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STUDY MATERIAL

SUBJECT : MECHANIC OF SOLIDS (MOS)

(MODULE - I & II)

SEMESTER : 3RD

BRANCH : MECHANICAL ENGINEERING

CONTENTS :

- OBJECTIVE TYPE QUESTIONS AND ANSWERS
- SHORT TYPE QUESTIONS AND ANSWERS
- LONG TYPE QUESTIONS AND ANSWERS

DEPARTMENT OF MECHANICAL ENGINEERING

SRINIX COLLEGE OF ENGINEERING, BALASORE

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CONTENTS :

MODULE-I

BPUT SYLLABUS (MODULE- I & II)

1. Concept of Stress:
Load, Stress, Principle of St.Vènant, Principle of Superposition, Strain, Hooke's law, Modulus of Elasticity, Stress-Strain Diagrams, Working Stress, Factor of safety, Strain energy in tension and compression, Resilience, Impact loads

2.Analysis of Axially Loaded Members : Composite bars in tension and compression ,temperature stresses in composite rods, Concept of Statically indeterminate problems.
Shear stress, Complimentary shear stress, Shear strain, Modulus of rigidity, Poisson's ratio, Bulk Modulus, Relationship between elastic constants.

3. Biaxial State of Stress :
Analysis of Biaxial Stress.Plane stress, Principal plane, Principal stress, Mohr's

4. Biaxial State of Strain :
Two dimensional state of strain, Principal strains, Mohr's circle for strain, Calculation of principal stresses from principal strains, Strain Rossette.
Circle for Biaxial Stress.

5.Thin Pressure Vessel :
Stresses in thin cylinders and thin spherical shells under internal pressure, wire winding of thin cylinders.

DEPARTMENT OF MECHANICAL ENGINEERING

MODULE – I, II OBJECTIVE TYPE QUESTIONS AND ANSWERS

1. A material with identical properties in all directions is known as
   (a) homogeneous (b) isotropic (c) elastic (d) none of these
2. The units of stress in the SI system are
   (a) kg/m^2 (b) N/mm^2 (c) MPa (d) any one of these
3. In a lap-riveted joint, the rivets are mainly subjected to _____ stress.
   (a) shear (b) tensile (c) bending (d) compressive
4. The resistance to deformation of a body per unit area is known as
   (a) stress (b) strain
   (c) modulus of elasticity (d) modulus of rigidity
5. Stress developed due to external force in an elastic material
   (a) depends on elastic constants (b) does not depend on elastic constants
   (c) depends partially on elastic constants
6. Strain is defined as deformation per unit
   (a) area (b) length (c) load (c) volume
7. Units of strain are
   (a) mm/m (b) mm/mm (c) m/mm (d) no units
8. Hooke's law is valid up to the
   (a) elastic limit (b) yield point
   (c) limit of proportionality (d) ultimate point
9. The ratio of linear stress to linear strain is known as
   (a) bulk modulus (b) modulus of rigidity
   (c) Young's modulus (d) modulus of elasticity
10. The units of modulus of elasticity are the same as of
    (a) stress (b) modulus of rigidity (c) pressure (d) any one of these
11. The change in length due to a tensile force on body is given by
    (a) PL/AE (b) PLA/E (c) PLE/A (d) AE/PL
12. Approximate Value of Young's modulus for mild steel is
    (a) 100 GPa (b) 205 MPa (c) 205 GPa (d) 100 MPa
13. 1MPa is equal to
    (a) $1N/m^2$ (b) $1N/mm^2$ (c) $1kN/m^2$ (d) $1kN/mm^2$

14. Deformation of a bar under its own weight is ...... the deformation due to a direct load equal to the weight of the body applied at the lower end.

(a) double (b) four times (c) half (d) equal to

15. Elongation of a conical bar under its own weight is ......that of a rectangular section of the same length.

(a) two-third (b) one-third (c) half (d) equal to

16. If a bar of length L m extends by l mm under load W, the strain is

(a) $1000\, l/L$ (b) l/L (c) $0.001 l/L$ (d) none of these

17. Four wires of same material are applied the same load. In which of the following cases, the elongation will be maximum (length, diameter)?

