Design of Machine Elements (ME6503)

2 Marks Question with Answers
UNIT I

1. Define: Factor of safety

   The ratio between maximum stresses to working stress is known as factor of safety.

   $$\text{Factor of safety} = \frac{\text{Maximum stress}}{\text{Working stress}}$$

2. Define endurance limit.

   Endurance limit is the maximum value of completely reversed stress that the standard specimen can sustain an infinite number (10^6) of cycles without failure.

3. What is impact load?

   If the time of load application is less than one third of the lowest natural period of vibration of the part, it is called an impact load.

4. What are the various phases of design process?
   i. Recognition of need.
   ii. Definition of problem
   iii. Synthesis
   iv. Analysis and optimization
   v. Evaluation
   vi. Presentation

5. What are the different types of loads that can act on machine components?
   a. Steady load.
   b. Variable load.
   c. Shock load
   d. Impact load.

6. What are the factors affecting endurance strength.

   Factors affecting endurance strength are
   i. Load ii. Surface finish
   iii. Size iv. Temperature
   v. Impact vi. Reliability

7. What are the types of variable stresses?
   a. Completely reversed or cyclic stresses
   b. Fluctuating stresses
   c. Repeated stresses

8. Differentiate between repeated stress and reversed stress.

   Repeated stress refers to a stress varying from zero to a maximum value of same nature.

   Reversed stress of cyclic stress varies from one value of tension to the same value of compression.

9. What are the types of fracture?
   a. Ductile fracture
   b. Brittle fracture

10. Distinguish between brittle fracture and ductile fracture.

    In brittle fracture, crack growth is up to a small depth of the material. In ductile fracture large amount of plastic deformation is present to a higher depth.

11. Define stress concentration and stress concentration factor.

Stress concentration is the increase in local stresses at points of rapid change in cross section or discontinuities.

Stress concentration factor is the ratio of maximum stress at critical section to the nominal stress

12. Explain size factor in endurance strength.

Size factor is used to consider the effect of the size on endurance strength. A large size object will have more defects compared to a small one. So, endurance strength is reduced. If K is the size factor,

Actual endurance strength = Theoretical endurance limit x K

13. Explain Griffith theory. (Or) State the condition for crack growth.

A crack can propagate if the energy release rate of crack is greater than crack resistance.

14. What are the modes of fracture?
    a. Mode I (Opening mode) – Displacement is normal to crack surface.
    b. Mode II (Sliding mode) – Displacement is in the plane of the plate.
    c. Mode III (Tearing mode) – Out of plane shear.

15. What are the factors to be considered in the selection of materials for a machine element?
    i. Required material properties
    ii. Manufacturing ease
    iii. Material availability
    iv. Cost

16. What are various theories of failure?
    i. Maximum principal stress theory.
    ii. Maximum shear stress theory.
    iii. Maximum principal strain theory.

17 List out the factors involved in arriving at factor of safety
    i. material properties
    ii. nature of loads
    iii. presence of localized stresses
    iv. mode of failures

18. Give some methods of reducing stress concentration.
    i. Avoiding sharp corners.
    ii. Providing fillets.
    iii. Use of multiple holes instead of single hole
    iv. Undercutting the shoulder parts.

19. Explain notch sensitivity. State the relation between stress concentration factor, fatigue stress concentration factor and notch sensitivity.

Notch sensitivity (q) is the degree to which the theoretical effect of stress concentration is actually reached. The relation is, $K_f = 1 + q\,(K_t - 1)$

20. What are the factors that effect notch sensitivity?
    i. Material
    ii. Notch radius
    iii. Size of component
    iv. Type of loading
    v. Grain Structure

21. What is the use of Goodman & Soderberg diagrams?

They are used to solve the problems of variable stresses.

22 Define machinability

It is the property of the material, which refers to a relative case with which a material can be cut. It is measured in a number of ways such as comparing the tool life for cutting different material

23. What is an S-N Curve?

An S- N curve has fatigue stress on Y axis and number of loading cycles in *X* axis. It is used to find the fatigue stress value corresponding to a given number of cycles.

24. Define Ductility

It is the property of the material enabling it to be drawn into wire, with the application of tensile force. It must be both strong and plastic. It is usually measured in terms of percentage elongation and reduction in area. (eg) Ni, Al, Cu

25. Define fatigue

When a material is subjected to repeated stress, it fails at stresses below the yield point stress; such type of failure of the material is called fatigue.

UNIT II

1 Define the term critical speed.

The speed, at which the shaft runs so that the additional deflection of the shaft from the axis of rotation becomes infinite, is known as critical or whirling speed.

