

M.E. CIVIL ENGINEERING FIRST YEAR SECOND SEMESTER EXAM 2025**Sub: ADVANCED COMPUTER METHODS AND FINITE ELEMENT ANALYSIS****Full Marks 100**Time: **Three hours****(60 marks for Part-I)****Use a separate Answer-Script for each part**

| No. of Questions | PART - I | Marks |
|--|--|--------------------------|
| <u>Answer any TWO questions</u> | | |
| 1. | <p>a) What is material nonlinearity in the structural engineering problem? How can it be taken into consideration in Finite Element Analysis of that problem?</p> <p>b) Write a short note on the terms ‘hardening parameter’, ‘initial modulus of elasticity’ and ‘tangential modulus of elasticity’ and the relationship among them.</p> <p>c) What is ‘yield criterion’? What is the utility of ‘yield criterion’ in nonlinear finite element analysis?</p> <p>d) Write a short note on Von-Mises yield criterion and Tresca’s yield criterion.</p> <p>e) How the ‘flow vector’ can be determined in nonlinear finite element analysis? Find the elements of flow vector corresponding to Von-Mises yield criterion both in terms of normal and shear stress components as well as in terms of principal stress components?</p> <p>f) Write a short note on the ‘tangential stiffness algorithm’ with reference to nonlinear finite element analysis.</p> | 5+8+3 +6+6+ 2 = 30 |
| 2. | <p>a) Derive the nonlinear stiffness matrix of one-dimensional two-noded bar element.</p> <p>b) Use above-mentioned element for the solution of this problem: An one dimensional bar of circular cross-section is fixed at upper end and free at lower end. The diameter of its circular cross-section is 8mm and its length is 1020mm. It is subjected to a vertically downward concentrated force of 15kN. Calculate the end deflection, strain and stress developed in it. The material behaviour is shown in Fig.1. Apply the load in two steps (i.e. 60% and 40% of total). Perform maximum three iterations in each step.</p> <div data-bbox="319 1209 1101 1590" style="text-align: center;"> <p>The figure shows a stress-strain curve. The vertical axis is labeled 'Stress, σ' and the horizontal axis is labeled 'Strain, ϵ'. A dashed line from the origin to the yield point (ϵ_y, σ_y) is labeled $E_0 = 2.0 \times 10^5 \text{ N/mm}^2$. The yield stress $\sigma_y = 200 \text{ N/mm}^2$ is marked on the vertical axis. The yield strain $\epsilon_y = 0.002$ is marked on the horizontal axis. The curve is parabolic in the elastic region and becomes horizontal after yielding.</p> </div> | |

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Ref. No. : Ex/PG/CE/T/1210A/2025

Name of the Examinations: M.E. CIVIL ENGINEERING FIRST YEAR SECOND SEMESTER - 2025

Subject : ADVANCED COMPUTER METHODS AND
FINITE ELEMENT ANALYSISTime : 3
hours

Full Marks : 40(100)

Part II

Instructions : Use Separate Answer scripts for each Part

1. Express the Cauchy stress tensor T in terms of deformation gradients F , the density ratio ρ/ρ_0 and (i) the nominal stress tensor S , (ii) the first Piola-Kirchoff stress tensor S^T and (iii) the second Piola-Kirchoff stress tensor S' . (10)
2. Find the components of material deformation gradient matrix F , spatial deformation gradient matrix H and right Cauchy Green deformation tensor G given that Lagrangian components of a particle motion $x_1 = X_1 + X_3(e^t - 1)$, $x_2 = X_2 + X_3(e^t - e^{-t})$ and $x_3 = X_3e^t$, where e is a constant. (X – material coordinates, x – spacial coordinates) (10)
3. Obtain the Green-Lagrangian strain for a two node beam element subjected to finite strain. Using consistent linearization process derive the axial strain and the shear strain component of the same. Hence obtain the strain displacement matrix for a beam element undergoing finite strain. (20)