full time positions

Grading of internship will consist of following format.

- Final internship Report 30%
- Employer Evaluation 70%

- TOTAL 100%

Students are expected to submit Interim reports periodically throughout the internship as specified by the instructor and should be submitted by email.

A final written report will be due at the end of the internship (i.e. the last week of classes for the semester to allow time for grading reports and submitting final grades). The final report should address the following:

1. Projects and Duties performed during the semester
2. Learning that occurred as a result of the internship
3. Regarding the engineering profession
4. Regarding the particular industry
5. Regarding the organization/company
6. Technical Skills that were developed
7. Individual interests and preferences that were discovered
8. Goals and plans regarding future professional development

Each student is required to live by the University student Code of conduct and most importantly the safety standards at the site while undergoing internship.

MAJOR PROJECT			MCSE 321 DISSERTATION PHASE- I			
Hours per week			Scheme of Examination			
L	T	P	Theory (Hrs)	Marks /Credits		
				IA	Oral	Total/Credits
-	-	16	-	100	100	200/8

Course content:

Dissertation: The topic of dissertation must be primarily of Structural Engineering related either theoretical or experimental or case study which a student has to carry out under the supervision of a faculty member/s of the Department. Students shall choose faculty as guide and also choose the dissertation topic at the end of semester II.
The nature of the project could be analytical, computational, experimental, or a combination of the three. The project report is expected to show clarity of thought and expression, critical appraisal of the literature, and analytical, Computational, experimental aptitudes of the student. At the end of the Semester III, the student shall submit a report containing the topic identified, literature review, critical appraisal of literature, identify gaps and objectives of the study, sample collection and testing programme/data collection and design softwares as the case may be and present the work before the two examiners appointed by the university.

NOTE: One National Journal/One International Conference paper (published/accepted for publication) is a pre-requisite for submission of the dissertation. Student shall start preparing the paper at this stage.

Suggested Reading:

1. Structural Engineering Journals.
2. Conference proceedings and technical magazines.
3. Structural Engineering text books/reference books/handbooks/relevant Indian Standards.

OPEN ELECTIVE - I			MCSE 331- NPTEL/MOOC/SWAYAM			
Hours per week			Scheme of Examination			
L	T	P	Theory (Hrs)	Marks /Credits		
				Theory	IA	Total/Credits
2	-	-	-	50*	-	50/2

Student shall choose NPTEL/MOOCS/SWAYAM course of 8 weeks duration, from the list of courses announced by the department at the end of Semester II or at the beginning of the Semester III. These courses shall be essentially from the non-geotechnical field. In the case of non-availability of suitable courses, student can choose one course form the Civil Engineering related courses but not from Geotechnical area. Course has to be minimum of 8 weeks duration. Students shall submit the assignment and answer the theory or online exams as conducted by course organisers/examining authority and obtain marks for the same.

*The marks awarded by the course organisers/authority will be scaled to 100 marks.

Semester IV

Programme Elective V			MCSE 411 DESIGN OF EARTHQUAKE RESISTANT STRUCTURES			
Hours per week			Scheme of Examination			
L	T	P	Theory (Hrs)	Marks /Credits		
				Theory	IA	Total/Credits
4	-	-	2.5	75	25	100/4

Course Objectives:|

1. To understand causes and effects of earthquakes.
2. To learn about analysis of structure subjected to earthquake loads.
3. To study the design criteria of earthquake resistant structures.
4. To get acquainted with ductile detailing requirements of earthquake resistant structures

Course Outcomes:

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

CO 1	Explain the causes & effects of earthquakes, architectural features on the seismic behavior of structures.
CO 2	Apply codal provisions in solving problems related to dynamic analysis of structure.
CO 3	Perform dynamic analysis of structure subjected to earthquake load
CO 4	Design earthquake resistant structures for controlling dynamic response.

Course Content:

