Hall Ticket No | | | | | | | | | | | Question Paper Code: AME014

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

MODEL QUESTION PAPER

B.Tech VI Semester End Examinations (Regular), April– 2020

Regulations: R16

FINITE ELEMENT MODELLING

(MECHANICAL ENGINEERING)

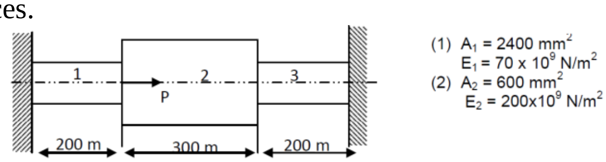
Time: 3 hours **Max. Marks: 70**

Answer ONE Question from each Unit
All Questions Carry Equal Marks
All parts of the question must be answered in one place only

UNIT – I

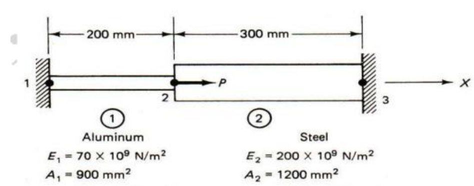
1. a)Explain the strain – displacement relations. **[7M]**

   b)An axial load P = 200X103 N is applied on a bar shown. Using the penalty approach for handling boundary conditions, determine nodal displacements, stress in each material and reaction forces. **[7M]**



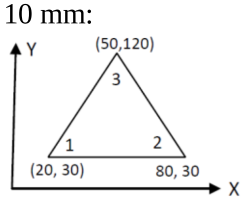
2. a)Discuss the basic steps involved in FEM and explain in detail **[7M]**

   b) Determine the displacements and the support reactions for the uniform bar shown in figure. Given P=300KN. **[7M]**



UNIT – II

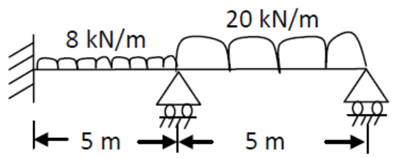
3. a)Evaluate the stiffness matrix for the elements shown in figure below. The coordinates are given in units of millimeters. Assume plane stress conditions. Let E = 210 GPa, passion ratio 0.25, andthickness 10 mm: **[7M]**



   b) Derive the element stiffness matrix for a 2-noded beam element. **[7M]**

4. a) Derive element stiffness matrix for two dimensional truss element. **[7M]**

b) Analyze the beam shown in figure by finite element method and determine the end reactions. Also determine the deflections at mid spans given E = 2 x 10^5 N/mm^2 and I= 5 x $10^5$$nm^4$. **[7M]**



UNIT – III

5. a)Derive the strain-displacement matrix, stiffness matrix and nodal load vectors for a linear strain triangular element. **[7M]**

b)Two dimensional simple elements are used to find the pressure distribution in a fluid medium. The (x, y) coordinates of nodes i, j and k of an element are given by (2,4), (4,0) and (2,6) respectively. Find the shape functions Ni, Nj and Nk of the element. **[7M]**

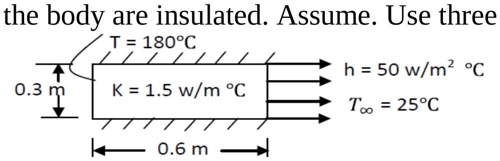
6. a)Write short notes on: **[7M]**
(i) Uniqueness of mapping of isoparametric elements. (ii) Gaussian quadrature integrationtechnique.

b)Triangular elements are used for stress analysis of a plate subjected to in-plane load. The components of displacement parallel to (x, y) axes at the nodes i, j and k of an element are found to be (- 0.001, 0.01), (-0.002, 0.01) and (- 0.002, 0.02) cm respectively. If the (x, y) coordinates of the nodes i, j and j are (20, 20), (40, 20) and (40, 40) in cm respectively, find (a) the distribution of the (x, y) displacement components inside the element and (b) the components of displacement of the point (xp,yp) = (30, 25) cm. **[7M]**

UNIT – IV

7. a)Explain 2-D finite element formulation in heat transfer analysis **[7M]**

b)For the 2-D body shown in figure, determine the temperature distribution. The edges on the top and bottom of the body are insulated. Assume. Use three element models. **[7M]**



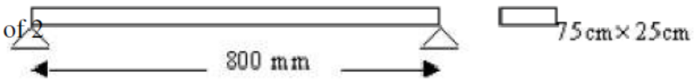
8. a)Write in general the process of formulation of the thermal stresses in engineering problems. **[7M]**

b)A composite slab consists of three materials of different conductivities is 20 W/mk, 30 W/mk and 50 W/mk of thickness 0.3 m , 0.15m and 0.15m respectively. The outer surface is 200C and the inner surface is exposed to the convective heat transfer coefficient of 25 W/m2k at 3000C. Determine the temperature distribution within the wall. **[7M]**

UNIT – V

9. a)Discuss the methodology to solve the Eigen value problem for the estimation of natural frequencies of a stepped bar. **[7M]**

b) Determine the natural frequencies of a simply supported beam of length 800 mm with the cross sectional area of 75 cm X 25 cm as shown in the figure **[7M]**
Take E= 200 Gpa and density of 7850 kg/m3.



