ATMANIRBHAR BHARAT
SWAYAMPURNA GOA

गोंय विद्यापीठ
ताळगांव पठार,
गोंय – ४०३ २०६
फोन : +९१-८६६९६०९०४८

Goa University
Taleigao Plateau, Goa-403 206
Tel : +91-8669609048
Email : registrar@unigoa.ac.in
Website : www.unigoa.ac.in

(Accredited by NAAC)

GU/Acad –PG/BoS -NEP Engg. /2024-25/789 Date: 28.01.2025

CIRCULAR

Ref. No.: GU/Acad –PG/BoS -NEP Engg. /2024/644 dated 11.11.2024

In supersession to the above referred Circular, the Syllabus of Semester II of the **Master of Engineering (Computer Aided Structural Engineering)** Programme approved by the Academic Council in its meeting held on 06th December 2024 is attached herewith. The syllabus of Semester I approved earlier by the Academic Council in its meeting held on 22nd August 2024 is also attached.

The Dean, Faculty of Engineering and Principals of affiliated Colleges offering the **Master of Engineering (Computer Aided Structural Engineering)** Programme are requested to take note of the above and bring the contents of the Circular to the notice of all concerned.

ASHWIN VYAS LAWANDE
Digitally signed by ASHWIN VYAS LAWANDE
Date: 2025.01.28 16:39:37 +05'30'

(Ashwin V. Lawande)
Deputy Registrar – Academic

To,

1. The Dean, Faculty of Engineering, Goa University.
2. The Principals of affiliated Engineering Colleges.

Copy to,

1. The Director, Directorate of Technical Education, Govt. of Goa
2. The Chairperson, BoS in Civil Engineering.
3. The Controller of Examinations, Goa University.
4. The Assistant Registrar Examinations (Prof.), Goa University.
5. Directorate of Internal Quality Assurance, Goa University for uploading the Syllabus on the University website.

MASTER OF ENGINEERING (COMPUTER AIDED STRUCTURAL ENGINEERING) RC 2024-25

TWO YEAR PROGRAMME STRUCTURE						
Semester I						
Sr No.	**Course Code**	**Title of the Course**	**L**	**T**	**P**	**Credits**
Programme Specific Core (PSC) Courses						
1	COS-500	Computational Structural Mechanics	3	0	0	3
2	COS-501	Theory of Deformable Bodies	3	0	0	3
3	COS-502	Python Programming	4	0	0	4
4	COS-503	Computer Aided Structural Engineering Lab-1	0	0	1	1
5	COS-504	Computer Aided Structural Engineering Lab-2	0	0	1	1
Programme Specific Elective (PSE) Courses						
6	COS-531	Numerical Techniques in Structural Engineering	3	1	0	4
OR						
7	COS-532	Structural Optimization	3	1	0	4
Research Specific Elective (RSE) Courses						
8	REC-561	Engineering Research & Publications	3	1	0	4
OR						
9	REC-562	Literature Review & Technical Writing for Engineers	3	1	0	4
		TOTAL	**16**	**2**	**2**	**20**
Semester II						
Sr. No.	**Course Code**	**Title of the Course**	**L**	**T**	**P**	**Credits**
Programme Specific Core (PSC) Courses						
1	COS-505	Advanced Design of Reinforced Concrete and Prestressed Structures	3	0	0	3
2	COS-506	Computer Aided Structural Engineering Lab-3	0	0	1	1
3	COS-507	Theory of Thin Plates & Shells	3	0	0	3
4	COS-508	Computational Structural Dynamics	3	0	0	3
5	COS-509	Computer Aided Structural Engineering Lab-4	0	0	2	2
Programme Specific Elective (PSE) Courses						
6	COS-533	Structural Health Monitoring	3	0	0	3
7	COS-534	Structural Health Monitoring Lab	0	0	1	1
OR						
8	COS-535	Stability of Structures	3	0	0	3
9	COS-536	Stability of Structures Lab	0	0	1	1
Research Specific Elective (RSE) Courses						
10	REC-563	Statistics and Data Analysis for Engineering Research	2	0	0	2
11	REC-564	Statistics and Data Analysis Lab	0	0	2	2
OR						
12	REC-565	Statistical Techniques for Engineering Research	2	0	0	2
13	REC-566	Probability and Statistical analysis lab	0	0	2	2
		TOTAL	**14**	**0**	**6**	**20**

Issued on: 28/01/2025

Semester III						
Sr. No.	**Course Code**	**Title of the Course**	**L**	**T**	**P**	**Credits**
Programme Specific Core (PSC) Courses						
1	**COS-600**	Advanced Design of Steel Structures	3	0	0	3
2	**COS-601**	Advanced Design of Steel Structures LAB	0	0	1	1
3	**COS-602**	Design of Substructures	3	0	0	3
4	**COS-603**	Design of Substructures LAB	0	0	1	1
Programme Specific Elective (PSE) Courses						
5	**COS-631**	Design of High Rise Structures	3	0	0	3
6	**COS-632**	Design of High Rise Structures Lab	0	0	1	1
OR						
7	**COS-633**	Design of Earthquake resistant structures	3	0	0	3
8	**COS-634**	Design of Earthquake resistant structures Lab	0	0	1	1
Research Specific Elective (RSE) Courses						
9	**COS-661**	Probabilistic Methods in Structural Engineering	2	0	0	2
10	**COS-662**	Probabilistic Methods in Structural Engineering Lab	0	0	2	2
OR						
11	**COS-663**	Forensic Structural Engineering	2	0	0	2
12	**COS-664**	Forensic Structural Engineering Lab	0	0	2	2
General Elective (GE) Courses						
13	**GEC-681**	Sustainability Principles & Practices	3	0	0	3
14	**GEC-682**	Sustainability Principals Lab	0	0	1	1
OR						
15	**GEC-683**	Project Management	3	0	0	3
16	**GEC-684**	Project Management Lab	0	0	1	1
		TOTAL	**14**	**0**	**6**	**20**
Semester IV						
Sr. No.	**Course Code**	**Title of the Course**	**L**	**T**	**P**	**Credits**
General Elective (GE) Courses						
1	**GEC-685**	Financial Management	4	0	0	4
OR						
2	**GEC-686**	Entrepreneurship	4	0	0	4
Program Specific Dissertation/Internship						
3	**COS-698**	Dissertation	0	0	0	**16**
OR						
4	**COS-699**	Internship	0	0	0	**16**
		TOTAL	**4**	**0**	**0**	**20**

THREE YEAR PROGRAMME STRUCTURE						
Semester I						
Sr No.	**Course Code**	**Title of the Course**	**L**	**T**	**P**	**Credits**
Programme Specific Core (PSC) Courses						
1	**COS-500**	Computational Structural Mechanics	3	0	0	3
2	**COS-503**	Computer Aided Structural Engineering Lab-1	0	0	1	1
Programme Specific Elective (PSE) Courses						
3	**COS-531**	Numerical Techniques in Structural Engineering	3	1	0	4
OR						
4	**COS-532**	Structural Optimization	3	1	0	4
Research Specific Elective (RSE) Courses						
5	**REC-561**	Engineering Research & Publications	3	1	0	4
OR						
6	**REC-562**	Literature Review & Technical Writing for Engineers	3	1	0	4
		TOTAL	**9**	**2**	**1**	**12**

Issued on: 28/01/2025

Semester – I
Programme Specific Core (PSC) Courses
Name of the Programme : Master of Engineering (Computer Aided Structural Engineering)
Course Code : COS-500
Title of the Course : Computational Structural Mechanics
Number of Credits : 03 (3L)
Effective from AY : 2024-25

Pre-requisites for the course:	Engineering Mathematics, Engineering Mechanics, Strength of Materials, Structural Analysis	
Course Objectives:	The course will enable the students to: 1. Understand the concept of Matrix methods and FEM 2. Apply stiffness matrix method and analyze 2-D structures 3. Analyze structural elements using FEM. 4. Design and analyze flowcharts, algorithms, and computer programs for the structural analysis of trusses, beams, grids, and frames, enhancing the capability to solve practical engineering problems using computational methods	
Contents:		**No. of Hours**
UNIT 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	**10**
UNIT 2	**Matrix Analysis of indeterminate Trusses**: Analysis of trusses with and without initial strains using Matrix Stiffness method. **FE Analysis of Bars and trusses:** Shape Functions for linear and higher order elements, FE formulation for bars and trusses. **Computer Applications:** Flowchart, Algorithm, Computer logic and concept of development of programs to analyze trusses.	**10**
UNIT 3	**Matrix Analysis of Beams**: Continuous beam analysis using Matrix Stiffness method. **FE Analysis of Beams:** Derivation of Shape Function for two nodded beam element, Hermitian Interpolation, Element Stiffness matrix, Consistent Nodal loads. Analysis of 2D beams using FEM. **Computer Applications:** Flowchart, Algorithm, Computer logic and concept of development of programs to analyze Continuous beams.	**10**
UNIT 4	**Matrix Analysis of Grids:** Torsional stiffness of grid element and advantage of torsion release; Analysis of Grids by Matrix Stiffness method **FE Analysis of Grids:** Grid analysis using FEM **Matrix Analysis of Frames**: Frame analysis using Matrix Stiffness method. **FE Analysis of Frames:** Analysis of 2D Frames using FEM.	**15**

