Form A : Paper-setting Blank

Ref. No. ...*Ex/PG/CT/T/113A/2018*

.....M. *E. Construction Engineering 1st Year*... EXAMINATION, *2018*
(1st / 2nd Semester / ~~Repeat / Supplementary / Annual / Bi-Annual~~)

SUBJECT ...*Theory of Elasticity, Plasticity & Elastic Stability*
(Name in full)

PAPER .....*XX*.....

Full Marks 100
(50 marks for part I)

Time: ~~Two hours~~/Three hours/~~Four hours/Six hours~~

Use a separate Answer-Script for each part

No. of Questions	PART I	Marks
	Answer any two questions.	
1.	Starting for general constitutive relationship, show that the number of independent coefficients for orthotropic material is only nine.	25
2. a)	Derive the equilibrium equations and strain compatibility equations (Saint Venant equation) for plane strain problem.	17
b)	The components of a first- and second-order tensor in a particular coordinate frame (X, Y and Z) are given by $a_i = \begin{Bmatrix} 1 \\ 4 \\ 2 \end{Bmatrix}$ *and* $\sigma_{ij} = \begin{bmatrix} 1 & 0 & 3 \\ 0 & 2 & 2 \\ 3 & 2 & 4 \end{bmatrix}$ Determine the components of each tensor in a new coordinate system found through a rotation of 45^0 about the Y-axis. Choose a counterclockwise rotation.	8
3.a)	Determine the principal values and directions of the following state of strain $\begin{bmatrix} 2 & -2 & 0 \\ -2 & -4 & 1 \\ 0 & 1 & 6 \end{bmatrix} \times 10^{-3}$. Also show that the principal directions are mutually orthogonal.	10
b)	Why stress tensor always be a symmetric tensor?	9
c)	For the following state of stress, determine the traction vector on a plane with unit normal $n = (0,1,1)\sqrt{2}$. $\sigma_{ij} = \begin{bmatrix} 3 & 1 & 1 \\ 1 & 0 & 2 \\ 1 & 2 & 0 \end{bmatrix}$	6

M.E. Constn. Engg. 1st Year 1st Sem. Exam. 2018

Theory of Elasticity, Plasticity & Elastic Stability

Part - II

Answer any two questions.

Q.1 (a) What do you mean by yield criteria and flow rule? Explain stress deviation tensors and the three invariants in connection with these giving the relevant equations wherever necessary. 10

Q.1(b) State the salient features of the two popular yield criteria. Explain any one of them giving suitable sketches. 15

Q.2(a) What do you mean by elastic, elastic perfectly plastic and plastic material behaviour? Explain with neat sketches. How do you define buckling past the proportional limit? 10

Q.2(b) State and explain the tangent modulus theory and reduced modulus theory. Deduce the expression for reduced modulus, E_t of a rectangular section of depth h and width b. 15

Q.3(a) Consider a beam of I- section of length L, subjected to a torque 'T' at the free end. The other end is fixed and the section is not allowed to warp. Deduce an expression for 'T' of this beam.

(b) Determine the smallest critical torsional buckling load of an I-section column under axial load assuming the ends to be built-in. 10 + 15

Q.4(a) Define shape factor and load factor. Deduce an expression for load factor in terms of shape factor and safety factor for a simply-supported beam of rectangular cross- section.

(b) Determine the expressions for plastic hinge lengths of a fixed-ended rectangular beam with a concentrated load W at a distance 'a' from the left support and 'b' from the right support. The total length of the beam is 'l'. 5+10+10