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Question Paper Code: 94704

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

Fourth Semester

Mechanical Engineering

19UME404 - Mechanics of Materials

(Regulations 2019)

Duration: Three hours

Maximum: 100 Marks

Answer ALL Questions

PART A - (10 x 1 = 10 Marks)

1. In a composite bar having two or more bars of different lengths, the extension or contraction in each bar will be, CO1- U
(a) Equal (b) Twice (c) Different (d) None of the above
2. A material which recovers fully after unloading is known as CO1- U
(a) Plastic (b) Elastic (c) In Elastic (d) partially elastic
3. In a cantilever, carrying a load whose intensity varies uniformly from zero at the free end to weight 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
4. BM at supports in case of simply supported beams is always CO1- U
(a) Less than unity (b) More than unity
(c) Zero (d) none of the above
5. In the torsion equation $T/J = \tau/R = C\theta/L$, the term J/R is called CO1- U
(a) Shear Modulus (b) Section modulus
(c) Polar modulus (d) None of these
6. Tensional Rigidity is defined as _____ CO1- U
(a) T / θ (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. According to Euler, the buckling load for a column is given by $P = \frac{\pi^2 EI}{xL^2}$ In CO1- U
 this equation, the value of x for a column with one end fixed and other end
 free is
 (a) 1 (b) 2 (c) 4 (d) 0.5
9. A thin cylindrical shell of diameter (d), length (l) is subjected to CO1- U
 an internal pressure (p). The circumferential stress of the shell is ____
 (a) bulk removal (b) minimum removal
 (c) surface finishing (d) none of the above
10. Which of the following are usually considered as thin cylinders? CO1- U
 (a) Boilers (b) Tanks (c) Steam pipes (d) Water pipes

PART – B (5 x 2= 10 Marks)

11. Define Factor of Safety. CO1- U
12. Explain what is cantilever beam? CO1- U
13. Write down the expression for power transmitted by a shaft. CO1- U
14. State the limitation of Euler's formula. CO1- U
15. A thin cylinder closed at both ends is subjected to an internal pressure CO2- App
 of 2 MP. Its internal diameter is 1m and wall thickness is 10 mm.
 What is the maximum shear stress in the cylinder material?

PART – C (5 x 16= 80 Marks)

16. (a) A steel tube 4.5 cm external diameter and 3 mm thick encloses CO2- App (16)
 centrally a solid copper bar of 30 mm diameter. The bar and
 the tube are rigidly connected at the ends at a temperature of
 30° C. Find the stress in each metal when heated to 180° C. if
 the original length is 300 mm. find the change in length of
 steel and copper. $\alpha_s = 1.08 \times 10^{-5} / ^\circ\text{C}$, $\alpha_c = 1.7 \times 10^{-5} / ^\circ\text{C}$.
 $E_s = 2 \times 10^5 \text{ N/mm}^2$, $E_c = 1.1 \times 10^5 \text{ N/mm}^2$.

Or

- (b) A reinforced concrete column 500mm X 500mm in section is reinforced with 4 steel bars of 20mm diameter, one in each corner. The column is carrying a load of 750kN. Determine the stress in concrete and steel bars. Take E for steel as 210 GPa and for concrete as 14 GPa. Also calculate load carried by steel and concrete. CO1- U (16)
17. (a) A Cantilever 3.6 m long carries load of 30 KN, 70 KN, 40 KN and 60 KN at distance of 0, 0.6, 1.5 and 2.4 m respectively from the free end. Draw the SF and BM diagrams for the cantilever CO2- App (16)
- Or
- (b) Draw the SF and BM diagrams for the overhanging beam of length 6 m carries a UDL of 20 KN/m over its whole length. The distance between two supports is 5 m. The beam overhangs at a distance of distance of 1 m from the right support. Locate the point of contra flexure and find the maximum and minimum values of BM CO2- App (16)
18. (a) A hollow cast iron column whose outside diameter is 200 mm has a thickness of 20 mm. It is 4.5 m long and is fixed at both ends. Calculate the safe load by Rankine's formula using a factor of safety of 4. Calculate the slenderness ratio and Euler's and Rankine's critical loads. Take $\sigma_c = 550 \text{ N/mm}^2$, $a = 1/1600$ and $E = 9.4 \times 10^4$. CO2- App (16)
- Or
- (b) A solid shaft is to transmit 300 KW at 100rpm if the shear stress is not to exceed 80 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)
19. (a) Compare the crippling loads given by Rankine's and Euler's formulae for tubular strut 2.25 m long having outer and inner diameters of 37.5 mm and 32.5 mm loaded through pin-joint at both ends. Take: Yield stress as 315 MN/m^2 ; $a = 1 / 7500$; and $E = 200 \text{ GN/m}^2$. If elastic limit for the material is taken as 200 MN/m^2 , then for what length of the strut does the Euler formula cease to apply? CO2- App (16)

Or

- (b) A hollow cast iron column whose outside diameter is 200 mm has a thickness of 20 mm. The length of the column is 4.5 m with both of its fixed. Calculate the safe load for the column using Rankine's formula. Also calculate the ratio of Euler's crippling load to that of Rankine's critical load. Take factor of safety as 4. $f_c = 550 \text{ N/mm}^2$, $\alpha = 1/1600$ and $E = 94 \text{ kN/mm}^2$. CO2- App (16)

20. (a) A cylindrical shell, 3m long, which is closed at the ends, has an internal diameter of 1m and a wall thickness of 15mm. calculate the circumferential and longitudinal stresses. Also find the changes in dimensions of the shell, if it is subjected to an internal pressure of 1.5 MPa. Take $E = 200 \text{ GPa}$ and $1/m = 0.3$ CO2- App (16)

Or

- (b) A cylindrical thin drum 800 mm in diameter and 3 m long has a shell thickness of 10 mm. If the drum is subjected to an internal pressure of 2.5 N/mm^2 , determine change in diameter, change in length and change in volume of the drum. $E = 2 \times 10^5 \text{ N/mm}^2$ and $1/m = 0.25$. CO2- App (16)