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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)**

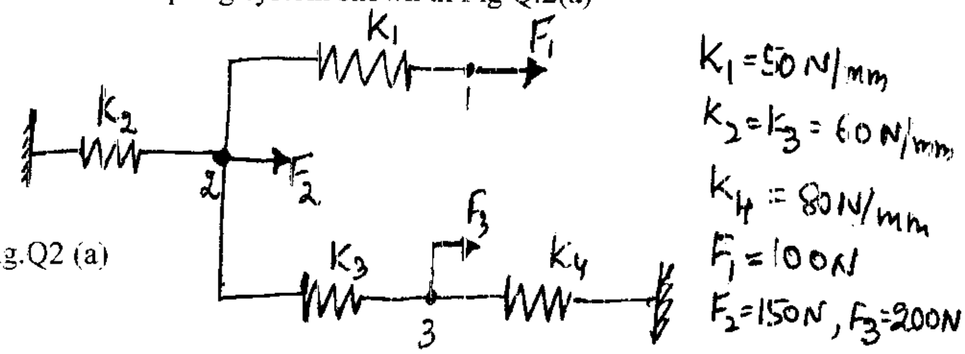


Fig.Q2 (a)

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)**

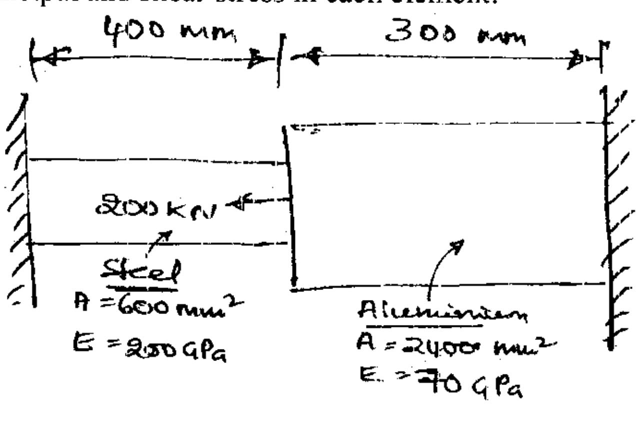


Fig.Q4 (a)

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)**

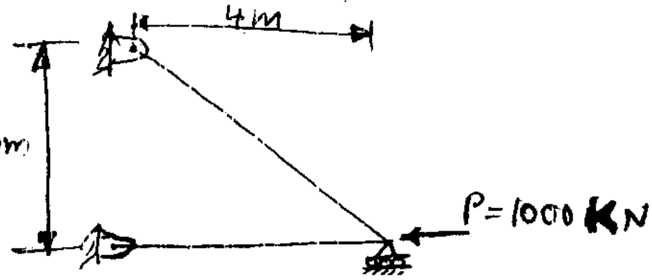
b. Evaluate $\int_{-1}^{+1} \left[3e^x + x^2 + \frac{1}{(x+2)} \right] dx$

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)**

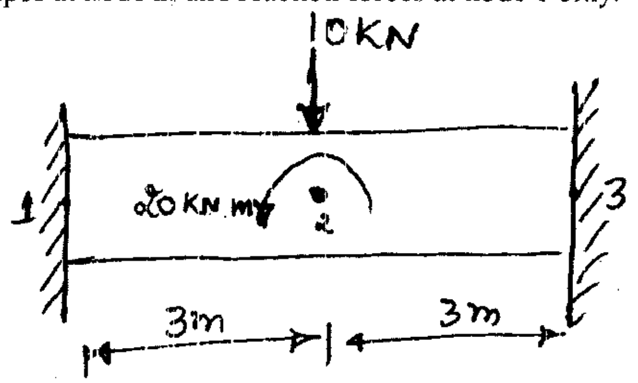
Fig.Q6 (b)



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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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.***

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. 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.

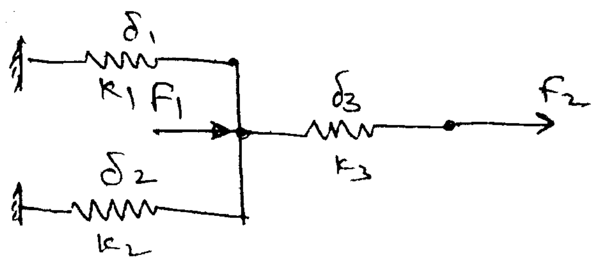

Fig. Q2(c)

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)**

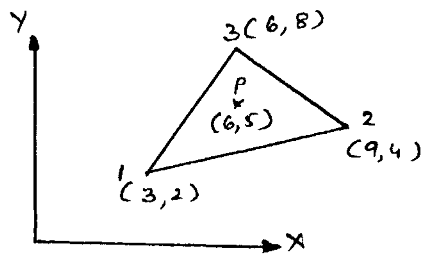

Fig. Q3(b)

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)**

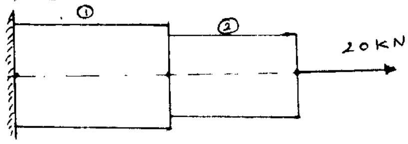

Fig. Q4(a)

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 ;
$P = 200 \times 10^3$N. **(10 Marks)**

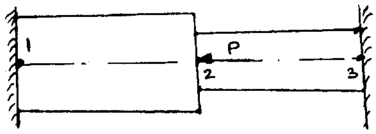

Fig. Q4(b)

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.

