Finite Element Methods VTU Question Paper Set

USN | | | | | | | | | | | **10ME64**

Sixth Semester B.E. Degree Examination, Dec.2016/Jan.2017
Finite Element Methods

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions, selecting atleast TWO questions from each part.***

PART – A

1 a. Explain the basic steps involved in FEM. **(06 Marks)**

b. Explain briefly about node location system and node numbering scheme. **(08 Marks)**

c. Explain plane stress and plane strain problem with examples and write the relation between stress and strain. **(06 Marks)**

2 a. Derive the stiffness matrix of bar element using direct approach. **(05 Marks)**

b. Using Rayleigh – Ritz method, determine the deflection of a cantilever beam subjected to point load at its end. **(10 Marks)**

c. Determine the displacement at nodes of spring system shown Fig. Q2(c) using principle of minimum potential energy, **(05 Marks)**

$K_1 = 40$ N/mm ; $K_2 = 60$N/mm ; $K_3 = 80$ N/mm ; $F_1 = 60$ N $F_2 = 50$ N.

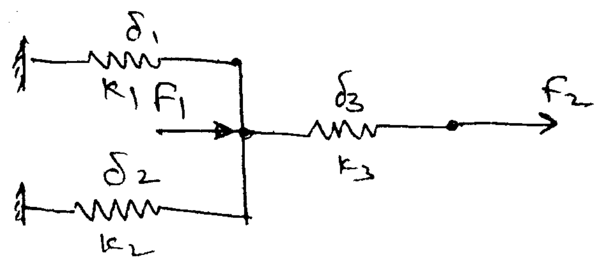

Fig. Q2(c)

3 a. Explain simplex, complex and multiplex elements using element shapes. **(06 Marks)**

b. Find the shape functions at point P for the CST element shown in Fig. Q3(b). Also find the area and Jacobian matrix for the element. **(08 Marks)**

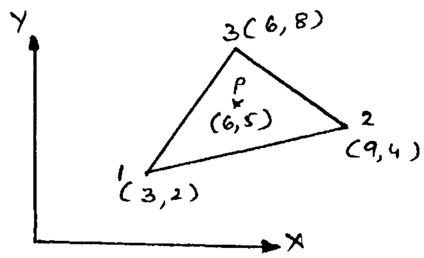

Fig. Q3(b)

c. What are the convergence requirements that an isoperimetric element should satisfy? Sketch and explain 2D Pascal triangle. **(06 Marks)**

4 a. Obtain the element stresses of the stepped bar shown Fig. Q4(a), take E = 200 GPA. $A_1 = 400\ mm^2$; $L_1 = 200$ mm ; $A_2 = 300\ mm^2$; $L_2 = 150$ mm. **(10 Marks)**

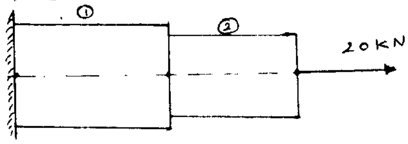

Fig. Q4(a)

b. Obtain the element stresses of the stepped bar shown in Fig. Q4(b) using penalty approach. $A_1 = 2400\ mm^2$ L_1 =150 mm ; E_1 = 70 GPa ; $A_2 = 750\ mm^2$ L_2 = 300 mm E_2 = 200 GPa ; P = 200 × 10^3N. **(10 Marks)**

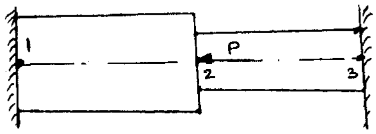

Fig. Q4(b)

PART – B

5 a. Explain briefly the iso-parametric, sub-parametric and super parametric elements, **(06 Marks)**

b. Derive the shape function of 2D quadrilateral element of linear model. **(08 Marks)**

c. Evaluate the following integral using two-point and 3–point gauss–integration method.

$$I = \int_{-1}^{+1} \left(3\xi^3 + 2\xi^2 + \xi + 2\right) d\xi \quad .$$ **(06 Marks)**

6 a. Derive the stiffness matrix for a 1 – D truss element. **(08 Marks)**

b. For the two – bar truss shown in Fig. Q6(b) determine the nodal displacement. Take E = 200 GPa ; $A_1 = A_2 = 200\ mm^2$. **(12 Marks)**

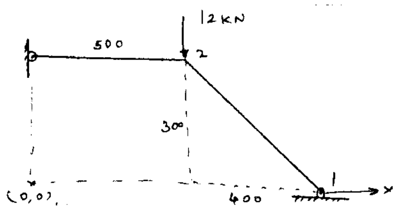

Fig. Q6(b)

7 a. Derive Hermite shape function for beam element. **(06 Marks)**

b. A uniform C – S beam is fixed at one end and supported by a roller at the other end. A concentrated load 20 kN is applied at the mid length of beam as shown in Fig. Q7(b). Determine the deflection under load. **(14 Marks)**

E = 200 GPa
I = 2500 × $10^4\ mm^4$

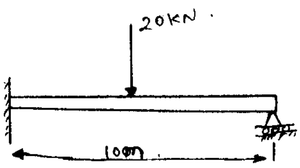

Fig. Q7(b)

8 a. Discuss the Galerkin approach for 1 – D heat conduction problem. **(10 Marks)**

b. Consider the brick wall of thickness L = 0.3m, k = 0.7 W/m°C. The inner surface is at 28°C and outer surface is exposed to cold air at –15°C. Heat transfer coefficient on outer surface h = 40 W/m^2°C. Determine steady state temperature distribution with the wall and heat flux through the wall. Use two element model. **(10 Marks)**

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USN 10ME64

Sixth Semester B.E. Degree Examination, June/July 2016
Finite element method

Time: 3 hrs. Max. Marks:100

Note: 1. ***Answer FIVE full questions, selecting at least TWO questions from each part.***
2. Missing data may suitably be assumed.

