Finite Element Analysis VTU CBCS Question Paper Set 2018

USN

10AE64

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

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. Enlist the steps involved in a typical Rayleigh Ritz-method. **(10 Marks)**

b. Derive the expression for potential energy of a 3D elastic body. **(10 Marks)**

2 a. Derive the shape functions for a typical beam element. **(10 Marks)**

b. Define shape function. Derive the shape functions for a typical bar element and plot them across the element. **(10 Marks)**

3 a. Determine Jacobian of the transformation J for the triangular element shown in the Fig. Q3 (a).

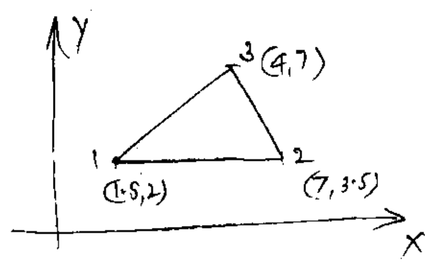

Fig. Q3 (a) **(08 Marks)**

b. Consider truss bar stress shown in the Fig Q3 (b). Determine displacements and stresses in each member. Find the support reaction also. A_1 = 1500 mm^2, A_2 = A_3 = 2000 mm^2 and E = 200 GPa.

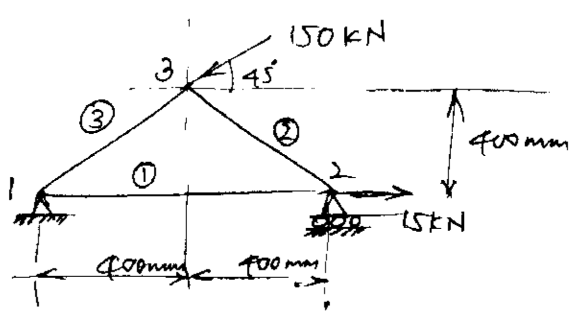

Fig. Q3 (b) **(12 Marks)**

4 a. Sketch and explain CST and LST elements. Write the difference between them. **(10 Marks)**

b. Write down the shape functions for a quadrilateral element with midside nodes. **(10 Marks)**

PART – B

5 a. Sketch the 8 noded hexahedral element, with suitable node numbering. Enlist the shape functions for the same element. **(10 Marks)**

b. Sketch and explain serendipity and Lagrange family of finite elements. **(10 Marks)**

6 a. Describe the various modules of finite element analysis tools with suitable examples. **(10 Marks)**

b. What are isoparametric, subparametric, and super parametric elements. Explain with suitable sketches. **(10 Marks)**

7 a. Compare three dimensional finite element model with the axisymmetric finite element model. **(08 Marks)**

b. Compute the strain displacement matrix for the axisymmetric triangular element. Use the following data: Fig.Q.7(b).
$u_1 = 0.002$mm; $w_1 = 0.001$mm
$u_2 = 0.001$mm; $w_2 = -0.004$mm
$u_3 = -0.003$mm; $w_3 = 0.007$mm **(12 Marks)**

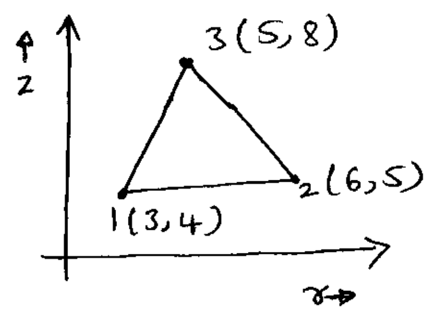

Fig.Q.7(b)

8 a. Derive the shape functions for a three noded, 1D thermal element and plot the shape functions across the element. **(10 Marks)**

b. Find the temperature distribution in one dimensional fin of length 50mm and radius 10mm by taking one element model. The heat will be lost to the surroundings through the perimeter surface and at the end (tip). Thermal conductivity of the material is 7000 (watt)/(m-k) conductivity heat transfer coefficient is 50kW/m^2-K, film temperature is 40 degrees and the left end of the fin is maintained at a temperature of 140°C. **(10 Marks)**