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

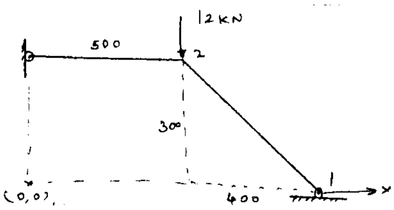

Fig. Q6(b)

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
$I = 2500 \times 10^4\ mm^4$

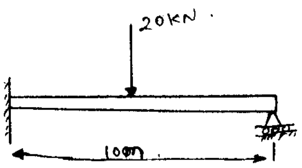

Fig. Q7(b)

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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10ME64

Sixth Semester B.E. Degree Examination, Dec.2017/Jan.2018

Finite Element Methods

Time: 3 hrs. Max. Marks:100

Note: ***Answer any 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. Describe the basic steps in the finite element method for engineering analysis in detail. **(06 Marks)**

b. For a 3-D elemental cube, obtain the differential equations of equilibrium subjected to a system of stresses in all the three directions. **(06 Marks)**

c. Distinguish clearly between plane stress and plane strain problems. Also give the constitutive equations (stress-strain equations) for both. **(08 Marks)**

2 a. A cantilever beam of span 'ℓ' is subjected to a uniformly distributed load P_0 over its entire length. The Young's modulus of elasticity of the beam material is 'E' and moment of inertia of the section is 'I'. Derive an equation for deflection by using the Rayleigh-Ritz method. **(12 Marks)**

b. Derive the element stiffness matrix for a two-node one-dimensional bar element using direct approach. **(08 Marks)**

3 a. Sketch and explain Pascal triangle for 2-D polynomials. **(04 Marks)**

b. Derive the strain displacement matrix [B] for a three noded constant strain triangle (CST) element. **(08 Marks)**

c. Derive the Jacobian matrix [J] for a four noded quadrilateral element. **(08 Marks)**

4 a. Explain in detail, 'Elimination approach' to handle boundary conditions. **(10 Marks)**

b. For the three stepped bar shown in Fig.Q4(b), find the nodal displacements, stress in the middle portion and left support reaction.

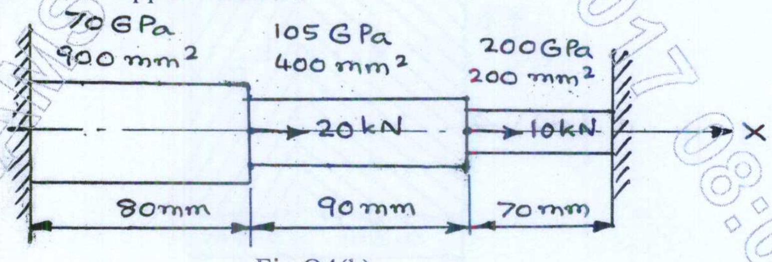

Fig.Q4(b) **(10 Marks)**

PART – B

5 a. Derive the shape functions for a four node 1-D cubic bar element and show the variations of them along the length of the element. **(10 Marks)**

b. Using two point Gaussian quadrature formula evaluate the following integrals:

i) $\int_{-1}^{+1}\int_{-1}^{+1}(r^2 + 2rs + s^2)\,dr.ds$ ii) $\int_{0}^{1} x^2.dx$ **(10 Marks)**

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

b. For the two-bar truss shown in Fig.Q6(b), determine the nodal displacement, stress in each element and reaction at the support.
Take $E = 2 \times 10^5$ N/mm^2, area of each bar = $A_e = 200$ mm^2.

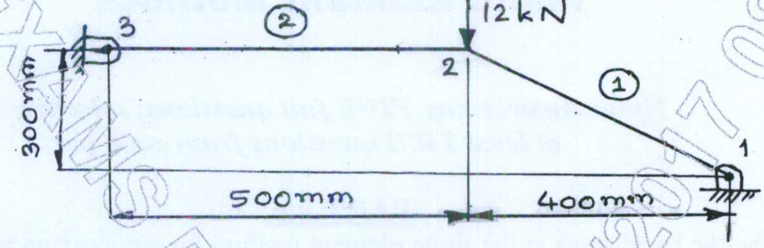


Fig.Q6(b) **(12 Marks)**

7 a. Obtain the shape functions for a 2-node beam element and plot them. **(10 Marks)**

b. Determine the maximum deflection of the cantilever beam with uniform cross section as shown in Fig.Q7(b), by assuming the beam as a single element. Take $E = 7 \times 10^9$ N/m^2, $I = 4 \times 10^{-4}$ m^4.