PART – A

1 a. Derive the equilibrium equations of a three dimensional body subjected to a body force. **(08 Marks)**

b. Explain the general description (steps) of FEM. **(06 Marks)**

c. Briefly explain the types of elements based on geometry. **(06 Marks)**

2 a. State principle of virtual work and principle of minimum potential energy. **(04 Marks)**

b. Calculate an expression for deflection in a simply supported beam under uniformly distributed load P_o ever entire span of length L using Rayleigh Ritz method. **(10 Marks)**

c. What are the steps involved in Galerkin's method to find out deflection? **(06 Marks)**

3 a. Explain two dimensional Pascal's triangle. **(05 Marks)**

b. Define interpolation polynomial, simplex, complex and multiplex elements and cubic element. **(05 Marks)**

c. Find the shape functions of a CST element and plot the same. **(10 Marks)**

4 a. Fig Q4(a) shows a thin plate of uniform thickness of 1 mm, weight density = 76.6×10^{-6} N/mm^3 and subjected to point load of 1kN at its midpoint. Take E = 200 GPa. Evaluate nodal displacement, stresses, and reactions. Using elimination techniques. **(10 Marks)**

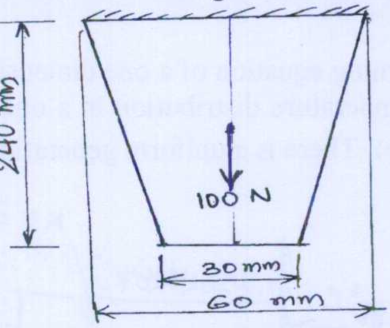

Fig Q4(a)

b. Find the nodal displacement, stresses and reactions of a Fig. Q4(b). Using penalty approach method. **(10 Marks)**

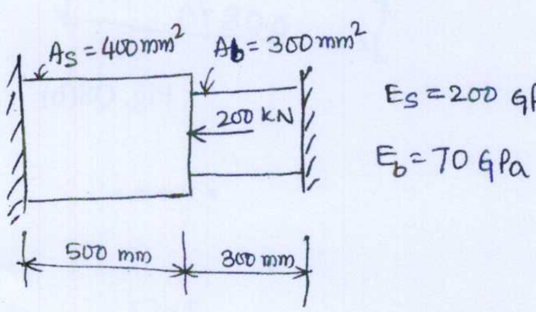

Fig Q4(b)

PART – B

5 a. Obtain the shape functions of quadratic bar element. **(10 Marks)**

b. Use two point Gauss quadrature to evaluate the integral $I = \int_0^3 (2^{\xi} - \xi)d\xi$. **(10 Marks)**

6 a. Derive an expression for stiffness matrix of a 2 noded truss element. **(10 Marks)**

b. Determine the nodal displacements in the truss segments subjected to concentrated load as shown in Fig Q6 (b). Take E = 70GPa A = 0.01 m^2. **(10 Marks)**

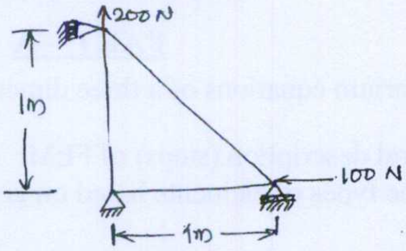

Fig Q6(b)

7 a. Obtain Hermite shape functions of a beam element. **(10 Marks)**

b. Find the deflection at the tip and the support reaction of a cantilever shown in Fig. 7(b).

F = 250kN
E = 200GPa
E = 4×10^6 mm^4

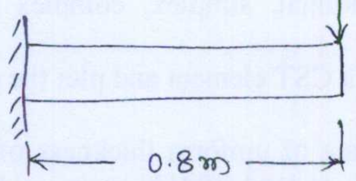

Fig. Q7(b)

(10 Marks)

8 a. Obtain the governing equation of a one dimension heat conduction. **(10 Marks)**

b. Calculate the temperature distribution in a one dimensional fin with the physical properties shown in Fig 8(b). There is a uniform generation of heat inside the wall of $\overline{Q} = 400$ W/m^3.

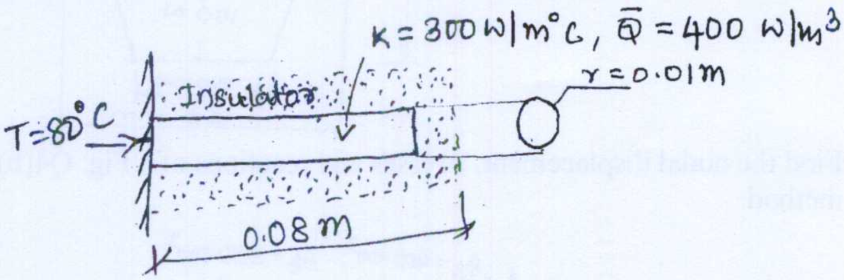

Fig. Q8(b)

(10 Marks)

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USN 10ME64

Sixth Semester B.E. Degree Examination, Dec.2015/Jan.2016

Finite Element Method

Time: 3 hrs. Max. Marks: 100

Note: ***Answer FIVE full questions, selecting at least TWO questions from each part.***

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg. 42+8 = 50, will be treated as malpractice.