	Computer Applications: Flowchart, Algorithm, Computer logic and concept of development of programs to analyze Frames.	
Pedagogy:	Constructive, Collaborative and inquiry based learning	
References/ Readings:	1. Chandrupatla, T. R. and Belegundu, A. D., Introduction to Finite Elements, Pearson, 2002. ISBN-13: 978-8120321069 2. Cook, R. D., Malkus, D. S. and Plesha, M. E., Concepts and Applications of Finite Element Analysis, John Wiley and Sons, 2007. ISBN-13: 978-8126513369 3. Rajasekaran, S. and Shankarsubramanian, G., Computational Structural Mechanics, PHI Learning, 2004. ISBN-13: 978-8120317345 4. Reddy, C. S., Basic Structural Analysis, Tata McGraw-Hill, 2010. ISBN-13: 978-0070702769 5. Weaver, W. and Gere, J. M., Matrix Analysis of Framed Structures, CBS Publishers and Distributors Pvt. Ltd, 2004. ISBN-13: 978-8123911519	
Course Outcomes:	After taking this course, student will be able: CO1. Understand the concept of Matrix methods and FEM CO2. Apply stiffness matrix method and analyze 2-D structures CO3. Analyse structural elements using FEM. CO4. Design and analyze flowcharts, algorithms, and computer programs for the structural analysis of trusses, beams, grids, and frames, enhancing the capability to solve practical engineering problems using computational methods.	

(Back to Index)

Name of the Programme : **Master of Engineering (Computer Aided Structural Engineering)**
Course Code : **COS-501**
Title of the Course : **Theory of Deformable Bodies**
Number of Credits : **03 (3L)**
Effective from AY : **2024-25**

Pre-requisites for the course:	Engineering Mathematics, Engineering Mechanics, Strength of Materials	
Course Objectives:	The course will enable the students to: 1. Understand stress and strain concepts in 2-D and 3-D cases. 2. Apply stress transformation principles to determine principal stresses and strains. 3. Apply methods like Airy's stress function and finite difference equations to elasticity problems. 4. Analyze torsion effects on bars using Prandtl's analogy and energy methods.	
Content:		**No. of Hours**
UNIT 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.	**10**
UNIT 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	**10**
UNIT 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 circular hole in plates.	**10**
UNIT 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. **Torsion of various shaped bars:** Prandtl's membrane analogy-energy method- Torsion of rolled Profiles- Stress concentration at re-entrant corners.	**15**
Pedagogy:	Constructive, Collaborative and inquiry-based learning	
References/ Readings:	1. Lu, Xi, Theory of Elasticity, John Wiley & Sons, 2000. ISBN-13: 978-9056992422 2. Sadhu Singh, Theory of Elasticity, Khanna Publishers, 1978. ISBN-13: 978-8174090607 3. Sadhu Singh, Applied Stress Analysis, Khanna Publishers, 1979. ISBN-13: 978-8174090768	

	4. Timoshenko, S. and Goodier, J. N., Theory of Elasticity, McGraw-Hill, 2010. ISBN-13: 978-0070701229 5. Verma, P. D. S., Theory of Elasticity, Vikas Publishing Pvt. Ltd., 1997. ISBN-13: 978-8125903697
Course Outcomes	After taking this course, student will be able to CO1. Apply elastic analysis to study mechanics of deformable bodies CO2. Demonstrate the application of plane stress and plane strain in a given situation CO3. Formulate and solve planar problems using Airy stress function for two dimensional problems. CO4. Solve specific three-dimensional problems like torsion, bending of non-circular prismatic bar, membrane analogy and simple plate bending

(Back to Index)

Name of the Programme : **Master of Engineering (Computer Aided Structural Engineering)**
Course Code : **COS-502**
Title of the Course : **Python Programming**
Number of Credits : **04 (4L)**
Effective from AY : **2024-25**

Pre-requisites for the course:	Basic Computer Programming	
Course Objectives:	The course will enable the students to: 1. Demonstrate the concepts of control structures in Python. 2. Implement Python programs using functions and strings. 3. Implement methods to create and manipulate lists, tuples and dictionaries. 4. Apply the concepts of file handling and using packages.	
Content:		**No. of Hours**
UNIT 1	**Introduction to Python**: Python variables, Python basic Operators, Understanding python blocks. Python Data Types, Declaring and using Numeric data types: int, float etc. **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.	**15**
UNIT 2	**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 manipulation methods, List manipulation. Dictionary manipulation, Programming using string, list and dictionary in-built functions. Python Functions, Organizing python codes using functions.	**15**
UNIT 3	**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.	**15**
UNIT 4	**Python packages**: Simple programs using the built-in functions of packages matplotlib, numpy, pandas etc. GUI Programming: Tkinter introduction, Tkinter and Python Programming, Tk Widgets, Tkinter examples. Python programming with IDE.	**15**
Pedagogy:	Constructive, Collaborative and inquiry based learning	
References/ Readings:	1. Chun, W. J., Core Python Applications Programming, Pearson Education. ISBN-13: 978-0134288768	

	2. Dierbach, Charles, Introduction to Computer Science Using Python, Wiley. ISBN-13: 978-1119456325 3. Downey, A. et al., How to Think Like a Computer Scientist: Learning with Python, John Wiley. ISBN-13: 978-1118290279 4. Jeeva Jose & Sojan Lal, P., Introduction to Computing and Problem Solving with Python, Khanna Publishers, New Delhi. ISBN-13: 978-8174093175 5. Lutz, Mark, Learning Python, O'Reilly Media. ISBN-13: 978-1492050628
Course Outcomes	After taking this course, student will be able to CO1. Demonstrate the concepts of control structures in Python. CO2. Implement Python programs using functions and strings. CO3. Implement methods to create and manipulate lists, tuples and dictionaries. CO4. Apply the concepts of file handling and using packages.

(Back to Index)

Name of the Programme : **Master of Engineering (Computer Aided Structural Engineering)**
Course Code : **COS-503**
Title of the Course : **Computer Aided Structural Engineering Lab - I**
Number of Credits : **01**
Effective from AY : **2024-25**

Pre-requisites for the course:	Structural Analysis, Finite Element Analysis and Basic Programming	
Course Objectives:	The course will enable the students to: 1. Understand the principles of modelling and analysing trusses, beams, and frames. 2. Apply programming techniques to create analysis tools for trusses, beams, and frames using the direct stiffness method. 3. Apply stress analysis techniques, including Mohr's circle, for evaluating 2-D stress states. 4. Analyze advanced structural behaviors, including moving loads, geometric nonlinearity, buckling, and eigenvalue problems, using industry-standard software	
Content:		**No. of Hours**
	List of Experiments: (Any 8 Experiments should be performed) 1. Modelling and analysis of Truss. 2. Modelling and analysis of Beam. 3. Modelling and analysis of Frame. 4. Program Development for Analysis of truss, beams and frames by direct stiffness method. 5. Program development for 2-D stress analysis 6. Program development for 2-D stress analysis using Mohr's circle 7. Stress analysis of Slabs. 8. Moving load Analysis 9. Geometric Nonlinear analysis. 10. Buckling Analysis 11. Eigen value Analysis (Any Industry standard software can be used for analysis)	**30**
Pedagogy:	Inquiry based learning, constructive planning of experiments, collaborative approach in performing experiments and field visits.	
References/ Readings:	1. Hibbeler R.C., "Structural Analysis", Pearson, 2017, ISBN-13: 978-0134610672 2. Kassimali A., "Matrix Analysis of Structures", Cengage Learning, 2011, ISBN-13: 978-1111426200. 3. Kim N, Sankar B.V., Kumar A.V. "Introduction to Finite Element Analysis and Design", Wiley, 2018, ISBN-13: 978-1119078722	
Course Outcomes	After taking this course, student will be able to CO1 Understand the principles of modelling and analysing trusses, beams, and frames.	