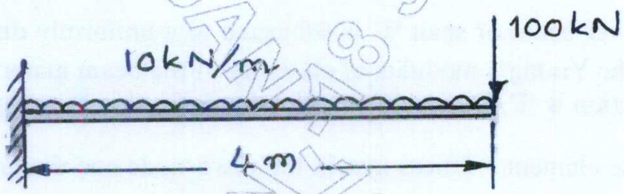
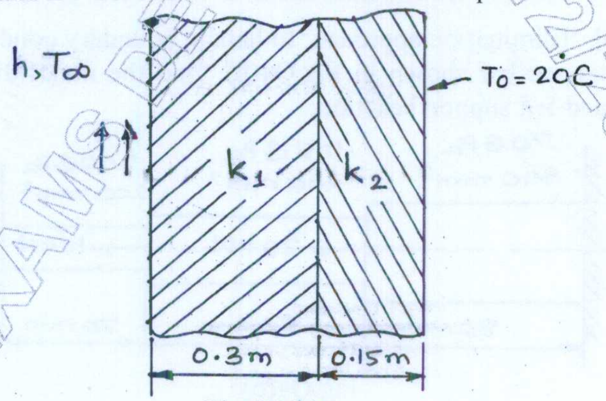


Fig.Q7(b) **(10 Marks)**

8 a. Explain the different types of boundary conditions in heat transfer problems. **(08 Marks)**

b. A composite wall consists of two materials is as shown in Fig.Q8(b). The outer temperature is $T_0 = 20$°C. Convection heat transfer takes place on the inner surface of the wall with $T_\infty = 800$°C and $h = 25$ W/m^2-°C. Determine the temperature distribution in the wall.



$k_1 = 20$ W/m-°C
$k_2 = 30$ W/m-°C
$h = 25$ W/m^2-°C
$T_\infty = 800$°C

Fig.Q8(b) **(12 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.***

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

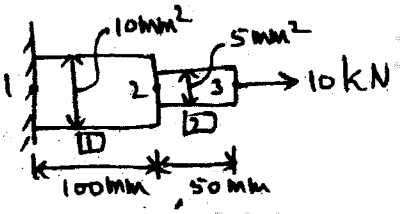
b. Write the stress-strain relationships for both plane stress and plane strain problems. **(06 Marks)**

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)**

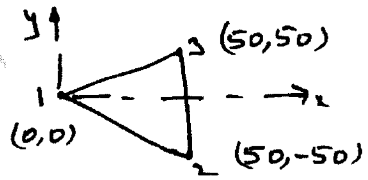


Fig.Q3(c)

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.

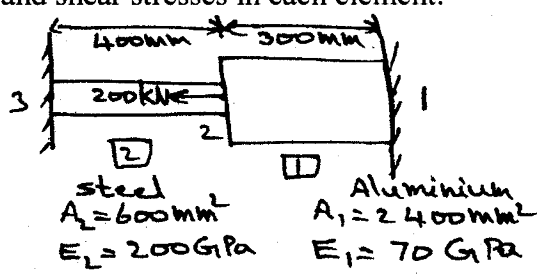


Fig.Q4

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, $A = 6 \times 10^{-4}\ m^2$.

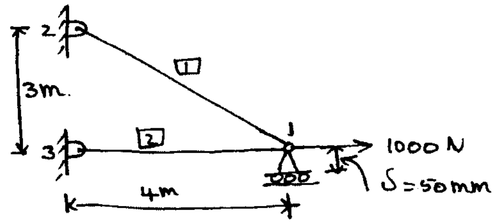


Fig.Q6 **(20 Marks)**

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 $W/m^2 {}^\circ C$. Determine the temperature distribution in the wall.