(a) 2 m, 1 mm (b) 4 m, 2 mm (c) 8 m, 4 mm (d) 12 m, 6 mm

18. If $E_s = 3E_a$, the stress in steel of a composite bar made of aluminium and steel strips each having a cross-sectional area of 300 mm^2 and subjected to an axial load of 12 kN is

(a) 10 MPa (b) 20 MPa (c) 30 MPa (d) 40 MPa

19. The ratio of modulus of rigidity to modulus of elasticity for most of the materials is

(a) 0.5 (b) > 0.5 (c) < 0.5 (d) > 1

20. Temperature stress is a function of

(a) modulus of elasticity (b) coefficient of linear expansion

(c) change in temperature (d) all of these

21. Factor of safety is defined as ratio of

(a) ultimate stress to allowable stress (b) ultimate stress to yield stress

(c) allowable stress to ultimate stress (d) allowable stress to yield stress

22. The modulus of rigidity in terms of modulus of elasticity is given by

(a) $\frac{E}{2(1-\nu)}$ (b) $\frac{E}{2(1+\nu)}$ (c) $\frac{2E}{(1-\nu)}$ (d) $\frac{2E}{(1+\nu)}$

23. The modulus of elasticity in terms of bulk modulus is given by

(a) $3K/(1+2\nu)$ (b) $3K(1+2\nu)$ (c) $3K/(1-2\nu)$ (d) $3K(1-2\nu)$

24. The ratio of Young's modulus and bulk modulus is given by

(a) $3/(1+2\nu)$ (b) $3(1-2\nu)$ (c) $3(1-\nu)$ (d) none of these

25. The modulus of elasticity in terms of bulk modulus and modulus of rigidity is

(a) $\frac{9KG}{3K+G}$ (b) $\frac{9KG}{K+3G}$ (c) $\frac{3K+G}{9KG}$ (d) $\frac{K+3G}{9KG}$

26. The bulk modulus of a material having $E = 200$ GPa and $G = 80$ GPa is

(a) 233.3 GPa (b) 133.3 GPa (c) 250 GPa (d) 160 GPa

27. For a Poisson's ratio 0.4 for a material, the ratio of the shear modulus of elasticity to modulus of elasticity is

(a) 14/5 (b) 5/7 (c) 7/5 (d) 5/14

28. The ratio of lateral strain to linear strain is known as

(a) modulus of rigidity (b) elastic limit

(c) Poisson's ratio (d) modulus of elasticity

29. The stress at which elongation of a material is quite large as compared to the increase in load is known as

(a) ultimate point (b) yield point (c) elastic limit (d) rupture point

30. The limit up to which the stress is linearly proportional to strain is _____ limit.

(a) elastic (b) plastic (c) ultimate (d) rupture

31. Poisson's ratio ν is defined as ratio of

(a) axial strain to transverse strain
(b) transverse strain to axial strain
(c) shear strain to axial strain
(d) axial strain to shear strain

Answers

1. (b)	2. (b and c)	3. (a)	4. (a)	5. (b)	6. (b)
7. (d)	8. (c)	9. (c and d)	10. (d)	11. (a)	12. (c)
13. (b)	14. (c)	15. (b)	16. (c)	17. (a)	18. (c)
19. (c)	20. (d)	21. (a)	22. (b)	23. (d)	24. (b)
25. (a)	26. (b)	27. (d)	28. (c)	29. (b)	30. (a)
31. (b)					

SET-1

Objective Type Questions

1. The strain energy stored in a bar is given by

(a) $\frac{PL}{AE}$ (b) $\frac{PL^2}{2AE}$ (c) $\frac{P^2L}{AE}$ (d) $\frac{P^2L}{2AE}$

2. Strain energy of a member is given by

(a) $\frac{\sigma^2}{2E} \times$ volume (b) $\frac{P^2L}{2AE}$

(c) $\frac{1}{2} \times$ stress $\times$ strain $\times$ volume (d) all of these

3. Modulus of resilience is
   (a) percentage of elongation of an elastic body
   (b) strain energy stored in the elastic body
   (c) strain energy per unit volume of the elastic body
4. Proof resilience is the maximum energy stored at
   (a) plastic limit (b) limit of proportionality (c) elastic limit
5. Modulus of toughness is the area of the stress–strain diagram up to
   (a) rupture point (b) yield point
   (c) limit of proportionality (d) none of these
6. Shear strain energy per unit volume is given by

