# Code : 011513

## B.Tech 5th Semester Examination, 2016

## Mechanics of solid-II

*Time : 3 hours* *Full Marks : 70*

***Instructions :***

(i) *There are Nine Questions in this paper.*

(ii) *Attempt Five questions in all.*

(iii) *Question No. 1 is compulsory.*

(iv) *The marks are indicated in the right-hand margin.*

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1. Choose the correct option (any seven). 2×7=14

(a) In plastic analysis, the stress-strain relation for the material of the structure is assumed to obey:

(i) true stress-strain graph of the material

(ii) engineering stress-strain graph of the material

(iii) an idealized rigid-plastic stress-strain graph for the material

(iv) an idealized elastic-plastic stress-strain graph for the material

(b) The Shape Factor (S) of a section of a flexural member is given in terms of elastic section modulus (Z) and plastic section modulus ($Z_p$) as :

P.T.O.





(i) $S = Z / Z_p$

(ii) $S = Z_p / Z$

(iii) $S = Z / (Z + Z_p)$

(iv) $S = Z_p / (Z + Z_p)$

(c) A planar body is subjected to a tensile stress of 1200 MPa in one direction and another compressive stress of 600 MPa perpendicular to the former, both on the plane of the body. The shear stress in these directions on the same plane are zero. The maximum shear stress will be:

(i) 300 MPa

(ii) 600 MPa

(iii) 900 MPa

(iv) 1200 MPa

(d) The state of stress at a point of an elastic body is given by the following:

$\sigma_x = x^2y + 20,\ \tau_{xy} = 3x^2y,\ \sigma_y = x^3z + y^2,$

$\tau_{yz} = yz,\ \sigma_z = yz^2 + 10,\ \tau_{xz} = xz$

The values of body forces in respective directions are:

(i) 8, 18, 8

(ii) −8, −18, −18

(iii) −8, −18, 18

(iv) 8, −18, −18

(e) Choose the most correct statement:

(i) A plane stress condition does not imply a plane strain condition

(ii) A plane strain condition does not imply a plane stress condition

(iii) Both of the above

(iv) None of the above

(f) A column of length *l* with both ends fixed may be considered as equivalent to a column of with one end fixed and the other end free of length:

(i) $l/8$

(ii) $l/4$

(iii) $l/2$

(iv) $l$

(g) To study the behaviour of viscoelastic materials, the basic test (s) is (are) :

(i) creep test

(ii) relaxation test

(iii) both

(iv) none of these

(h) In Maxwell model spring and viscous dashpot are connected in:







(i) Parallel

(ii) series

(iii) both way

(iv) none of these

(i) Unsymmetric bending occurs when:

(i) loading plane is neither coincident nor parallel to any principal plane

(ii) loading plane is coincident / parallel to a principal plane

(iii) loading does not pass through the shear centre

(iv) loading passes through the shear centre

(j) When a column in subjected to an eccentric load, the stress induced in the column will be:

(i) axial stress only

(ii) bending stress only

(iii) shear stress only

(iv) combined axial and bending stress

2. Determine the Shape Factors for the Diamond-section and the T-section of two different flexural sections, is show in Figure-1(a-b). 6+8=14

3. (a) Obtain expressions for maximum normal and shear stresses that would be induced at a section of a circular Torsional-Flexural member of diameter *d*.

The section of the member is subjected to a bending moment $M$ and a Torque $T$. 7

(b) A circular steel shaft of diameter $d$ and length 3 m, is supported in bearings at its two ends. The shaft carries a Pulley of diameter 50 cm at a distance of 1 m from left support. Power is applied by a torque $T$ at the left and taken off through a belt overrunning the pulley. The tension in the two sides of the belt are 1.5 kN on the taut side and 0.5 kN on the slack side, respectively. Find the safe required diameter $d$ for the shaft, if the working normal and shear stresses are $\sigma_w = 80$ MPa and $\tau_w = 40$ MPa, respectively. Consider a factor of safety of 2.5. 7

4. (a) Derive expression for shear stress to be induced on a cross section of a thin-walled beam, that is subjected to a shear force $V_x$. 6