PART – A

1 a. What is Finite Element Method (FEM)? Explain the steps involved in FEM. **(10 Marks)**

b. Differentiate between plane stress and plane strain problems. Also state the stress strain relations for both. **(10 Marks)**

2 a. State the principle of minimum potential energy and apply the same to determine nodal displacement of a spring system shown in Fig Q.2(a) **(10 Marks)**

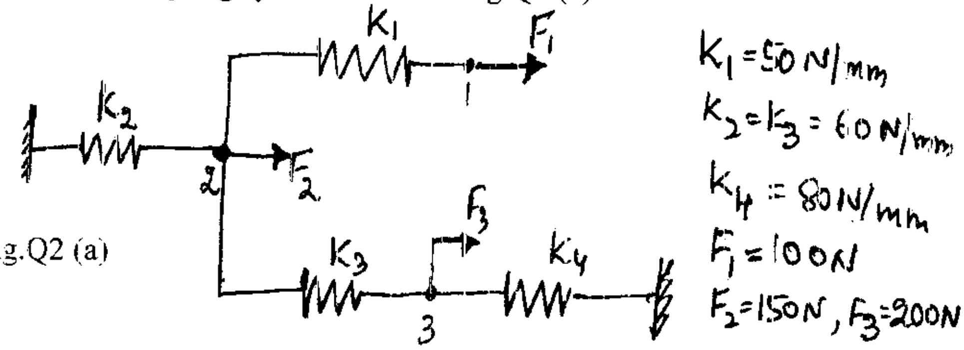

Fig.Q2 (a)

b. Using Rayleigh's – Ritz method, derive an expression for maximum deflection of the simply supported beam with point load 'p' at centre. **(10 Marks)**

3 a. Derive the shape function for triangular element (CST Element) in natural co-ordinate system. **(10 Marks)**

b. Derive an expression for Jacobean matrix for a four noded quadrilateral element. **(10 Marks)**

4 a. A stepped bar is shown in Fig. 4(a).
Determine i) The nodal displacement and nodal forces
ii) The stresses in each element
iii) The principal and shear stress in each element. **(10 Marks)**

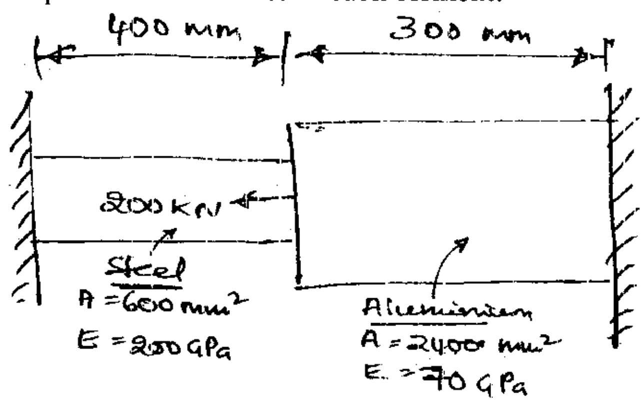

Fig.Q4 (a)

b. Solve the following system of equations by Gauss Elimination method.

$$x_1 + x_2 + x_3 = 6$$
$$x_1 - x_2 + 2x_3 = 5$$
$$x_1 + 2x_2 - x_3 = 2$$

(10 Marks)

PART – B

5 a. Derive the shape function for a quadratic bar element using Lagrange's interpolation. **(10 Marks)**

b. Evaluate $\int_{-1}^{+1}\left[3e^x + x^2 + \frac{1}{(x+2)}\right]dx$

Using one – point and two – point Gauss quadrature. **(10 Marks)**

6 a. Derive the stiffness matrix for truss element. **(10 Marks)**

b. For the two bar truss shown in Fig.6 (b), determine the nodal displacements. Assume E = 200GPa, A = 6×10^{-4}m^2 **(10 Marks)**

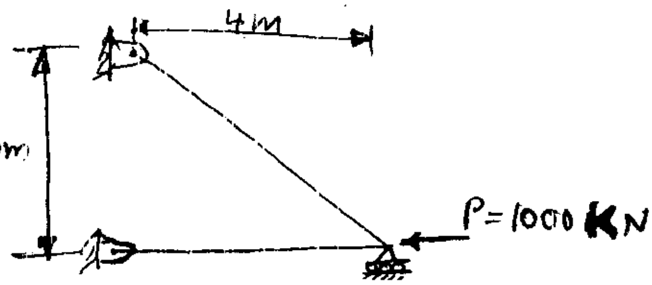

Fig.Q6 (b)

7 a. Derive the Hermite shape functions for a beam element. **(10 Marks)**

b. For the beam fixed at both ends and loaded as shown in Fig.Q7(b). Determine the displacement and shapes at node 2, and reaction forces at node 1 only. **(10 Marks)**

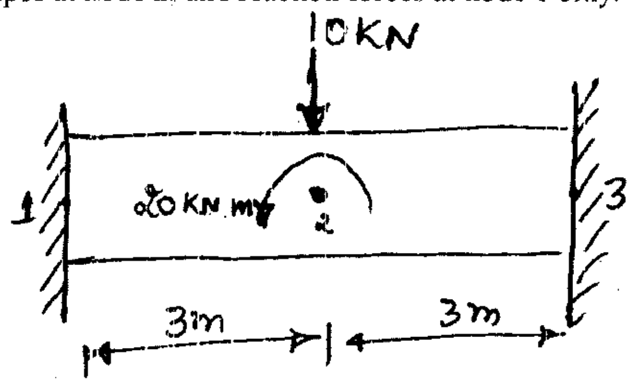

Fig.Q7 (b)

8 a Derive element conductivity matrix for one dimensional heat flow element. **(10 Marks)**

b. Find the temperature distribution and heat transfer through an iron fin of thickness 5mm, height 50mm and width 1000mm. The heat transfer coefficient around the fin is 10W/m^2 K and ambient temperature is 28°C. The base of fin is at 108°C. Take K = 50W/m K. Use two elements. **(10 Marks)**

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10ME64

Sixth Semester B.E. Degree Examination, June/July 2015
Finite Element Methods

Time: 3 hrs. Max. Marks:100

Note: ***1. Answer any FIVE full questions, selecting atleast TWO questions from each part.***
2. Missing data, if any, may be suitably assumed.

