Hall Ticket No | | | | | | | | | | | Question Paper Code: AAE009

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

MODEL QUESTION PAPER - II

B.Tech V Semester End Examinations, November/December – 2019

Regulations: IARE - R16

FINITE ELEMENT METHODS

(AERONAUTICAL ENGINEERING)

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

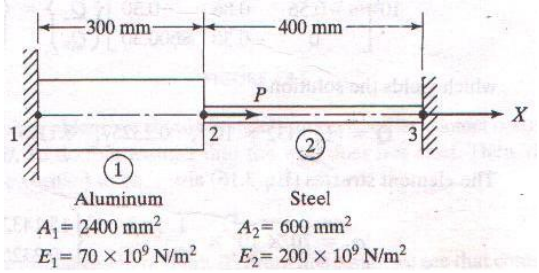
Answer ONE Question from each Unit
All Questions Carry Equal Marks
All parts of the question must be answered in one place only

UNIT – I

1. a) Explain the criteria for nodal selection for structural elements. **[7M]**

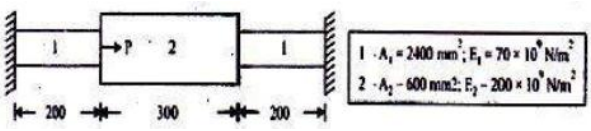
   b) Consider the following figure. An axial load P=200 KN is applied as shown **[7M]**

   a) Determine the nodal displacements.
   b) Determine the stress in each material.
   c) Determine the reaction forces.



2. a) Explain the equilibrium state of the system, when the system is subjected to different types of loads and explain the stress and equilibrium relations **[7M]**

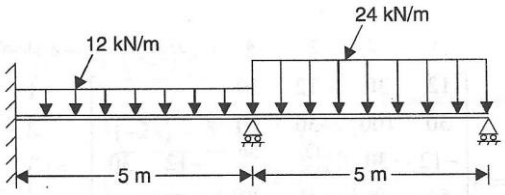
   b) An axial load P = 200×103 N is applied on a bar as shown in figure. Determine nodal displacements, stress in each material and reactions. **[7M]**



UNIT – II

3. a) Derive the stiffness matrix for two dimensional plane truss elements. **[7M]**

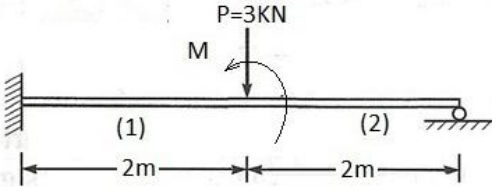
   b) Apply the beam shown in Figure below by finite element method and determine the end reactions. Also determine the deflections at mid spans given E=2X105N/mm2, and I=5X106 mm^4. **[7M]**



4. a) What is a beam? Derive the shape functions for beams and draw the shape functions. **[7M]**

b) Determine the nodal displacements and slopes for the beam shown in fig. find the moment at the midpoint of element. **[7M]**

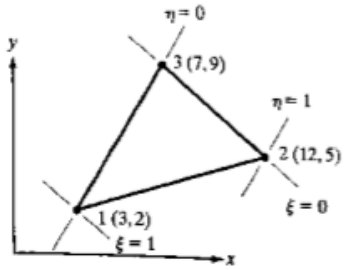
Take E=200 GPa,,I=5 x 104 mm4, M=6KN-M.



UNIT – III

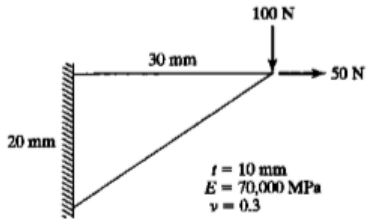
5. a) Define Iso-parametric, Super Parametric and Sub-Parametric elements **[7M]**

b) Determine the jacobian for the (x, y) – (ξ, η) transformation for the element shown in fig, also find the area of the triangle. **[7M]**



6. a) Derive the shape function and strain displacement matrices for triangular element of revolving body **[7M]**

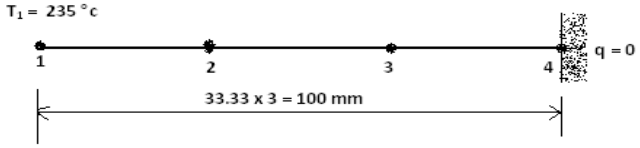
b) For the two dimensional plate shown in figure, determine the deflection at the point of load application. **[7M]**



UNIT – IV

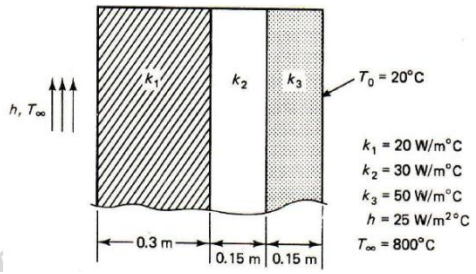
7. a) Derive the conductivity matrix for two dimensional triangular element subjected to convection on one face of the element. **[7M]**

b) A metallic fin with thermal conductivity K=360W/m^{0}c, 1mm thick and100mm long extends from a plane wall whose temperature is 235^{0}c. Determine the distribution and amount of heat transferred from the fin to air at 20^{0}c with h= 9W/m^{20}c take width of the fin is 1000 mm. Assume tip is insulted. **[7M]**



8. a) Derive one dimensional steady state heat conduction equation and apply to one dimensional fin problem **[7M]**

b) A composite wall consists of three materials as shown in figure. The outer temperature is T_0 = 200C. Convection heat transfer takes place on the inner surface of the wall with T_∞=8000C and h= 25 W/m^{2o}C. Determine the temperature distribution in the wall. **[7M]**

