Hall Ticket No | | | | | | | | | | |  Question Paper Code: AAEB04

# INSTITUTE OF AERONAUTICAL ENGINEERING

**(Autonomous)**

**Dundigal, Hyderabad - 500 043**

## MODEL QUESTION PAPER - I

B.Tech III Semester End Examinations, November/ December – 2019

**Regulations: IARE - R18**

## MECHANICS OF SOLIDS

(AERONAUTICAL ENGINEERING)

**Time: 3 hours** **Max. Marks: 70**

Answer ONE Question from each Module
All Questions Carry Equal Marks
All parts of the question must be answered in one place only

### MODULE– I

1. a) The extension in a rectangular steel bar of length 800mm and of thickness 20mm is found to be 0.21mm. The bar tapers uniformly in width from 80mm to 40mm. if E for the bar is 2×105 N/mm2. Determine the axial tensile load on the bar. **[7M]**

   b) A load of 100N falls through a height of 2cm on to a collar rigidly attached to the lower end of a vertical bar 1.5m long and of 1.5cm2 cross-sectional area. The upper end of the vertical bar is fixed. Determine: **[7M]**
      i. Maximum instantaneous stress induced in the vertical bar,
      ii. Maximum instantaneous elongation and
      iii. Strain energy stored in the vertical rod. Take E=2 ×105N/mm2

2. a) A vertical bar 4m long and 2000 mm2 cross-sectional area is fixed at the upper end and has a collar at the lower end. Determine the maximum stress induced when a weight of: **[7M]**
      i. 3000 N falls through a height of 20cm on the collar,
      ii. 30KN falls through a height of 2 cm on the collar.
   Take E=2 ×105N/mm2

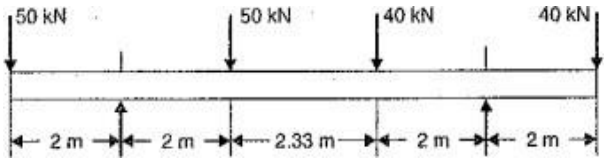
   b) The shear stress in a material at a point is given as 45 N/mm2. Determine the local strain energy per unit volume stored in the material due to shear stress. Take C=8 ×104N/mm2 **[7M]**

### MODULE – II

3. a) A cantilever of length 2m carries a udl of 2KN/m run over the length of 1m from the free end. It also carries a point load of 4KN at a distance of 0.5m from the free end. Draw the S.F.D and B.M.D. **[7M]**

   b) A beam is loaded as shown in the figure. Draw S.F.D and B.M.D and find **[7M]**
      a) Maximum Shear Force

b) Maximum Bending Moment
c) Point of inflexion

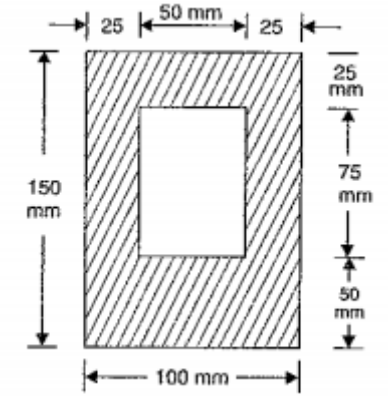



4. a) Draw the sheer force and bending moment diagrams for a cantilever of length L carrying a uniformly varying load zero at free end to w per unit length at the fixed end. **[7M]**
   b) Draw the shear force and bending moment diagrams for a simply supported beam of length L carrying a uniformly varying load zero at each end to w per unit length at the centre. **[7M]**

## MODULE – III

5. a) A tie rod of solid circular section is subjected to a tensile force of 94.25KN at an eccentricity of 5mm from the longitudinal axis. If the maximum tensile stress is limited to 150N/mm2 find the minimum diameter of the rod. **[7M]**
   b) An I-section consists of the following sections: upper flange=130mm×50mm Web=200mm×50mm, lower flange=200mm×50mm. If the beam is subjected to a shearing force of 50KN, find the maximum shear stress across the section. Also draw the shear stress distribution diagram. Take I=284.9×106 mm4 **[7M]**