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

Finite Element Analysis

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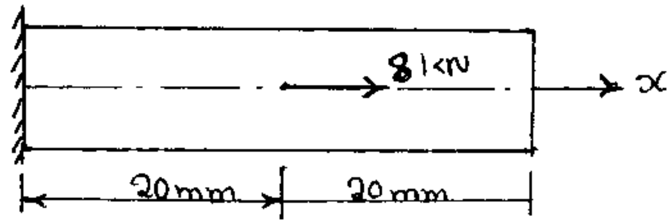
Note: ***Answer FIVE full questions, selecting at least TWO questions from each part.***

PART – A

1 a. Use Rayleigh – Ritz method to find stress and displacement at the midpoint of a bar shown in Figure Q 1 (a). Take E = 70MPa, A = 100mm^2. **(12 Marks)**

Fig. Q1 (a)



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

c. Define shape function. **(02 Marks)**

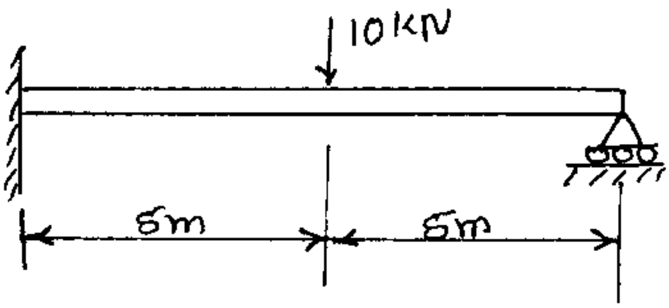
2 a. Explain the convergence criteria with suitable examples and compatibility requirements. **(06 Marks)**

b. Derive the shape function for one dimension beam element in natural co – ordinate. **(14 Marks)**

3 a. Derive stiffness matrix for bar element. **(08 Marks)**

b. For the beam element shown in fig Q3 (b) determine deflection under the given load. Take $E = 2 \times 10^8$ kN/m^2 $I = 4 \times 10^{-6}$ m^4

Fig. Q3 (b)



(12 Marks)

4 a. Derive shape function for quadrilateral element and show the variation of shape function by using neat sketch. **(10 Marks)**

b. Derive shape function for three noded bar element and show the variation of shape function. **(10 Marks)**

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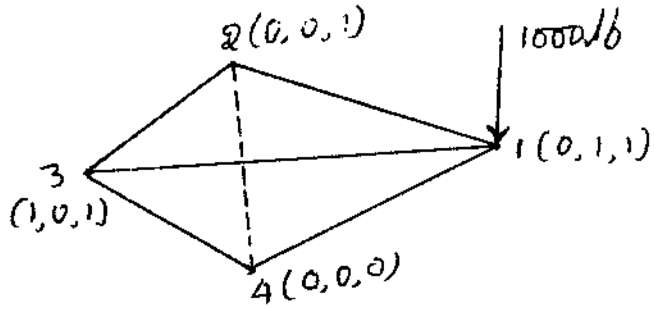
PART – B

5 a. Figure Q 5 (a) shows a four node tetrahedral object. The coordinate dimensions shown are in inches. The nodes 2, 3 and 4 are fixed and a 1000 ℓb load is applied at node 1 as show. Determine the displacement of node 1 using a single element.
Take $E = 30 \times 10^6$ Psi and $\nu = 0.3$ **(14 Marks)**

Fig. Q5 (a)



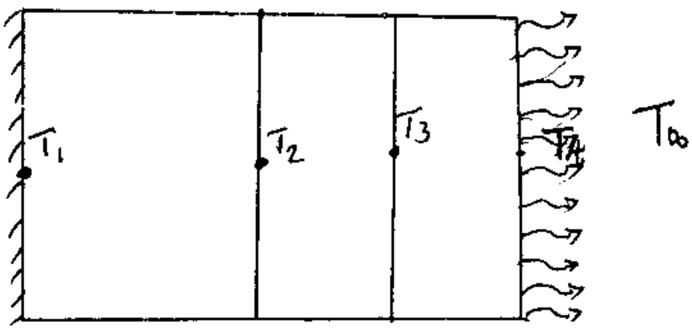
b. Explain serendipity and large family of finite element. **(06 Marks)**