	CO2 Apply programming techniques to create analysis tools for trusses, beams, and frames using the direct stiffness method. CO3 Apply stress analysis techniques, including Mohr's circle, for evaluating 2-D stress states. CO4 Analyze advanced structural behaviors, including moving loads, geometric nonlinearity, buckling, and eigenvalue problems, using industry-standard software.

(Back to Index)

Name of the Programme : **Master of Engineering (Computer Aided Structural Engineering)**
Course Code : **COS-504**
Title of the Course : **Computer Aided Structural Engineering Lab - 2**
Number of Credits : **01**
Effective from AY : **2024-25**

Pre-requisites for the course:	Basic Computer Programming, Fundamentals of Python Programming	
Course Objectives:	The course will enable the students to: 1. Write algorithms and programs to solve Engineering problems. 2. Implement a variety of list operations, demonstrating the ability to manipulate and manage data using Python's list data structure effectively. 3. Implement a recursive approach to calculate the factorial of a number, showcasing an understanding of recursion and its practical applications. 4. Implement built-in functions from the matplotlib package for data visualization, demonstrating the ability to create and interpret graphical representations of data.	
Content:		**No. of Hours**
UNIT 1	**Part A (Any three experiments):** 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.	**10**
UNIT 2	**Part B (Any three experiments):** 1. Implementation of dictionary and basic operations in Python 2. Implementation of functions in Python 3. Implementation of file I/O in Python 4. Implementation of basic database operations 5. Exception handling in database.	**10**
UNIT 3	**Part C (Any one experiments):** 1. Implementation of built- in functions from matplotlib package. 2. Implementation of arrays using numpy package	**5**
UNIT 4	**Part D (Any two experiments):** 1. Structural engineering application of Interpolation techniques 2. Structural engineering application of numerical integration 3. Structural engineering applications of curve fitting and errors	**5**
Pedagogy:	Inquiry based learning, constructive planning of experiments, collaborative approach in performing experiments.	
References/ Readings:	1. Kiusalaas J., “Numerical Methods in Engineering with Python 3”,Cambridge University Press,2013, ISBN-13: 978-1107033856	

	2. Kong Q, Siauw T., Bayen A., "Python Programming and Numerical Methods: A Guide for Engineers and Scientists, Academic Press, 2020, ISBN-13: 978-0128195499 3. Lora V. and Spanou K. "Python for Civil and Structural Engineers", Independent publisher, 2019, ISBN-13: 978-1077250939
Course Outcomes	After taking this course, student will be able to CO1 Write algorithms and programs to solve Engineering problems. CO2 Implement a variety of list operations, demonstrating the ability to manipulate and manage data using Python's list data structure effectively. CO3 Implement a recursive approach to calculate the factorial of a number, showcasing an understanding of recursion and its practical applications. CO4 Implement built-in functions from the matplotlib package for data visualization, demonstrating the ability to create and interpret graphical representations of data.

(Back to Index)

Programme Specific Elective (PSE) Courses
Name of the Programme : Master Of Engineering (Computer Aided Structural Engineering)
Course Code : COS-531
Title of the Course : Numerical Techniques in Structural Engineering
Number of Credits : 04 (3L + 1T)
Effective from AY : 2024-25

Pre-requisites for the course:	Engineering Mathematics	
Course Objectives:	The course will enable the students to: 1. Solve first order initial value problems of Ordinary Differential Equations using appropriate Numerical methods. 2. Understand the implementation of numerical techniques for polynomial interpolation and numerical integration. 3. Apply numerical techniques to Solve an algebraic and transcendental equation and system of equations to the desired accuracy. 4. Apply numerical techniques to solve real life structural engineering problems.	
Content:		**No. of Hours**
UNIT 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 **Solution of Nonlinear Equations**: Newton Raphson's Method, Regula-Falsi Method.	**15**
UNIT 2	**Solution of ordinary Differential equations:** Euler 's Method, Modified Euler's Method, Fourth order Runge – Kutta method, Taylor series Method. **Numerical Integration:** Trapezoidal and Simpson's Rule, Weddle's Rule, Gauss Quadrature technique	**15**
UNIT 3	**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 Indeterminate Problems, Buckling of Columns, Vibration of beams, bending of laterally loaded thin plates.	**15**
UNIT 4	**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. **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	**15**

	fitting). Structural Engineering Applications.	
Pedagogy:	Constructive, Collaborative and inquiry based learning	
References/ Readings:	1. Chapra, S. C., & Canale, R. P., Numerical Methods for Engineers, McGraw-Hill. ISBN-13: 978-1260464381 2. Jain, K. K., Iyengar, S. R. K., & Jain, R. K., Numerical Methods: Problems and Solutions, Wiley India Pvt. Ltd. ISBN-13: 978-8126531270 3. Hamming, R. W., Numerical Methods for Scientists and Engineers, McGraw-Hill. 2012, ISBN-13: 978- 0486134826 4. Mathews, J. H., & Fink, K. D., Numerical Methods Using MATLAB, Pearson Education. ISBN-13: 978-0134694703 5. Scarborough, J. B., Numerical Mathematical Analysis, Oxford & IBH Publishing Co. Pvt. Ltd. ISBN-13: 978-0195684356	
Course Outcomes	After taking this course, 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.	

(Back to Index)

Name of the Programme : Master of Engineering (Computer Aided Structural Engineering)
Course Code : COS-532
Title of the Course : Structural Optimization
Number of Credits : 04 (3L +1T)
Effective from AY : 2024-25

Pre-requisites for the course:	Engineering Mathematics, Engineering Mechanics, Structural Analysis, Design of concrete structures	
Course Objectives:	The course will enable the students to: 1. Understand the fundamentals of optimization, including the formulation of structural optimization problems and their applications in engineering. 2. Apply classical optimization techniques, including single and multivariable optimization, to solve unconstrained and constrained engineering problems using various algorithms and methods. 3. Apply linear programming methods, such as the simplex algorithm and duality concepts, to optimize linear systems in structural engineering. 4. Analyze non-linear and constrained optimization techniques, including direct search methods, penalty function techniques, and the cutting plane method, for solving complex structural optimization problems	
Content:		**No. of Hours**
UNIT 1	**Introduction:** Introduction to optimization, engineering applications of optimization, formulation of structural optimization problems as programming problems. **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.	**15**
UNIT 2	**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 systems of equations, simplex algorithms, revised simplex methods, duality in linear programming.	**15**
UNIT 3	**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	**15**
UNIT 4	**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.	**15**

Pedagogy:	Constructive, Collaborative and inquiry based learning
References/ Readings:	1. Bhavikatti, S. S., Structural Optimization Using Sequential Linear Programming, Vikas Publishing House, 2003. ISBN-13: 978-8125911814 2. Bronson, R., Operations Research, Schaum's Outline Series, 1997. ISBN-13: 978-0070080201 3. Krisch, Uri, Optimum Structural Design, McGraw-Hill, 2012. ISBN-13: 978-3642848452 4. Rao, S. S., Optimization: Theory and Practice, Wiley Eastern Ltd., 2000. ISBN-13: 978-8122411492 5. Spunt, Optimum Structural Design, Prentice Hall, 2007. ISBN-13: 978-0136382706
Course Outcomes	After taking this course, student will be able to CO 1. Understand the fundamentals of optimization, including the formulation of structural optimization problems and their applications in engineering. CO 2. Apply classical optimization techniques, including single and multivariable optimization, to solve unconstrained and constrained engineering problems using various algorithms and methods. CO 3. Apply linear programming methods, such as the simplex algorithm and duality concepts, to optimize linear systems in structural engineering. CO 4. Analyze non-linear and constrained optimization techniques, including direct search methods, penalty function techniques, and the cutting plane method, for solving complex structural optimization problems.