6. a) A timber beam 150mm wide and 100 mm deep is to be reinforced by two steel flitches each 150mm×10mm in section. Calculate the ratio of the moments of the resistance in the two mentioned cases: **[7M]**
      i. Flitches attached symmetrically on the sides
      ii. Flitches attached at top and bottom.
   b) A SSB of length 4m carries a point load of 16kN at a distance of 3m from left support. The cross-section of the beam is as shown in figure. Determine the maximum tensile and compressive stress at a section which is at a distance of 2.25m from the left support. **[7M]**




## MODULE – IV

7. a) Derive the expression for maximum deflection and maximum deflection for a strut subjected to compressive axial load or axial thrust and a transverse UDL of intensity w per unit length when both ends are pinned. **[7M]**
   b) A hollow cylindrical cast iron column is 6m long with both ends fixed. Determine the minimum diameter of the column if it has to carry a safe load of 300KN with a factor of safety of 4. Take the internal diameter as 0.7 times the external diameter. Take fc =550N/mm2 and α=1/1600 in Rankine's formula. **[7M]**

8. a) Determine Euler's crippling load for an I-section joist 30cm × 15cm ×2cm and 5m long which is used as a strut with both ends fixed. Take E= 2 ×105N/mm2 for the joist. **[7M]**

b) A tubular steel strut is of 65mm external diameter and 50 mm internal diameter. It is 2.5 m long and hinged at both ends. The load acting is eccentric. Find the maximum eccentricity for a crippling load of 0.75 of the Euler load, the yield stress being 330 MPa, E = 210 GPa. **[7M]**

## MODULE – V

9. a) The principal tensile stress at a point across two mutually perpendicular planes is 100N/mm2 and 50 N/mm2. Determine the normal, tangential and resultant stresses on a plane inclined at 300 to the axis of the minor principal stress. **[7M]**

b) At a point in a strained material, the principal stresses are 140 N/mm2(tensile) and 60N/mm2(compressive). Determine the resultant stress in magnitude and direction on a plane inclined at 450 to the axis of the major principal stress. What is the maximum intensity of shear stress in the material at the point? **[7M]**

10. a) At a point in a two dimensional system, the normal stress on two mutually perpendicular planes are $\sigma 1$ and $\sigma 2$ (both alike) and shear stress is $\tau$. Show that one of the principal stresses is zero if $\tau = \sqrt{\sigma 1 \times \sigma 2}$. **[7M]**

b) A rectangular block of material is subjected to a tensile stress of 100 N/mm2 on one plane and a tensile stress of 50N/mm2 on a plane at right angles, together with shear stresses of 60N/mm2 on the faces. Find: **[7M]**

i. The direction of principal planes
ii. The magnitude of principal stresses and
iii. Magnitude of the greatest shear stress.

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## MECHANICS OF SOLIDS

### COURSE OBJECTIVES:

**The course should enable the students to:**

| | |
|---|---|
| I | Understand the behavior of structure basic structural components under loading conditions |
| II | Apply the shear force, bending moment and deflection methods to the beam in different load conditions |
| III | Relate the bending and flexural stress solving methods to real time problems |
| IV | Pertain the concept of buckling behavior of the columns along with eigen modes |

### COURSE OUTCOMES (COs):

| | |
|---|---|
| CO 1 | To understand the basics of material properties, stress and strain. |
| CO 2 | To apply knowledge of various kinds of beams for engineering applications. |
| CO 3 | Ability to identify, formulate, and solve engineering & real life problems. |
| CO 4 | Ability to design and conduct experiments, as well as to analyze and interpret data |
| CO 5 | Ability to design a component to meet desired needs within realistic constraints of safety. |