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

PART – A

1 a. Write the stress – strain relationship for both plane stress and plane strain problems. **(06 Marks)**

b. Discuss the types of elements based on geometry. **(06 Marks)**

c. Explain the various application fields of finite element method. **(08 Marks)**

2 a. Derive an expression for total potential energy of an elastic body subjected to body force, traction force and point force. **(08 Marks)**

b. Using Raleigh's Ritz method, determine the displacement at mid point and stress in linear one-dimensional rod as shown in Fig. Q2(b). Use second degree polynomial approximation for the displacement. **(12 Marks)**

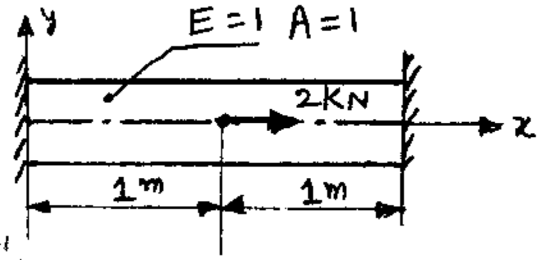

Fig.Q2(b)

3 a. Write an interpolation polynomial for linear, quadratic and cubic element. **(06 Marks)**

b. Explain simplex, complex and multiplex elements using element shapes. **(06 Marks)**

c. Derive the shape functions for a CST element. **(08 Marks)**

4 a. Solve for nodal displacement and elemental stresses for the following Fig.Q4(a), shows a thin plate of uniform thickness of 1 mm, Young's modulus = 200 GPa, weight density of the plate = 76.6×10^{-6} N/mm^3. In addition to its weight, it is subjected to a point load of 100 N at its midpoint and model the plate with 2 bar elements. **(10 Marks)**

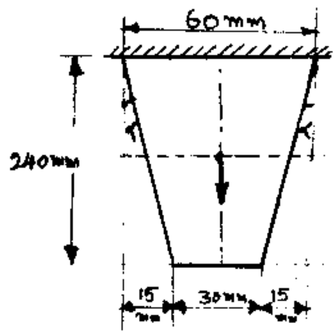

Fig.Q4(a)

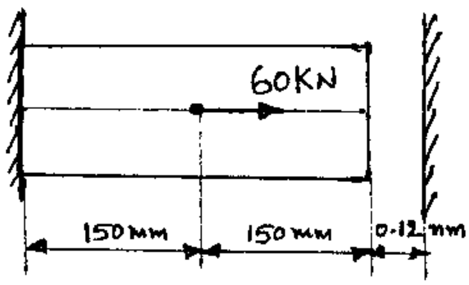

Fig.Q4(b)

b. Determine the nodal displacements, reactions and stresses for the Fig. Q4(b) using Penalty approach. Take E = 210 GPa, Area = 250 mm^2. **(10 Marks)**

PART – B

5 a. Distinguish between lower and higher order elements. **(08 Marks)**
b. Explain the concept of ISO, sub and super parametric elements and their uses. **(06 Marks)**
c. Write a note on 2 – point integration rule for 1D and 2D problems. **(06 Marks)**

6 a. Derive an expression for stiffness matrix of a truss element. **(08 Marks)**
b. For the pin-jointed configuration shown in Fig.Q6(b), formulate the stiffness matrix. Also determine nodal displacement and stress in each element. **(12 Marks)**

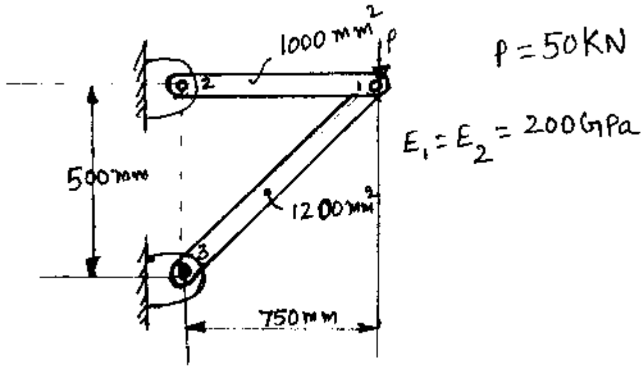

Fig.Q6(b)

7 a. Derive the Hermite shape function for a beam element. **(08 Marks)**
b. For the beam and loading shown in Fig. Q7(b), determine the slopes at 2 and 3, vertical deflection at the mid points of the distributed load. Take E = 200 GPa, I = 4×10^6 mm^4. **(12 Marks)**

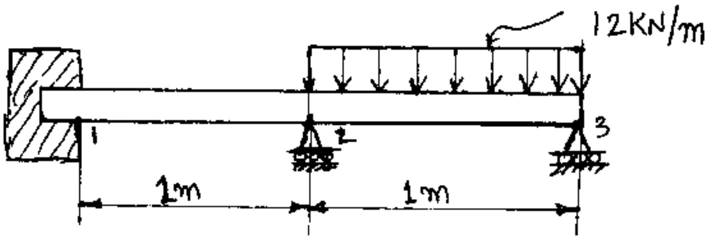

Fig.Q7(b)

8 a. Discuss the derivation of one dimensional heat transfer in thin fin. **(08 Marks)**
b. Determine the temperature distribution through the composite wall, subjected to convection heat transfer on the right side surface, with convective heat transfer co-efficient shown in Fig.Q8(b). The ambient temperature is – 5°C. Assume unit area. **(12 Marks)**

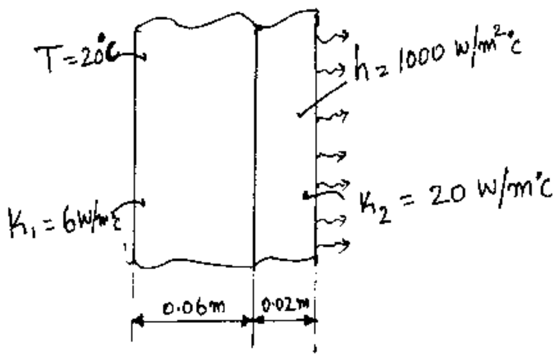

Fig.Q8(b)