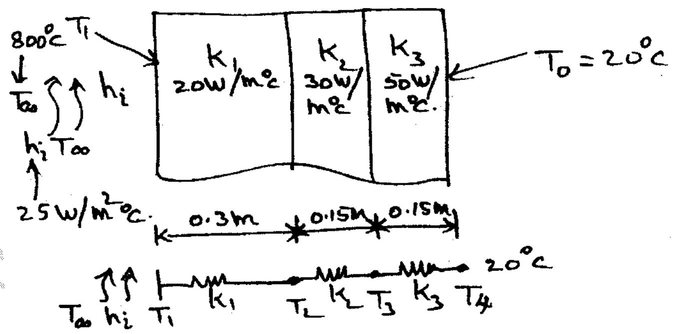


Fig.Q8 **(20 Marks)**

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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.***

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 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)**

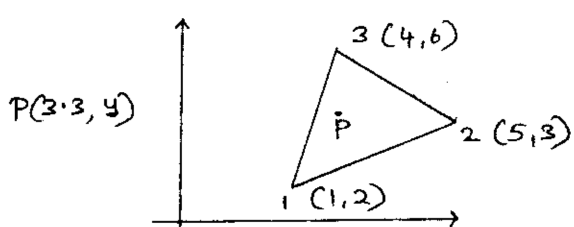
c. Derive the equilibrium equation in elasticity subjected to body force and traction force. **(10 Marks)**

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)**

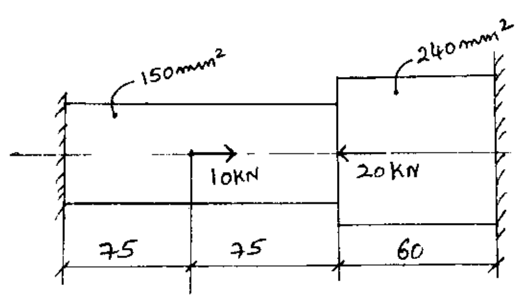
c. Derive the shape function of a 4 noded quadrilateral element. **(10 Marks)**

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.

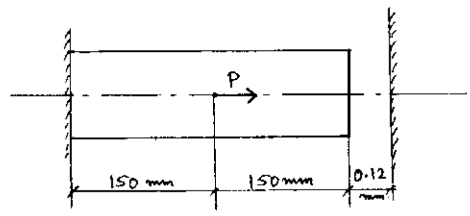
Take E = 200GPa. **(10 Marks)**

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 $A = 250$mm^2; $E = 200$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)**

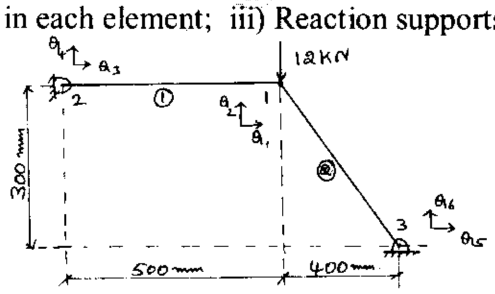
b. Evaluate $I = \int_{-1}^{+1} \left(3e^{\xi} + \xi^2 + \frac{1}{\xi + 2} \right) d\xi$ using 1P and 2P Gaussian quadrature. **(06 Marks)**

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)

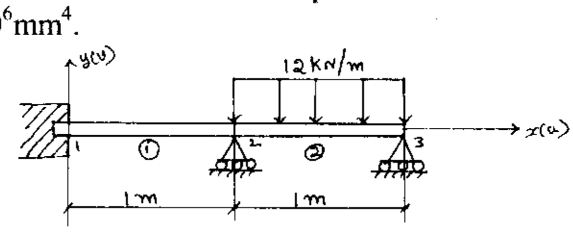


$A = 200$mm^2; $E = 70$GPa. **(16 Marks)**

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; $I = 4 \times 10^6$mm^4. **(12 Marks)**

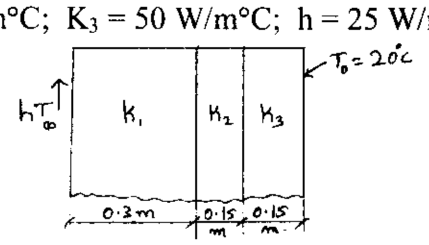
Fig.Q.7(b)



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)**
$K_1 = 20$W/m°C; $K_2 = 30$W/m°C; $K_3 = 50$ W/m°C; $h = 25$ W/m^2°C; $T_\infty = 800$°C

Fig.Q.8(b)



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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)**

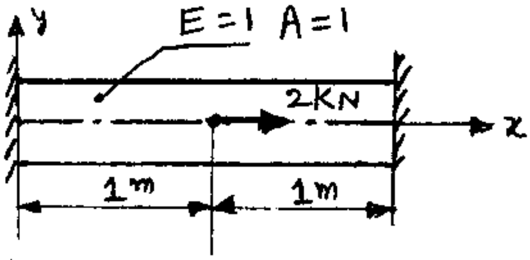

Fig.Q2(b)

