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NOIDA INSTITUTE OF ENGINEERING AND TECHNOLOGY, GREATER NOIDA

(An Autonomous Institute Affiliated to AKTU, Lucknow)

B.Tech

SEM: IV - THEORY EXAMINATION (2021 - 2022)

Subject: Strength of Materials

Time: 3 Hours

Max. Marks: 100

General Instructions:

1. The question paper comprises three sections, A, B, and C. You are expected to answer them as directed.
2. Section A - Question No- 1 is 1 mark each & Question No- 2 carries 2 mark each.
3. Section B - Question No-3 is based on external choice carrying 6 marks each.
4. Section C - Questions No. 4-8 are within unit choice questions carrying 10 marks each.
5. No sheet should be left blank. Any written material after a blank sheet will not be evaluated/checked.

SECTION A

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1. Attempt all parts:-

- 1-a. The ratio of linear stress to linear strain is known as (CO1) 1
- (a) Poisson's ratio
 - (b) Bulk modulus
 - (c) Modulus of rigidity
 - (d) Modulus of elasticity.
- 1-b. If poisson ratio is $(1/m)$ then the modulus of elasticity (E) and bulk modulus (K) are related by (CO1) 1
- (a) $K = mE / 3(m-2)$
 - (b) $K = mE / 2(m+2)$
 - (c) $K = 3(m-2) / mE$
 - (d) $K = 2(m+2) / mE$
- 1-c. If a member is subjected to a uniform bending moment (M), the radius of curvature of the deflected form of the member is given by (CO2) 1
- (a) $M/R=E/I$
 - (b) $M/I=E/R$
 - (c) $M/I=R/E$
 - (d) $M/E=RI$
- 1-d. In the theory of simply bending, the bending stress in the beam section varies (CO2) 1
- (a) Linearly
 - (b) Parabolically
 - (c) Elliptically
 - (d) None of them
- 1-e. When a closely coiled spring is subjected to an axial load, it is said to be under (CO3) 1
- (a) Bending
 - (b) Shear
 - (c) Torsion
 - (d) all of these
- 1-f. Column is defined as a (CO3) 1
- (a) member of a structure which carries a tensile load
 - (b) Member of a structure which carries an axial compressive load
 - (c) Vertical member of a structure which carries a tensile load

- (d) Vertical member of a structure which carries an axial compressive load.
- 1-g. A cylindrical vessel is said to be thin if the ratio of its internal diameter to the wall thickness is (CO4) 1
- (a) less than 20
 - (b) equal to 20
 - (c) more than 20
 - (d) none of the above.
- 1-h. The longitudinal stress in case of thick cylinders (CO4) 1
- (a) Is uniformly distributed
 - (b) Varies from maximum at the outer circumference to minimum at inner circumference
 - (c) Varies from maximum at the inner circumference to minimum at outer circumference
 - (d) None of the above.
- 1-i. Neutral axis of a beam always coincides with (CO5) 1
- (a) Axis passing through bottom of beam
 - (b) Axis passing through height $h/2$ from bottom
 - (c) Axis passing through height $h/3$ from bottom
 - (d) Axis passing through centroid
- 1-j. In steel sections, the junction between a flange and web is known as _____ (CO5) 1
- (a) Edge
 - (b) Fillet
 - (c) Corner
 - (d) Lug

2. Attempt all parts:-

- 2.a. What is Modulus of resilience (CO1) 2
- 2.b. Describe Torsional rigidity (CO2) 2
- 2.c. What is the difference between thin and thick cylinder? (CO3) 2
- 2.d. How does a thin cylinder fail due to internal fluid pressure? (CO4) 2
- 2.e. Write a short note of deflection of beams in unsymmetrical bending. (CO5) 2

SECTION B

30

3. Answer any five of the following:-

- 3.a. If a weight of 25 N is dropped on to a bar of length 1 m and diameter 20 mm. find the maximum normal stress in the bar, elongation of the bar. (CO1) 6
- 3.b. Explain modulus of elasticity, modulus of rigidity, bulk modulus and poisson's ratio.(CO1) 6
- 3.c. A cantilever 1.8 m long carries uniformly distributed load over the entire length. Find the deflection at the free end if the slope at free end is 1.5 degrees. (CO2) 6
- 3.d. Derive the expressions for maximum shear stresses and polar moment of inertia for a hollow shaft of internal diameter d and external diameter D , and a solid shaft of diameter D . (CO2) 6
- 3.e. A closed coil helical spring is made of 12 mm diameter steel wire wound on a 120 mm diameter mandrel. If there are 10 active coils. Find spring constant, Take $G = 82$ GPa, also find the force that must be applied to the spring to elongate it by 40 mm. (CO3) 6
- 3.f. Calculate the thickness of the metal required for a cast iron main 800 mm in diameter for water at a pressure head of 100 m if the hoop stress is 20 MPa and weight of the water is 10 KN/m³. (CO4) 6
- 3.g. Derive the expression for slope of neutral axis. (CO5) 6

SECTION C

50

4. Answer any one of the following:-

- 4.a. Define and explain the following theories of failure: (CO1) 10

- (i) Maximum principal stress theory.
(ii) Maximum shear stress theory.
(iii) Maximum strain energy theory.
- 4.b A steel rod of 3 cm diameter is enclosed centrally in a hollow 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 each bar is equal to 15 cm. Determine: (i) the stresses in the rod and the tube. (ii) Load carried by each rod. E for steel = 200 GPa and for Copper = 100 GPa. (CO1) 10
5. Answer any one of the following:-
- 5.a A beam of uniform cross section and constant depth is simply supported over a span of length 3 m. If the point load at the mid span is 30 KN and $I = 15.614 \times 10^{-6} \text{ m}^4$, Calculate (i) The central deflection (ii) Slope at the end. Take $E = 200 \text{ GPa}$ (CO2) 10
- 5.b A hollow circular bar having outside diameter twice the inside diameter is used as a beam. From the bending moment diagram of the beam, it was found that the bar is subjected to bending moment of 40 KNm. If the allowable bending stress in the beam is to be limited to 100 MPa. Find the inside diameter of the bar. (CO2) 10
6. Answer any one of the following:-
- 6-a. From the first principles derive the expression for the critical buckling for a column having both end fixed. (CO3) 10
- 6-b. Derive the expression for Euler's crippling load for a long column when one end of column is fixed and other is free. (CO3) 10
7. Answer any one of the following:-
- 7.a A mild steel hollow cylinder has diameter to thickness ratio of 25. Find the internal pressure to which the cylinder should be subjected so that its volume is increased by 5×10^{-3} of its original volume. Take $E = 2 \times 10^5 \text{ GPa}$ and $\mu = 0.3$. (CO4) 10
- 7.b Derive the expressions for longitudinal and hoop stresses in a thin cylindrical shell. (CO4) 10
8. Answer any one of the following:-
- 8.a Determine the position of shear centre of a channel having dimensions: flanges $120 \text{ mm} \times 20 \text{ mm}$ and web $160 \text{ mm} \times 10 \text{ mm}$. (CO5) 10
- 8.b A beam of rectangular section $40 \text{ mm} \times 50 \text{ mm}$ has its central line curved to a radius of 60mm. The beam is subjected to a bending moment of $140 \times 10^3 \text{ N-mm}$. Find the greatest tension and compression stresses in the beam. (CO5) 10