MARIA COLLEGE OF ENGINEERING AND TECHNOLOGY,

ATTOOR

DEPARTMENT OF MECHANICAL ENGINEERING
ME 45 STRENGTH OF MATERIALS
2 MARKS QUESTIONS & ANSWERS

UNIT 1:

1. Define stress?

The magnitude of the internal resistance offered by a body to the applied external force per unit area is called stress.

Stress (σ) = load (P)/area (A).

2. Define strain?

When a body is subjected to an external force there is some change in dimension in a body . numerically the strain is equal to the ratio of change in length to the original length of the body.

Strain = change in length/ original length

e= δL /L

3. State Hooke's law

It state that when a material is loaded within elastic limit the stress is directly proportional to the strain.

Stress α strain

σ α e

4. Define factor of safety?

It is defined as the ratio of ultimate tensile stress to the permissible stress (working stress).

Factor of safety = ultimate tensile stress / permissible stress

5. State tensile stress and tensile strain

When a member is subjected to equal and opposite axial pulls, the length of the member is increased. The stress is induced at any cross section of the member is called tensile stress and the corresponding strain is known as tesile strain.

6. State volumetric strain

Volumetric strain is defined as the ratio of change in volume to the original volume of the body.

Volumetric strain= change in volume / original volume.

7. Define modulus of elasticity?

When a body is stressed, within the elastic limit the ratio of tensile stress to the corresponding tensile stain is constant. This ratio is known as Young's modulus.

Young's modulus or modulus of elasticity = tensile stress / tensile stain.

8. Define modulus of rigidity?

When a body is stressed within the elastic limit the ratio of shearing stress to the corresponding shearing strain is constant. This ratio is known as modulus of rigidity.

Modulus of rigidity or shear modulus = shearing stress / shearing strain.

9. Define Poisson's ratio?

When a body is stressed within its elastic limit the ratio of lateral srain to the longitudinal strain is constant for a given material.

Poisson's ratio (μ) or 1/m = lateral srain / longitudinal strain.

10. State principal plane

The planes which have no shear stress are known as principal planes. These planes carry only normal stresses.

11. Define principal stresses ?

The normal stresses acting on the principal plane are known as principal stresses.

12. The Poisson's ratio for a material cannot be more than ----------.

Ans: 0.5.

13. State the relationship between Young's modulus and modulus of rigidity.

$$E = 2G (1+ 1/m).$$

Where,
E – Young's modulus, N/mm^2
G – Modulus of rigidity, N/mm^2
1/m – Poisson's ratio.

14. State the relationship between bulk modulus and Young's modulus

$$E = 3K (1-2/m)$$

Where,
E – Young's modulus, N/mm^2
K- Bulk modulus
1/m – Poisson's ratio.

15. The principal stress is ---------- to the plane and the shear stress is ---------- to the plane.

Ans: Normal, Tangential.

16. What do you understand by a compound bar?

A composite member is composed of two or more different material which are joined together so that the system is elongated or compressed as a single unit.

17. What are the types of elastic constant?

a. Modulus of elasticity, E
b. bulk modulus, K
c. modulus of rigidity, G

18. What is stability?

The stability may be defined as an ability of material to withstand high load without major deformation.

19. Give the relation for change in length of a bar hanging freely under its own weight.

Change in length, **$\delta L = PL/AE$**

Where, P – Axial load
L – Length of the bar
E - Young's modulus of the bar
A – Rea of the bar

20. A brass rod 2 m long is fixed at both its ends if the thermal stress is not to exceed 76.5N/mm^2. Calculate the temperature through which the rod should be heated. Take the value of α and E as 17x 10^{-6} / K and 90 GPa respectively.

Sol: Thermal Stress, $\sigma = \alpha TE$

$$76.5 = 17x\ 10^{-6} \times T \times 90 \times 10^3$$

therefore, 90 GPa = 90 x 10^9 = 90 x 10^9 N m^2

= 90 x 10^3 N/ mm^2

T = 50 K

UNIT: 2

1. What types of stresses are caused in a beam subjected to a constant shear force?
   Vertical and horizontal shear force.

2. State the main assumptions while deriving the general formula for shear stresses?
   a. The material is homogeneous, isotropic, and elastic.
   b. The modulus of elasticity in tension and compression are same.
   c. The shear stress is constant along the beam width.
   d. The presence of shear stress does not affect the distribution of bending stress.

