

E-547

B. E. IIIrd Semester (M. E.) Examination, December – 2017

BASIC SOLID MECHANICS

Time : Three Hours]

[Maximum Marks : 75

[Min. Marks : 30

Note : Attempt *all* questions of *Section – A*, *four* questions from *Section – B* and *three* questions from *Section – C*.

SECTION – A

[Marks : $1.5 \times 10 = 15$

(Objective Type Questions)

1. For a thin cylinder, the ratio of thickness to internal diameter is of the order of :
(a) $1/10$ (b) $1/20$
(c) $1/30$ (d) $1/40$
2. Maximum deflection of a cantilever beam of length l carrying uniformly distributed load w per unit length will be :
(a) $\frac{wl^2}{EI}$ (b) $\frac{wl^4}{4EI}$
(c) $\frac{wl^4}{8EI}$ (d) $\frac{wl^4}{384EI}$
3. If closed coil helical spring absorbs 30 N. mm of energy while extending by 5 mm, its stiffness is :
(a) 2 N/mm (b) 4 N/mm
(c) 6 N/mm (d) 10 N/mm
4. A structural member subjected to an axial compressive force is called :
(a) Beam (b) Column
(c) Frame (d) Strut.

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5. Force required to double the length of the wire of unit cross-sectional area is numerically equal to :
- (a) Ultimate stress (b) Yield point stress
(c) Elastic limit stress (d) Modulus of elasticity
6. A bar of copper and steel from a composite system. They are heated to a temperature of 40°C . What type of stress is induced in copper bar ?
- (a) Tensile (b) Compressive
(c) Shear (d) Tensile as well as compressure
7. The state of plane stress at a point is given by $\sigma_x = 200\text{MPa}$, $\sigma_y = 100\text{MPa}$ and $\tau_{xy} = 100\text{MPa}$. The maximum shear stress (in MPa) is then :
- (a) 111.8 (b) 150.1
(c) 180.3 (d) 223.6
8. The radial stress in a thin spherical pressure vessel is :
- (a) Equal to hoop stress (b) Double the hoop stress
(c) Halp of the hoop stress (d) Zero
9. The bending moment for a certain portion of the beam is constant For that section shear force would be :
- (a) Zero (b) Increasing
(c) Decresing (d) Constant
10. Which of the following beams is likely to have the point of contraflexure ?
- (a) Contiliver beam (b) Simply supported beam
(c) Bheam with overhangs (d) Beam fixed at both ends

SECTION – B

[Marks : $6 \times 4 = 24$]

(Short Answer Type Questions)

1. Draw and derive the expression for normal stress and tangential stress in case of Mohr's circle when a body is subjected mutually perpendicular principal tensile stresses accompanied by a simple shear stress.
2. Sate the assumption made in the analysis of stress in thick cylinder. Derive lame's equation to find the stresses in thick cylinder.

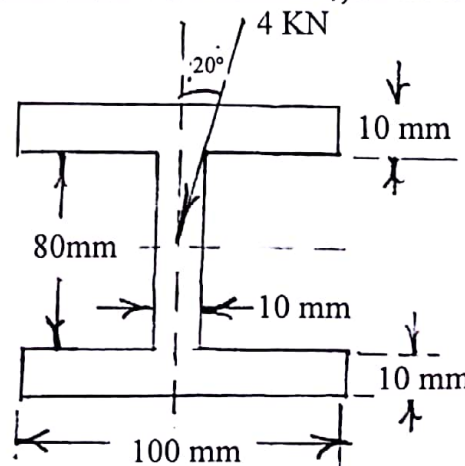
3. A simply supported beam of length 4 m is subjected to a UDL of 30 kN/m over the whole span and deflects 15 mm at the centre. Determine the crippling loads when this beam is used as a column with the following conditions :
 - (i) One end fixed and other end hinged.
 - (ii) Both the ends pin jointed.
4. State the assumption made in the analysis of column. Derive for crippling load for a long column when one end of the column is fixed and other end is hinged.
5. Using Macaulay's method, derive the expression for the deflection and slope in case of simply supported beam with an eccentric point load.
6. A system under biaxial loading induces principal stresses of 100 N/cm² tensile and 50 N/cm² compressive at a point. Find the normal stress at that point on the maximum shear stress plane.

SECTION – C

[Marks : 12 × 3 = 36]

(Long Answer Type Questions)

1. A solid circular shaft and a hollow circular shaft whose inside diameter is $(3/4)$ of the outside diameter, are of the same material, of equal length and are required to transmit a given torque compare the weight of these two shafts if the maximum shear stresses developed in the shaft are equal.
2. A hollow cylindrical cast iron column is 4m long with both ends fixed. Determine the minimum diameter of the column if it has to carry a safe load of 250 kN with a factor of safety of 5. Take the internal diameter as 0.8 times the external diameter. Take $\sigma_0 = 550 \text{ N/mm}^2$ and $a = 1/1600$ in Rankine's formula.
3. A simply supported I section beam of span 2m carrying concentrated load of 4 kN at an angle of 20° from vertical as shown in figure, the load passes through CG of the section. Determine the maximum and minimum bending stresses in the beam.