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10ME64

Sixth Semester B.E. Degree Examination, Dec.2014/Jan.2015

Finite Element Methods

Time: 3 hrs. Max. Marks:100

Note: 1. ***Answer FIVE full questions, selecting at least TWO questions from each part.***
2. ***Missing data may suitably be assumed.***

PART – A

1 a. Obtain an equilibrium equations of a 3-D elastic body subjected to a body force. **(08 Marks)**
b. Discuss the types of elements based on geometry. **(06 Marks)**
c. Explain the general description of finite element method. **(06 Marks)**

2 a. Derive an expression for Total potential energy of an elastic body subjected to body force, traction force and a point force. **(08 Marks)**
b. Using Raleigh's Ritz method find a deflection of a simply supported beam of length L subjected to a uniformly distributed load of P_0 N/m. **(12 Marks)**

3 a. Write an interpolation polynomial for linear, quadratic and cubic element. **(06 Marks)**
b. Obtain an expression for a strain displacement matrix of a rectangular element. **(14 Marks)**

4 a. Determine the nodal displacements, reactions and stresses for the Fig. Q4 (a) using penalty approach. Take E = 210 GPa, Area = 250 mm^2. **(12 Marks)**

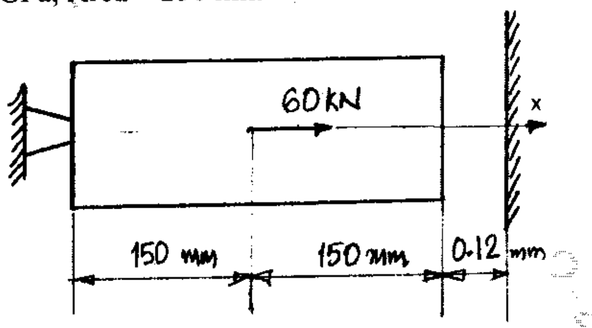

Fig. Q4 (a)

b. Find the nodal displacement, stress and strain of the system shown in Fig. Q4 (b). Take E = 70 GPa, Area = 1 m^2. **(08 Marks)**

(Linear varying load)

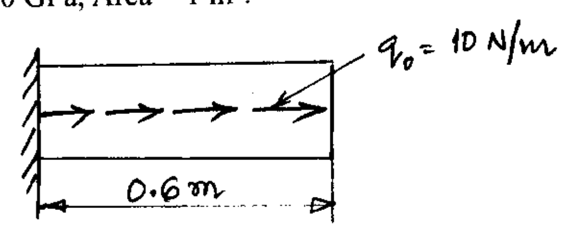

Fig. Q4 (b)

PART – B

5 a. Find the shape functions of a 2-D quadrilateral quadratic (9 noded) element. **(14 Marks)**
b. With a sketch define Iso, Sub and Super parametric elements. **(06 Marks)**

6 a. Obtain an expression for stiffness matrix of a truss element. **(08 Marks)**

b. Find the nodal displacement, stress and reaction of truss element shown in Fig. Q6 (b). Take E = 70 GPa, Area = 200 mm^2. **(12 Marks)**

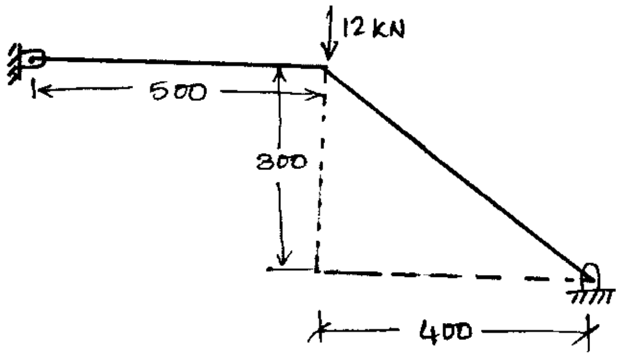

Fig. Q6 (b)

7 a. Derive the Hermite shape functions of a beam element. **(08 Marks)**

b. For the beam and loading shown in Fig. Q7 (b), determine the slopes at 2 and 3 and the vertical deflection at the midpoints of the distributed load. Take E = 200 GPa, I = 4×10^6 mm^4. **(12 Marks)**

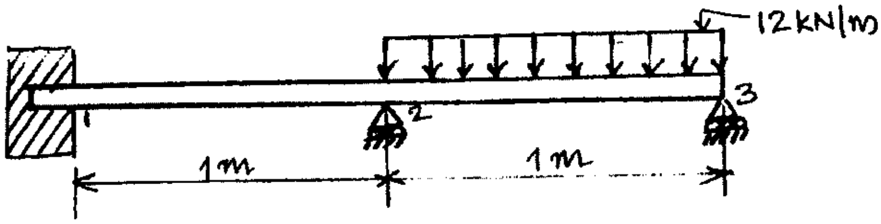

Fig. Q7 (b)

8 a. Discuss the derivation of one dimensional heat transfer in thin films. **(08 Marks)**

b. A composite wall consists of 3 materials shown in Fig. Q8 (b). The outer temperature is $T_0 = 20^0 C$, determine the temperature distribution in the wall. Convection heat transfer takes place at inner surface with $T_\infty = 800^0 C$. Take h = 25 w/m^2°C, Area = 1 m^2 **(12 Marks)**

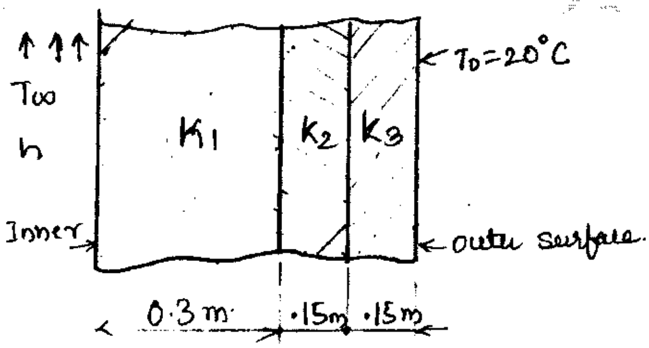

Fig. Q8 (b)