3. Define shear stress distribution.
   The variation of shear stress along the depth of the beam is called shear stress distribution.

4. Write down the expression for shear stress distribution in a beam subjected to shear force F.
   Shear stress distribution, $q = F.\ A\bar{y} / Ib$.

5. What is the ratio of maximum shear stress to the average shear stress for a rectangular section?
   $q_{max} = 1.5 \times q_{ave}$

6. Define Beam.
   Beam is a structural member which is supported along the length and subjected to external loads acting transversely *i.e.,* perpendicular to the centre line of the beam. Beam is sufficiently long as compared to the lateral dimensions.

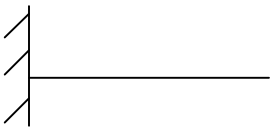
7. What is meant by transverse loading on beams?
   If a load is acting on the beam which is perpendicular to the centre line of it, then it is called transverse loading.

8. How to classify the beams according to its supports?
   The beam may be classified according to the support as following:
   a) Cantilever beam
   b) Simply supported beam
   c) Over hanging beam
   d) Fixed beam and
   e) Continuous beam

9. What are the types of transverse load?
   A beam may be subjected to the following types of transverse load.
   a) Point or concentrated load
   b) Uniformly distributed load
   c) uniformly varying load

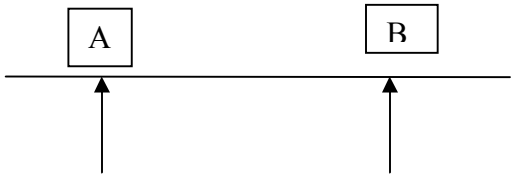
10. What is cantilever beam?

A beam with one end free and the other end fixed is called cantilever beam.



11. What is meant by over hanging beam?

If one or both of the end portions are extended beyond the support, then it is called over hanging beam.



12. What is meant by point of contra flexure?

Point of contra flexure is a point on loaded beam at which the bending movement changes its sign or is zero called point of contra flexure.

13. Give the relationship between shear force and bending movement.

The rate of changed of bending movement equals to the shear force at the section.

Mathematically, $dM/dx = -F$

14. What is section modulus?

Section modulus is the movement of inertia of the section to the distance from the neutral axis.

Section modulus (Z) = I / y

15. What are flitched beam?

A beam which is constructed by two different materials and behaves a single unit during loading is called flitched beam.

16. What is mean by reaction?

The upward force provided by the support to balance the vertical downward load is called reaction.

17. When will be the BM is maximum?

BM will be maximum when the SF changes its sign.

18. What is the nature of curve when the beam carrying UDL?

The curve follows parabolic relation or parabolic curve.

19. The maximum bending movement in a SSB of span 'L' subjected to UDL of w over the entire span is ----------

$$M_{max} = wL^2 / 8$$

20. State the theory of simple bending.

If a beam is bend only due to the application of constant bending movement and not due to shear then it is called simple bending.

UNIT: 3

1. Define Torsion.

When a pair of forces of equal magnitude but opposite directions acting on body, it tends to twist the body. It is known as twisting momemt or torsional moment or simply as torque.

2. What are the assumptions made in torsion equation?
   1. the material of the shaft is homogeneous, perfectly elastic and obeys Hooke's law.
   2. Twist in uniform along the length of the shaft.
   3. the stress does not exceed the limit of proportionality.

4. Write torsional equation.

$T / J = \tau / R = C \theta / l$

Where,

T – Torque – N /mm
J – Polar moment of inertia – mm^4
τ - Shear stress – N / mm^2
R – Radius mm
C – Modulus of rigidity
θ - Angle of twist – rad
l – Length – mm

5. Define polar modulus.

It is the ratio between polar moment of inertia and radius of the shaft.

Z_p = Polar moment of inertia / Radius = J / R

6. Write the polar modulus for solid shaft and circular shaft.

For solid shaft

Polar modulus, Z_p = polar moment of inertia/ radius
= J /R
where, $J = \pi / 32 \, D^4$

for hollow shaft

polar modulus, Z_p = polar moment of inertia/ radius
= J/ R
where, $J = \pi / 32 [D^4 - d^4]$

7. What is a spring?

A spring is aq device which is used to absorb energy by taking very large change in its form without permanent deformation and then release the3 same when it is required.