(a) $\frac{\tau^2}{4G}$ (b) $\frac{\tau^2}{2G}$ (c) $\frac{2\tau^2}{3G}$ (d) $\frac{\tau}{4G}$

7. Strain energy of a bar of conical section is

(a) $\frac{P^2L}{\pi EdD}$ (b) $\frac{2PL}{\pi EdD}$ (c) $\frac{2P^2L}{EdD}$ (d) $\frac{2P^2L}{\pi EdD}$

8. Strain energy stored in a body due to suddenly applied load compared to when applied slowly is
   (a) twice (b) four times (c) eight times (d) half

Answers:

1. (d) 2. (d) 3. (c) 4. (c) 5. (a) 6. (b)
7. (d) 8. (a)

SET-2

Objective Type Questions

1. Under uniaxial loading, the maximum shear stress is _____ times the uniaxial stress.
   (a) half (b) two (c) 1.5 (d) three
2. The shear stress on the principal plane is
   (a) $\frac{\sigma_x + \sigma_y}{2}$ (b) $\frac{\sigma_x - \sigma_y}{2}$ (c) $\sigma_x + \sigma_y$ (d) Zero
3. 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
4. Normal stress on a plane, the normal to which is inclined at angle θ with the line of action of uniaxial stress σ is given by
   (a) $\sigma \sin^2 \theta$ (b) $\sigma \cos^2 \theta$ (c) $\sigma/\sin^2 \theta$ (d) $\sigma/\cos^2 \theta$
5. Shear stress on a plane the normal to which is inclined at angle θ with the line of action of uniaxial stress σ is given by
   (a) $\frac{1}{2}\sigma \sin 2\theta$ (b) $\sigma \sin^2 \theta$ (c) $\frac{1}{2}\sigma \cos 2\theta$ (d) $\sigma \cos^2 \theta$
6. In case of biaxial stresses, the maximum value of shear stress is
   (a) difference of normal stresses (b) half the difference of normal stresses
   (c) sum of normal stresses (d) half the sum of normal stresses
7. In case of biaxial stresses, the shear stress is maximum on a plane at ___ degrees to the given planes.
   (a) 45° (b) 90° (c) 135° (d) 180°
8. Normal stress on an oblique plane inclined at angle 45° to the axis of a bar of square cross-section of side s when acted upon by a tensile force P is
   (a) $\frac{P}{s^2}$ (b) $\frac{2P}{s^2}$ (c) $\frac{P}{2s^2}$ (d) $\frac{P}{4s^2}$
9. Each normal stress on two planes of maximum shear stresses are
   (a) difference of normal stresses (b) half the difference of normal stresses
   (c) sum of normal stresses (d) half the sum of normal stresses
10. In a Mohr's circle, the radius gives the value of
    (a) minimum shear stress (b) maximum normal stress
    (c) minimum normal stress (d) maximum shear stress
11. Ellipse of stress can be drawn only when a body is acted upon by
    (a) one normal stress (b) two normal stresses
    (c) one shear stress (d) two normal stresses and one shear stress
12. The angle between planes of principal stresses and principal strains is
    (a) zero (b) 45° (c) 90° (d) 135°
13. A strain rosette consists of at least ______ strain gauges
    (a) two (b) three (c) four (d) five
14. In a rectangular strain rosette, the strain gauges are set at
    (a) 45° (b) 60° (c) 75° (d) 90°
15. In an equiangular strain rosette, the strain gauges are set at
    (a) 45° (b) 60° (c) 75° (d) 90°
16. In a linear strain system, strain in a direction θ with x-direction is
    (a) $\varepsilon_x \cdot \cos\theta$ (b) $\varepsilon_x \cdot \sin\theta$ (c) $\varepsilon_x \cdot \sin^2\theta$ (d) $\varepsilon_x \cdot \cos^2\theta$

Answers

1. (a)	2. (d)	3. (c)	4. (b)	5. (c)	6. (b)
7. (a)	8. (c)	9. (d)	10. (d)	11. (b)	12. (a)
13. (b)	14. (a)	15. (b)	16. (d)		