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10ME64

Sixth Semester B.E. Degree Examination, June/July 2014
Finite Element Methods

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions, selecting atleast TWO questions from each part.***

PART – A

1 a. What is FEM? Sketch the different types of elements used based on geometry in finite element analysis. (1D, 2D and 3D). **(04 Marks)**

b. Explain with a sketch plane stress and plane strain. **(06 Marks)**

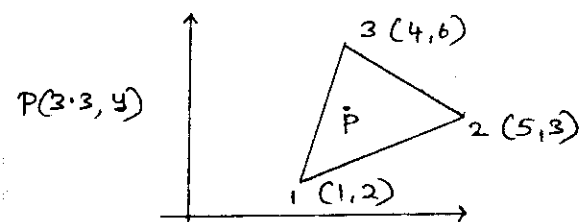
c. Derive the equilibrium equation in elasticity subjected to body force and traction force. **(10 Marks)**

2 a. A cantilever beam of span 'L' is subjected to a point load at free end. Derive an equation for the deflection at free end by using RR method. Assume polynomial displacement function. **(10 Marks)**

b. Write the properties of stiffness matrix and derive the element stiffness matrix (ESM) for a 1D bar element. **(10 Marks)**

3 a. A modal co-ordinate of the triangular element is shown in Fig.Q.3(a). At the interior point 'P' the co-ordinate is 3.3 and $N_1 = 0.3$. Determine 'N_2' and 'N_3' and the y co-ordinate at point P. **(05 Marks)**

Fig.Q.3(a)



b. What is convergence requirement? Discuss the 3 conditions of convergence requirement. **(05 Marks)**

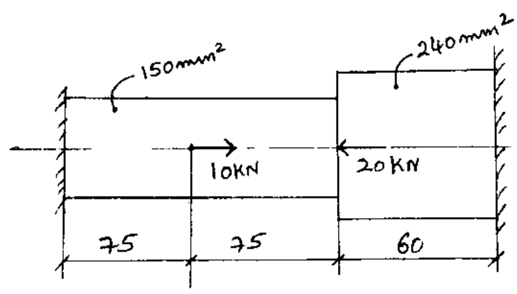
c. Derive the shape function of a 4 noded quadrilateral element. **(10 Marks)**

4 a. Consider the bar shown in Fig.Q.4(a). Using elimination method of handling boundary conditions. Determine the following:

i) Nodal displacements.
ii) Stress in each element.
iii) Reaction forces.

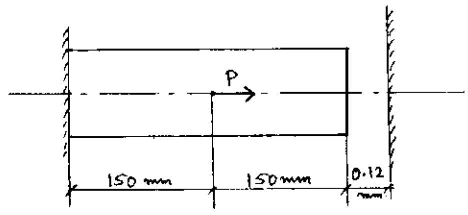
Take E = 200GPa. **(10 Marks)**

Fig.Q.4(a)



b. Consider the bar shown in Fig.Q.4(b). An axial load $P = 60 \times 10^3$N is applied at its midpoint. Using penalty method of handling boundary condition. Determine: i) Nodal displacements; ii) Stress in each element; iii) Reaction at supports. Take $A = 250\text{mm}^2$; $E = 200\text{GPa}$. **(10 Marks)**

Fig.Q.4(b)



PART – B

5 a. Derive the shape function for a quadratic bar element using Lagrange's interpolation. **(05 Marks)**

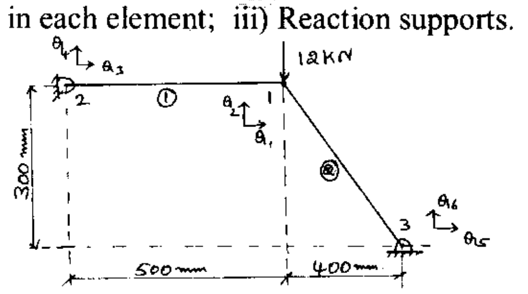
b. Evaluate $I = \int_{-1}^{+1}\left(3e^{\xi} + \xi^2 + \frac{1}{\xi+2}\right)d\xi$ using 1P and 2P Gaussian quadrature. **(06 Marks)**

c. Derive Lagrange quadratic quadrilateral element (9 noded quadrilateral element). **(09 Marks)**

6 a. List out the assumptions made in the derivation of a truss element. **(04 Marks)**

b. For the truss shown in Fig.Q.6(b), determine:
i) Nodal displacement; ii) Stress in each element; iii) Reaction supports.

Fig.Q.6(b)

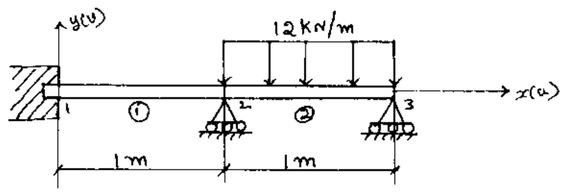


$A = 200\text{mm}^2$; $E = 70\text{GPa}$. **(16 Marks)**

7 a. Derive the Hermite shape function for a beam element. **(08 Marks)**

b. For the beam and loading shown in Fig.Q.7(b). Determine:
i) Slopes at 2 and 3; ii) Vertical deflection at the midpoint of the load.
Take $E = 200$ GPa; $I = 4 \times 10^6\text{mm}^4$. **(12 Marks)**

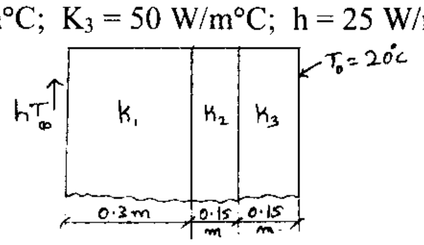
Fig.Q.7(b)