8. Classify the spring.
   1. torsion spring
   2. bending spring

9. What is mean by stiffness?

The stiffness of the spring is defined as the load required producing unit reflection.

10. What is the formula for the stiffness of a closed coil helical spring subjected an axial load?
    Stiffness $K = Cd^4 / 64R^3 n$ N / mm.

11. Difference between closed coil and open coil helical spring.

Close- coiled helical spring	**Open- coiled helical spring**
Adjacent coil are very close to each other	Large gap between adjacent coil
Only tensile load can carry	Tensile and compressive load can carry
Helix angle is negligible	Helix angle is considerable

12. Give shear stress and deflection relation for closed coil helical spring
    Deflection, $\delta = 64WR^3n / Cd^4$
    Shear stress $\tau = 16WR / \pi d^3$
    $\delta = 4\pi R^2 n / Cd \times \tau$

13. What kind of stress induced when an axial load act on a close- coiled spring?
    Shear stress.

13. What kind of stress induce when an axial load load act on a open coiled spring?

    Bending stress and shear stress.

14. The angle of helix of the spring α, write down equation for torque and moment under an axial load 'W' at the free end.
    Torque $T = WR \cos \alpha$
    Moment, $M = WR \sin \alpha$

15. Write down the equation for shear strain energy of a close- coiled spring.
U = τ^2 /4 C x volume of the spring.

16. What is the value of maximum shear stress in a closed coil helical spring subjected to axial force W?
$\tau = 16\ W\ R / \pi d^3$

17. Write the expression for vertical deflection of a close- coiled helical spring due to vertical load W.
$\delta = 64\ WR^3n / Cd^4$

18. What are the uses of close- coiled helical spring?
Railway wagons, cycle seating, pistols, brakes.

19. What is mean by spring constant or spring index?
Spring constant is the ratio of mean diameter of the spring to the diameter of the wire.

20. What is Wahl's factor?
Wahl's factor is a factor which compensate for the direct shear stress and curvature of wire into consideration for calculating shear stress in a spring.

Wahl's factor, $K = K_x \times K_c$
K_x – stress factor due to shear
K_c – stress concentration due to curvature.

UNIT 4:

1. Where the slope and deflection will be maximum for the cantilever with point load at its free end?
Both slope and deflection will be maximum at the free end.

2. What are the units of slope and deflection?
Slope in radians
Deflection, meter or millimeter.

3. Name the method which employs BMD for the calculation of slope and deflection.
Moment area method.

4. What is the slope at a support for a SSB of constant EI and span L carrying central concentrated load?
Slope of the support $\theta_A = \theta_B = wL^2 / 16\ EI$

5. What is the advantages of Macaulays's method?

In Macaulays's method a continuous expression is formed for bending moment and it is integrayted in such a way that the constant of integration are valid for all section of the beam eventhough law of bending moment varies from section to section.

6. What is the use of momemt area method?

Moment area method is very much useful to find the deflection and slope of a beam at any particular point on the beam this method can be applied to all types loads or beams of variable cross section.

7. where does the maximum deflection occur on cantilever beam?

For cantilever beam having any load on any cross section along the length of the beam, a maximum deflection occur only at the free end of the beam.

8. State first moment- area or Mohr's I theorem.

The change of slope between any two parts on the beam is equal to the net area of the M / EI diagram between this two points.

9. State second moment- area or Mohr's II theorem.

The tangential division between two points on the elastic curve is equal to the net moment of the area of the M / EI diagram between that two points about any vertical line.

10. Define column.

Any structural member which is subjected to axial compressive load is known as column. In column the member of structure is vertical and both of its end are rigidly fixed.

11. what is buckling load?

The load at which the column just buckles is called buckling load or critical load or crippling load.

12. what is the use of Euler's formula?

Euler's formula is used for finding buckling load of long column based on the bending stress in this equation the direct compressive stress is neglected.

13. Tate two assumption made in the Euler's column theory.

1. The cross section of the column is throughout its length
2. the length of the column is very long as compared to its cross sectional dimensions.

14. what are the different end condition of the long column?

1. both end of the column are pinned
2. one end is fixed and other is free.
3. one end is fixed and other is pinned .
4. both ends of the column are fixed.