(Back to Index)

Research Specific Elective (RSE) Courses

Name of the Programme : Master of Engineering (Artificial Intelligence and Data Science)
Course code : REC-561
Title of the course : Engineering Research & Publication
Number of credits : 4(3L+1T)
Effective from AY : 2024-25

Pre-requisites for the Course:	Knowledge of research requirements in real life	
Course Objectives:	The course will enable the students to 1. Understand the importance of literature review, defining the research objectives. 2. Explain qualitative and quantitative methods of data analyses and its importance. 3. Classify research publications, select appropriate journals based on research areas. 4. Practice ethics in publication and academic integrity	
Content:		**No of Hours**
Unit -1	**Overview of scientific research in engineering**, foundational and fundamental concepts like types of research and considerations for research in specific domains, motivation to do research, critical thinking, assumptions and hypotheses, basic and applied research, importance of formulation of broad research objectives	**11 + 4T**
Unit -2	**Purpose and Methodology of Literature Search and Review** of the scientific and engineering publications. Sources such as scholarly databases, public domain, open access, current literature, review articles, critical review and gap analysis, defining research objectives	**11 + 4T**
Unit -3	**Quantitative and qualitative Data –** importance of data in research, types of data, data collection techniques, Quantitative methods for analysis of data – statistical tools, mathematical modeling, simulation, experimental data, optimization methods; Qualitative data collection, preparing questioners, rating scale, conducting survey, validation of models.	**12 + 4T**
Unit- 4	**Preparation of Publications-** Elements of research publications, types of publications, writing for journal publications, basic requirements for publication, selection of journals, journal quality indicators, peer review, reply to comments and responses, publication ethics, references, citations, authorship, plagiarism, academic integrity	**11 + 3T**
Pedagogy:	Inquiry based learning, Integrative, Reflective Learning , Constructive learning and Collaborative learning	
References/ Readings:	1. Herman Tang, 'Engineering Research-Design, Methods and Publications', John Wiley and Sons, 2021, ISBN:9781119624486. 2. Michael Jay Katz, 'From Research to Manuscript', Springer Publication,	

	2009, ISBN:9781402094668. 3. Rob Dekkers, Lindsey Casey, Peter Langhorne, 'Making Literature Review Work', Springer Publications, 2022, ISBN:9783030900243 4. Meikang Qiu, Han Qiu, Yi Zeng, 'Research & Technical Writing for Science and Engineering', Taylor & Francis Publications, 2022, ISBN:9781003139058.
Course Outcomes:	CO 1. Understand the importance of literature review, defining the research objectives. CO 2. Explain qualitative and quantitative methods of data analyses and its importance. CO 3. Classify research publications, select appropriate journals based on research areas. CO 4. Practice ethics in publication and academic integrity

(Back to Index)

Name of the Programme : Master of Engineering (Artificial Intelligence and Data Science)
Course code : REC-562
Title of the course : Literature Review & Technical Writing for Engineers
Number of credits : 4(3L + 1T)
Effective from AY : 2024-25

Pre-requisites for the Course:	Basics of Technical writing skills.	
Course Objectives:	The course will enable the students to 1. Understand the importance of literature review and writing a review paper. 2. Explain the method to be followed to write a review paper. 3. Classify data for qualitative and quantitative analysis 4. Demonstrate technical writing for conference.	
Content:		**No of Hours**
Unit -1	**Overview on Literature Review**, difference between objectives of literature review and research objectives; types of literature review, qualitative and quantitative reviews, search strategies, primary and secondary sources, database search strategies, field search, root search, complimentary search, meta-analysis	**12 + 4T**
Unit -2	**Database management of literature reviews**, bibliometric analysis, importance of writing a review paper, reply to comments and responses, publication ethics, references, citations, authorship, plagiarism, academic integrity; public domain, open access, current literature.	**11 + 4T**
Unit -3	**Technical writing on a specific research topic**, structure of the paper, abstract, introduction, experimental, simulation, analysis, discussion, inferences, title, acknowledgment, referencing, presentation of tables, figures, graphs, equations; comparison between technical writing for conference papers and journal paper	**11 + 4T**
Unit- 4	**Importance of data in research**, types of data, data collection techniques, Quantitative methods for analysis of data – statistical tools, mathematical modeling, simulation, experimental data, optimization methods; Qualitative data collection, preparing questioners, rating scale, conducting survey, validation of models.	**11 + 3T**
Pedagogy:	Inquiry based learning, Integrative, Reflective Learning, Constructive learning and Collaborative learning	
References/ Readings:	1. Rob Dekkers, Lindsey Casey, Peter Langhorne, 'Making Literature Review Work – Multidisciplinary Guide to Systematic Approaches', Springer Publications, 2022, ISBN:9783030900243. 2. Michael Jay Katz, 'From Research to Manuscript', Springer Publication, 2009, ISBN:9781402094668. 3. Herman Tang, 'Engineering Research-Design, Methods and Publications', John Wiley and Sons, 2021, ISBN:9781119624486. 4. Meikang Qiu, Han Qiu, Yi Zeng, 'Research & Technical Writing for	

	Science and Engineering', Taylor & Francis Publications, 2022, ISBN:9781003139058.
Course Outcomes:	After taking this course, student will be able to: CO 1. Understand the importance of literature review and writing a review paper. CO 2. Explain the method to be followed to write a review paper. CO 3. Classify data for qualitative and quantitative analysis CO 4. Demonstrate technical writing for conference.

(Back to Index)

Semester – II
Programme Specific Core (PSC) Courses
Name of the Programme : Master of Engineering (Computer Aided Structural Engineering)
Course Code : COS-505
Title of the Course : Advanced Design of Reinforced Concrete and Prestressed Structures
Number of Credits : 03 (3L)
Effective from AY : 2024-25

Pre-requisites for the course:	Structural Analysis, Design of Concrete Structures	
Course Objectives:	The course will enable the students to: 1. Understand the direct design method for flat slabs, including moment distribution and shear checks. 2. Apply the equivalent frame and direct design methods to analyze flat slabs, including reinforcement detailing. 3. Apply the limit state method to design prestressed concrete sections, including rectangular and flange sections, and calculate principal tension and shear strength. 4. Analyse the design of grid floors, storage structures, and chimneys, considering self-weight, wind, temperature, and stress combinations.	
Content:		**No. of Hours**
UNIT 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.	**12**
UNIT 2	**Grid Floor**: Concept, Design and detailing of grid floors.	**11**
UNIT 3	**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. **Post tensioned slabs**	**12**
UNIT 4	**Storage Structures:** Design of Bunkers and Silos. **Chimneys**: Introduction, Design factors, Stresses due to self-weight, wind and temperature, Combinations of stresses.	**10**
Pedagogy:	Constructive, Collaborative and inquiry based learning, Field Visits	
References/ Readings:	1. Punmia, B. C., Jain, Ashok Kumar, & Jain, Arun Kumar, R.C.C. Structures, Laxmi Publications, New Delhi, 2015, ISBN-13: 978-8131809426 2. Raju, Krishna, Advanced Reinforced Cement Concrete Design, CBS	

	Publishers & Distributors, New Delhi, 2016, ISBN-13: 978-8123929606 3. Raju, Krishnam, Structural Design and Drawing (RCC and Steel), University Press, New Delhi, 2005, ISBN-13: 978-8173714894 4. Raju, N. Krishna, Prestressed Concrete, McGraw-Hill Education Pvt. Ltd., 2012, ISBN-13: 978-1259050817 5. Varghese, P., Advanced Reinforced Cement Concrete Design, PHI Learning Pvt. Ltd., New Delhi, 2010, ISBN-13: 978-8120327870
Course Outcomes	After taking this course, students will be able to CO 1. Understand the direct design method for flat slabs, including moment distribution and shear checks. CO 2. Apply the equivalent frame method and direct design method to analyze flat slabs, including reinforcement detailing. CO 3. Apply the limit state method to design prestressed concrete sections, including rectangular and flange sections, and calculate principal tension and shear strength. CO 4. Analyze the design of grid floors, storage structures, and chimneys, considering factors such as self-weight, wind, temperature, and stress combinations.

(Back to Index)

Name of the Programme : **Master of Engineering (Computer Aided Structural Engineering)**
Course Code : **COS-506**
Title of the Course : **Computer Aided Structural Engineering Lab 3**
Number of Credits : **01 (1P)**
Effective from AY : **2024-25**

Pre-requisites for the course:	Structural Analysis, Finite Element Analysis and Basic Programming	
Course Objectives:	The course will enable the students to: 1. Understand and apply IS/ACI codes for high-grade and self-compacting concrete mix designs and study their flow characteristics. 2. Analyse and design flat slabs, grid floors, and prestressed concrete members using software and spreadsheets. 3. Encourage practical learning through case studies and field observation 4. Compile findings, analysis, and insights from design, case studies, and field visits into comprehensive reports demonstrating understanding and applying learned concepts.	
Content:		**No. of Hours**
	List of Experiments (Minimum 8): 1. Design mix for high-grade concrete based on IS and ACI codes. 2. Design mix for self-compacting concrete based on IS and ACI codes. 3. Flow Characteristics of Self-Compacting Concrete. 4. Analysis of flat slab systems using industry-standard software and designing using spreadsheets. 5. Analysis of grid floor systems using industry-standard software and designing using spreadsheets. 6. Analysis of prestressed slab using industry-standard software and designing using spreadsheets. 7. Detailed Case study report (unique) on the design and execution of ongoing RCC structure projects. 8. Field visit on RCC construction site and Report submission (Any Industry standard software can be used for analysis)	**30**
Pedagogy:	Inquiry-based learning, constructive planning of experiments, collaborative approach in performing experiments and field visits.	
References/ Readings:	1. Guidelines for Concrete Mix Design Proportioning [CED 2: Cement and Concrete], IS 10262 (2009). 2. Punmia, B. C., Jain, Ashok Kumar, & Jain, Arun Kumar, R.C.C. Structures, Laxmi Publications, New Delhi, 2015, ISBN-13: 978-8131809426. 3. Raju, Krishna, Advanced Reinforced Cement Concrete Design, CBS Publishers & Distributors, New Delhi, 2016, ISBN-13: 978-8123929606.	