6 a. Briefly explain isoparametric, subparametric and super parametric elements. **(06 Marks)**
b. Mention the different software packages used for FEA. **(04 Marks)**
c. Explain briefly preprocessing, processing and portprocessing in FEA. **(10 Marks)**

7 a. Derive strain – displacement matrix for triangular element in the axisymmetric body. **(15 Marks)**
b. Obtain an expression for potential energy functional to axisymmetric solid subjected axisymmetric loading. **(05 Marks)**

8 a. Derive the element stiffness matrix for heat conduction in one dimensional element. **(08 Marks)**
b. An induction furnace wall is made up of three layer, inside, middle and outer layer with thermal conductivity k_1, k_2, and k_3 respectively as shown in figure Q 8 (b). Determine the nodal temperature. Take k_1 = 8.5 W/m°k, k_2 = 0.25W/m°k, k_3 = 0.0.8W/m°k, h = 45W/m²k, T_∞ = 30°C and T_1 = 600°C. **(12 Marks)**

Fig. Q8 (b)



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Sixth Semester B.E. Degree Examination, June/July 2016
Finite Element Analysis

Time: 3 hrs. Max. Marks:100

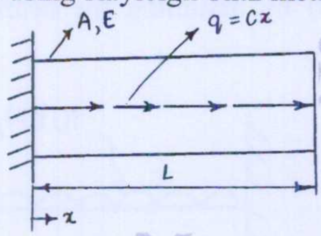
Note: ***Answer FIVE full questions, selecting at least TWO questions from each part.***

PART – A

1 a. State the principle of minimum potential energy. Derive an expression for total potential energy for a 3-D elastic body subjected to body force, traction and point load. **(10 Marks)**

b. A bar of length L, cross sectional area A and modulus of elasticity E, is subjected to distributed axial load q = cx, where c is a constant as shown in Fig.Q.1(b). Determine the displacement of the bar at the end using Rayleigh-Ritz method. **(10 Marks)**

Fig.Q.1(b)



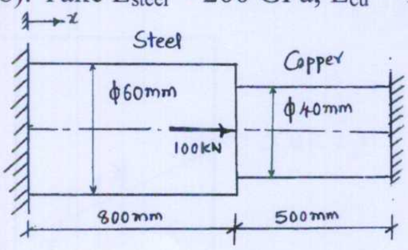
2 a. What are convergence requirements? Discuss the three conditions of convergence requirements. Also define confirming (compatible) and non-confirming elements. **(10 Marks)**

b. Derive the shape functions for 1-D bar element in natural coordinate and also show the variation. **(10 Marks)**

3 a. Derive the elemental stiffness matrix for a 2-D truss element. **(10 Marks)**

b. Determine the nodal displacement, stress in each element and the support reaction in the stepped bar shown in Fig.Q.3(b). Take E_{steel} = 200 GPa, E_{cu} = 100GPa. **(10 Marks)**

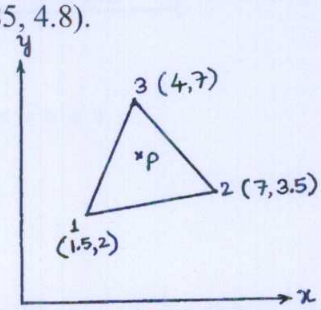
Fig.Q.3(b)



4 a. Differentiate between CST and LST elements. **(06 Marks)**

b. For the triangular element shown in Fig.Q.4(b). Determine the Jacobian matrix and also the shape functions at the point P(3.85, 4.8). **(08 Marks)**

Fig.Q.4(b)



c. Write a short note on Geometrical Isotropy for 2-D Pascal triangle. **(06 Marks)**

PART – B

5 a. Derive the shape function for 4-noded tetrahedral elements. **(10 Marks)**

b. Differentiate between Lagrange and serendipity family of elements, with neat sketches. **(10 Marks)**

6 a. What are iso-parametric, sub-parametric and super parametric elements? Explain with neat sketches. **(09 Marks)**