SET -3

Objective Type Questions

1. A shell may be termed as *thin* if the ratio of thickness of the wall to the diameter of the shell is less than one to
   (a) 5 (b) 10 (c) 15 (d) 20
2. In a thin cylinder, the hoop stress is given by
   (a) $\frac{pd}{4t}$ (b) $\frac{pd}{t}$ (c) $\frac{pd}{2t}$ (d) $\frac{2pd}{t}$
3. In a thin cylinder, the longitudinal stress is given by
   (a) $\frac{2pd}{t}$ (b) $\frac{pd}{t}$ (c) $\frac{pd}{2t}$ (d) $\frac{pd}{4t}$
4. In a thin cylinder, the ratio of hoop stress to longitudinal stress is
   (a) 1/4 (b) 1/2 (c) 2 (d) 4
5. In a thin spherical shell, the hoop stress is given by
   (a) $\frac{pd}{4t}$ ×(b) $\frac{pd}{2t}$ (c) $\frac{pd}{t}$ (d) $\frac{2pd}{t}$
6. The volumetric strain in a thin spherical shell is
   (a) $\frac{3pd}{4tE}(1-\nu)$ (b) $\frac{3pd}{4tE}(1-2\nu)$ (c) $\frac{pd}{4tE}(1-\nu)$ (d) $\frac{pd}{4tE}(1-2\nu)$
7. The initial hoop stress in a thin cylinder when it is wound with a wire under tension is
   (a) zero (b) tensile (c) compressive (d) bending
8. In a thick-walled cylinder subjected to internal pressure, maximum hoop stress occurs at
   (a) outer wall (b) inner wall (c) midpoint of thickness
9. In thick cylindrical pressure vessels, the variation of the hoop stress is
   (a) parabolic (b) uniform (c) linear (d) cubic
10. In thick cylindrical pressure vessels, the variation of the radial stress is
    (a) parabolic (b) uniform (c) linear (d) cubic
11. In a thick-walled cylinder subjected to external pressure, the hoop stresses are
    (a) tensile (b) compressive (c) bending
12. The use of compound tubes subjected to internal pressure are made to
    (a) even out the stresses (b) increase the thickness
    (c) increase the diameter of the tube (d) increase the strength
13. In compound tubes, initially, the inside diameter of the outer tube is _______ the outside diameter of the inner tube.
    (a) smaller than (b) larger than (c) equal to (d) 1.2 times
14. The maximum stress in thick cylinders is
    (a) Radial stress (b) hoop stress (c) longitudinal stress
15. In thick spherical pressure vessels, the variation of the stresses is
    (a) linear (b) uniform (c) parabolic (d) cubic

Answers

1. (c)	2. (c)	3. (d)	4. (c)	5. ~~(b)~~ (a)	6. (a)
7. (c)	8. (b)	9. (a)	10. (a)	11. (b)	12. (a)
13. (a)	14. (b)	15. (d)			

Strength Of Materials

MODULE-1 & 2

SHORT TYPE QUESTIONS AND ANSWERS

Q.1. Define 'stress'. How it is expressed?

Ans: When a material is subjected to an external force, a resisting force is set up within the component. The internal resisting force per unit area of acting on a material or intensity of force distributed over a given section is called the 'stress' at a point.

- Stress is expressed as, stress, $\sigma = \frac{\text{Resisting force}}{\text{Area}} = \frac{P}{A}$

So, the unit through which, stress is expressed are MN/M^2 (or MPa), N/M^2 (Pa), KN/M^2 (or KPa) or N/MM^2

Q.2. Define 'true stress' and 'true strain'.

Ans: True stress :- True stress is the load at any elongation divided by the cross-sectional area at that elongation.

$$\text{True stress} = \frac{\text{Force or load}}{\text{Cross-section area existing at the instant being considered (or, instantaneous area)}}$$

$$= \sigma\,(1+\varepsilon)$$

True strain : True strain is the change in length with reference to the instantaneous gauge length rather than the original length.

$$\text{True strain} = \int_{L_0}^{L} \frac{dL}{L} = \ln\left(\frac{L}{L_0}\right) = \ln(1+\varepsilon)$$

Q.3. Define proof stress.

Ans: Proof stress is the stress at which the stress-strain curve departs from a straight line by not more than 0.1 % of length of the test piece. The material is said to have passed the proof stress if application of certain load for 15 seconds does not produce more than 0.1 % elogation.