UNIT IV TORSION

1.Write down the expression for power transmitted by a shaft

$P=2\pi NT/60$

Where, N-speed in rpm

T-torque

2. Write down the expression for torque transmitted by hollow shaft

$T= (\pi/16)*Fs*((D4-d4)/d4$

Where, T-torque

q- Shear stress

D-outer diameter

d- Inner diameter

3. Write down the equation for maximum shear stress of a solid circular section in diameter 'D' when subjected to torque 'T' in a solid shaft.

$T=\pi/16 * Fs*D3$

where, T-torque

q - Shear stress

D – diameter

4. Define torsional rigidity

The torque required to introduce unit angle of twist in unit length is called torsional rigidity or stiffness of shaft.

5. What is composite shaft?

Sometimes a shaft is made up of composite section i.e. one type of shaft is sleeved over other types of shaft. At the time of sleeving, the two shafts are joined together, that the composite shaft behaves like a single shaft.

6. What is a spring?

A spring is an elastic member, which deflects, or distorts under the action of load and regains its original shape after the load is removed.

7. State any two functions of springs

1. To measure forces in spring balance, meters and engine indicators.

2. To store energy

8. What are the various types of springs?

i. Helical springs ii. Spiral springs

iii. Leaf springs Iv. Disc spring or Belleville springs

9**. Classify the helical springs.**

1. Close – coiled or tension helical spring.

2. Open –coiled or compression helical spring.

10.What is spring index (C)?

The ratio of mean or pitch diameter to the diameter of wire for the spring is called the spring index.

11**. What is solid length?**

The length of a spring under the maximum compression is called its solid length. It is the product of total number of coils and the diameter of wire.

$L_s = n_t \times d$

Where, n_t = total number of coils.

12. Define spring rate (stiffness).

The spring stiffness or spring constant is defined as the load required per unit deflection of the spring. $K = W/y$

Where , W - load

y- Deflection

13.Define pitch.

Pitch of the spring is defined as the axial distance between the adjacent coils in uncompressed state. Mathematically,

Pitch=free length n-1

14.Define helical springs. .

The helical springs are made up of a wire coiled in the form of a helix and are primarily intended for compressive or tensile load.

15.What are the differences between closed coil & open coil helical springs?

Closed coil spring

The spring wires are coiled very closely, each turn is nearly at right angles to the axis of helix . Helix angle is less (70 to 10o)

Open coil spring

The wires are coiled such that there is a gap between the two consecutive turns. Helix angle is large (>10o)

16.Write the assumptions in the theory of pure torsion.

1. The material is homogenous and isotropic.

2. The stresses are within elastic limit

3. C/S which are plane before applying twisting moment remain plane even after the application of twisting moment.

4. Radial lines remain radial even after applying torsional moment

. 5. The twist along the shaft is uniform

17.Define : Polar Modulus

Polar modulus is defined as the ratio of polar moment of inertia to extreme radial distance of the fibre from the centre.

18.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 moment or torsion moment or simply as torque. Torque is equal to the product of the force applied and the distance between the point of application of the force and the axis of the shaft.

20.What are the assumptions made in Torsion equation

The material of the shaft is homogeneous, perfectly elastic and obeys Hooke‟s law.

2 Twist is uniform along the length of the shaft

3.The stress does not exceed the limit of proportionality

4. The shaft circular in section remains circular after loading

5.Strain and deformations are small.

21.Why hollow circular shafts are preferred when compared to solid circular shafts?

• The torque transmitted by the hollow shaft is greater than the solid shaft.

• For same material, length and given torque, the weight of the hollow shaft will be less compared to solid shaft.

UNIT 4- TORSION

PART – A (2 Marks)

1. What are the assumptions made in the theory of torsion?
2. Define torsion and polar modulus?
3. Write Torsional equation.
4. Why hollow circular shafts are preferred when compared to solid circular shafts?
5. Write the expression for power transmitted by a shaft.
6. Define springs. What are the different types of springs?
7. What is leaf spring?
8. A circular shaft is subjected to a torque of 10kNm. The power transmitted by the shaft is 209.33kW. Find the speed of shaft in revolution per minute.
9. Define spring stiffness.
10. What is a stepped shaft?
11. Compare close coiled and open coiled springs under the action of an axial load.
12. What is the value of maximum shear stress in a close coiled helical spring subjected to an

axial force?