10 a) Differentiate lumped mass matrix and consistent mass matrix. **[7M]**

b) Find the natural frequencies and the corresponding mode shapes for the longitudinal vibrations for a stepped bar having A1 = 2A and A2 = A ; I1 = I2 = I & ; E1 = E2 = E. **[7M]**

COURSE OBJECTIVES:

The course should enable the students to:

	Description
I	Introduce basic concepts of finite element methods including domain discretization, polynomial interpolation and application of boundary conditions.
II	Understand the theoretical basics of governing equations and convergence criteria of finite element method.
III	Develop of mathematical model for physical problems and concept of discretization of continuum
IV	Discuss the accurate Finite Element Solutions for the various field problems
V	Use the commercial Finite Element packages to build Finite Element models and solve a selected range of engineering problems

COURSEOUTCOMES(COs):

CO 1	Describethe concept ofFEMand difference between the FEMwith othermethods and problems based on 1-D barelements andshape functions.
CO 2	Derive elemental properties and shapefunctionsfortrussand beamelements and relatedproblems.
CO 3	Understand the concept derivingthe elementalmatrix and solving the basic problems ofCSTand axi-symmetric solids.
CO 4	Explorethe concept ofsteady stateheat transfer infin and composite slab.
CO 5	Understand the concept of consistent andlumpedmassmodels and slovethe dynamic analysis of all types of elements.

COURSE LEARNING OUTCOMES (CLOs):

Students, who complete the course, will have demonstrated the ability to do the following:

AME014.01	Understand the numerical methods and development of mathematical models for physical system
AME014.02	Identify mathematical model for solution of common engineering problems in the field of aeronautical, mechanical and civil
AME014.03	Understand the concepts of shape functions for one dimensional and quadratic elements, stiffness matrix and boundary conditions
AME014.04	Remember the steps involved in finite element methods while solving the model of physical problem
AME014.05	Apply numerical methods for solving one dimensional bar problems
AME014.06	Identify the mathematical models for two-dimensional, three-dimensional truss and beam elements.
AME014.07	Solve the equations of truss and beam elements
AME014.08	Calculate stress strain and strain energy for common engineering problems
AME014.09	Derive element matrix by different methods by applying basic laws in mechanics and integration by parts
AME014.10	Demonstrate the ability to evaluate and interpret FEA analysis results for design and development purposes

AME014.11	Formulate simple and complex problems into finite elements and solve structural and thermal problems
AME014.12	Derive the element stiffness matrices for triangular elements and axi- symmetric solids and estimate the load vector and stresses.
AME014.13	Understand the concepts of steady state heat transfer analysis for one dimensional slab, fin and thin plate.
AME014.14	Understand the concepts of mass and spring system and derive the equations for various structural problems
AME014.15	Calculate the mass matrices; Eigen values Eigen vectors and natural frequency for dynamic problems.
AME014.16	Model multi-dimensional structural and heat transfer problems by using automatic and fully automatic software such as ANSYS, NISA, NASTRAN.
AME014.17	Understand the concept of dynamic analysis for all types of elements.
AME014.18	Calculate the mass matrices, Eigen values, Eigen vectors, natural frequency and mode shapes for dynamic problems.

MAPPING OF SEMESTER END EXAMINATION TO COURSE OUTCOMES

SEE Question No.		Course Learning Outcomes		Course Outcomes	Blooms 'Taxonomy Level
1	a	AME014.01	DescribethebasicconceptsofFEMandsteps involved in it.	CO 1	Remember
	b	AME014.05	Apply numericalmethodsforsolving onedimensional barproblems	CO 1	Understand
2	a	AME014.03	Understand the stress-strain relation for2-D and their field problem.	CO 1	Remember
	b	AME014.05	Apply numericalmethodsforsolving onedimensional barproblems	CO 1	Understand
3	a	AME014.07	Solve the equations oftruss and beamelements	CO 2	Remember
	b	AME014.09	Applythenumericalmethodsforsolvingtrussand beamproblems	CO 2	Understand
4	a	AME014.08	Understandtheconceptsofshapefunctionsforbeam element.	CO 2	Understand
	b	AME014.09	Applythenumericalmethodsforsolvingtrussand beamproblems	CO 2	Understand
5	a	AME014.10	Derivetheelementstiffnessmatricesfortriangular elementsandaxi-symmetricsolidsandestimatethe loadvectorand stresses.	CO 3	Understand
	b	AME014.11	Formulatesimpleandcomplexproblemsintofinite elementsand solve structuraland thermal problems	CO 3	Understand
6	a	AME014.10	Derivetheelementstiffnessmatricesfortriangular elementsandaxi-symmetricsolidsandestimatethe loadvectorand stresses.	CO 3	Understand
	b	AME014.11	Formulatesimpleandcomplexproblemsintofinite elementsand solve structuraland thermal problems	CO 3	Understand
7	a	AME014.13	Understandtheconceptsofsteadystateheattransfer analysisfor one dimensional slab, finand thin plate.	CO 4	Remember
	b	AME014.14	Derive thestiffnesmatrixforforfinelement.	CO 4	Remember
8	a	AME014.14	Derive thestiffnesmatrixforforfinelement.	CO 4	Remember
	b	AME014.15	Solve thesteadystateheat transfer problems forfin and composite slab.	CO 4	Understand

9	a	AME014.18	Calculatethemassmatrices,Eigenvalues,Eigen vectors,naturalfrequencyandmodeshapesfor dynamic problems.	CO 5	Understand
	b	AME014.18	Calculatethemassmatrices,Eigenvalues,Eigen vectors,naturalfrequencyandmodeshapesfor dynamic problems.	CO 5	Understand
10	a	AME014.16	Understandtheconceptsofmassandspringsystem andderivetheequationsforvariousstructural problems	CO 5	Remember
	b	AME014.18	Calculatethemassmatrices,Eigenvalues, Eigen vectors, natural frequency andmode shapesfor dynamic problems.	CO 5	Understand

Signature of Course Coordinator **HOD, ME**