8 a. Bring out the differences between continuum methods and FEM. **(06 Marks)**

b. Solve the temperature distribution in the composite wall using 1D heat elements, use penalty approach of handling boundary conditions. (Fig.Q.8(b)). **(14 Marks)**
$K_1 = 20\text{W/m°C}$; $K_2 = 30\text{W/m°C}$; $K_3 = 50\text{ W/m°C}$; $h = 25\text{ W/m}^2\text{°C}$; $T_\infty = 800°C$

Fig.Q.8(b)



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Sixth Semester B.E. Degree Examination, Dec.2013/Jan.2014
Finite Element Methods

Time: 3 hrs. Max. Marks:100

Note: ***Answer FIVE full questions, selecting at least TWO questions from each part.***

PART – A

1 a. Differentiate between plane stress and plain strain problems with examples. Write the stress-strain relations for both. **(08 Marks)**

b. Explain the node numbering scheme and its effect on the half band-width. **(06 Marks)**

c. List down the basic steps involved in FEM for stress analysis of elastic solid bodies. **(06 Marks)**

2 a. State the principle of minimum potential energy. Determine the displacements at nodes for the spring system shown in the Fig.Q.2(a). **(08 Marks)**

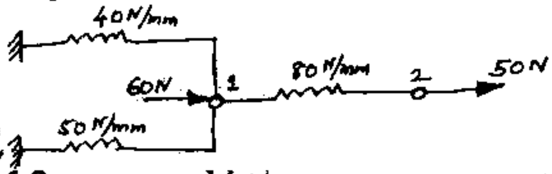
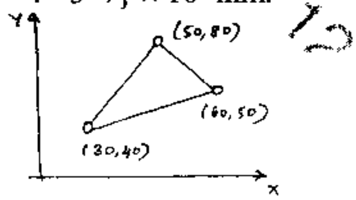


Fig.Q.2(a)

b. Determine the deflection of a cantilever beam of length 'L' subjected to uniformly distributed load (UDL) of P_o/unit length, using the trail function $y = a \sin\left(\frac{\pi x}{2L}\right)$. Compare the results with analytical solution and comment on accuracy. **(12 Marks)**

3 a. Derive an expression for Jacobian matrix for a four-noded quadrilateral element. **(10 Marks)**

b. For the triangular element shown in the Fig.Q.3(b). Obtain the strain-displacement matrix 'B' and determine the strains ϵ_x, ϵ_y and γ_{xy}.
Nodal displacements $\{q\} = \{2\ \ 1\ \ 1\ \ -4\ \ -3\ \ 7\} \times 10^{-2}$ mm. **(10 Marks)**



Note: All dimensions in mm. Fig.Q.3(b)

4 a. An axial load $P = 300 \times 10^3$ N is applied at 20°C to the rod as shown in the Fig.Q.4(a). The temperature is then raised to 60°C.
i) Assemble the global stiffness matrix (K) and global load vector (F).
ii) Determine the nodal displacements and element stresses.

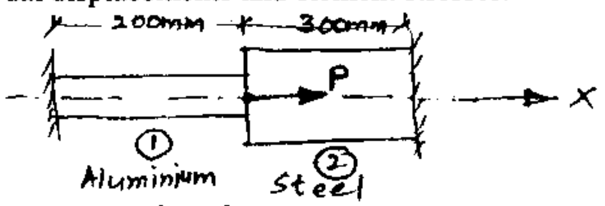


Fig.Q.4(a)

$E_1 = 70 \times 10^9$ N/m^2, $E_2 = 200 \times 10^9$ N/m^2
$A_1 = 900$ mm^2, $A_2 = 1200$ mm^2
$\alpha_1 = 23 \times 10^{-6}$/°C, $\alpha_2 = 11.7 \times 10^{-6}$/°C. **(12 Marks)**

b. Solve the following system of equations by Gaussian-Elimination method:
$x_1 - 2x_2 + 6x_3 = 0$
$2x_1 + 2x_2 + 3x_3 = 3$
$-x_1 + 3x_2 = 2.$ **(08 Marks)**

PART – B

5 a. Using Lagrangian method, derive the shape function of a three-noded one-dimension (1D) element [quadratic element]. **(06 Marks)**

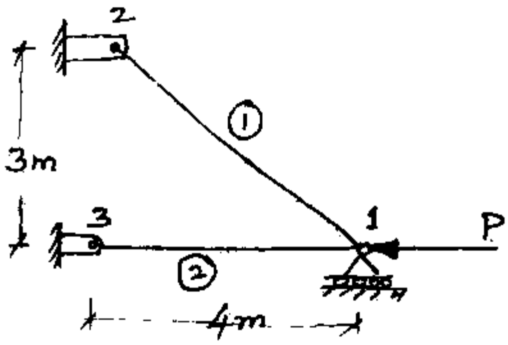
b. Evaluate $I = \int_{-1}^{+1} \left[3e^x + x^2 + \frac{1}{(x+2)} \right] .dx$

using one-point and two-point Gauss quadrature. **(06 Marks)**

c. Write short notes on higher order elements used in FEM. **(08 Marks)**

6 a. For the two-bar truss shown in the Fig.Q.6(a). Determine the nodal displacements and element stresses. A force of P = 1000 kN is applied at node 1. Take E = 210 GPa and A = 600mm^2 for each element. **(12 Marks)**

Fig.Q.6(a)

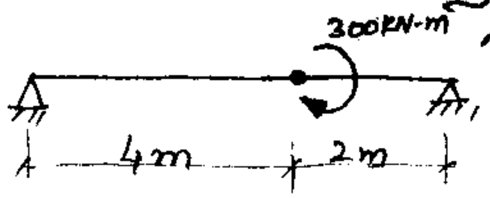


b. Derive an expression for stiffness matrix for a 2-D truss element. **(08 Marks)**