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)**

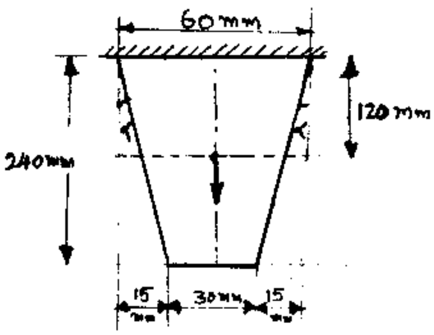

Fig.Q4(a)

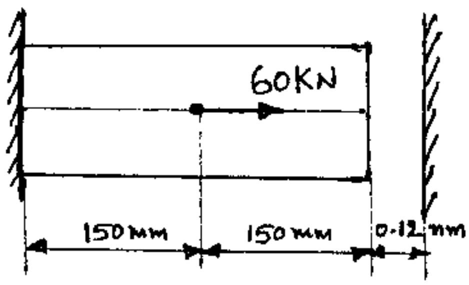

Fig.Q4(b)

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)**

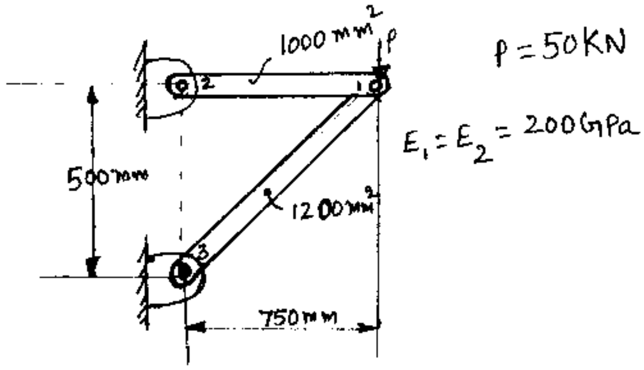

Fig.Q6(b)

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, $I = 4 \times 10^6\ mm^4$. **(12 Marks)**

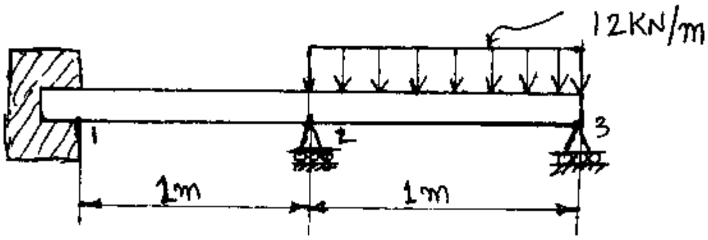

Fig.Q7(b)

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)**

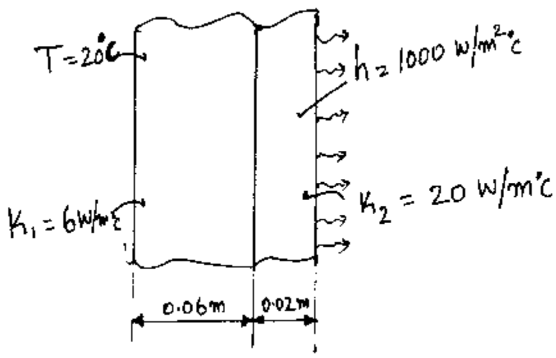

Fig.Q8(b)

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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.

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. 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)**

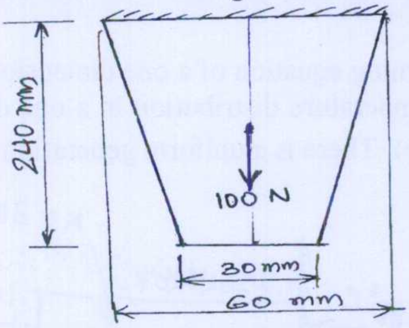
3 a. Explain two dimensional Pascal's triangle. **(05 Marks)**

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)**

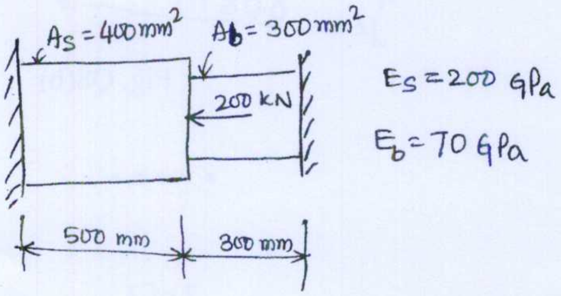
4 a. Fig Q4(a) shows a thin plate of uniform thickness of 1 mm, weight density = 76.6×10^{-6} N/mm^3 and subjected to point load of 1kN at its midpoint. Take E = 200 GPa. Evaluate nodal displacement, stresses, and reactions. Using elimination techniques. **(10 Marks)**

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)**

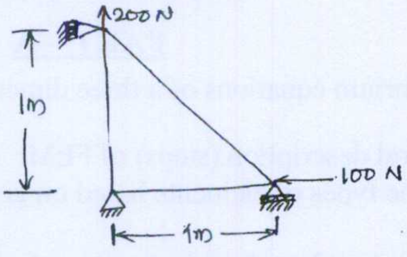


Fig Q6(b)

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).