	4. Raju, Krishna, Structural Design and Drawing (RCC and Steel), University Press, New Delhi, 2005, ISBN-13: 978-8173714894. 5. Raju, N. Krishna, Prestressed Concrete, McGraw-Hill Education Pvt. Ltd., 2012, ISBN-13: 978-1259050817. 6. Varghese, P., Advanced Reinforced Cement Concrete Design, PHI Learning Pvt. Ltd., New Delhi, 2010, ISBN-13: 978-8120327870.
Course Outcomes	After taking this course, student will be able to CO 1. Apply IS and ACI codes for high-grade and self-compacting concrete mix designs and study its flow characteristics. CO 2. Analyse and design flat slabs, grid floors, prestressed concrete members using software, spreadsheets. CO 3. Apply practical learning through case studies and field observation CO 4. Analyse and compile findings, insights from design, case studies, and field visits into comprehensive reports that demonstrate understanding and application of learned concepts.

(Back to Index)

Name of the Programme : Master of Engineering (Computer Aided Structural Engineering)
Course Code : COS-507
Title of the Course : Theory of Thin Plates & Shells
Number of Credits : 03 (3L)
Effective from AY : 2024-25

Pre-requisites for the course:	Engineering Mathematics, Strength of materials, Theory of Deformable bodies	
Course Objectives:	The course will enable the students to: 1. Understand plate theory, including small deflection theory for rectangular plates and solutions for various boundary conditions. 2. Apply energy methods to analyze rectangular and circular plates with clamped edges under symmetric loadings. 3. Apply curved surface theories to analyze different shell types, including spherical, cylindrical, and hyperbolic paraboloids. 4. Analyze axially symmetrical bending and finite element formulations for plates and shells.	
Content:		**No. of Hours**
UNIT 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**
UNIT 2	**Energy methods for plates:** Energy methods for rectangular and circular plates with clamped edges subjected to symmetric loadings.	**11**
UNIT 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**
UNIT 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 **Finite Element Approach:** Finite element formulation for Plates and shells.	**10**
Pedagogy:	Constructive, Collaborative and inquiry based learning	
References/ Readings:	1. Chatterjee, B. K., Theory and Design of Concrete Shell Roofs, Chapman and Hall, 1978, ISBN-13: 978-0412316609. 2. Reddy, J. N., Mechanics of Laminated Composite Plates and Shells: Theory and Analysis, CRC Press, 2003, ISBN-13: 9780203502808. 3. Szilard, R., Theory and Analysis of Plates: Classical and Numerical Methods, Prentice Hall, 1974, ISBN-13: 978-0139134265. 4. Timoshenko, S. and Woinowsky-Kreiger, Theory of Plates and Shells, McGraw-Hill Book Company, New York, 1959, ISBN-13: 9780070647794.	

	5. Ugural, A. C., Stresses in Plates and Shells, McGraw-Hill Book Company, 1999, ISBN-13: 9780070657694.
Course Outcomes	After taking this course, 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

(Back to Index)

Name of the Programme : Master of Engineering (Computer Aided Structural Engineering)
Course Code : COS-508
Title of the Course : Computational Structural Dynamics
Number of Credits : 03 (3L)
Effective from AY : 2024-25

Pre-requisites for the course:	Mathematics, Numerical Techniques, Engineering Mechanics, Structural	
Course Objectives:	The course will enable the students to: 1. Understand the fundamentals of single degree of freedom systems, including free and damped vibrations, and the associated equations of motion. 2. Apply methods to analyse the response of single degree of freedom systems to harmonic and general dynamic loading, including evaluation of damping and numerical methods. 3. Apply concepts to multiple degrees of freedom systems, including free and forced vibration analysis, natural frequencies, and mode shapes. 4. Analyse dynamic behaviour in continuous systems and beams, including the formulation of stiffness and mass matrices and the application of computer programs for dynamic response analysis	
Content:		**No. of Hours**
UNIT 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 – viscous damping, equation of motion, critically damped system, over damped system, under damped system, and logarithmic decrement.	**12**
UNIT 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. **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.	**11**
UNIT 3	**Multiple degrees of Freedom system:** Dynamics of Multi-degree freedom systems: Mathematical models of multi-degree-of-freedom systems, Shear building concept, free and forced vibration of undamped and damped multi-degree-of- freedom	**12**

	systems – Natural frequencies and mode shapes – Orthogonality of modes. **Dynamics of continuous systems:** Dynamics of Continuous systems: Flexural vibration of beams with different end conditions **Basics of Vibration Control:** Base Isolation, Tuned Mass Damper	
UNIT 4	**Dynamic Analysis of Beams:** Stiffness matrix, mass matrix (lumped and consistent); equations of motion for the discretized beam in matrix form and its solutions. **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.	**10**
Pedagogy:	Constructive, Collaborative and inquiry based learning	
References/ Readings:	1. Chopra, A. K., Dynamics of Structures – Theory and Applications, Pearson Education, 2017, ISBN-13: 9788131713297. 2. Clough, R. W. and Penzien, J., Dynamics of Structures, McGraw-Hill, New York, 1975, ISBN-13: 9780070113923. 3. Craig, R. R. and Kurdila, A. J., Fundamentals of Structural Dynamics, John Wiley & Sons, 2011, ISBN-13: 9781118174449. 4. Mukhopadhyay, M., Vibration, Dynamics, and Structural Problems, Oxford & IBH Publishing Co., 2008, ISBN-13: 9788180520907. 5. Paz, Mario, Structural Dynamics: Theory and Computations, 2nd Edition, CBS Publishers and Distributors, New Delhi, 2012, ISBN-13: 9781461504818.	
Course Outcomes	After taking this course, student will be able to CO 1. Understand the fundamentals of single degree of freedom systems, including free and damped vibrations, and the associated equations of motion. CO 2. Apply methods to analyze the response of single degree of freedom systems to harmonic and general dynamic loading, including evaluation of damping and numerical methods. CO 3. Apply concepts to multiple degrees of freedom systems, including free vibration analysis, natural frequencies, and mode shapes CO 4. Analyze dynamic behavior in continuous systems and beams, including the formulation of stiffness and mass matrices and the application of computer programs for dynamic response analysis	

(Back to Index)

Name of the Programme : **Master of Engineering (Computer Aided Structural Engineering)**
Course Code : **COS-509**
Title of the Course : **Computer Aided Structural Engineering Lab 4**
Number of Credits : **2 P**
Effective from AY : **2024-25**

Pre-requisites for the course:	Theory of Plates and shells, Computational Structural Dynamics, Finite Element Analysis	
Course Objectives:	The course will enable the students to: 1. Understand the principles and methodologies for analyzing thin plates and shells, including the differences between thin shells, thick shells, and membranes. 2. Apply program development techniques to perform free and forced vibration analysis of single degree of freedom systems. 3. Apply dynamic modeling and analysis methods to two-dimensional frame structures and develop Excel sheets for numerical evaluation of SDOF systems. 4. Analyze the dynamic behavior of three-dimensional building structures using industry-standard methods, including modal analysis, the equivalent static method, and the response spectrum method.	
Contents:		**No. of Hours**
	List of Experiments (Minimum 12): 1. Analysis of Thin Plates 2. Analysis of Spherical Shells 3. Comparative analysis of thin shells, thick shells and membrane for Slab 4. Analysis of Cylindrical Shells 5. Analysis of axially symmetric bending of shells of revolution. 6. Analysis of axially symmetric bending of Closed Cylindrical shells. 7. Design of simple Shells- Spherical dome and Water tanks 8. Program Development for Free vibration Analysis of Single Degree of Freedom systems 9. Program Development for Forced vibration Analysis of Single Degree of Freedom systems 10. Dynamic modelling and analysis of a two-dimensional Frame structure. 11. Development of excel sheets for Numerical evaluation of SDOF systems. 12. Modal analysis of Three- dimensional building structure. 13. Dynamic Analysis of Three- dimensional building structure using Equivalent Static method 14. Dynamic Analysis of Three- dimensional building structure using Response Spectrum method (Any Industry standard software can be used for analysis)	**60**

