



B.E. DEGREE EXAMINATIONS: APRIL / MAY 2023

(Regulation 2017)

Fourth Semester

MECHANICAL ENGINEERING

U17MEI4201: Strength of Materials

COURSE OUTCOMES

- CO1:** Apply fundamental concepts and compute simple stresses and deformations in structural members.
CO2: Construct shear force and bending moment diagrams for statically determinate beams and determine stress distribution.
CO3: Compute slope and deflection in statically determinate beams.
CO4: Examine the buckling failure in columns and calculate strain energy under varying load conditions.
CO5: Solve problems on shafts and springs subjected to twisting moments.
CO6: Apply the concepts of complex stress systems in 2D systems and in thin-walled containers.

Time: Three Hours

Maximum Marks: 100

Answer all the Questions:-

PART A (10 x 2 = 20 Marks)

(Answer not more than 40 words)

1. Distinguish between suddenly applied and impact load. CO1 [K₂]
2. Find the minimum diameter of a steel wire, which is used to raise a load of 4000 N if the stress in the rod is not to exceed 95 MPa. CO1 [K₃]
3. Mention the shape of bending moment and shear force diagrams for different types of loads. CO2 [K₂]
4. Summarize the assumptions made in theory of simple bending. CO2 [K₂]
5. A cantilever 1.5 m long carries a uniformly distributed load over the entire length. Find the deflection at the free end if the slope at the free end is 1.5°. CO3 [K₃]
6. Classify determinate and indeterminate beams. CO3 [K₂]
7. Write an expression for the Euler's crippling load for a long column with both ends hinged as an end condition. CO4 [K₂]
8. A tensile load of 60 kN is applied suddenly to a circular bar of 0.04 m diameter and 5m long. If the value of E = 200 GPa, determine the maximum instantaneous stress induced and strain energy absorbed in the rod. CO4 [K₃]
9. A closely coiled helical spring is to carry a load of 500 N. Its mean coil diameter is to be 10 times that of the wire diameter. Calculate these diameters if the maximum shear stress in the spring material is 80 MPa. CO5 [K₃]
10. Illustrate the failure of thin cylindrical shells subjected to internal pressure. CO6 [K₂]

Answer any FIVE Questions:-
PART B (5 x 16 = 80 Marks)
(Answer not more than 400 words)

11. a) The following observations were made during a tensile test on a mild steel specimen of 40 mm diameter and 200 mm long: Elongation with 40,000 N load (within the limit of proportionality) = 0.0304 mm, Yield load = 165,000 N, Maximum load = 245,000 N, Length of the specimen at fracture = 252 mm, Determine the yield stress, the modulus of elasticity, the ultimate stress, and the percentage elongation. 8 CO1 [K₃]
- b) Three bars made of copper, zinc, and aluminium are of equal length and have cross-sections of 500, 750 and 1000 mm² respectively. They are rigidly connected at their ends. If this compound member is subjected to a longitudinal pull of 250 kN, estimate the proportional of the load carried on each rod and the induced stresses. Take the value of E for copper = 1.3×10^5 N/mm², for zinc = 1×10^5 N/mm², and for aluminium = 0.8×10^5 N/mm². 8 CO1 [K₃]
12. A cantilever of length 2m carries a uniformly distributed load of 2kN/m length over the whole length and a point of 3kN at the free end. Draw the shear force and bending moment diagrams for the cantilever. 16 CO2 [K₃]
13. A beam of length 6m is simply supported at its ends and carries two point loads of 48 kN and 40 kN at a distance of 1m and 3m respectively from the left support. Find (i) deflection under each load, (ii) maximum deflection, and (iii) the point at which maximum deflection occurs. Given $E = 2 \times 10^5$ N/mm², and $I = 85 \times 10^6$ mm⁴. 16 CO3 [K₃]
14. a) A hollow mild steel tube 6 m long 4 cm internal diameter and 5 mm thick is used as a strut with both ends hinged. Find the crippling load and safe load taking the factor of safety as 3. Take $E = 2 \times 10^5$ N/mm². 8 CO4 [K₃]
- b) A rod 12.5 mm in diameter is stretched 3.2 mm under a steady load of 10 kN. What stress would be produced in the bar by weight of 700 N, falling through 75 mm before commencing to stretch, is the rod being initially unstressed? Take $E = 2.1 \times 10^5$ N/mm² 8 CO4 [K₃]

15. a) A solid steel shaft has to transmit 75 kW power at 200 rpm. Taking the allowable shear stress of the shaft as 70 N/mm^2 , find the suitable diameter for the shaft, if the maximum torque transmitted at each revolution exceeds the mean by 30%. 8 CO5 [K₃]
- b) The normal stress in two mutually perpendicular directions are 600 N/mm^2 and 300 N/mm^2 both tensile. The complimentary shear stresses in these directions are of intensity 450 N/mm^2 . Find the normal and tangential stresses on the two planes which are equally inclined to the planes carrying the normal stresses mentioned above. 8 CO6 [K₃]
16. a) An open coiled helical spring made from a wire of circular cross-section is required to carry a load of 120 N. The wire diameter is 8 mm, and the mean coil radius is 48mm. If the helix angle of the spring is 30° and the number of turns is 12, calculate (i) axial deflection, and (ii) angular rotation of the free end with respect to the fixed end of the spring. Take $C_{\text{steel}} = 80 \text{ GPa}$ and $E_{\text{steel}} = 200 \text{ GPa}$. 8 CO5 [K₃]
- b) A closed cylindrical vessel made of steel plates 4mm thick with plane ends, carries fluid under a pressure of 3 N/mm^2 . The diameter of the cylinder is 25 cm, and the length is 75 cm, calculate the longitudinal and hoop stresses in the cylinder wall and determine the change in diameter, length, and volume of the cylinder. Take $E = 2.1 \times 10^5 \text{ N/mm}^2$ and $\mu = 0.286$. 8 CO6 [K₃]