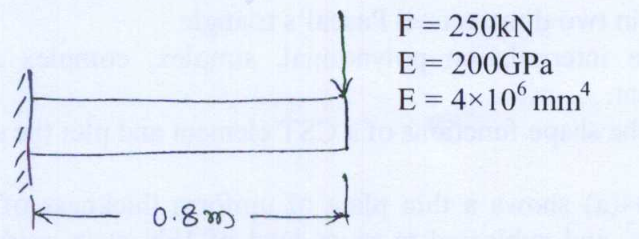


Fig. Q7(b)

(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 $\overline{Q} = 400\ W/m^3$.

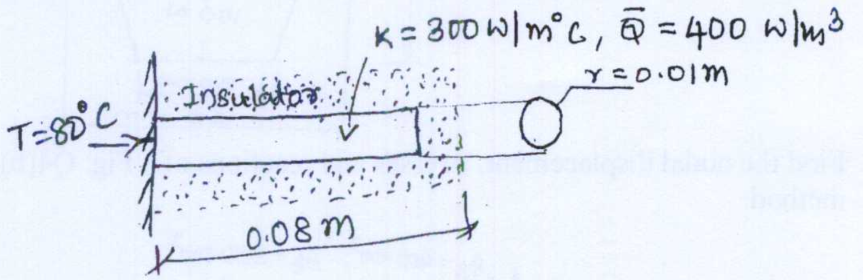


Fig. Q8(b)

(10 Marks)

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Sixth Semester B.E. Degree Examination, June/July 2017
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.***

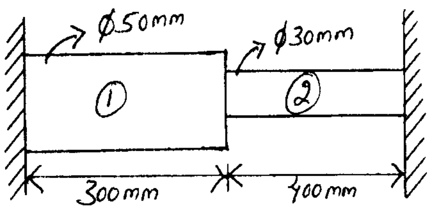
PART – A

1 a. Explain with neat sketch, plain stress and plain strain. **(06 Marks)**
b. Sketch the different types of 1D, 2D and 3D elements used in the finite element analysis. **(06 Marks)**
c. Derive the equilibrium equation in elasticity of 3D elastic body subjected to a body force and traction force. **(08 Marks)**

2 a. Write the properties of stiffness matrix and derive the element stiffness matrix for a 1D bar element. **(10 Marks)**
b. A cantilever beam of span 'L' is subjected to a point at free end. Derive an equation for the deflection at free end by using Rayleigh Ritz method. Assume polynomial displacement function. **(10 Marks)**

3 a. Define interpolation polynomial, simplex, complex and multiplex element. **(04 Marks)**
b. Explain two Dimensional Pascal's triangle. **(06 Marks)**
c. Derive the shape function for C.S.T element. **(10 Marks)**

4 a. Determine the nodal displacements, elemental stresses and support reactions for the Fig Q4(a). Use elimination approach to handle the Boundary conditions. **(10 Marks)**

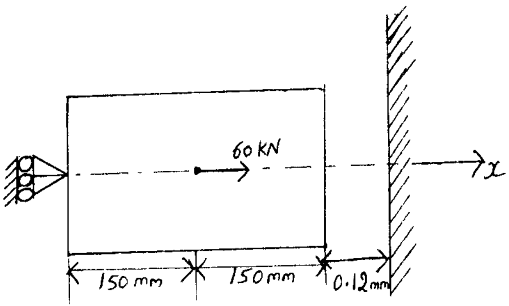


(1) Aluminium
$E_1 = 0.7 \times 10^5$ MPa

(2) Steel
$E_2 = 2 \times 10^5$ MPa

Fig Q4(a)

b. Consider the bar shown Fig Q4 (b). An axial load P = 60 × 10^3N is applied at its mid point. Using penalty method of handling Boundary conditions. Determine the nodal displacement and support reactions. **(10 Marks)**



A = 250mm^2

B = 200 GPa

Fig Q4(b)

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 – B

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

b. With a neat sketch explain iso, sub and super parametric elements. **(06 Marks)**

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

6 a. Derive the expression for stiffness matrix of a truss element. **(08 Marks)**

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

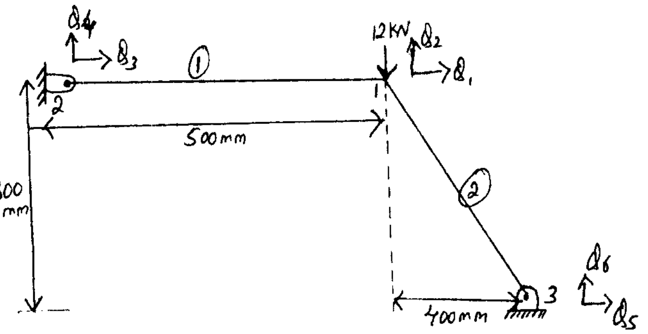


Fig Q6(b)

