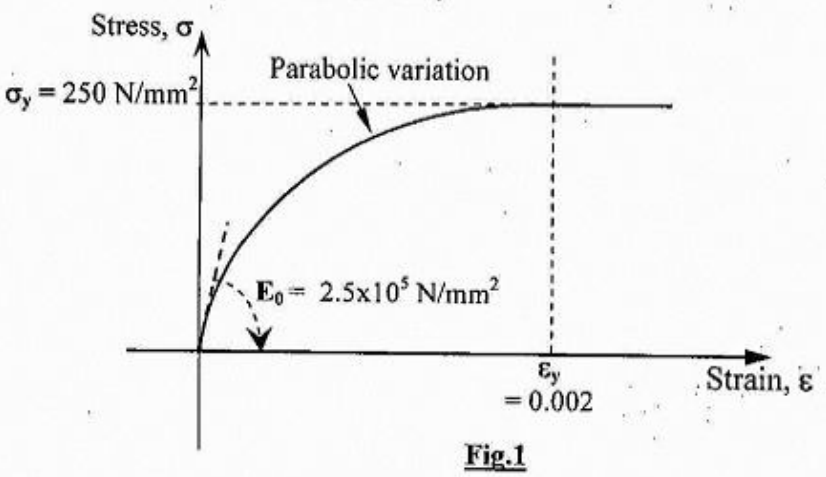
.....*M.E. Civil Engineering 1st Year 2nd Semester*..... EXAMINATION, *2019*

SUBJECT .....*Advanced Computer Methods and Finite Element Analysis*.....

Full Marks 100
(50 marks for each part)

Time: **Three hours**

Use a separate Answer-Script for each part

No. of Questions	**PART I.**	Marks
	Answer any TWO questions	
1.	a) What are the reasons for which non-linear behaviour of the structural response arises? b) Write short note on nonlinear stress-strain relationship beyond yield point. c) Explain the terms: 'hardening parameter', 'initial modulus of elasticity' and 'tangential modulus of elasticity'. Derive the relationship among them. d) What do you mean by 'yield criterion'? State 'Von-Mises yield criterion' and 'Tresca yield criterion' and explain their difference. e) Write short note on 'flow vector and its use in nonlinear finite element analysis'. f) Write short note on different solution algorithm used for materially nonlinear finite element analysis. g) How is the 'residual force' calculated and used in nonlinear finite element analysis?	4+3+5 +6+2+ 3+2 = 25
2.	a) Derive the nonlinear stiffness matrix of **one-dimensional three-noded** bar element. 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 25mm and its length is 1200mm. It is subjected to a vertically downward concentrated force of 35kN. 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.  **Fig.1**	5+20 = 25
3.	a) Derive elasto-plastic constitutive relationship matrix $[D_{ep}]$ for plane stress problem. Write the expression to calculate the plastic strain increment in the elasto-plastic nonlinear finite element analysis. b) For a plane stress problem, the stresses at a point are: σ_x = 180N/mm^2, σ_y = 260N/mm^2 and τ_{xy} = 100N/mm^2. Check whether the material at that point is yielded or not according to Von-Mises yield criterion if uniaxial yield stress of the material is 250N/mm^2. If it is yielded then find flow vector and elasto-plastic constitutive relationship matrix $[D_{ep}]$ considering H' = 300N/mm^2. Given E = 2.5x10^5 N/mm^2 and ν = 0.3. c) Write the steps for elasto-plastic nonlinear finite element analysis of two dimensional problem.	10+8+7 = 25

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Ref. No. : Ex/PG/CE/T/1210A/2019

Name of the Examinations: M.E. CIVIL ENGINEERING FIRST YEAR SECOND SEMESTER - 2019

Subject : ADVANCED COMPUTER METHODS AND FINITE ELEMENT ANALYSIS

Time : Three Hours Full Marks : 100

Part II

Instructions : Use Separate Answer scripts for each Group

1 a) Obtain the expression for 2nd Piola-Kirchhoff stress tensor in terms of Cauchy's stress tensor. 06

1 b) The Lagrangian description of motion for a line element is given as follows:
$x_1 = X_1 + X_3(e^t - 1)$
$x_2 = X_2 + X_3(e^t - e^{-t})$
and $x_3 = X_3 e^t$
where x_i and X_i 's are spatial and material coordinates, respectively and 'e' is a constant.
Find the components of material deformation gradient **F**, Spatial deformation gradient **H**, Lagrangian Strain tensor **L**, Eulerian strain tensor **E** and Cauchy-Green deformation tensor **G**. 08

2. Develop the strain – displacement matrix for a bar element subjected to finite deformation and hence obtain the Material Stiffness matrix and the Geometric Stiffness matrix for the same. 15

3 a) Obtain the expression for Green – Lagrangian strain for a Timoshenko beam element after performing consistent linearization process. 06

3 b) Obtain the strain displacement matrix for the Timoshenko beam element and hence develop the expression for internal force vector. 15