(Fig. 1)

(3)

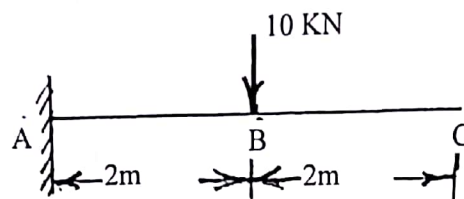
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4. Write short notes on any *three* :

- (i) Define the stress and strain
- (ii) Slope of neutral axis.
- (iii) Axial and circumferential stresses in thick cylinders.
- (iv) Buckling and stability of column
- (v) Composite beams.

5. A cantilever beam is loaded as shown in fig-2. Find the deflection at the free end and at the point B. If $E = 2.1 \times 10^8 \text{ KN/m}^2$ and $I = 8.98 \times 10^{-5} \text{ m}^4$.



(Fig. 2)

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Note : Attempt **all** questions of **Section-A**, **four** questions from **Section-B** and **three** questions from **Section-C**.

Section-A

1.5×10=15

1. In case of biaxial stresses, the maximum value of shear stress is :
(a) Difference of normal stresses (b) Half of difference of normal stresses
(c) Sum of normal stresses (d) Half of sum of normal stresses
2. If a body is acted upon by pure shear stresses on two perpendicular planes, the planes inclined at 45° are subjected to no _____ stress.
(a) Tensile (b) Compressive
(c) Shear (d) None of these
3. A beam is said to be loaded in pure bending if :
(a) Shear force and bending moment are uniform throughout
(b) Shear force is zero and bending moment is uniform throughout
(c) Shear force can vary but and bending moment is uniform throughout
(d) Shear force and bending moment both can vary.
4. The flexural rigidity of a beam is :
(a) E/I (b) EI
(c) I/E (d) I^2E

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5. The predominant effect of an axial tensile force on a helical spring is :
 - (a) Bending
 - (b) Tension
 - (c) Compression
 - (d) Twisting
6. Leaf spring is subjected to :
 - (a) Tensile stress
 - (b) Compressive stress
 - (c) Shear Stress
 - (d) Bending stress
7. In a thin cylinder, the ratio of hoop stress to longitudinal stress is :
 - (a) $1/4$
 - (b) $1/2$
 - (c) 2
 - (d) 4
8. The use of compound tubes subjected to internal pressure are to :
 - (a) Even out the stresses
 - (b) Increase the thickness
 - (c) Increase the diameter of the tube
 - (d) Increase the strength
9. The variation of bending stress in a curved beam is :
 - (a) Linear
 - (b) Parabolic
 - (c) Hyperbolic
 - (d) Cubic
10. For two shafts joined in parallel, the _____ in each shaft is the same :
 - (a) Shear stress
 - (b) Angle of twist
 - (c) Torque
 - (d) None of these

Section-B

6×4=24

1. Show that a body subjected to a pure shear is also acted upon by tensile and compressive stresses as well.
2. Find the expression for displacement of a fixed beam with a point load at the midspan.
3. What is meant by buckling load? Derive the expression for buckling load for a long column when its one end is fixed and the other end free.
4. Obtain a relation for maximum principal stress and maximum shear stress for a shaft under the action of combined bending and torsion.
5. An 800 mm long closed-end copper tube of 72 mm internal diameter and 2 mm thickness is filled with water under pressure. Find the change in pressure if additional volume of 4000 mm³ of water is pumped into the tube. Neglect any -

distortion of the end plated. Take $E=102 \text{ GPa}$, $K=2200 \text{ MPa}$ and Poisson's ratio $\nu=0.3$.

6. Determine the position of the shear centre for a channel section of 80 cm by 40 cm outside and 5mm thick.

Section-C

12×3=36

1. The stresses on two perpendicular planes through a point in a body are 30 MPa and 15 MPa both tensile along with shear stress of 25MPa. Find :
 - (i) The magnitude and direction of principal stresses
 - (ii) The planes of maximum shear stress
 - (iii) The normal and shear stresses on the planes of maximum shearing stress.
2. Determine the width and depth of the strongest beam which can be cut out of a cylindrical log of wood of diameter d .
3. The coil diameter of a closed-coiled helical spring having 10 coils is eight times the wire diameter. The spring absorbs 60 N.m of energy when compressed by 40 mm. Find the coil and the wire diameters and the maximum shear stress. $G=85\text{GPa}$.
4. A 1.5 m long solid aluminium shaft with a 60 mm diameter is to be replaced by a steel hollow shaft of the same length and same external diameter s to transmit the same torque. With same angle of twist over the same length. Determine the diameter of the hollow shaft. $G(\text{steel})=82 \text{ GPa}$ and $G(\text{aluminium})=27 \text{ GPa}$.
5. A beam of square section is subjected to uniform bending moment 660 Nm. If the cross-section of the beam is 4cm×4cm. Find for each of the following cases, the maximum tensile and compressive stresses in the section :
 - (a) The beam is straight
 - (b) The beam is curved to radius of 20 cm along the centroidal axis and bending moment increases the curvature.
 - (c) The beam is curved to radius of 4cm along the centroidal axis and bending moment increases the curvature.

What do you conclude from the results of this problem regarding the effect of curvature on stresses?

(3)