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

b. For the beam and loading shown in the Fig Q7(b). Determine the end reaction and deflection at midspan. Take E = 200 GPa, $I = 4 \times 10^6 mm^4$. **(12 Marks)**

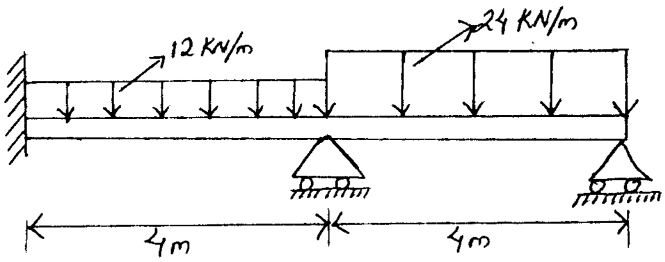


Fig Q7(b)

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

b. Determine the temperature distribution in the composite wall using 1D heat elements, use penalty approach of handling boundary conditions (Fig Q8(b). **(12 Marks)**

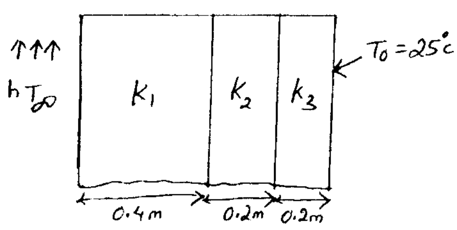


Fig Q8(b)

K_1 = 25 W/m °C
K_2 = 35 W/m °C
K_3 = 55 W/m °C
h = 30 W/m^2 °C
T_∞ = 900°C
A = Unit area

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10ME64

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.***

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

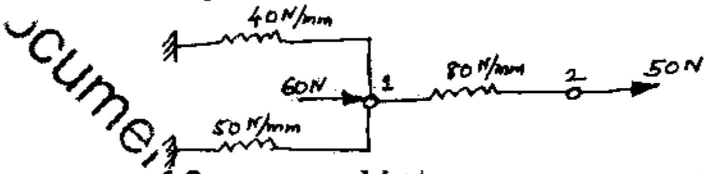
1 a. Differentiate between plane stress and plain strain problems with examples. Write the stress-strain relations for both. **(08 Marks)**

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)

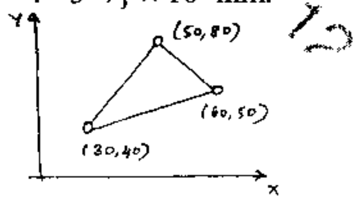


b. Determine the deflection of a cantilever beam of length 'L' subjected to uniformly distributed load (UDL) of P_o/unit length, using the trail function $y = a \sin\left(\frac{\pi x}{2L}\right)$. Compare the results with analytical solution and comment on accuracy. **(12 Marks)**

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} × 10^{-2}mm. **(10 Marks)**



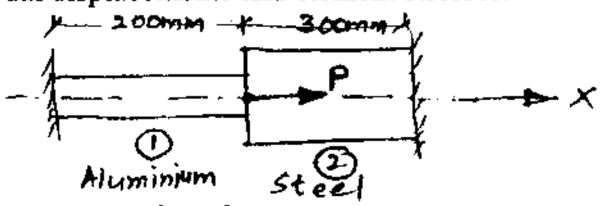
Note: All dimensions in mm. Fig.Q.3(b)

4 a. An axial load P = 300 × 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/m², $E_2 = 200 \times 10^9$N/m²

$A_1 = 900$mm², $A_2 = 1200$mm²

$\alpha_1 = 23 \times 10^{-6}$/°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)**

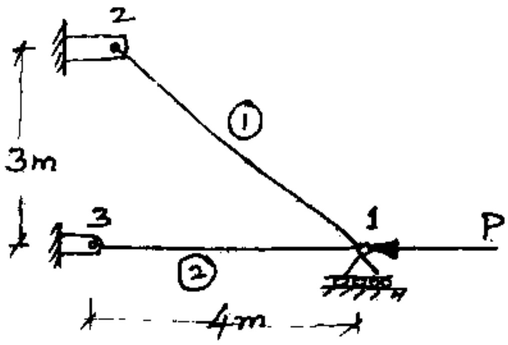
b. Evaluate $I = \int_{-1}^{+1}\left[3e^x + x^2 + \frac{1}{(x+2)}\right].dx$

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 = 600mm² for each element. **(12 Marks)**