(b) A beam of thin-walled channel section, as show in Figure-2, has uniform thickness of 10 mm throughout the flanges and the web. The beam is to be loaded in a vertical plane parallel to the web, so as a produce pure bendig. Find the location of the shear centre of the section, through which the load should act. Show the distribution of the shear stress on the cross section. 6+2







5. (a) A stress tensor is given by the following array.

$$\sigma = \begin{bmatrix} 18 & 0 & 24 \\ 0 & -50 & 0 \\ 24 & 0 & 32 \end{bmatrix} \text{KPa}$$

Determine the numerical value of the stress invariants, principal stresses and principal direction. Also, compute the maximum shearing stresss. 10

(b) Decompose the stress tensor into hydrostatic and pure shear state. 4

6. Obtain the constitutive equation for the four-element viscoelastic model shown in Figure-3. Discuss Maxwell and Kelvin-Voigt model. 10+4=14

7. An I-beam of length 2 m has moment of inertia $I_x = 4\times10^6$, mm$^4$, Modulus of elasticity $E$=200GPa and width of flange 80 mm. It is attached to a rubber foundation for which stiffness constant is $k$=0.4 N/mm$^3$. A concentrated load $p$=30 kN is applied at one end of the beam. Determine the maximum deflection, maximum flexural stress in the beam and the location of each of them. 7+7=14

8. Write short notes on the following: 5+4+5=14

(A) Creep compliance and Relaxation modulus

(B) Maximum shear stress theory of failure

(C) Total strain energy theory of failure

9. (a) For the torsion of a non-circular member, obtain expressions for torsional shearing stresses in terms of the cross-sectional warping function. 4

(b) A hollow tube having a rectangular cross-section as shown in Figure-4, is subjected to a torque of 180 N-mm. Determine the distribution of shearing stresses in the walls of the tube, considering uniform wall thickness of 20 mm. 10

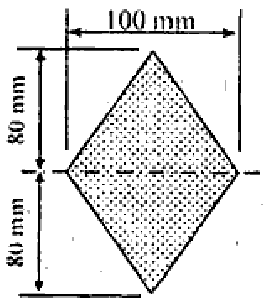


Figure-1(a)

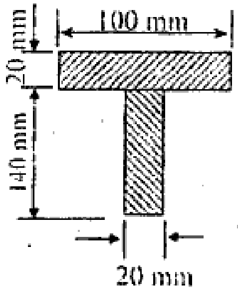


Figure-1(b)







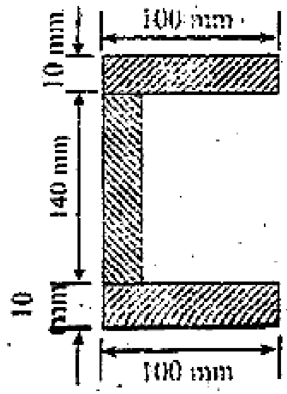


Figure-2

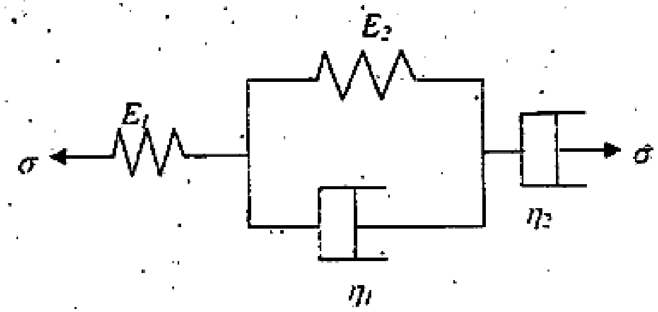


Figure-3

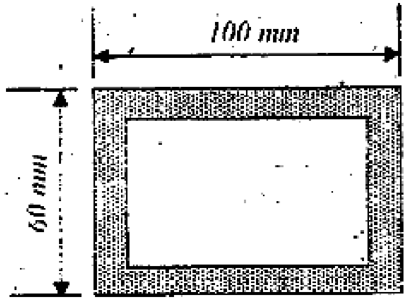


Figure-4

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