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**Question Paper Code: U4704**

B.E. / B.Tech. DEGREE EXAMINATION, APRIL 2024

Fourth Semester

Mechanical Engineering

21UME404 - MECHANICS OF MATERIALS

(Regulations 2021)

Duration: Three hours

Maximum: 100 Marks

Answer All Questions

PART A - (10 x 1 = 10 Marks)

1. A material which recovers fully after unloading is known as CO1 U  
(a) Plastic (b) Elastic (c) In Elastic (d) partially elastic
2. Thermal Strain is \_\_\_\_\_. CO1 U  
(a)  $\alpha T / E$  (b)  $\alpha T$  (c)  $\alpha T + E$  (d)  $\alpha TE$
3. A continuous beam is one which has CO1 U  
(a) Less than two supports (b) Two supports only  
(c) More than two supports (d) None of the above
4. In a cantilever, carrying a load whose intensity varies uniformly from zero at the free end to  $w$  per unit run at the fixed end, the BM changes following a CO1 U  
(a) linear law (b) Parabolic law  
(c) cubic law (d) none of the above
5. The Torque transmitted by a solid circular shaft is given by CO1 U  
a)  $T = \pi/16 \tau D^3$  b)  $T = \pi/32 \tau D^3$  c)  $\pi/64 \tau D^3$  d)  $\pi/16 \tau D^4$
6. Torsional Rigidity is defined as----- CO1 U  
(a)  $T / \Theta$  (b)  $C \times \Theta$  (c)  $C \times J$  (d)  $J \times \Theta$
7. The column which has highest equivalent length has ----- CO1 U  
(a) one end fixed other pin joined (b) both ends fixed  
(c) both ends hinged (d) one end fixed other end free

8. A column whose slenderness ratio is greater than 120 is known as CO1 U  
(a) Short columns (b) Long columns  
(c) Medium columns (d) Composite columns

9. A boiler shell of 100cm diameter and plate thickness 12mm is CO1 U  
subjected to an internal pressure of 1.2 N/mm<sup>2</sup>. The hoop stress will be  
\_\_\_\_\_ (d) 180 N/mm<sup>2</sup>  
(a) 45 N/mm<sup>2</sup> (b) 50 N/mm<sup>2</sup> (c) 135 N/mm<sup>2</sup>

10. In a thin shell, the ratio of longitudinal stress to the hoop stress is CO1 U  
\_\_\_\_\_ (d) 2  
(a) 1/2 (b) 3/4 (c) 1

PART – B (5 x 2= 10 Marks)

11. Define the term Stiffness CO1 U  
12. Classify shear force and bending moment. CO1 U  
13. Show why hollow circular shafts are preferred when compared to solid circular CO1 U  
shafts.  
14. Summarize the factors affecting strength of a column. CO1 U  
15. Differentiate between thin cylinder and thick cylinder. CO1 U

PART – C (5 x 16= 80 Marks)

16. (a) A mild steel rod of 20 mm diameter and 300 mm long is enclosed CO1 App (16)  
centrally inside a hollow copper tube of external diameter 30 mm  
and internal diameter of 25 mm. The ends of the tube and rods are  
brazed together and the composite bar is subjected to an axial pull  
of 50 KN, If E for steel and copper is 200 GN/m<sup>2</sup> and 100 GN/m<sup>2</sup>  
respectively, find the stresses developed in the rod and tube.

Or

- (b) A steel rod of 3cm diameter is enclosed centrally in a hollow CO1 App (16)  
copper tube of external diameter 5 cm and Internal diameter 4 cm.  
The composite bar is then subjected to an axial pull of 45000 N.  
If the length of the bar is equal to 15 cm. Determine the stresses  
in rod and tube. Also determine the load carried by each bar.

17. (a) A beam 8 m long is simply supported at the ends and carries a uniformly distributed load of 1500 N/m and three concentrated load of 1000 N, 2000 N and 4000 N acting respectively at the left quarter point, centre point and right quarter point. Draw SFD and BMD. CO2 App (16)

Or

- (b) A simply supported beam 9 m long is loaded with a UDL of 1800 N/m over a length of 4 m from the left end. Draw the SF and BM diagram for the beam and calculate the magnitude and position of the maximum BM. CO2 App (16)

18. (a) A solid shaft is to transmit 300 KW at 100 rpm if the shear stress is not to exceed  $80\text{N/mm}^2$ . Find the diameter of the shaft. If this shaft is to be replaced by hollow shaft of same material and length with an internal diameter of 0.6 times the external diameter, what percentage saving in weight is possible? CO2- App (16)

Or

- (b) A solid circular shaft transmits 75 KW power at 200 rpm. Calculate the shaft diameter, if the twist in the shaft is not to exceed 1 degree in 2 m length of the shaft, and shear stress is limited to  $50\text{N/mm}^2$ . Take  $C = 1 \times 10^5\text{N/mm}^2$ . CO2- App (16)

19. (a) A steel rod 4m long and 40 mm diameter is used as a column. Determine the crippling load by Euler's formula when the given column is used with the following conditions. Take  $E = 2 \times 10^5\text{N/mm}^2$ . (a) Both ends are hinged. (b) One end is fixed and the other end is free. (c) Both ends are fixed. (d) One end is fixed and other end is hinged. CO3- App (16)

Or

- (b) A 1.5 m long column has a circular cross-section of 5 cm diameter. One of the ends of the column is fixed and the other end is free. Taking factor of safety as 3, calculate the safe load using:  
(a) Rankine's formula, take  $\sigma_c = 560\text{N/mm}^2$ ,  $a = 1/1600$   
(b) Euler's formula, take  $E = 1.2 \times 10^5\text{N/mm}^2$ . CO3- App (16)

20. (a) A cylindrical shell 1 m diameter and 3 m length is subjected to an internal pressure of 2 MPa. Calculate the minimum thickness if the stress should not exceed 50 MPa. Find the changes in diameter and volume of the shell. Take  $\mu = 0.3$  and  $E = 200 \text{ KN/mm}^2$ . CO3- App (16)

Or

- (b) A closed cylindrical thin drum 600 mm in diameter and 2 m long has a shell thickness of 12 mm. If the drum is subjected to an internal pressure of  $3 \text{ N/mm}^2$ , determine the longitudinal and hoop stress in the drum wall and also change in diameter, change in length and change in volume of the drum.  $E = 2 \times 10^5 \text{ N/mm}^2$  and  $\mu = 0.3$ . CO3- App (16)