Fig.Q.6(a)

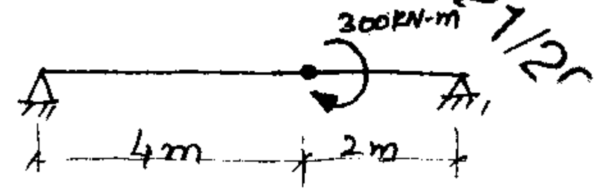


b. Derive an expression for stiffness matrix for a 2-D truss element. **(08 Marks)**

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

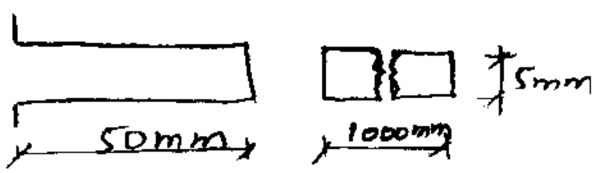
b. A simply supported beam of span 6m and uniform flexural rigidity EI = 40000 kN-m² is subjected to clockwise couple of 300 kN-m at a distance of 4m from the left end as shown in the Fig.Q.7(b). Find the deflection at the point of application of the couple and internal loads. **(12 Marks)**

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/m². 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, 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.***

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. 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)**

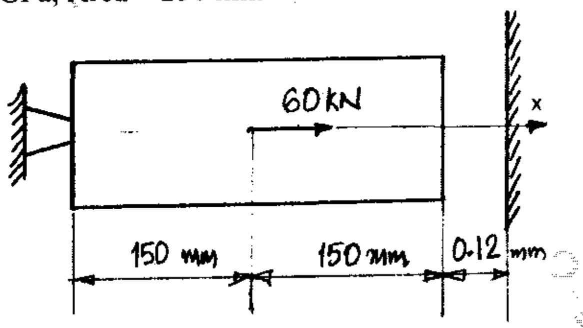
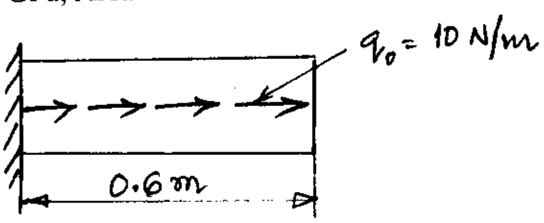


Fig. Q4 (a)

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)**

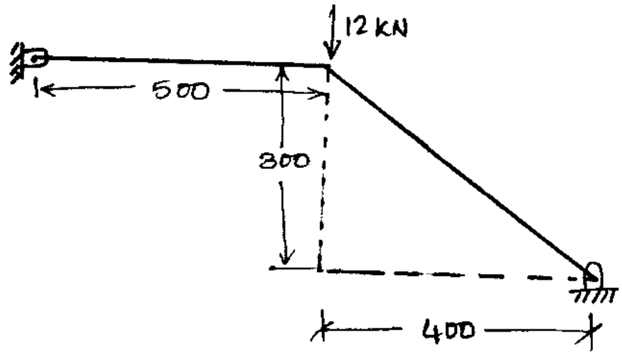


Fig. Q6 (b)

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, $I = 4\times10^6 mm^4$. **(12 Marks)**

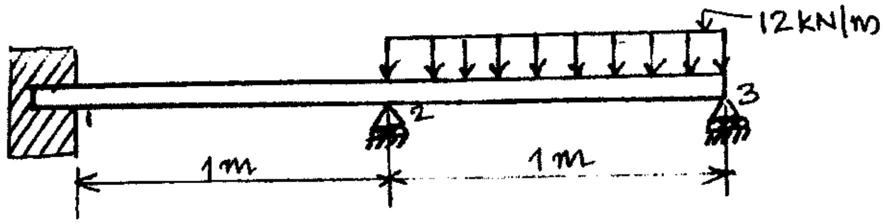


Fig. Q7 (b)

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)**

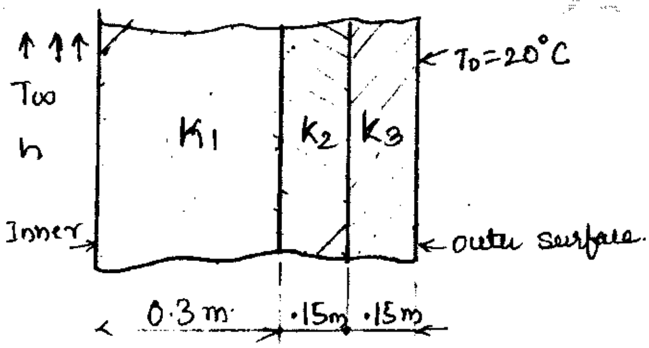


Fig. Q8 (b)

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