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Question Paper Code:R4704

B.E./B.Tech. DEGREE EXAMINATION, APRIL/MAY 2025

Fourth Semester

Mechanical Engineering

R21UME404– MECHANICS OF MATERIALS

(Regulations R2021)

Duration: Three hours

Maximum: 100 Marks

Answer ALL Questions

PART A - (10 x 2 = 20 Marks)

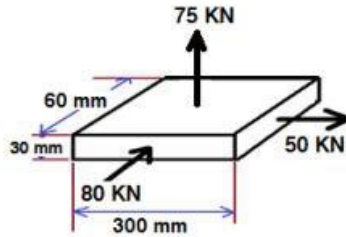
1. State Hooke's law with equation. CO1- U
2. Determine the Poisson's ratio and bulk modulus of a material for which young's modulus is $1.2 \times 10^5 \text{ N/mm}^2$ and modulus of rigidity is $4.8 \times 10^4 \text{ N/mm}^2$. CO1-App
3. List out the various types of supports. CO1- U
4. Draw the shape of the bending moment diagram for a uniform cantilever beam carrying a uniformly distributed load over its length CO2-App
5. Summarize the assumptions made in torsion equation. CO1- U
6. Explain polar modulus. CO1- U
7. Explain the effective length of a column. CO1- U
8. Outline Rankine's formula for critical load. CO1- U
9. A cylindrical pipe of diameter 1.5 m and of thickness 1.5 cm is subjected to internal fluid pressure of 1.2 N/mm^2 . Determine the longitudinal stress developed in the pipe. CO2-App
10. Give the expression for the volumetric strain of a thin cylindrical shell subjected to internal pressure 'P'. CO1- U

PART – B (5 x 16= 80 Marks)

11. (a) A reinforced concrete column 500 mm x 500 mm in section is reinforced with 4 steel bars of 25 mm diameter; one in each corner, the column is carrying a load of 1000 kN. Find the stresses in the concrete and steel bars. Take E for steel $= 2.10 \times 10^5 \text{ N/mm}^2$ and E for concrete $= 0.14 \times 10^5 \text{ N/mm}^2$. CO2- App (16)

Or

- (b) A steel plate 300mm long, 60 mm wide and 30 mm deep is acted upon by the forces shown in figure. Determine the change in volume. Take $E = 200 \text{ kN/mm}^2$ and Poisson's ratio = 0.3. CO2- App (16)



12. (a) A cantilever of length 3 m carries a uniformly distributed load of 1.5 kN/m over a length of 2 m from the free end. Draw the Shear force and Bending Moment Diagrams for the beam. CO2- App (16)

Or

- (b) A simply supported beam of span 10 m carries a concentrated load of 10 kN at 2 m from the left support and a UDL of 4 kN/m over the entire length. Sketch the Shear force and Bending Moment Diagrams for the beam. CO2- App (16)

13. (a) 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 N/mm^2 . Take $C = 1 \times 10^5 \text{ N/mm}^2$. CO2- App (16)

Or

- (b) A composite shaft consists of a steel rod of 60 mm diameter surrounded by a closely fitting tube of brass. Find the outside diameter of the brass tube when a torque of 1 kN-m is applied on the composite shaft and shared equally by the two materials. Take C for steel as 84 GPa and C for brass as 42 GPa. Also determine the common angle of twist in a length of 4 metres. CO2- App (16)

14. (a) A steel rod 4m long and 40 mm diameter is used as a column. Determine the crippling load by using Euler's formula when the given column is used with the following conditions. Take $E = 2 \times 10^5 \text{ N/mm}^2$. CO3- App (16)

- (i) Both ends are hinged
- (ii) One end is fixed and the other end is free
- (iii) Both ends are fixed
- (iv) One end is fixed and other end is hinged.

Or

- (b) A hollow cylindrical cast iron whose internal diameter is 0.6 times the external diameter is 5 m long with both the ends being fixed. If the column carries a safe load of 200×10^3 N with a factor of safety of 6, find the minimum diameter of the column. Take $\sigma_c = 550 \text{ N/mm}^2$, $\alpha = 1/1600$. CO3- App (16)
15. (a) A cylindrical shell 1 m internal diameter and 15 mm wall thickness is 3 m long. Calculate the circumferential and longitudinal stresses induced and also the changes in the dimensions of the shell if it is subjected to an internal pressure of 1.5 N/mm^2 . Take $E = 2 \times 10^5 \text{ N/mm}^2$ and $\nu = 0.3$. CO3- App (16)
- Or
- (b) A boiler shell is to be made of 15 mm thick plate having a limiting tensile stress of 120 N/mm^2 . If the efficiencies of the longitudinal and circumferential joints are 70 % and 30 % respectively. Determine: CO3- App (16)
- (i) The maximum permissible diameter of the shell for an internal pressure of 2 N/mm^2 and
 - (ii) Permissible intensity of internal pressure when the shell diameter is 1.5 m.