7 a. Derive the Hermite shape functions of a beam element. **(08 Marks)**

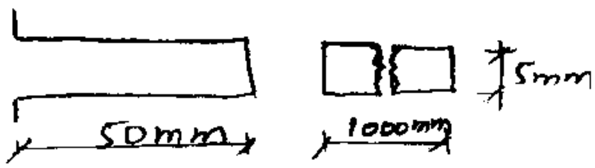
b. A simply supported beam of span 6m and uniform flexural rigidity EI = 40000 kN-m^2 is subjected to clockwise couple of 300 kN-m at a distance of 4m from the left end as shown in the Fig.Q.7(b). Find the deflection at the point of application of the couple and internal loads. **(12 Marks)**

Fig.Q.7(b)



8 a. Find the temperature distribution and heat transfer through an iron fin of thickness 5mm, height 50mm and width 1000mm. The heat transfer coefficient around the fin is 10 W/m^2.K and ambient temperature is 28°C. The base of fin is at 108°C. Take K = 50 W/m.K. Use two elements. **(10 Marks)**

Fig.Q.8(a)



b. Derive element matrices for heat conduction in one-dimensional element using Galerkin's approach. **(10 Marks)**

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10ME64

Sixth Semester B.E. Degree Examination, June/July 2013

Finite Element Methods

Time: 3 hrs. Max. Marks: 100

Note: ***Answer FIVE full questions, selecting at least TWO questions from each part.***

PART – A

1 a. Write equilibrium equations in elasticity subjected to body and traction forces. **(06 Marks)**

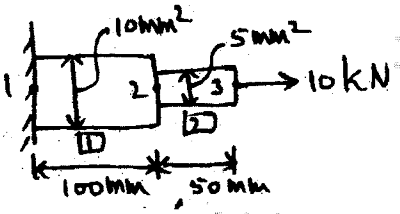
b. Write the stress-strain relationships for both plane stress and plane strain problems. **(06 Marks)**

c. Define finite element method. Explain the various application fields of finite element method. **(08 Marks)**

2 a. Explain minimum potential energy principle. **(06 Marks)**

b. Derive the stiffness matrix for a single element bar, using direct stiffness method. **(04 Marks)**

c. A two element two noded bar is shown in Fig.Q2(c). Determine the nodal displacements and the nodal forces. **(10 Marks)**



E = 200 GPa
Fig.Q2(c)

3 a. Write a note on the polynomials involved in linear, quadratic and cubic 1D elements. **(06 Marks)**

b. Derive shape functions for one dimensional two noded bar element. Hence explain the conditions that the shape function has to satisfy. **(06 Marks)**

c. Write the Jacobian matrix for the triangular element shown in Fig.Q3(c). **(08 Marks)**

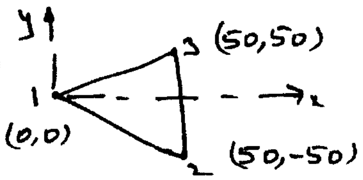


Fig.Q3(c)

4 A stepped bar is shown in Fig.Q4. Determine:

a. The nodal displacements and nodal forces.

b. The stresses in each element.

c. The principal and shear stresses in each element.

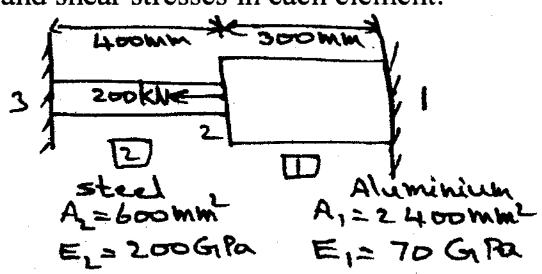


Fig.Q4

Use penalty method to handle the boundary conditions. **(20 Marks)**

PART – B

5 a. Distinguish between lower and higher order elements. **(08 Marks)**

b. Define isoparametric element. What are the advantages? **(04 Marks)**

c. Write a note on 2-point integration rule for 1D and 2D problems. **(08 Marks)**

6 For the two bar truss shown in Fig.Q6, determine the nodal displacements and forces. Assume E = 200 GPa, A = 6×10^{-4} m^2.

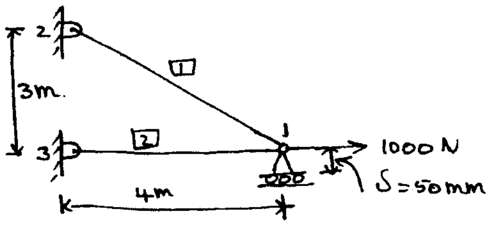


Fig.Q6 **(20 Marks)**

7 a. Define Hermite shape functions. Derive shape functions for the beam element. **(10 Marks)**

b. Derive stiffness matrix for the beam element using Hermite shape functions. **(10 Marks)**

8 A composite wall shown in Fig.Q8 consists of three materials. The outer temperature T_0 is 20°C. Convective heat transfer takes place on the inner surface of the wall with T_∞ = 800°C. The convective heat transfer coefficient hi is 25 W/m^2°C. Determine the temperature distribution in the wall.

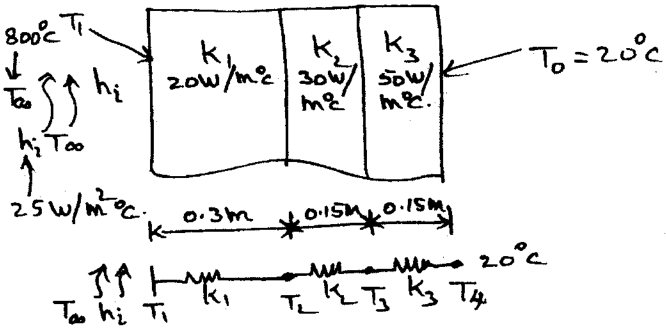


Fig.Q8 **(20 Marks)**

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