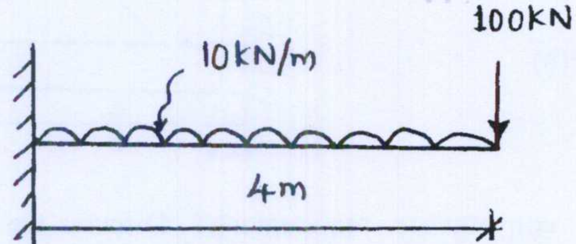
b. Explain the three phases in finite element analysis. **(06 Marks)**

c. List the 10-software packages used in FEA. **(05 Marks)**

7 a. What are Axisymmetric elements? Explain the axisymmetric triangular element, with neat sketch. **(10 Marks)**

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

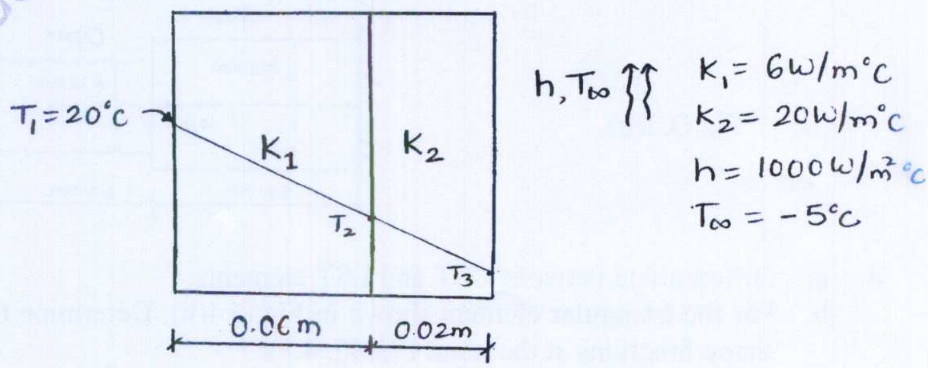
Fig.Q.7(b)



8 a. Derive an expression for the thermal conductivity matrix for 1-D two noded heat element. **(08 Marks)**

b. Determine the temperature distribution through the composite wall subjected to convection heat loss on the right side surface with convective heat transfer coefficient as shown in Fig.Q.8(b). The ambient temperature is -5°C. **(12 Marks)**

Fig.Q.8(b)



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Sixth Semester B.E. Degree Examination, June/July 2017
Finite Element Analysis

Time: 3 hrs. Max. Marks:100

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

PART – A

1 a. Define FEM and describe simplex, complex and multiplex elements with example. **(08 Marks)**

b. Use Rayleigh-Ritz method to find stress and displacement at the mid point of a bar shown in Fig. Q1 (b). Take E = 70 GPa; A = 100 mm^2. Assume the displacement model to be a 2nd order polynomial. **(12 Marks)**

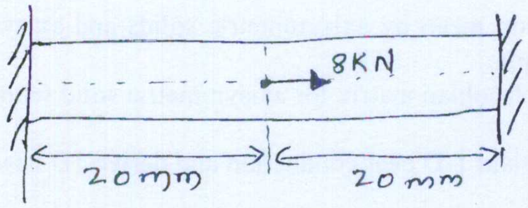


Fig. Q1 (b)

2 a. Define shape function and derive shape function for a 1-D quadratic bar element. **(07 Marks)**

b. List and describe convergence requirements. **(04 Marks)**

c. Construct shape function for beam element. **(09 Marks)**

3 a. Using penalty method of handling boundary condition determine the nodal displacement, stress in each element and support reaction in the bar shown in Fig. Q3 (a) due to applied force P = 100 kN. Take E_{steel} = 200 GPa; E_{copper} = 100 GPa **(10 Marks)**

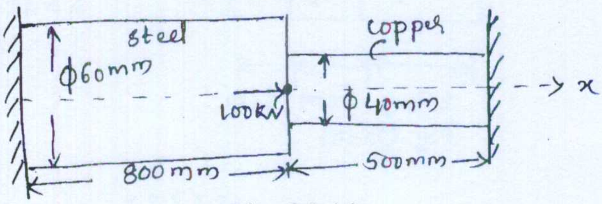


Fig. Q3 (a)

b. For the two bar truss shown in Fig. Q3 (b) determine the nodal displacement, stress in each element and reaction at the support. Take E = 2×10^5 N/mm^2, A = 200 mm^2. **(10 Marks)**