2. Factor is considered to design a shaft?
   i. strength
   ii. stiffness

3. What is key?

A key is device, which is used for connecting two machine parts for preventing relative motion of rotation with respect to each other.

4. What are the types of keys?
   i. Saddle key
   ii. Tangent key
   iii. Sunk key
   iv. Round key and taper pins
   v.

5. What is the main use of woodruff keys?

A woodruff key is used to transmit small value of torque in automotive and machine tool industries. The keyway in the shaft is milled in a curved shape whereas the key way in the hub is usually straight.

6. List the various failures occurred in sunk keys.
   1. Shear failure
   2. Crushing failure
   3.

7. What is the function of a coupling between two shafts?

Couplings are used to connect sections of long transmission shafts and to connect the shaft of a driving machine to the shaft of a driven machine.

8. Under what circumstances flexible couplings are used?

They are used to join the abutting ends of shafts when they are not in exact alignment.

They are used to permit an axial misalignment of the shafts without under absorption of the power, which the shafts are transmitting.

9. What are the purposes in machinery for which couplings are used?

1. To provide the connection of shafts of units those are manufactured separately such as motor and generator and to provide for disconnection for repairs or alterations.
2. To provide misalignment of the shafts or to introduce mechanical flexibility.
3. To reduce the transmission of shock from one shaft to another.
4. To introduce protection against over load.

10 What are the main functions of the knuckle joints?

It is used to transmit axial load from one machine element to other.

11. What is curved beam?

In curved beam the neutral axis does not coincide with the centroidal axis.

12. Give some example for curved beam.

C frame, crane hook

13. What is principle stress and principle plane?

A plane which has no shear stress is called principle plane the corresponding stress is called principle stress.

14. Write the bending equation.

$M/I = E/R = Fs/Y$.

M – Bending moment
I - Moment of intertia
E - Youngs modulus
R - Radius of the shaft
Fs – Shear stress
Y - Distance from neutral axis

15. Write the torsion equation.

$T/J = C\Ø/L = Fs/R$

T – Torque
J - Polar moment of intertia
C- Rigidity modulus
Ø – Angle of twist
L – Length of the shaft
Fs – Shear stress
R - Radius of the shaft

UNIT III

1 How is a bolt designated?

A bolt is designated by a letter M followed by nominal diameter and pitch in mm.

2. What factors influence the amount of initial tension?
   i. External load
   ii. Material used
   iii. Bolt diameter

3. What is bolt of uniform strength?

A bolt of uniform strength has equal strength at the thread and shank portion.

4. What are the ways to produce bolts of uniform strength?
   i. Reducing shank diameter equal to root diameter.
   ii. Drilling axial hole

5. What stresses act on screw fastenings?
   i. Initial stresses due to screwing up

ii. Stresses due to external forces
iii. Combined stresses.

6. What are the different applications of screwed fasteners?

The different applications of screwed fasteners are

a. For readily connecting & disconnecting machine parts with out damage
b. The parts can be rigidly connected
c. Used for transmitting power

7. What are the advantages of screwed fasteners?

The advantages of screwed fasteners are

a. They are highly reliable in operation
b. They are convenient to assemble & disassemble
c. A wide range of screws can be used for various operating conditions
d. They are relatively cheap to produce.

8. Define pitch.

Pitch is defined as the distance from appoint on one thread to the corresponding on the adjacent thread in the same axis plane.

9. Define lead.

Lead is defined as the distance, which a screw thread advances axially in one rotation of the nut.

10. What are the different types of metric thread?

1. BSW (British standard Whit worth)
2. BSE (British standard End

11. Define welding.

Welding can be defined as a process of joining two similar or dissimilar metals with or without application of pressure along with or without addition of filler material.

12. What are the types of welded joints?

i. Butt joint
ii. Lap joint
iii. T – joint
iv. Corner joint
v. Edge joint.

13. What are the two types of stresses are induced in eccentric loading of loaded joint?

1. Direct shear stress.
2. Bending or torsional shear stress.

14 Define butt and lap joint

Butt joint: The joint is made by welding the ends or edges of two plates.

Lap joint: The two plates are overlapping each other for a certain distance. Then welded. Such welding is called fillet weld.

15 When will the edge preparation need?

If the two plates to be welded have more than 6mm thickness, the edge preparation should be carried out.

16 What are the two types of fillet weld?

i. Longitudinal or parallel fillet weld
ii. Transverse fillet weld

17 State the two types of eccentric welded connections.

i. Welded connections subjected to moment in a plane of the weld.

ii. Welded connections subjected to moment in a plane normal to the plane of the weld.

