

FINITE ELEMENT METHOD AND ITS APPLICATION (SEMESTER - 8)**CS/B.TECH(ME/PE)/SEM-8/ME-807/09**

1.
Signature of Invigilator

2.
Signature of the Officer-in-Charge

Reg. No.

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Roll No. of the Candidate

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CS/B.TECH(ME/PE)/SEM-8/ME-807/09**ENGINEERING & MANAGEMENT EXAMINATIONS, APRIL – 2009****FINITE ELEMENT METHOD AND ITS APPLICATION (SEMESTER - 8)**

Time : 3 Hours]

[Full Marks : 70

INSTRUCTIONS TO THE CANDIDATES :

- This Booklet is a Question-cum-Answer Booklet. The Booklet consists of **32 pages**. The questions of this concerned subject commence from Page No. 3.
- In **Group – A**, Questions are of Multiple Choice type. You have to write the correct choice in the box provided **against each question**.
 - For **Groups – B & C** you have to answer the questions in the space provided marked 'Answer Sheet'. Questions of **Group – B** are Short answer type. Questions of **Group – C** are Long answer type. Write on both sides of the paper.
- Fill in your Roll No. in the box** provided as in your Admit Card before answering the questions.
- Read the instructions given inside carefully before answering.
- You should not forget to write the corresponding question numbers while answering.
- Do not write your name or put any special mark in the booklet that may disclose your identity, which will render you liable to disqualification. Any candidate found copying will be subject to Disciplinary Action under the relevant rules.
- Use of Mobile Phone and Programmable Calculator is totally prohibited in the examination hall.**
- You should return the booklet to the invigilator at the end of the examination and should not take any page of this booklet with you outside the examination hall, **which will lead to disqualification**.
- Rough work, if necessary is to be done in this booklet only and cross it through.

No additional sheets are to be used and no loose paper will be provided**FOR OFFICE USE / EVALUATION ONLY**

Marks Obtained

	Group – A										Group – B					Group – C					Total Marks	Examiner's Signature
Question Number																						
Marks Obtained																						

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Head-Examiner/Co-Ordinator/Scrutineer**807 (21/04)**

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[Full Marks : 70

Graph sheet is provided on Page 31.

GROUP – A**(Multiple Choice Type Questions)**

1. Choose the correct answer for the following :

10 × 1 = 10

i) Stiffness matrix is

- a) symmetrical about top left to bottom right diagonal
- b) symmetrical about top right to bottom left diagonal
- c) antisymmetric
- d) none of these.

ii) Elemental stiffness matrix [K] is obtained in terms of B-matrix and elasticity matrix, D as

- a) (Product of B-matrix & elasticity matrix D) ($K = \int_v BD \, dv$)
- b) (Product of D-matrix & B-Matrix) ($K = \int_v DB \, dv$)
- c) (Product of B^T , D & B matrices) ($K = \int_v B^T DB \, dv$)
- d) none of these.

iii) Accuracy of solution of FEM depends upon

- a) refinement of element
- b) larger size of element
- c) nodal forces on the boundary
- d) all of these.

iv) Suitable shape function for the element is selected

- a) on the basis of variation of sides of elements
- b) on the variation of area of element
- c) strain field



- d) boundary conditions.
- v) Isoparametric element is one in which
- a) geometry of the element is described by a parameter
 - b) displacement of the element is described by another parameter
 - c) both geometry & displacement of element are described by same parameter
 - d) none of these.
- vi) The circular cylinder with longer length will be treated for 2-D case as
- a) plane stress
 - b) plane strain
 - c) either plane stress or plain strain
 - d) none of these.
- vii) Convenient way of using numerical integration in FEM is
- a) Gaussian Quadrature formula b) Newton - Cotes Quadrature
 - c) Simpson's rule d) Trapezoidal rule.
- viii) Finite element can be applied to the problems of
- a) Solid Mechanics b) Fluid Mechanics
 - c) Thermal Science d) all types.
- ix) $U = a_0 + bx + cy$ is the deformation field in case of
- a) constant strain field
 - b) linearly varying strain field
 - c) parabolic variation of strain field
 - d) cubic variation of strain field.
- x) Solution of FEM is found by
- a) Matrix inversion method b) Gauss Elimination method

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c) Gauss-Seidel method

d) All of these.

GROUP – B**(Short Answer Type Questions)**Answer any *three* of the following.

3 × 5 = 15

2. Explain the Rayleigh-Ritz method and compare it with Potential Energy method.
3. Express the shape functions of quadratic element in terms of line co-ordinates.
4. Write down the minimum Potential Energy Theorem. Considering linear shape function, prove that element stiffness matrix

$$[K^e] = \frac{E_e A_e}{L_e} \begin{bmatrix} 1 & -1 \\ -1 & 1 \end{bmatrix}$$

for one-dimensional problem, E_e , A_e and L_e represent Young's modulus, area and length of the element respectively.

5. Describe the Gauss-Seidel iterative technique to solve the following simultaneous equations of two variables x , y and state the condition of convergence :

$$5x + 4y = 9$$

$$x - y = 2.$$

6. Explain the Saint Venant's Principle and Von Mises stress theory.

GROUP – C**(Long Answer Type Questions)**Answer any *three* questions.

3 × 15 = 45

7. a) How do you compare finite element method with finite difference method in the context of numerical solution ? Explain finite element 'discretization'.
- b) Find the deflection at the centre of a simply supported beam subjected to a concentrated load P at its midpoint as shown in *Figure - 1*. Find the maximum stress induced in the beam.

5 + 10

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Figure - 1

8. a) Explain how the numerical integration is evaluated using one-point formula. Show graphical representation of one point Gauss-quadrature for simple function.
- b) For the three stepped bar shown in *Figure - 2*, the bar is fitted snugly between the rigid walls at room temperature. The temperature is then raised by 40°C . Determine the displacements at 2 and 3 and stresses in the three segments.
- 5 + 10

Figure - 2

9. a) Explain Galerkin's method.
- b) A composite wall consists of three materials as shown in *Figure - 3*. The outer temperature is $T_o = 20^{\circ}\text{C}$. Convection heat transfer takes place on the inner surface of the wall with $T_{\infty} = 800^{\circ}\text{C}$ and $h = 25\text{W/m}^2 \text{ }^{\circ}\text{C}$. Determine the temperature distribution in the wall.
- 5 + 10



Figure - 3

10. For the two-element plate as shown in *Figure - 4*, determine the strain displacement matrix and the element stiffness matrices if thickness $t = 10$ mm, the material aluminium with Young's modulus $E = 70$ GPa and Poisson's ratio $\nu = 0.33$. Assume plane stress condition. 15

Figure - 4

11. Consider the four-bar truss as shown in *Figure - 5*. It is given that $E = 2000$ GPa and $A_e = 6.5 \text{ cm}^2$ for all elements.
- Determine the element stiffness matrix for each element.
 - Assemble the structural stiffness matrix $[K]$ for the entire truss.
 - Using the elimination approach, solve for the nodal displacement.
 - Calculate the stress in each element.
- 15

Figure - 5

12. a) Write a short note on variational principles.
- b) A system of springs is shown in *Figure - 6*. Derive the assemble equations of equilibrium by Direct Approach. Prove that minimization of potential energy also yields the same result. 5 + 10

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Figure - 6

END