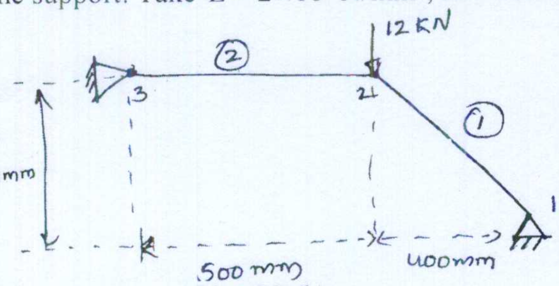


Fig. Q3 (b)

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.

4 a. Derive the expression for Jacobian matrix [J] displacement matrix [B] and stiffness matrix [K] for CST element. **(15 Marks)**

b. Construct shape function for linear quadrilateral element in natural co-ordinate system with shape function variation. **(05 Marks)**

PART – B

5 a. Describe and distinguish serendipity family elements and langranges family elements with illustration. **(04 Marks)**

b. Construct shape function for eight noded hexahedral element[HEXA 8]. **(08 Marks)**

c. Derive the Jacobian matrix [J] for tetrahedral element [TET 4] **(08 Marks)**

6 a. Briefly describe isoparametric, subparametric and super parametric elements with neat sketch. **(06 Marks)**

b. Construct shape function for nine-node quadrilateral. **(08 Marks)**

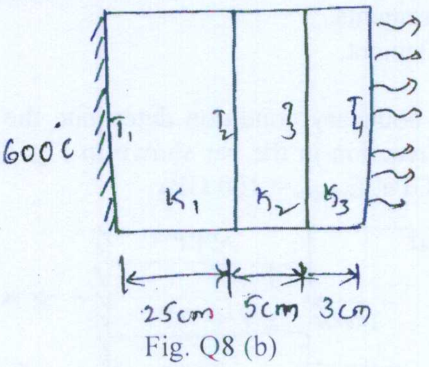
c. Explain the stages of FEA. **(06 Marks)**

7 a. What do you mean by axisymmetric solids and axisymmetric loading condition? Illustrate with example. **(06 Marks)**

b. Formulate Jacobian matrix for axisymmetric solid with triangular element. **(14 Marks)**

8 a. Briefly explain 1-D heat conduction and derive 1D heat conduction governing equation. **(08 Marks)**

b. An induction furnace wall is made up of three layers, inside, middle and outer layer with thermal conductivity K_1, K_2 and K_3 respectively as shown in Fig. Q8 (b), determine the nodal temperature. **(12 Marks)**



$K_1 = 8.5$ W/mK
$K_2 = 0.25$ W/mK
$K_3 = 0.08$ W/mK
$h = 45$ W/m^{2}K
$T_\infty = 30$°C

Fig. Q8 (b)

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

Time: 3 hrs. Max. Marks:100

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

PART – A

1 a. Derive the equilibrium equations of elasticity in 3D. **(10 Marks)**

b. Write short notes on plane stress and plane strain with stress – strain relations. **(08 Marks)**

c. List the applications of FEM. **(02 Marks)**

2 a. Obtain the expression for shape functions of 2D triangular element using area co-ordinate method. **(08 Marks)**

b. Explain convergence criteria and its requirements. **(06 Marks)**

c. Explain the local and natural coordinate systems used in FEM. **(06 Marks)**

3 a. For the continuum shown in Fig. 3(a). Determine nodal displacement and reaction at the supports. **(12 Marks)**

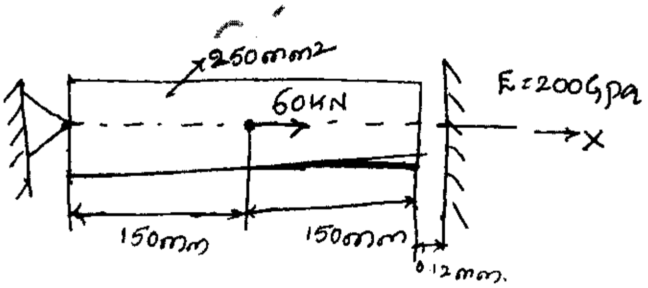

Fig.Q3(a)

b. Write stiffness matrix for :

i) Bar element
ii) Beam element
iii) Truss element. **(08 Marks)**

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

b. Derive the shape functions for 8 – noded Quadrilateral element. **(12 Marks)**

