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NOIDA INSTITUTE OF ENGINEERING AND TECHNOLOGY, GREATER NOIDA
(An Autonomous Institute Affiliated to AKTU, Lucknow)

B.Tech

SEM: III - THEORY EXAMINATION (2025 - 2026)

Subject: Engineering Mechanics & Strength of Materials

Time: 3 Hours

Max. Marks: 100

General Instructions:

IMP: Verify that you have received the question paper with the correct course, code, branch etc.

1. This Question paper comprises of three Sections -A, B, & C. It consists of Multiple Choice Questions (MCQ's) & Subjective type questions.

2. Maximum marks for each question are indicated on right -hand side of each question.

3. Illustrate your answers with neat sketches wherever necessary.

4. Assume suitable data if necessary.

5. Preferably, write the answers in sequential order.

6. No sheet should be left blank. Any written material after a blank sheet will not be evaluated/checked.

SECTION-A

20

1. Attempt all parts:-

- 1-a. The resultant of two forces P and Q (such that $P > Q$) acting along the same straight line, but in opposite direction, is given by. [CO1,k1] 1
- (a) $P + Q$
- (b) $P - Q$
- (c) P / Q
- (d) Q / P
- 1-b. Effect of a force on a body depends upon [CO1, K1] 1
- (a) magnitude
- (b) direction
- (c) position or line of action
- (d) all of the above
- 1-c. Which point on the stress strain curve occurs after the proportionality limit? [CO2,K1] 1
- (a) Upper yield point
- (b) Lower yield point
- (c) Elastic limit
- (d) Ultimate point
- 1-d. When tensile stress is applied axially on a circular rod its 1
- (1)diameter decreases
- (2)length increases
- (3) volume decreases [CO2, K1]

- (a) Only i
(b) Only ii
(c) i & ii
(d) all of the above
- 1-e. A steel bar 10 cm wide and 8 mm thick is subjected to bending. The radius of neutral surface is 100 cm. Determine maximum and minimum bending stress in the beam [CO3,K1] 1
- (a) 80 N/mm² (Tensile), 80 N/mm² (Compressive)
(b) 800 N/mm² (Compressive), 800 N/mm² (Tensile)
(c) 800 N/mm² (Tensile), 800 N/mm² (Compressive)
(d) 80 N/mm² (Compressive), 80 N/mm² (Tensile)
- 1-f. The value of maximum bending moment in case of cantilever beam loaded with one point load w at the free end. [CO3, K1] 1
- (a) WL
(b) $WL^2/2$
(c) $WL/4$
(d) $WL^2/8$
- 1-g. Torsional rigidity of a shaft is given by. [CO4, K1] 1
- (a) T/G
(b) T/J
(c) GJ
(d) J/G
- 1-h. 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° in 2 m length and the shear strength is limited to 50 MN/m². Take $G = 100 \text{ GN/m}^2$. [CO4,K2] 1
- (a) 80.4 mm
(b) 106.73 mm
(c) 106.73 cm
(d) 80.4 cm
- 1-i. What is the primary failure mode considered in thin pressure vessel theory?[CO5, K1] 1
- (a) Tensile failure
(b) Shear failure
(c) Buckling failure
(d) Yielding failure
- 1-j. Which theory is used to determine stress in thin pressure vessels?[CO5, K1] 1
- (a) Hooke's Law
(b) Poisson's Ratio
(c) Lamé's Theory
(d) Thin Shell Theory

2. Attempt all parts:-
- 2.a. Write down the assumptions of truss. [CO1,K2] 2
- 2.b. Define the following term. 2
1. longitudinal strain.
 2. Engineering strain. [CO2, K2]
- 2.c. Write down the different types of loads and supports. [CO3,K2] 2
- 2.d. Differentiate between long column and short column. [CO4,K2] 2
- 2.e. Name the stresses set up in thin cylinder subjected to internal fluid pressure. [CO5,K1] 2

SECTION-B 30

3. Attempt all parts:-
- 3.a. Answer any one of the following:-
- 3.a.(i) Define angle of repose. In case of limiting friction prove that angle of friction is equal to angle of repose. [CO1,K3] 6
- 3.a.(ii) A body, resting on a rough horizontal plane, required a pull of 200N inclined at 60° to the plane just to move it. It was found that a push of 180 N inclined at 45° to the plane just moved the body. Determine the weight of the body and the coefficient of friction. [CO1,K3] 6
- 3.b. Answer any one of the following:-
- 3.b.(i) A steel rod of 3 cm diameter is enclosed centrally in a hollow copper tube of external diameter 5cm and internal diameter of 4cm. the composite bar is then subjected to an axial pull of 45000N. if the length of each bar is equal to 15 cm, determine: i) The stresses in the rod and tube, and (ii) Load carried by each bar. [CO2,K3] 6
- 3.b.(ii) Define Strain energy & resilience. A tensile load of 60 KN is gradually applied to a circular bar of 4 cm diameter and 5 m long if $E=2 \times 10^5 \text{ N/mm}^2$. Determine: i) stretch in the rod (ii) stress in the rod and (iii) strain energy absorbed by the rod. [CO2,K3] 6
- 3.c. Answer any one of the following:-
- 3.c.(i) A timber beam of rectangular section is to support a load of 30 k N uniformly distributed over a span of 4 m when beam is simply supported. If the depth of section is to be twice the breadth, and the stress in the timber is not to exceed 8 N/mm^2 , find the dimensions of the cross section [CO3,K3] 6
- 3.c.(ii) A beam of length 8 m is simply supported at its ends and carries two-point loads of 36 KN and 46 KN at a distance of 1.5 m and 4 m from the left support. Find: (i) deflection under each load. (ii) Maximum deflection and (iii) The point at which maximum deflection occurs, given $E = 2 \times 10^5 \text{ N/mm}^2$ and $I = 85 \times 10^6 \text{ mm}^4$. Use Macaulay's method? [CO3,K3] 6
- 3.d. Answer any one of the following:-
- 3.d.(i) Calculate the diameter of a solid shaft transmitting 150 kW at 25 rpm, if the maximum shear stress in the shaft is not to exceed 70 MPa. Compare this with the shaft delivering same power at 25000 rpm. [CO4,K3] 6

