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|  | **National Institute of Technology Meghalaya**An Institute of National Importance | **CURRICULUM** |
| Programme | **Doctor of Philosophy**  | Year of Regulation | **2018** |
| Department | **Civil Engineering** | Semester | **I** |
| Course Code | Course Name | Pre-requisite | Credit Structure | Marks Distribution |
| L | T | P | C | INT | MID | END | Total |
| **CE 701** | **FINITE ELEMENT METHOD**  | **NIL** | **3** | **0** | **0** | **3** | **50** | **50** | **100** | **200** |
| Course Objectives | **To develop the student’s knowledge on understanding of ordinary and partial differential equations.** | Course Outcomes | CO1 | Student will be able to have a solid foundation on the theoretical basis of the weighted residual Finite Element Method. |
| CO2 | Be able to use the commercial Finite Element packages to build Finite Element models and solve a selected range of engineering problems. |
| **To provide some knowledge on mathematical concepts of the Finite Element Method for obtaining an approximate solution of ordinary and partial differential equations.**  |
| CO3 | Be able to use these solutions to guide and validate a Finite Element model using a range of techniques. |
| CO4 | Be able to communicate effectively in writing to report (both textually and graphically) the method used, the implementation and the numerical results obtained. |
| CO5 | Be able to discuss the accuracy of the Finite Element solutions |
| SYLLABUS |
| No. | Content | Hours | COs |
| I | **Introduction:** Introduction; Basic Concepts of Finite Element Analysis; Introduction to Elasticity; Steps in Finite Element Analysis | 06 | CO1 |
| II | **Finite Element Formulation Techniques:** Virtual Work and Variational Principle; Galerkin Method; Finite Element Method: Displacement Approach; Stiffness Matrix and Boundary Conditions. | 06 | CO2 |
| III | **Element Properties:** Natural Coordinates; Triangular Elements; Rectangular Elements; Lagrange and Serendipity Elements; Solid Elements; Isoparametric Formulation; Stiffness Matrix of Isoparametric Elements; Numerical Integration: One Dimensional; Numerical Integration: Two and Three Dimensional | 06 | CO3 |
| IV | **Analysis of Frame Structures:** Stiffness of Truss Members; Analysis of Truss; Stiffness of Beam Members; Finite Element Analysis of Continuous Beam; Plane Frame Analysis | 06 | CO4 |
| V | **FEM for Two and Three Dimensional Solids:** Constant Strain Triangle; Linear Strain Triangle; Rectangular Elements; Numerical Evaluation of Element Stiffness; Computation of Stresses, Geometric Nonlinearity and Static Condensation; Axisymmetric Element; Finite Element Formulation of Axisymmetric Element; Finite Element Formulation for 3 Dimensional Elements | 06 | CO5 |
| VI | **FEM for Plates and Shells:** Introduction to Plate Bending Problems; Finite Element Analysis of Thin Plate; Finite Element Analysis of Thick Plate; Finite Element Analysis of Skew Plate; Introduction to Finite Strip Method; Finite Element Analysis of Shell. | 06 | CO1, CO3 |
| Total Hours | 36 |  |
| **Essential Readings** |
| 1. Reddy, J. N., “*An Introduction to the Finite Element Method*”, Tata McGraw Hill, 2nd Ed, 2003 |
| 2. Krishnamoorthy, C. S., “*Finite Elements Analysis: Theory and Programming*”, Tata McGraw Hill, 2nd Ed, 1994 |
| **Supplementary Readings** |
| 1. Cook, R. D., Malkus, D. S., and Plesha, M. E., “*Concepts and Applications of Finite Element Analysis*”, John Wiley & Sons, 4th Ed, 2002. |
| 2. Zienkiewicz, O. C., Taylor, R. L., and Zhu, J. Z., “*Finite Element Method Its Basis and Fundamentals*”, Elsevier, 6th Ed, 2005. |