PART – B

5 a. Write short notes on Lagrangian family of elements and serendipity – family of elements with examples. **(08 Marks)**

b. Derive the shape functions for hexahedral element. **(12 Marks)**

6 a. Write short notes on ISO-parametric, subparametric and superparametric elements. **(12 Marks)**

b. Explain preprocessing, processor and post processing used in commercial FEM analysis software. **(08 Marks)**

7 a. Derive elemental stiffness matrix for axissymetric triangular element. **(12 Marks)**

b. What is Jacobian matrix? Prove that area of axissymetric element $[A_e] = \frac{1}{2}|\det J|$. **(08 Marks)**

8 a. Derive thermal conductivity matrix for 1D bar element. **(06 Marks)**

b. A composite wall consists of thee materials 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 $h = 25\ W/m^2C$. Determine temperature distribution in the wall. **(14 Marks)**

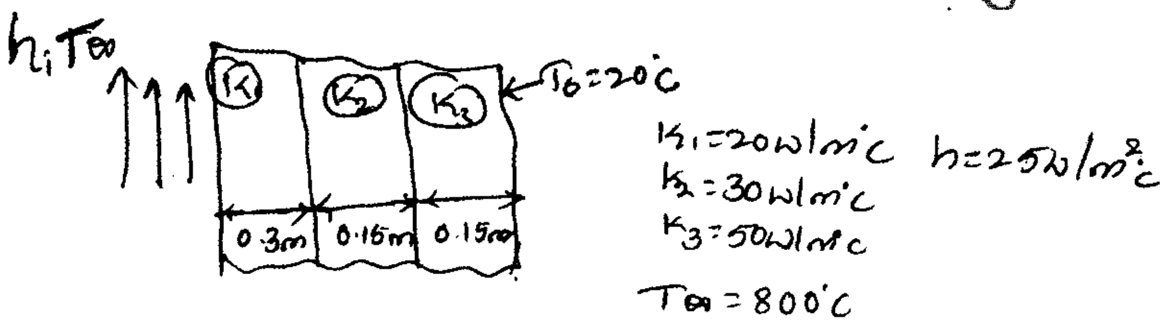

Fig.Q8(b)

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

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PART – A

1 a. Derive an expression for the potential energy functional for a three–dimensional body subjected to body forces, surface forces and point loads. **(06 Marks)**

b. Determine the nodal displacements for the spring system shown in the Fig. Q1(b) using the principle of minimum potential energy. **(06 Marks)**

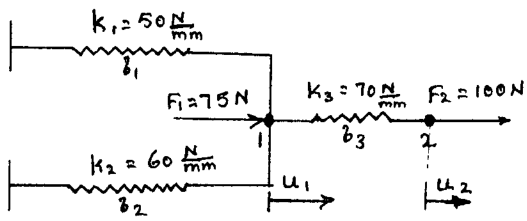

Fig. Q1(b)

c. Derive an expression for the displacement at the free end of the cantilever bar subjected to uniaxial as shown in the Fig. Q1(c). Also find the expression for stress. Consider the cross sectional area as A and elastic modulus as E. **(08 Marks)**

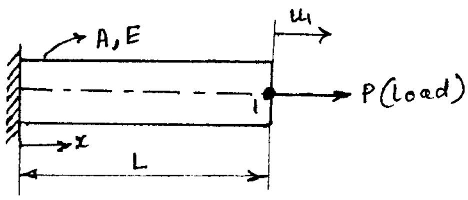

Fig. Q1(c)

2 a. Derive an expression for the shape function for 1–D bar element in natural co-ordinates. **(07 Marks)**

b. Explain the convergence requirements in finite element formulation using Pascal 2D triangle. **(07 Marks)**

c. Explain the co-ordinate systems used in finite element formulation. **(06 Marks)**