15. State slinderness ratio.

The ratio between actual length and least radius of gyration of the column is known as slinderness ratio.

Slinderness ratio = actual length / least radius of gyration.

$= L / K$

16. what is mean by effective length?

Effective length of the given column with given end condition is the length of the equivalent column of the same material and section with both end hind having the value of the critical load equal to the given column.

17. what is the advantages of Rankine's formula?

The column are neither too short nor long. The failure of the member will be due to the cobined effect of direct and bending stresses.

18. All short column fail due to ---------- whereas long column fail due to --------- and ----------

Crushing, buckling, crushing.

19. Write the Rankinr's crippling load formula?

$$P = F_d A / 1 + \alpha (L_e / k)^2$$

20. What is the crippling load when both ends of column are pinned?

$$P_{cr} = \pi^2 EI / L^2$$

UNIT 5:

1. When will you call a cylinder as thin cylinder?

A cylinder is called as a thin cylinder when the ratio of wall thickness to the diameter of the cylinder is less than 1/20.

2. In a thin cylinder will be radial stress vary over the thickness of wall.

No, in thin cylinder radial stress developed in its wall assumed to be constant since the wall thickness is very small as compared to the diameter of the cylinder.

2. In a thin cylinder maximum principle stress is ----------

Circumferential stress.

3. In a thin cylinder the maximum shear stress is ----------

$$\tau_{max} = \sigma_c - \sigma_a / 2$$

4. Differentiate between thin and thick cylinder.

Thin cylinder	Thick cylinder
Ratio of wall thickness to the diameter of the cylinder is less than 1/20.	Ratio of wall thickness the diameter of the cylinder is more than 1/ 20.
Circumferential stress is assumed to be constant throughout the wall thickness.	Circumferential stress various from inner to outer wall thickness.

5. Differentiate between cylindrical shell and spherical shell.

Cylindrical shell	Spherical shell
Circumferential stress is twice the longitudinal stress.	Only Hoop's stress is present.
It withstands low pressure thin spherical shell for the same diameter.	It withstand more pressure then cylindrical shell for the same diameter.

6. What is the effect of riveting the thin cylindrical shell?

Riveting reduces the area offering the resistance due to this the circumferential and longitudinal stresses are more. It reduces the pressure carrying capacity of the shell.

7. In thin spherical shell volumetric strain is---------- times the circumferential strain.

Three times.

8. What do you understand by the term wire winding of thin cylinder?

In order to increase the tensile strength of a thin cylinder to withstand high internal pressure without excessive increase in wall thickness they are sometimes pre stressed by winding with steel wire under tension.

9. Define principal stresses and principal plane.

Principal stresses- the magnitude of the normal stresses acting on the principal plane is known as principal stresses.

Principal plane- the plane which has no shear stress are known as principal plane.

10. On a principal plane------stress is zero.

Ans: Shear stress.

11. The angle between the principal plane and the plane of the maximum shear stress is ----------

Ans: 45^o

12. The angle between the principal planes are ----------

Ans: 90^o

13. What is the radius of Mohr's circle?

Radius of Mohr's circle is equal to the maximum shear stress.

14. What is the use of Mohr's circle?

Mohr's circle is the graphical method of determining the normal, tangential resultant stresses, principal stresses, and principal planes for the given stresses.

15. List the various theories of failure?
    1. maximum principal stress theory of Rankine theory
    2. Maximum strain theory
    3. Maximum shear stress theory
    4. Maximum strain energy theory.

16. What are the planes along which the greatest shear stresses occur?

    Greatest shear stress occurs at the plane which its inclined at 45^o to its normal.

17. In case of equal like principal stresses what is the diameter of the Mohr's circle.

    Ans: zero.

18. What is the value of maximum shear stress when the principal stresses are σ_1 compression and σ_2 tension?

    Maximum shear stress $(\sigma_{t)}) = - \sigma_1 - \sigma_2 / 2$.

19. the shear stress and the principal planes are----------

    Ans: zero.

20. Write the expression for normal stress on an inclined plane in block which is subjected to mutually perpendicular normal stresses and shear stresses?

    Normal stress $\sigma_n = (\sigma_1 + \sigma_2 / 2) + (\sigma_1 - \sigma_2 / 2) \cos 2\theta + q \sin 2\theta$