Pedagogy:	Inquiry based learning, constructive planning of experiments, collaborative approach in performing experiments and field visits.
References/ Readings:	1. Chatterjee, B. K., Theory and Design of Concrete Shell Roofs, Chapman and Hall, 1978, ISBN-13: 978-0412316609. 2. Chopra, A. K., Dynamics of Structures – Theory and Applications, Pearson Education, 2017, ISBN-13: 9788131713297. 3. Clough, R. W. and Penzien, J., Dynamics of Structures, McGraw-Hill, New York, 1975, ISBN-13: 9780070113923. 4. Craig, R. R. and Kurdila, A. J., Fundamentals of Structural Dynamics, John Wiley & Sons, 2011, ISBN-13: 9781118174449. 5. Mukhopadhyay, M., Vibration, Dynamics, and Structural Problems, Oxford & IBH Publishing Co., 2008, ISBN-13: 9788180520907. 6. Paz, Mario, Structural Dynamics: Theory and Computations, 2nd Edition, CBS Publishers and Distributors, New Delhi, 2012, ISBN-13: 9781461504818. 7. Reddy, J. N., Mechanics of Laminated Composite Plates and Shells: Theory and Analysis, CRC Press, 2003, ISBN-13: 9780203502808. 8. Szilard, R., Theory and Analysis of Plates: Classical and Numerical Methods, Prentice Hall, 1974, ISBN-13: 978-0139134265. 9. Timoshenko, S. and Woinowsky-Kreiger, W., Theory of Plates and Shells, McGraw-Hill Book Company, New York, 1959, ISBN-13: 9780070647794. 10. Ugural, A. C., Stresses in Plates and Shells, McGraw-Hill Book Company, 1999, ISBN-13: 9780070657694.
Course Outcomes	After taking this course, student will be able to CO 1. Understand the principles and methodologies for analyzing thin plates and shells, including the differences between thin shells, thick shells, and membranes. CO 2. Apply program development techniques to perform free and forced vibration analysis of single degree of freedom systems. CO 3. Apply dynamic modeling and analysis methods to two-dimensional frame structures and develop Excel sheets for numerical evaluation of SDOF systems. CO 4. Analyze the dynamic behavior of three-dimensional building structures using industry-standard methods, including modal analysis, the equivalent static method, and the response spectrum method.

(Back to Index)

Programme Specific Elective (PSE) Courses
Name of the Programme : Master Of Engineering (Computer Aided Structural Engineering)
Course Code : COS-533
Title of the Course : Structural Health Monitoring
Number of Credits : 03 (3L)
Effective from AY : 2024-25

Pre-requisites for the course:	Material Science, Nondestructive testing methods	
Course Objectives:	The course will enable the students to: 1. Understand the principles of structural health monitoring (SHM), including definitions, motivations, and non-destructive testing (NDT) methods. 2. Apply static field-testing techniques and response measurement tools to evaluate real-world scenarios 3. Apply dynamic field-testing methods, such as vibration and impact tests, to evaluate structural performance. 4. Analyse and evaluate data acquisition systems and remote monitoring methods, including communication technologies and data compression techniques.	
Content:		**No. of Hours**
UNIT 1	**Introduction** - Definition of SHM - Motivation for structural health monitoring - Assessment by NDT equipment's. **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**
UNIT 2	**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.	**11**
UNIT 3	**Data Acquisition** - Static data acquisition systems - Dynamic data acquisition systems - Components of Data acquisition system - Hardware for Remote data acquisition systems.	**12**
UNIT 4	**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	**10**
Pedagogy:	Constructive, Collaborative and inquiry-based learning, Field Visits	
References/ Readings:	1. Adams, D. E., Health Monitoring of Structural Materials and Components: Methods with Applications, John Wiley and Sons, 2010, ISBN-13: 9780470511572. 2. Daniel, B., Claus-Peter, F., & Güemes, A., Structural Health Monitoring, John Wiley and Sons, 2010, ISBN-13: 9780470394403. 3. Giurgiutiu, V., Structural Health Monitoring with Wafer Active	

	Sensors, Academic Press Inc., 2014, ISBN-13: 9780124201026. 4. Huston, D., Structural Sensing, Health Monitoring, and Performance Evaluation, 2010, ISBN-13: 9781420012354. 5. Ou, J. P., Li, H., & Duan, Z. D., Structural Health Monitoring and Intelligent Infrastructure Vol-1, Taylor and Francis Group, London, U.K., 2005, ISBN-13: 978-0415396523.
Course Outcomes	After taking this course, student will be able to CO 1. Diagnose the distress in the structure CO 2. Apply knowledge of static and dynamic field-testing techniques to assess structural performance and health. CO 3. Effectively use static and dynamic data acquisition systems and understand their components for remote monitoring applications. CO 4. Implement remote structural health monitoring solutions, utilizing communication technologies, sensor networks, and data compression techniques.

(Back to Index)

Name of the Programme : **Master of Engineering (Computer Aided Structural Engineering)**
Course Code : **COS-534**
Title of the Course : **Structural Health Monitoring Lab**
Number of Credits : **1 P**
Effective from AY : **2024-25**

Pre-requisites for the course:	Concepts of Concrete Technology and Design of Concrete Structures.	
Course Objectives:	The course will enable the students to: 1. Evaluate the strength, integrity and homogeneity of concrete using non-destructive testing methods. 2. Evaluate durability by measuring different parameters like creep and shrinkage to assess its impact on the performance of concrete. 3. Assess the condition and performance of concrete using electrical resistance strain gauges Thermal Imaging Test 4. Document findings from condition surveys, including reinforcement details, concrete quality, durability factors, and any structural issues identified through testing, following CPWD guidelines.	
Contents:		**No. of Hours**
	List of Experiments (Minimum 8): 1. Conduct Condition Survey of a building and prepare detailed Visual Inspection Report as per CPWD guidelines. 2. To detect reinforcement details in concrete elements using Profometer. 3. Assess the quality of concrete with Rebound Hammer equipment. 4. Assess the quality of concrete with Ultrasonic Pulse Velocity equipment. 5. Carbonation Test on Concrete. 6. Rapid Chloride Permeability Test on Concrete. 7. Rapid Chloride Migration Test on Concrete. 8. Strain measurement – electrical resistance, strain gauges. 9. Short- and long-term durability tests and analysis using software 10. Shrinkage and Creep of concrete 11. Thermal imaging test.	**30**
Pedagogy:	Inquiry based learning, constructive planning of experiments, collaborative approach in performing experiments and field visits.	
References/ Readings:	1. Adams, D. E., Health Monitoring of Structural Materials and Components: Methods with Applications, John Wiley and Sons, 2010, ISBN-13: 9780470511572. 2. Daniel, B., Claus-Peter, F., & Güemes, A., Structural Health Monitoring, John Wiley and Sons, 2010, ISBN-13: 9780470394403. 3. General Standard for Qualification and Certification of Non-Destructive Testing Personnel [MTD 21: Non-Destructive Testing], IS	

	13805 (2004). 4. Giurgiutiu, V., Structural Health Monitoring with Wafer Active Sensors, Academic Press Inc., 2014, ISBN-13: 9780124201026. 5. Handbook on Repair and Rehabilitation of RCC Buildings, CPWD (Central Public Works Department), 2002. 6. Huston, D., Structural Sensing, Health Monitoring, and Performance Evaluation, 2010, ISBN-13: 9781420012354. 7. Method of Non-Destructive Testing of Concrete, Part 1: Ultrasonic Pulse Velocity [CED 2: Cement and Concrete], IS 13311-1 (1992). 8. Method of Tests for Strength of Concrete, BIS, New Delhi, India, IS 516:2006. 9. Ou, J. P., Li, H., & Duan, Z. D., Structural Health Monitoring and Intelligent Infrastructure Vol-1, Taylor and Francis Group, London, U.K., 2005, ISBN-13: 978-0415396523.
Course Outcomes	After taking this course, student will be able to CO 1. Evaluate the strength, integrity and homogeneity of concrete using non-destructive testing methods. CO 2. Evaluate durability by measuring different parameters like creep, shrinkage to access its impact on the performance of concrete. CO 3. Access the condition and performance of concrete using electrical resistance strain gauges Thermal Imaging Test CO 4. Compile and document findings from condition surveys, including reinforcement details, concrete quality, durability factors, and any structural issues identified through testing, following CPWD guidelines.