3 a. Derive the elemental stiffness matrix for a plane truss element. **(10 Marks)**

b. Determine the nodal displacement, elemental stresses and support reaction of the bar shown in the Fig. Q3(b). Take $E_{steel} = 200$ GPa ; $E_{copper} = 100$ GPa. **(10 Marks)**

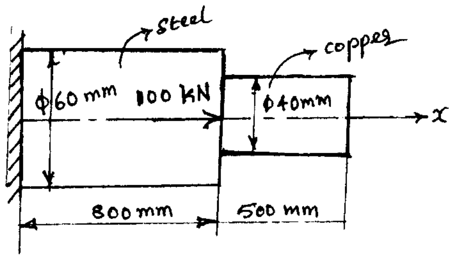

Fig. Q3(b)

4 a. Derive the shape function for a none noded quadrilateral element in natural co-ordinates. **(10 Marks)**

b. Derive the Jacobian matrix for 2–D CST element and thus determine the Jacobian for the triangular stiffness element shown in the Fig. Q4(b). **(10 Marks)**

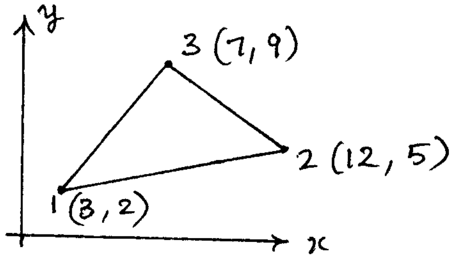

Fig. Q4(b)

PART – B

5 a. Derive the shape function for 4 noded tetrahedral elements. **(10 Marks)**

b. Differentiate between Lagrange and serendipity family of elements with neat sketches. **(10 Marks)**

6 a. Explain the three phases in finite element analysis. **(06 Marks)**

b. What are ISO–parametric, sub parametric and super parametric elements? Explain with suitable sketches. **(08 Marks)**

c. Explain the different schemes of node numbering and thus explain half band width. **(06 Marks)**

7 a. Derive the shape function for 8 noded hexahedral elements. **(12 Marks)**

b. What are axisymmetric elements? Explain the finite element analysis of ax symmetric quadrilateral element. **(08 Marks)**

8 a. Derive the governing differential equation for 1–D heat conduction. **(06 Marks)**

b. A composite wall consists of three materials as shown in the Fig. Q8(b). The outer surface temperature is 20°C. Convective heat transfer takes place on the inner surface with T_∞ = 800°C and h = 25 W/m^2 °C. Determine the temperature distribution in the inner wall. **(14 Marks)**

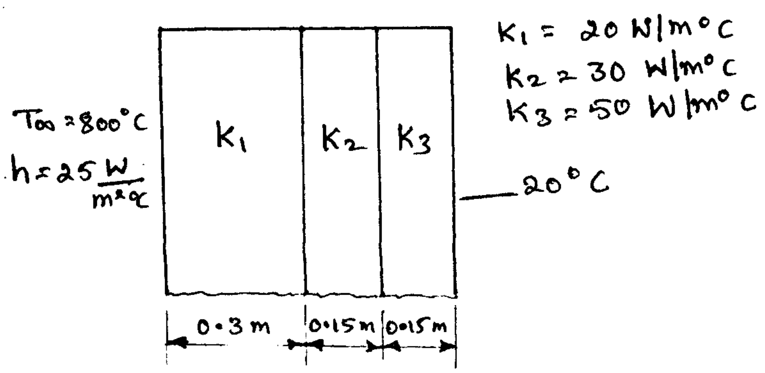

Fig. Q8(b)

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

Time: 3 hrs. Max. Marks:100

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

PART – A

1 a. Explain plane stress and plane strain condition with suitable examples. **(10 Marks)**

b. For the spring system shown in Fig. Q1(b). Using the principle of minimum potential energy, determine the nodal displacement. Take : $F_1 = 75N$ and $F_2 = 100N$. **(10 Marks)**

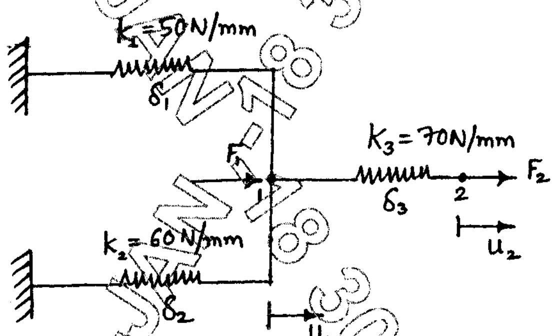

Fig. Q1(b)