3.d.(ii) Find the Euler's crippling load for a hollow cylindrical steel column of 38 mm external diameter and 2.5 mm thick. Take length of the column as 2.3 m and hinged at its both ends. Take $E = 205 \text{ kN/mm}^2$. Also determine the crippling load by Rankine's formula using $f_c = 335 \text{ N/mm}^2$ and $a = 1/7500$. [CO4, K3] 6

3.e. Answer any one of the following:-

3.e.(i) A boiler shell is to be mad of 15mm 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; (i) The max permissible diameter of the shell for an internal pressure of 2 N/mm^2 (ii) permissible intensity of internal pressure when the shell diameter is 1.5m. [CO5, K4] 6

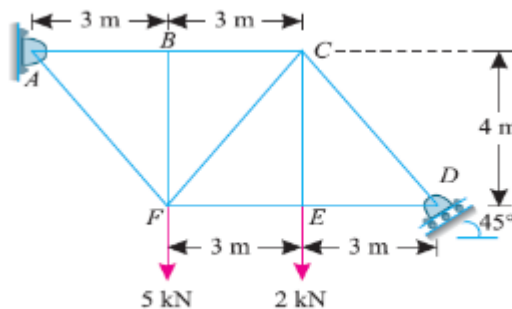
3.e.(ii) Derive the formula for circumferential stress and longitudinal stress developed in thin cylinder subjected to internal fluid pressure. [CO5, K3] 6

SECTION-C 50

4. Answer any one of the following:-

4-a. A ladder 5 meters long rests on a horizontal ground and leans against a smooth vertical wall at an angle 70° with the horizontal. The weight of the ladder is 900 N and acts at its middle. The ladder is at the point of sliding, when a man weighing 750N stands on a rung 1.5 meter from the bottom of the ladder. Calculate the coefficient of friction between the ladder and the floor. [CO1K3] 10

4-b. Determine the forces in all the members of the trusses shown in fig. Indicate the nature of forces using the convention tension as +ve and compression as 10



-ve. [CO1, K4]

5. Answer any one of the following:-

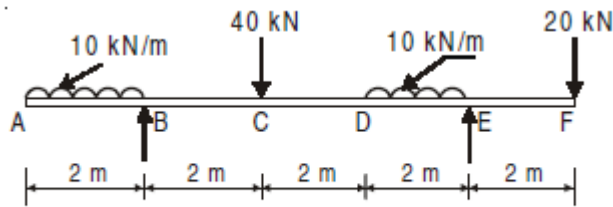
5-a. Derive the formula for change in length of varying cross section bar subjected to external axial pull 'P'. [CO2, K3] 10

5-b. At a point in a strained material, the principle stresses are 100 N/mm^2 tensile and 40 N/mm^2 compressive. Determine the resultant stress in magnitude and direction on a plane inclined at 60° to the axis of the major principle stress. What is the maximum intensity of shear stress in material at the point. [CO2, K3] 10

6. Answer any one of the following:-

6-a. Derive the bending equation of the beam. Also write down the assumption made. [CO3, K3] 10

6-b. Draw the shear force and bending moment diagram of the following beam as shown in fig below. [CO3, K3] 10



7. Answer any one of the following:-

7-a. Derive an expression for the Euler's crippling load for a long column with one end is fixed and other is free condition. Also write down the assumption made. [CO4,K4] 10

7-b. Find the expression for the maximum and minimum stresses when a rectangular column is subjected to a load which is eccentric to Y-Y axis. [CO4,K3] 10

8. Answer any one of the following:-

8-a. The internal and external diameters of a thick hollow cylinder are 80 mm and 120 mm respectively. It is subjected to an external pressure of 40 N/mm^2 and an internal pressure of 120 N/mm^2 . Calculate the circumferential stress at the external and internal surfaces and determine the radial and circumferential stresses at the mean radius. [CO5,K4] 10

8-b. A copper tube of 50 mm diameter and 1200 mm length has a thickness of 1.2 mm with closed ends. It is filled with water at atmospheric pressure. Find the increase in pressure when an additional volume of 32 cc of water is pumped into the tube. Take E for copper = 100 GPa, Poisson's ratio = 0.3 and K for water = 2000 N/mm^2 . [CO5,K4] 10