M.E Semester: 2 M.E Mechanical (Automobile Engineering)
Subject Name: Finite Element Modeling and Analysis (Elective- II) MEA206B

A. **Course Objective**

- To present a problem oriented in depth knowledge of finite element modeling and analysis
- To address the underlying concepts and methods behind finite element modeling and analysis

B. **Teaching / Examination Scheme**

SUBJECT		Teaching Scheme				Total Credit	Evaluation Scheme					Total Marks
		L	T	P	Total		THEORY		IE	CIA	PR. / VIVO	
CODE	NAME	Hrs	Hrs	Hrs	Hrs		Hrs	Marks	Marks	Marks	Marks	
MEA206B	Finite element modeling and analysis	3	0	0	3	3	3	70	30	20	0	120

C. **Detailed Syllabus**

1. INTRODUCTION TO FEM: Engineering design analysis-meaning and purpose, steady state, propagation and transient problems. Basic concepts of FEM. Applicability of FEM to structural analysis, heat transfer and fluid flow problems. Advantages and limitations of FEM. Test for convergence. Element choice. Commercial finite element packages-organization-advantages and limitations.
2. STATIC ANALYSIS OF ONE DIMENSIONL ELEMENT: General procedure of FEM. Skeletal and continuum structures. Discretization of domain, basic types of elements. Concept of stiffness analysis, direct approach, Rayleigh-Ritz method, formal approach using shape function. Formulation of element stiffness matrices by potential energy approach, 1D spar and beam elements. Galerkin's residual method and its application to a one, dimensional bar.
3. STATIC ANALYSIS OF 2D AND 3D ELEMENTS: 2D triangular and quadrilateral elements, axisymmetric elements, 3D tetrahedron element, Isoparametric formulation. Treatment of boundary condition. Mesh generation techniques.

4. DYNAMIC ANALYSIS: Equations of motion for dynamic problems. Consistent and lumped mass matrices. Formulation of element mass matrices. Free vibration problem formulation. Time, dependent one-dimensional bar analysis.
5. HEAT TRANSFER AND FLUID FLOW ANALYSIS: Basic equations of heat transfer and fluid flow problems. Finite element formulation using variational method. One dimensional heat transfer and fluid flow problems, Transient thermal analysis. Application of Galerkin's method to heat transfer problems.
6. BOUNDARY ELEMENT METHOD: Principle of boundary element method. Conversion of basic weighted residue statement into boundary integral equation. Concept of fundamental solution. Application to heat transfer problems. Brief introduction to formulation of problems in elastostatics.

D. **Lesson Planning**

SR.NO	DATE/WEEK	UNIT NO	%WEITAGE	TOPIC NO
1	1^{ST} , 2^{ND} , 3^{RD}	1	20	1
2	4^{TH} ,5^{TH} , 6^{TH}	2	20	2
3	7^{TH} ,8^{TH} , 9^{TH}	3	20	3
4	10^{TH} ,11^{TH} , 12^{TH}	4	20	4
5	13^{TH} ,14^{TH} , 15^{TH}	5	20	5,6

E. **Instructional Method & Pedagogy**

- At the start of course, the course delivery pattern , prerequisite of the subject will be discussed
- Lecture may be conducted with the aid of multi-media projector, black board, OHP etc. & equal weightage should be given to all topics while teaching and conduction of all examinations.
- Attendance is compulsory in lectures and laboratory, which may carries five marks in overall evaluation.
- One/Two internal exams may be conducted and total/average/best of the same may be converted to equivalent of 30 marks as a part of internal theory evaluation.
- Assignment based on course content will be given to the student for each unit/topic and will be evaluated at regular interval. It may carry an importance of ten marks in the overall internal evaluation.
- Surprise tests/Quizzes/Seminar/Tutorial may be conducted and having share of five marks in the overall internal evaluation.

F. **Students Learning Outcomes**

- The student can identify different areas of Finite element modeling and analysis.
- Can find the applications of all the areas in day to day life.

G. **Recommended Study Materials**

- **Text & Reference Books:**

1. Cook R.D. "Concepts and applications of finite element analysis" Wiley, New York, 1981.
2. Bathe K.J., Cliffs, N.J. "Finite element procedures in Engineering Analysis", Englewood. Prentice Hall, 1981.
3. Reddy J. N., Finite Element Method, Tata McGrawHill Edition, 2E, 2003.
4. Chandrupatla and Belegundu "Introduction to finite elements in Engineering", Prentice Hall of India Pvt. Ltd. New Delhi, 2001.
5. Segerling L.J. – 'Applied finite elements analysis' John Wiley and Sons.
6. Bathe- 'Finite Element Methods' Prentice Hall of India (P) Ltd, New delhi.
7. O.C. Zienkiewicz 'Finite Element Method' Tata Mc Graw Hill, New Delhi.
8. J.N. Reddy- 'An Introduction to FEM', Mc Graw Hill International Edition
9. C.S. Krishnamoonthy-'Finite Element Analysis – Theory and Programming', Tata Mc Graw Hill Publishing Co. Ltd, New Delhi.
10. Nitin Gokhale, Deshpande-'Practical Finite Element Analysis, Finite to Infinite Pune.