13. State the types of stresses when a closed coiled spring is subjected to (i) axial load and (ii) axial twisting moment.
14. Write the equation for strain energy stored in a shaft due to torsion.
15. What is the equivalent bending moment for a shaft subjected to moment M and torsion T?
16. A shaft is having a diameter of 30mm. What is its polar moment of inertia?
17. How will you apply a moment to produce bending in a shaft?
18. How will you apply a moment to produce torque in a shaft?
19. Write the expression for vertical deflection of the closed coiled helical spring due to axial load W.
20. What are the uses of leaf spring?

PART – B (16 Marks)

1. i) Derive the torsion equation for a circular shaft of diameter'd' subjected to torque 'T'.
   ii) Find the torque that can be transmitted by a thin tube 6 cm mean diameter and wall thickness 1 mm. the permissible shear stress is 6000 N/cm^2.

2. A close coiled helical spring is made of a round wire having 'n' turns and the mean coil radius R is 5 times the wire diameter. Show that the stiffness of the spring = 2.05 R/n. If the above spring is to support a load of 1.2kN with 120mm compression. Calculate mean radius of the coil and number of turns assuming G = 8200 N/mm^2 and permissible shear stress, $\lambda_{allowable} = 250\ N/mm^2$.

3. A steel shaft ABCD having a total length of 2400mm is contributed by three different sections as follows. The portion AB is hollow having outside and inside diameters 80mm and 50mm respectively, BC is solid and 80mm diameter. CD is also solid and 70mm in diameter. If the angle of twist is same for each section, determine the length of each portion and the total angle of twist. Maximum permissible shear stress is 50 MPa and shear modulus $0.82x10^5$ MPa.

4. It is required to design a close coiled helical spring which shall deflect 1mm under and axial load of 100N at a shear stress of 90 MPa. The spring is to be made of round wire having shear modulus of $0.8x10^5$ MPa. The mean diameter of the coil is to times that at

the coil wire. Find the diameter and length of the wire.

5. A solid circular shaft transmits 75kW power at 200rpm. Calculate the shaft diameter, if the twist in the shaft is not to exceed one degree in 2m length of shaft and shear stress is not exceed 50 N/mm^2. Assume the modulus of rigidity of the material of the shaft as 100 kN/mm^2.
6. A shaft has to transmit 110 kW at 160rpm. If the shear stress is not to exceed 65N/mm^2 and the twist in a length of 3.5m must not exceed 1o, find a suitable diameter. Take C = 8x104 N/mm^4.

7. A leaf spring 750mm long is required to carry a central load of 8kN. If the central deflection is not to exceed 20mm and the bending stress is not to be greater than 200N/mm^2. Determine the thickness, width and number of plates. Assume the width of the plates is 12 times, their thickness and modulus of elasticity of the springs material as 200kN/mm^2.
8. A closely coiled helical spring made out of a 10mm diameter steel bar has 12 complete coils, each of mean diameter of 100mm. Calculate the stress induced in the section of rod, the deflection under the pull and the amount of energy stored in the spring during the extension. It is subjected to an axial pull of 200N. Modulus of rigidity is $0.84x10^5 N/mm^2$.
9. A close coiled helical spring has a stiffness of 5N/mm. its length when fully compressed with adjacent coils touching each other is 40 cm. the modulus of rigidity of the material of the spring is $8x10^4$ N/mm^2. Determine the wire diameter and mean coil diameter if their ratio is 1/10. What is the corresponding maximum shear stress in the spring?
10. A circular shaft of 1000mm diameter and 2m length is subjected to a twisting moment which creates a shear stress of 20N/mm^2 at 30mm from the axis of the shaft. Calculate the angle of twist and the strain energy stored in the shaft. Take G=$8x10^4$ N/mm^2.