### COURSE LEARNING OUTCOMES (CLOs):

**Students, who complete the course, will have demonstrated the ability to do the following:**

| | |
|---|---|
| AAEB04.01 | Calculate the stress strain relations in conjunction with elasticity and material properties |
| AAEB04.02 | Describe the resistance and deformation in members which are subjected to axial, flexural and torsion loads. |
| AAEB04.03 | Discuss thermal explanations in solid bars and induced thermal stresses |
| AAEB04.04 | Solve for bending and shear parameters of beams under loading conditions |
| AAEB04.05 | Explain for deflections of beams under loading with various approaches. |
| AAEB04.06 | Determine the deflections of different beams under different loading conditions. |
| AAEB04.07 | Compute the bending stresses developed in various sections of beams of real field problems. |
| AAEB04.08 | Apply the bending equation on various sections |
| AAEB04.09 | Determine the shear stresses developed in various sections of beams |
| AAEB04.10 | Calculate the stability of structural elements and determine buckling loads. |
| AAEB04.11 | Discuss critical buckling load for column with various loading and end conditions |

| | |
|---|---|
| AAEB04.12 | Apply theories and to predict the performance of bars under axial loading including buckling. |
| AAEB04.13 | Understand the theory of beam column & determine buckling loads on it. |
| AAEB04.14 | Solve the principal stress problems by graphical methods. |
| AAEB04.15 | Explain the stress transformation and concept of principle plane and principle stresses |
| AAEB04.16 | Evaluate principal stresses, strains and apply the concept of failure theories for design |
| AAEB04.17 | Acquire knowledge to solve real time problems in Aircraft structure subjected loading conditions |

**MAPPING OF SEE – COURSE OUTCOMES**

| SEE Question No. | | Course Outcomes | | Course Outcomes | Blooms' Taxonomy Level |
|---|---|---|---|---|---|
| 1 | a | AAEB04.01 | Calculate the stress strain relations in conjunction with elasticity and material properties | CO1 | Remember |
| | b | AAEB04.02 | Describe the resistance and deformation in members which are subjected to axial, flexural and torsion loads. | CO1 | Remember |
| 2 | a | AAEB04.03 | Discuss thermal explanations in solid bars and induced thermal stresses | CO1 | Remember |
| | b | AAEB04.01 | Calculate the stress strain relations in conjunction with elasticity and material properties | CO1 | Understand |
| 3 | a | AAEB04.04 | Solve for bending and shear parameters of beams under loading conditions | CO2 | Remember |
| | b | AAEB04.05 | Explain for deflections of beams under loading with various approaches. | CO2 | Remember |
| 4 | a | AAEB04.04 | Solve for bending and shear parameters of beams under loading conditions | CO2 | Remember |
| | b | AAEB04.05 | Explain for deflections of beams under loading with various approaches. | CO2 | Remember |
| 5 | a | AAEB04.07 | Compute the bending stresses developed in various sections of beams of real field problems. | CO3 | Understand |
| | b | AAEB04.07 | Compute the bending stresses developed in various sections of beams of real field problems. | CO3 | Remember |
| 6 | a | AAEB04.09 | Determine the shear stresses developed in various sections of beams | CO3 | Understand |
| | b | AAEB04.09 | Determine the shear stresses developed in various sections of beams | CO3 | Understand |
| 7 | a | AAEB04.10 | Calculate the stability of structural elements and determine buckling loads. | CO4 | Understand |
| | b | AAEB04.11 | Discuss critical buckling load for column with various loading and end conditions | CO4 | Remember |
| 8 | a | AAEB04.12 | Apply theories and to predict the performance of bars under axial loading including buckling. | CO4 | Understand |
| | b | AAEB04.13 | Understand the theory of beam column & determine buckling loads on it. | CO4 | Understand |
| 9 | a | AAEB04.14 | Solve the principal stress problems by graphical methods. | CO5 | Remember |
| | b | AAEB04.15 | Explain the stress transformation and concept of principle plane and principle stresses | CO5 | Understand |

| | | | | | |
|---|---|---|---|---|---|
| 10 | a | AAEB04.16 | Evaluate principal stresses, strains and apply the concept of failure theories for design | CO5 | Remember |
| | b | AAEB04.17 | Acquire knowledge to solve real time problems in Aircraft structure subjected loading conditions | CO5 | Remember |

**Signature of Course Coordinator** **HOD, AE**