Sr. No.	Content	Hours
1	Introduction to engineering seismology, Geological and tectonic features of India, Origin and propagation of seismic waves,	12

	characteristics of earthquake and its quantification – Magnitude and Intensity scales, seismic instruments. Earthquake Hazards in India, Earthquake Risk Evaluation and Mitigation. Structural behavior under gravity and seismic loads, Lateral load resisting structural systems, Requirements of efficient earthquake resistant structural system.	
2	The Response history and strong motion characteristics. Response Spectrum – elastic and inelastic response spectra, tripartite (D-V-A) response spectrum, use of response spectrum in earthquake resistant design. Computation of seismic forces in multi-storied buildings – using procedures (Equivalent lateral force and dynamic analysis) as per IS- 1893	**12**
3	Structural Configuration for earthquake resistant design, Concept of plan irregularities and vertical irregularities, Soft storey, Torsion in buildings. Design provisions for these in IS-1893. Effect of infill masonry walls on frames, modeling concepts of infill masonry walls. Behaviour of masonry buildings during earthquakes, failure patterns, strength of masonry in shear and flexure, Slenderness concept of masonry walls, concepts for earthquake resistant masonry buildings – codal provisions.	**12**
4	Design of Reinforced concrete buildings for earthquake resistance-Load combinations, Ductility and energy absorption in buildings. Confinement of concrete for ductility, design of columns and beams for ductility, ductile detailing provisions as per IS1893. Structural behavior, design and ductile detailing of shear walls.	**12**
5	Seismic response control concepts – Seismic demand, seismic capacity, Overview of linear and nonlinear procedures of seismic analysis. Performance Based Seismic Engineering methodology, Seismic evaluation and retrofitting of structures.	**12**

Text and reference books (latest editions of the books to be referred):

1. Anil K. Chopra, Dynamics of Structures – Theory and Application to Earthquake Engineering- 2nd ed. –, Prentice Hall.
2. Vinod Hosur, Earthquake Resistant Design of Building Structures, , WILEY (India.
3. Duggal S. K., Earthquake Resistant Design of Structures, , Oxford University Press.
4. Pankaj Agarwal, Manish Shrikande Earthquake resistant design of structures - PHI India.
5. IS – 1893 (Part I): 2016, IS – 13920: 2016, IS – 4326: 2013, IS-13828: 1993
6. Minoru Wakabayashi, Design of Earthquake Resistant Buildings, McGraw Hill Pub.
7. T Paulay and M J N Priestley, Seismic Design of Reinforced Concrete and Masonry Buildings, John Wiley and Sons.

Programme Elective V			MCSE 412- DESIGN OF HIGH-RISE STRUCTURES			
Hours per week			Scheme of Examination			
L	T	P	Theory (Hrs)	Marks /Credits		
				Theory	IA	Total/Credits
4	-	-	2.5	75	25	100/4

Course Objectives

1. To learn principles of stability of tall structures.
2. To design the tall buildings for seismic and wind resistance.
3. To evaluate the performance of tall structures for strength and stability.

Course Outcomes:

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

CO 1	Understand design philosophy of tall structures
CO 2	Identify different systems and various loads in tall structures
CO 3	Analyze the behavior of various structural systems for high rise buildings
CO 4	Design the tall structures and understand the concept of stability for high rise buildings

Course Content:

Sr. No.	Content	Hours
1	**Design criteria:** Design philosophy, loading, sequential loading and material, high performance concrete, fibre reinforced concrete, light weight concrete, design mixes, loading and movement- gravity loading- dead load & live load, methods of live load reduction, impact, gravity loading, construction loads.	12
2	**Wind loading:** Static and dynamic approach, analytical and wind tunnel experimentation method, earthquake loading- equivalent lateral force, modal analysis, combination of loading and design.	12

3	**Behaviour of various structural systems:**Factor affecting growth, height and structural form, high rise behavior, rigid frames, braced frames, in-filled frames, shear walls, coupled shear walls, wall-frames, tubular, cores, outrigger- braced and hybrid mega system.	**12**
4	**Analysis and design:** Modelling for approximate analysis, accurate analysis and reduction techniques, analysis of building as total structural system considering overall integrity and major subsystem interaction, analysis of member forces, drift and twist, computerized general three-dimensional analysis.	**12**
5	**Stability of tall buildings:** Overall buckling analysis of frames, second order effects of gravity loading, P-Delta analysis, simultaneous first order and P-Delta analysis, translational, torsional instability, effect of foundation rotation, structural elements- sectional shapes, properties and resisting capacities, design, deflection, cracking, pre stressing, shear flow, creep, shrinkage, temperature effects and fire.	**12**

Text and reference books (latest editions of the books to be referred):

1. Taranath B. S., Structural Analysis and Design of Tall Buildings, McGraw Hill

2. Wilf gang Schuller, High Rise Building Structures, John Wiley

3. Bryan Stafford Smith and Alexcoull, Tall Building Structures Analysis and Design, John Wiley

4. Lynn S. beedle, Advances in Tall Buildings, CBS Publishers and Distributors

Programme Elective V			MCSE 413- AI AND EXPERT SYSTEMS IN STRUCTURAL ENGINEERING			
Hours per week			Scheme of Examination			
L	T	P	Theory (Hrs)	Marks /Credits		
				Theory	IA	Total/Credits
4	-	-	2.5	75	25	100/4

Course objectives:

1. To use expert systems to achieve fairly high levels of performance in task areas which require a good deal of specialized knowledge and training.