(Back to Index)

Name of the Programme : **Master of Engineering (Computer Aided Structural Engineering)**
Course Code : **COS-535**
Title of the Course : **Stability of Structures**
Number of Credits : **03 (3L)**
Effective from AY : **2024-25**

Pre-requisites for the course	Engineering Mathematics, Theory of deformable bodies, Theory of Plates and shells, Finite Element Analysis	
Course Objectives:	The course will enable the students to: 1. Understand the differential equations and formulations for beam-columns subjected to various lateral loads, including Euler's formulations for different column end conditions. 2. Apply methods to calculate critical loads and analyze buckling in frames and continuous beams, including the energy approach and effects of varying cross-sections. 3. Apply the finite element approach to stability analysis, including the calculation of critical loads for discretized columns and pin-jointed frames. 4. Analyse lateral buckling of beams and buckling of rectangular plates under various loading conditions, including uniaxial and biaxial loads.	
Content:		**No. of Hours**
UNIT 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**
UNIT 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, determination of critical loads by successive approximation, bars with varying cross section, effect of shear force on critical load.	**11**
UNIT 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). **Lateral buckling of beams:** Differential equations, pure bending, cantilever beam with tip load, simply supported beam of I section subjected to central concentrated load.	**12**
UNIT 4	**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.	**10**

Pedagogy:	Constructive, Collaborative and inquiry based learning
References/ Readings:	1. Cook, R. D., et al., Concepts and Applications of Finite Element Analysis, John Wiley and Sons, New York, 1981, ISBN-13: 9780471030508. 2. Jerath, S., Structural Stability Theory and Practice: Buckling of Columns, Beams, Plates, and Shells, John Wiley & Sons, 2020, ISBN-13: 9781119694526. 3. Simitse, G., et al., Fundamentals of Structural Stability, Hardcover, 2006, ISBN-13: 9780750678759. 4. Timoshenko, S. P., and Gere, J. M., Theory of Elastic Stability, McGraw-Hill, New Delhi, 2012, ISBN-13: 9780486134802. 5. Zeigler, H., Principles of Structural Stability, Blaisdell Publications, 1977, ISBN-13: 978376430886.
Course Outcomes	After taking this course, student will be able to CO 1. Understand the differential equations and formulations for beam-columns subjected to various lateral loads, including Euler's formulations for different column end conditions. CO 2. Apply methods to calculate critical loads and analyze buckling in frames and continuous beams, including the energy approach and effects of varying cross-sections. CO 3. Apply the finite element approach to stability analysis, including the calculation of critical loads for discretized columns and pin-jointed frames. CO 4. Analyze lateral buckling of beams and buckling of rectangular plates under various loading conditions, including uniaxial and biaxial loads.

(Back to Index)

Name of the Programme : **Master of Engineering (Computer Aided Structural Engineering)**
Course Code : **COS-536**
Title of the Course : **Stability of Structures Lab**
Number of Credits : **01 P**
Effective from AY : **2024-25**

Pre-requisites for the course:	Engineering Mathematics, Theory of deformable bodies, Theory of Plates and shells, Finite Element Analysis, Basics of Programming	
Course Objectives:	The course will enable the students to: 1. Analyze the stability and buckling behavior of different structural elements under various loading conditions. 2. Develop and implement Python programs to perform buckling analysis for beam columns, continuous beams, frames, beams subjected to lateral instability, and rectangular plates. 3. Compare the results obtained from industry-standard software and Python-based buckling analysis to evaluate accuracy, efficiency, and applicability in real-world scenarios. 4. Apply learned techniques to solve real-world buckling problems, enabling students to interpret results and make informed decisions for structural design and safety.	
Contents:		**No. of Hours**
	List of Experiments (Minimum 8): 1. Buckling analysis of beam column using industry standard software 2. Buckling analysis of continuous beam using industry standard software 3. Buckling analysis of frames using industry standard software 4. Buckling analysis of beam subjected to lateral instability using industry standard software 5. Buckling analysis of rectangular plates using industry standard software 6. Developing a computer program to perform buckling analysis of beam column 7. Developing a computer program to perform buckling analysis of continuous beam 8. Developing a computer program to perform buckling analysis of frames 9. Developing a computer program to perform buckling analysis of beam subjected to lateral instability 10. Developing a computer program to perform buckling analysis of rectangular plates	**30**
Pedagogy:	Inquiry based learning, constructive planning of experiments, collaborative approach in performing experiments and field visits.	
References/ Readings:	1. Adams, D. E., Health Monitoring of Structural Materials and Components: Methods with Applications, John Wiley and Sons, 2010,	

	ISBN-13: 9780470511572. 2. Daniel, B., Claus-Peter, F., & Güemes, A., Structural Health Monitoring, John Wiley and Sons, 2010, ISBN-13: 9780470394403. 3. General Standard for Qualification and Certification of Non-Destructive Testing Personnel [MTD 21: Non-Destructive Testing], IS 13805 (2004). 4. Giurgiutiu, V., Structural Health Monitoring with Wafer Active Sensors, Academic Press Inc., 2014, ISBN-13: 9780124201026. 5. Handbook on Repair and Rehabilitation of RCC Buildings, CPWD (Central Public Works Department), 2002. 6. Huston, D., Structural Sensing, Health Monitoring, and Performance Evaluation, 2010, ISBN-13: 9781420012354. 7. Method of Non-Destructive Testing of Concrete, Part 1: Ultrasonic Pulse Velocity [CED 2: Cement and Concrete], IS 13311-1 (1992). 8. Method of Tests for Strength of Concrete, BIS, New Delhi, India, IS 516:2006. 9. Ou, J. P., Li, H., & Duan, Z. D., Structural Health Monitoring and Intelligent Infrastructure Vol-1, Taylor and Francis Group, London, U.K., 2005, ISBN-13: 978-0415396523.
Course Outcomes	After taking this course, student will be able to CO 1. Analyze the stability and buckling behavior of different structural elements under various loading conditions. CO 2. Develop and implement Python programs to perform buckling analysis for beam columns, continuous beams, frames, beams subjected to lateral instability, and rectangular plates. CO 3. Compare the results obtained from industry-standard software and Python-based buckling analysis to evaluate accuracy, efficiency, and applicability in real-world scenarios. CO 4. Apply learned techniques to solve real-world buckling problems, enabling students to interpret results and make informed decisions for structural design and safety

(Back to Index)

Research Specific Elective (RSE) Courses
Name of the Programme : Master of Engineering (Computer Aided Structural Engineering)
Course Code : REC-563
Title of the Course : Statistics and Data Analysis for Engineering Research
Number of Credits : 2
Effective from AY : 2024-25

Pre-requisites for the Course:	Basic Knowledge of Statistics	
Course Objectives:	The course will enable the students to 1. Explain the different types of data and parameter estimations 2. Explain standard probability distributions 3. Select the appropriate parameter estimation & distribution method 4. Co-relate different Hypotheses	
Content:		**No of Hours**
Unit -1	**Data Analysis:** Types of data, data collection techniques, Quantitative methods for analysis of data – statistical tools, experimental data, Qualitative data collection, questioners, rating scale, conducting survey. Statistical Modeling and Graphical Diagnostics - Scatter Plot, Stem-and-Leaf Plot, Histogram, Box Plot **Correlation and Regression Modeling:** Basic concept and numericals.	**9**
Unit -2	**Probability distributions and Sampling distributions:** Basic introduction to Bernoulli, Binomial and Normal distribution. Basic introduction to Sampling distributions- Normal, t-distribution, Chi-square and F- distributions.	**7**
Unit -3	**Parameter estimation:** Point Estimation – Concept, unbiased estimator, method of maximum likelihood. Parameter estimation of standard distributions- Binomial and Normal. Confidence Interval Estimation - Concept, Confidence interval on mean of single normal population with variance known, Confidence interval on the ratio of variances of two normal distributions	**7**
Unit- 4	**Tests of Hypotheses:** Introduction, Type I and type II errors, significance level and power of the test, Test of hypotheses - on mean of single normal population with variance known, on variance of single normal population.	**7**
Pedagogy:	Inquiry based learning, Integrative, Reflective Learning, Constructive learning and Collaborative learning	
References/ Readings:	1. D. V Thiel, 'Research Methods for Engineers', Cambridge Press, 2014, ISBN:978-110-70-3-488 2. T. Mustafy, T. U Rahman, 'Statistics & Data Analysis for Engineers and Scientists', Springer, 2024, ISBN:9789819946600. 3. D. C. Montgomery, C. G. Runger, 'Applied Statistics and Probability for Engineers', 6th Edition, Wiley India, 2016, ISBN 0-471-20454-4	

Issued on: 28/01/2025

	4. R. E. Walpole, R. H. Myers, S. L. Myers, K. E. Ye; Probability and Statistics for Engineers and Scientists ,9th Edition, Pearson Education India, 2013, ISBN 978-0-321-62911-1 5. J. Schmuller, Statistical Analysis with Excel for Dummies, 5th Edition, John Wiley & Sons, 2022.
Course Outcomes:	After taking this course, student will be able to: CO 1. Explain the different types of data and probability distributions. CO 2. Select the appropriate parameter estimation & distribution method CO 3. Apply estimators for the given situations. CO 4. Evaluate Hypotheses based on the statistical considerations.