2 a. Explain the different types of elements used in FEA with suitable examples. **(10 Marks)**

b. Explain the convergence requirements and compatibility condition. **(10 Marks)**

3 a. Derive the hermit shape function for beam element and also show their variation. **(10 Marks)**

b. A stepped bar shown in Fig.Q3(b). Determine the nodal displacements and the support reaction. Take $E_1 = E_2 = 2 \times 10^5$ MPa ; $A_1 = 100mm^2$; $A_2 = 5mm^2$. **(10 Marks)**

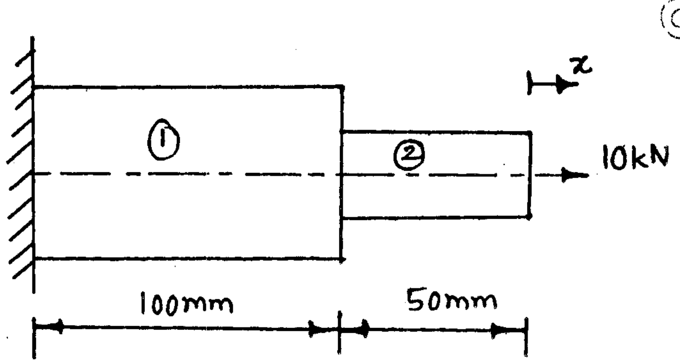

Fig.Q3(b)

4 a. Derive the shape function for CST element in natural coordinates and also show the variation. **(10 Marks)**

b. Sketch and explain Pascal triangle for 2 – D polynomial. **(04 Marks)**

c. Determine the Jacobian matrix and area for the triangular element shown in Fig.Q4(c). **(06 Marks)**

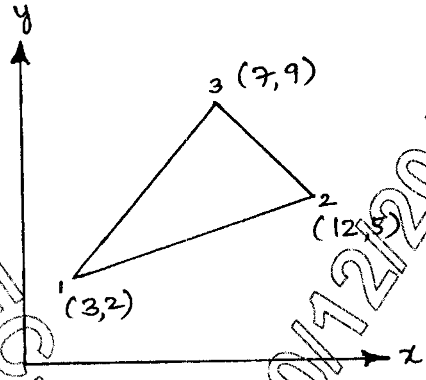

Fig.Q4(c)

PART – B

5 a. Obtain the shape functions for 8-noded hexahedral element(HEXA 8). **(10 Marks)**

b. List out the differences between serendipity and Lagrange family elements. **(10 Marks)**

6 a. Explain ISO parameteric, sub paraemteric and super parametric elements with the help of neat sketches. **(10 Marks)**

b. List out any ten software packages used for FEA. **(10 Marks)**

7 a. Explain axisymmetric triangular element with neat sketch. **(10 Marks)**

b. Derive an expression for thermal conductivity matrix for 1-D fin. **(10 Marks)**

8 a. Solve for temperature distribution in the composite wall show in Fig.Q8(a). Using 1 – D heat elements, use penalty approach of handling boundary condition. **(16 Marks)**

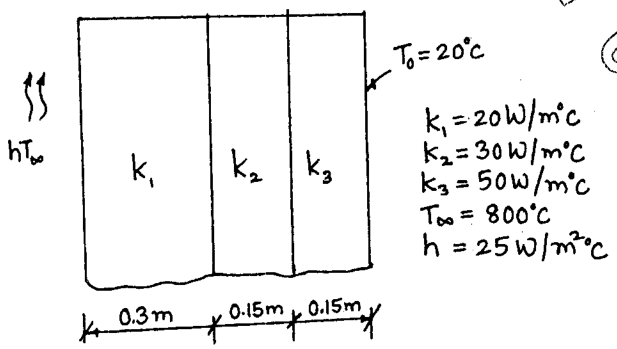

Fig.Q8(a)

b. Write the expression for element mass matrices. **(04 Marks)**

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