2. Develop expert systems to perform tasks which are physically difficult, tedious, or expensive to have a human perform

Course Outcomes

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

CO 1	Explain the history of AI and formulate problems and search strategies.
CO 2	Adopt different methods of reasoning and logic for problem identification.
CO 3	Apply the basic techniques of artificial intelligence
CO 4	Distinguish Non-monotonic reasoning and statistical reasoning

Course Content

Sr. No.	Content	Hours
1	**Artificial Intelligence:** `Introduction: AI – Applications fields, defining the problems – state space representation – problem characteristics – production system, production system characteristics. Knowledge Representation: Formal logic – predicate logic – logic programming – forward v/s backward reasoning – matching control knowledge.	10

2	**Search and Control:** Concepts – uninformed / blind search: depth first search – breadth first search - bi-directional search – informed search – heuristic graph search – generate and test - hill climbing – best–first search – AND OR graph search. Non-formal Knowledge Representation – semantic networks – frames – scripts – production systems. Programming in LISP	**10**
3	**Expert Systems:** Their superiority over conventional software – components of an expert system, expert system life cycle, expert system development process, nature of expert knowledge, techniques of soliciting and encoding expert knowledge. Inference: Forward chaining, backward chaining, rule value approach.	**10**
4	**Uncertainty:** Symbolic reasoning under uncertainty: logic for non-monotonic reasoning. Statistical reasoning: Probability and Bayes' theorem, certainty factor and rule based systems, Bayesian network, Dempster-Shafer theory.	**10**
5	**Fuzzy reasoning:** Features of rule-based, network- based and frame - based expert systems – examples of expert systems in Structural Engg. Expert system shells.	**10**
6	**Neural Networks:** An introduction– their possible applications in Structural Engineering.	**10**

Text and reference books (latest editions of the books to be referred):

1. Adeli, H., "Expert Systems in Constructions and Structural Engg", Chapman &Hall, New York

2. Patterson D W, "Artificial Intelligence and Expert Systems", Prentice-Hall,Publishing Co

3. Rich, E. and Knight K. "Artificial Intelligence", T MH, New Delhi.

4. Rolston,D.W., "Artificial Intelligence and Expert Systems" McGraw Hill, NewYork.

5. Nilsson, N.J., "Principals of Artificial Intelligence", Narosa Publications, New Delhi.

Open Elective -2			MCSE 421- NPTEL/MOOCS/SWAYAM			
Hours per week			Scheme of Examination			
L	T	P	Theory (Hrs)	Marks /Credits		
				Theory	IA	Total/Credits
2	-	-	-	50*	-	50/2

Student shall choose NPTEL/MOOCS/SWAYAM course of 8 weeks duration, from the list of courses approved by University and announced by the department at the end of Semester III or at the beginning of the Semester IV. These courses shall be essentially from the non-structural field. In the case of non-availability of suitable courses, student can choose one course from the Civil Engineering related courses but not from Structural area. Course has to be minimum of 8 weeks duration. Students shall submit the assignment and answer the theory or online exams as conducted by course organisers/examining authority and obtain marks for the same.

*The marks awarded by the course organisers/authority will be scaled to 100 marks.

Major Project:			MCSE 431- Dissertation Phase II			
Hours per week			Scheme of Examination			
L	T	P	Theory (Hrs)	Marks /Credits		
				IA	Orals	Total/Credits
-	-	16	-	100	100	200/8

Dissertation: The topic of dissertation chosen by the student at the end of Semester II and the work completed at the end of Semester III shall be continued further and completed on or before Semester IV.

The project report shall show clarity of thought and expression, critical appraisal of the literature, and analytical, Computational, experimental aptitudes of the student.

Dissertation report shall contain literature review, lab or design work completed, results and discussion and the conclusions drawn from the study. The report shall be subjected to plagiarism check at Goa University.

The dissertation will be assessed by internal and external examiners appointed by the University. The examination shall consist of power point presentation and detailed report presented by the student on his/her work, in the presence of other interested teachers and students and two examiners appointed by university.

NOTE: One National Journal/One International Conference/Conference paper (published/accepted for publication) is a pre-requisite for submission of the dissertation.