(Back to Index)

Name of the Programme : **Master of Engineering (Computer Aided Structural Engineering)**
Course Code : **REC-564**
Title of the Course : **Statistics and Data Analysis Lab**
Number of Credits : **2**
Effective from AY : **2024-25**

Pre-requisites for the Course:	Basic Knowledge of Statistics	
Course Objectives:	The course will enable the students to 1. Apply the different types of data and parameter estimations 2. Analyze standard probability distributions 3. Demonstrate parameter estimation & distribution methods 4. Co-relate different Hypotheses	
Content:		**No of Hours**
	Using open-source software like libreoffice or any proprietary software perform following experiments: 1. Obtain measures of central tendency and dispersion. 2. Obtain Quartiles, Percentiles and prepare Box-and-Whisker Diagram 3. Develop Pie chart, Bar Chart, Histogram and Stem-and-Leaf Plot, 4. Develop_correlation using Pearson's Correlation Coefficient and showing Scatter Diagrams and Trendlines 5. Develop Linear and Nonlinear Regression Models 6. Obtain probability values involving probability distributions – Binomial and Normal 7. Obtain values of Normal, t-distribution, Chi-square and F-statistic. 8. Develop confidence interval for single population and two populations with variance known. 9. Develop confidence interval on the ratio of variances of two normal distributions. 10. Perform test of hypotheses on mean/variance of single/ two population(s).	**60**
Pedagogy:	Inquiry based learning, Integrative, Reflective Learning, Constructive learning and Collaborative learning	
References/ Readings:	1. D. V Thiel, 'Research Methods for Engineers', Cambridge Press, 2014, ISBN:978-110-70-3-488 2. T. Mustafy, T. U Rahman, 'Statistics & Data Analysis for Engineers and Scientists', Springer, 2024, ISBN:9789819946600. 3. D. C. Montgomery, C. G. Runger, 'Applied Statistics and Probability for Engineers', 6th Edition, Wiley India, 2016, ISBN 0-471-20454-4 4. R. E. Walpole, R. H. Myers, S. L. Myers, K. E. Ye; Probability and Statistics for Engineers and Scientists ,9th Edition, Pearson Education India, 2013, ISBN 978-0-321-62911-1 5. J. Schmuller, Statistical Analysis with Excel for Dummies, 5th Edition,	

	John Wiley & Sons, 2022.
Course Outcomes:	After taking this course, student will be able to: CO 1. Apply the different types of data and parameter estimations CO 2. Analyze standard probability distributions CO 3. Demonstrate parameter estimation & distribution methods CO 4. Co-relate different Hypotheses

(Back to Index)

Name of the Programme : **Master of Engineering (Computer Aided Structural Engineering)**
Course Code : **REC-565**
Title of the Course : **Statistical Techniques for Engineering Research**
Number of Credits : **2**
Effective from AY : **2024-25**

Pre-requisites for the Course:	Basic knowledge of Statistics and Probability	
Course Objectives:	The course will enable the students to 1. Understand the importance of statistical methods for research 2. Select the appropriate factorial design method for a given set of experimental plan. 3. Apply basic probability theorems and draw relevant inferences. 4. Analyze suitable probability model for given set of data	
Content:		**No of Hours**
Unit-1	**Overview on Statistical methods**, collection of data, one dimensional and two-dimensional statistical analysis, computation of central tendency and dispersion for grouped and ungrouped data, correlation preliminary, understanding variability in data.	**6**
Unit-2	**Design of Experiments**, Preparation of experimental plan, full factorial design, fractional factorial design, identification of parameters and levels, randomization, replication, blocking, interaction; numerical; Optimization methods for two parameters.	**9**
Unit-3	**Probability Preliminary**: Introduction to Probability, definition, Sample Space, Events, Conditional Probability, Theorem on total probability, Bayes' theorem. Random Variable: Introduction, Discrete and Continuous distribution, Characteristics- Mean, Variance and distribution function.	**8**
Unit-4	**Probability and Sampling Distribution**: Bernoulli, Binomial, Exponential, Normal, distribution. Mean, variance and distribution function, important properties, approximations and applications. Statistic and Sampling Distribution: Population and Sample. Statistic, Sampling distributions- Normal, t-distribution, Chi-square and F- distributions.	**7**
Pedagogy:	Inquiry based learning, Integrative, Reflective Learning, Constructive learning and Collaborative learning	
References/ Readings:	1. Tahvir Mustafy, Tauhid U Rahman, 'Statistics & Data Analysis for Engineers and Scientists', Springer, 2024, ISBN:9789819946600. 2. Jiju Antony, 'Design of Experiments for Engineers & Scientists', Elsevier, 2023, ISBN 978-044-315-1736 3. Douglas Montgomery, 'Design and Analysis of Experiments', Wiley India, Eighth Edition, 2013, 9788126540501 4. J. Ravichandran, Probability and Statistics for Engineers, Wiley India, 2010, ISBN: 9788126523504	

	5. R. Johnson, Probability and Statistics for engineers, Eighth Edition, Prentice Hall of India, New Delhi, 2015, ISBN 978-1-292-17601-7 6. J. Schmuller, Statistical Analysis with Excel for Dummies, 5th Edition, John Wiley & Sons, 2022.
Course Outcomes:	After taking this course, student will be able to: CO 1. Understand the importance of statistical methods for research CO 2. Select the appropriate factorial design method for a given set of experimental plans. CO 3. Apply basic probability theorems and draw relevant inferences. CO 4. Analyze suitable probability model for given set of data

(Back to Index)

Name of the Programme : Master of Engineering (Computer Aided Structural Engineering)
Course Code : REC-566
Title of the Course : Statistical Techniques Lab
Number of Credits : 2
Effective from AY : 2024-25

Pre-requisites for the Course:	Basic knowledge of Statistics and Probability	
Course Objectives:	The course will enable the students to 1. Apply basic probability theorems and draw relevant inferences. 2. Analyze suitable probability model for given set of data 3. Demonstrate factorial design methods 4. Synthesize fractional and full factorial experimental design data	
Content:		**No of Hours**
	Using open-source software like libreoffice or any proprietary software perform following experiments: 1. Obtain probability values involving discrete probability distributions - Bernoulli, Binomial. 2. Obtain probability values involving continuous probability distributions - Exponential and Normal distributions. 3. Obtain values of Normal, t-distribution, Chi-square and F-statistic. 4. Obtain values of Mean, Variance and distribution function of Bernoulli and Binomial distribution. 5. Obtain values of Mean, Variance and distribution function of Exponential and Normal distributions. 6. Obtain values of central tendency of grouped and ungrouped data. 7. Obtain values of dispersion of grouped and ungrouped data. 8. Analyse experimental output using full factorial design. 9. Analyse experimental output using fractional factorial design. 10. Analyse a full case study in involving full factorial design or fractional factorial design.	**60**
Pedagogy:	Inquiry based learning, Integrative, Reflective Learning, Constructive learning and Collaborative learning	
References/ Readings:	1. Tahvir Mustafy, Tauhid U Rahman, 'Statistics & Data Analysis for Engineers and Scientists', Springer, 2024, ISBN:9789819946600. 2. Jiju Antony, 'Design of Experiments for Engineers & Scientists', Elsevier, 2023, ISBN 978-044-315-1736 3. Douglas Montgomery, 'Design and Analysis of Experiments', Wiley India, Eighth Edition, 2013, 9788126540501 4. J. Ravichandran, Probability and Statistics for Engineers, Wiley India, 2010, ISBN: 9788126523504 5. R. Johnson, Probability and Statistics for engineers, Eighth Edition, Prentice Hall of India, New Delhi, 2015, ISBN 978-1-292-17601-7 6. J. Schmuller, Statistical Analysis with Excel for Dummies, 5th Edition,	

	John Wiley & Sons, 2022.
Course Outcomes:	After taking this course, student will be able to: CO 1. Apply basic probability theorems and draw relevant inferences. CO 2. Analyze suitable probability model for given set of data CO 3. Demonstrate factorial design methods CO 4. Synthesize fractional and full factorial experimental design data

(Back to Index)