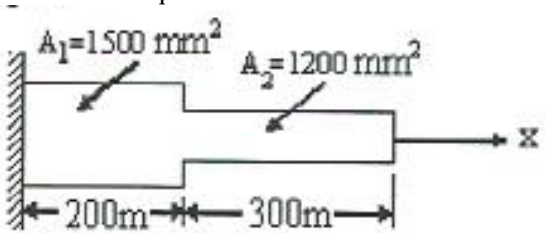


UNIT – V

9. a) State the properties of Eigen Values. Determine the eigen values and the associated Eigen Vectors of matrix [A] given by **[7M]**

$$A = \begin{bmatrix} 3 & 4 \\ 4 & -3 \end{bmatrix}$$

b) Consider axial vibration of the steel bar shown in figure below. Develop the global stiffness mass matrix and determine the natural frequencies and mode shapes using the characteristic polynomial technique. **[7M]**



10 a). Discuss the importance of semi-automatic meshing and auto mesh along with the practical applications **[7M]**

b) Find the natural frequencies in the vibration of two element simply supported beam having the parameters as length L= 2m, area of cross section A = 30 cm^2, moment of inertia I=400 mm^{4}density ρ = 7800 kg/m^3 and Young's modulus E = 200 GPa. **[7M]**

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COURSE OBJECTIVES:

S. No	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

COURSE OUTCOMES (COs):

CO 1	Describe the concept of FEM and difference between the FEM with other methods and problems based on 1-D bar elements and shape functions.
CO 2	Derive elemental properties and shape functions for truss and beam elements and related problems.
CO 3	Understand the concept deriving the elemental matrix and solving the basic problems of CST and axi-symmetric solids.
CO 4	Explore the concept of steady state heat transfer in fin and composite slab.
CO 5	Understand the concept of consistent and lumped mass models and slove the dynamic analysis of all types of elements.

COURSE LEARNING OUTCOMES (CLOs):

AAE009.01	Describe the basic concepts of FEM and steps involved in it.
AAE009.02	Understand the difference between the FEM and Other methods.
AAE009.03	Understand the stress-strain relation for 2-D and their field problem.
AAE009.04	Understand the concepts of shape functions for one dimensional and quadratic elements, stiffness matrix and boundary conditions
AAE009.05	Apply numerical methods for solving one dimensional bar problems
AAE009.06	Derive the elemental property matrix for beam and bar elements.
AAE009.07	Solve the equations of truss and beam elements

AAE009.08	Understand the concepts of shape functions for beam element.
AAE009.09	Apply the numerical methods for solving truss and beam problems
AAE009.10	Derive the element stiffness matrices for triangular elements and axi- symmetric solids and estimate the load vector and stresses.
AAE009.11	Formulate simple and complex problems into finite elements and solve structural and thermal problems
AAE009.12	Understand the concept of CST and LST and their shape functions.
AAE009.13	Understand the concepts of steady state heat transfer analysis for one dimensional slab, fin and thin plate.
AAE009.14	Derive the stiffnes matrix for for fin element.
AAE009.15	Solve the steady state heat transfer problems for fin and composite slab.
AAE009.16	Understand the concepts of mass and spring system and derive the equations for various structural problems
AAE009.17	Understand the concept of dynamic analysis for all types of elements.
AAE009.18	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	AAE009.01	Describe the basic concepts of FEM and steps involved in it.	CO 1	Remember
	b	AAE009.05	Apply numerical methods for solving one dimensional bar problems	CO 1	Understand
2	a	AAE009.03	Understand the stress-strain relation for 2-D and their field problem.	CO 1	Remember
	b	AAE009.05	Apply numerical methods for solving one dimensional bar problems	CO 1	Understand
3	a	AAE009.07	Solve the equations of truss and beam elements	CO 2	Remember
	b	AAE009.09	Apply the numerical methods for solving truss and beam problems	CO 2	Understand
4	a	AAE009.08	Understand the concepts of shape functions for beam element.	CO 2	Understand
	b	AAE009.09	Apply the numerical methods for solving truss and beam problems	CO 2	Understand
5	a	AAE009.10	Derive the element stiffness matrices for triangular elements and axi- symmetric solids and estimate the load vector and stresses.	CO 3	Understand
	b	AAE009.11	Formulate simple and complex problems into finite elements and solve structural and thermal problems	CO 3	Understand
6	a	AAE009.10	Derive the element stiffness matrices for triangular elements and axi- symmetric solids and estimate the load vector and stresses.	CO 3	Understand
	b	AAE009.11	Formulate simple and complex problems into finite elements and solve structural and thermal problems	CO 3	Understand

7	a	AAE009.13	Understand the concepts of steady state heat transfer analysis for one dimensional slab, fin and thin plate.	CO 4	Remember
	b	AAE009.14	Derive the stiffnes matrix for for fin element.	CO 4	Remember
8	a	AAE009.14	Derive the stiffnes matrix for for fin element.	CO 4	Remember
	b	AAE009.15	Solve the steady state heat transfer problems for fin and composite slab.	CO 4	Understand
9	a	AAE009.18	Calculate the mass matrices, Eigen values, Eigen vectors, natural frequency and mode shapes for dynamic problems.	CO 5	Understand
	b	AAE009.18	Calculate the mass matrices, Eigen values, Eigen vectors, natural frequency and mode shapes for dynamic problems.	CO 5	Understand
10	a	AAE009.16	Understand the concepts of mass and spring system and derive the equations for various structural problems	CO 5	Remember
	b	AAE009.18	Calculate the mass matrices, Eigen values, Eigen vectors, natural frequency and mode shapes for dynamic problems.	CO 5	Understand

Signature of Course Coordinator **HOD, AE**