**20CE32E3 - FINITE ELEMENT ANALYSIS**

**(Civil Engineering)**

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| **Course Category**  | Professional Elective | **Credits** | 3 |
| **Course Type** | Theory | **Lecture-Tutorial-Practical** | 3-0-0 |
| **Prerequisite** | Structural Analysis | **Sessional Evaluation** | 40 |
| **External Evaluation** | 60 |
| **Total Marks** | 100 |

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| **Course Outcomes** | CO1 | Understand the basic principles of finite element method. |
| CO2 | Comprehend the concepts of finite element modelling and discretization,shape functions. |
| CO3 | Apply the finite element method in one dimensional elements. |
| CO4 | Utilize the finite element method in analyzing plane trusses. |
| CO5 | Make use of finite element formulation for beam elements and apply plane stress and plane strain concepts to plane elements. |
| CO6 | Apply the knowledge of isoperimetric elements for analysis. |
| **Course****Content** | **UNIT –I****INTRODUCTION:** Historical background - Functional approximation- weighted residual methods – Rayleigh ritz method -Basic steps in Finite element method– Advantages and disadvantages – Limitations.**UNIT – II****FINITE ELEMENT MODELING AND DISCRETIZATION:** Finite element modeling and discretization – Interpolation and shape functions – Types of elements –Nodes and degrees of freedom- serendipity elements.**UNIT – III****ONE DIMENSIONAL FINITE ELEMENTS:** Introduction – Bar element – Beam element – Bar and beam elements of arbitrary orientation ––Element stiffness matrices –Assembly of element stiffness matrices––Loads––Boundary conditions –– Applications.**UNIT – IV****TWO DIMENSIONAL FINITE ELEMENTS:** Plane trusses – Local and global coordinate systems – Direction cosines – element stiffness matrix – Assembly of element stiffness matrices – Stress calculation - Temperature effects.**UNIT – V****FINITE ELEMENT FORMULATION:** Introduction – Beam stiffness matrix– Assembly of beam stiffness matrices – Loads – Boundary conditions – temperature effects.Plane stress analysis – Plane strain analysis.**UNIT – VI****ISOPARAMETRIC ELEMENTS:** Introduction– coordinate transformation - shape functions for isoparametric elements - Mesh generation – Mesh refinement– Numerical integration – Application to plane stress problems –Introduction to analysis software (for practice purpose only). |
| **Text****& Reference books** | **TEXT BOOKS:*** 1. C.S. Krishnamoorthy, *Finite Element Analysis*, McGraw–HillEducation, 2nd Edition, 2017.
	2. S. S. Bhavikatti, *Finite Element Analysis*, New age international publishers, 3rd Edition, 2015.
	3. Tirupathi R. Chandrupatla & Ashok D. Belegundu, *Introduction to Finite Elementsin Engineering*, Pearson Education, 4th Edition, 2011.

**REFERENCE BOOKS:** * + 1. O.C. Zienkiewicz, R.L. Taylor and J.Z. Zhu, *The Finite Element Method: Its basics and Fundamentals*, Butterworth-Heinemann publishers, 7th Edition, 2013.
		2. Robert D. Cook, David S. Malkus, Michael E. Plesha, Robert J. Witt, *Concepts and Applications of Finite Element Analysis*, John Wiley& Sons Publishers, 4th Edition, 2001.
		3. Daryl L. Logan, *A First Course in the Finite Element Method*, CL Engineering, 5th Revised Edition, 2010.
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**CO-PO Mapping:** 3-High Mapping, 2-Moderate Mapping, 1-Low Mapping, - -Not Mapping

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|   | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** | **PSO1** | **PSO2** | **PSO3** |
| **CO1** | 2 | 1 | - | - | - | - | - | - | - | - | - | 2 | 1 | - | - |
| **CO2** | 1 | 1 | - | - | - | - | - | - | - | - | - | 2 | 3 | 3 | 1 |
| **CO3** | 3 | 2 | - | 2 | 1 | - | - | - | - | - | - | 1 | 2 | 2 | 1 |
| **CO4** | 3 | 2 | - | 1 | 1 | - | - | - | - | - | - | 1 | 2 | 2 | 1 |
| **CO5** | 3 | 2 | - | 1 | 1 | - | - | - | - | - | - | 1 | 2 | 2 | 1 |
| **CO6** | 2 | 1 | 1 | 1 | 2 | - | - | - | - | - | - | 2 | 3 | 3 | - |