18 What are the practical applications of welded joints?

It has employed in manufacturing of machine frames, automobile bodies, aircraft, and structural works.

UNIT IV

1. 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.

2. State any two functions of springs.
   i. To measure forces in spring balance, meters and engine indicators.
   ii. To store energy.

3. What are the various types of springs?
   i. Helical springs
   ii. Spiral springs
   iii. Leaf springs
   iv. Disc spring or Belleville springs

4. Classify the helical springs.
   a. Close – coiled or tension helical spring.
   b. Open –coiled or compression helical spring.

5. Define : Leaf springs

A leaf spring consists of flat bars of varying lengths clamped together and supported at both ends, thus acting as a simply supported beam.

6. Define : Belleville Springs

They are made in the form of a cone disc to carry a high compressive force. In order to improve their load carrying capacity, they may be stacked up together. The major stresses are tensile and compressive.

7. 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.

8. What is pitch?

The axial distance between adjacent coils in uncompressed state.

9. 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.

$Ls = n_t \times d$

Where, n_t = total number of coils.

10. What are the requirements of spring while designing?
    a. Spring must carry the service load without the stress exceeding the safe value.
    b. The spring rate must be satisfactory for the given application.

11 What are the end conditions of spring?
   a. Plain end.
   b. Plain and ground end
   C. Squared end
   D. Squared and ground end.

12. What is buckling of springs?

The helical compression spring behaves like a column and buckles at a comparative small load when the length of the spring is more than 4 times the mean coil diameter.

13. What is surge in springs?

The material is subjected to higher stresses, which may cause early fatigue failure. This effect is called as spring surge.

14. What is a laminated leaf spring?

In order to increase, the load carrying capacity, number of flat plates are placed and below the other.

15. What semi – elliptical leaf springs?

The spring consists of number of leaves, which are held together by U- clips. The long leaf fastened to the supported is called master leaf. Remaining leaves are called as graduated leaves.

16. What is nipping of laminated leaf spring?

Prestressing of leaf springs is obtained by a difference of radii of curvature known as nipping.

17. What are the various application of springs?

The springs are used in various applications, they are

a. Used to absorb energy or shocks (e.g. shock absorbers, buffers, e.t.c.)
b. To apply forces as in brakes clutches, spring-loaded valves, e.t.c.
c. To measure forces as in spring balances and engine indicators
d. To store energy as in watches

18. Define free length.

Free length of the spring is the length of the spring when it is free or unloaded condition. It is equal to the solid length plus the maximum deflection or compression plus clash allowance.

$$L_f = \text{solid length} + Y_{max} + 0.15\ Y_{max}$$

19. Define spring index.

Spring index (C) is defined as the ratio of the mean diameter of the coil to the diameter of the wire. C =D/d

20. 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

21. Define pitch.

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

$$\text{Pitch} = \frac{\text{free length}}{n-1}$$

22. What are the points to be taken into consideration while selecting the pitch of the spring?

The points taken into consideration of selecting the pitch of the springs are

a. The pitch of the coil should be such that if the spring is accidentally compressed the stress does not increase the yield point stress in torsion.
b. The spring should not be close up before the maximum service load is reached.

23. Define active turns.

Active turns of the spring are defined as the number of turns, which impart spring action while loaded. As load increases the no of active coils decreases.

24. Define inactive turns.

Inactive turns of the spring is defined as the number of turns which does not contribute to the spring action while loaded. As load increases number of inactive coils increases from 0.5 to 1 turn.

25. What are the different kinds of end connections for compression helical springs?

The different kinds of end connection for compression helical springs are

a. Plain ends
b. Ground ends
c. Squared ends
d. Ground & square ends

26. Write about the eccentric loading of springs?

If the load acting on the spring does not coincide with the axis of the spring, then spring is said to be have eccentric load. In eccentric loading the safe load of the spring decreases and the stiffness of the spring is also affected.

27. Explain about surge in springs?

When one end of the spring is resting on a rigid support and the other end is loaded suddenly, all the coils of spring does not deflect equally, because some time is required for the propagation of stress along the wire. Thus a wave of compression propagates to the fixed end from where it is reflected back to the deflected end this wave passes through the spring indefinitely. If the time interval between the load application and that of the wave to propagate are equal, then resonance will occur. This will result in very high stresses and cause failure. This phenomenon is called surge.

28. What are the methods used for eliminating surge in springs?

The methods used for eliminating surge are

a. By using dampers on the center coil so that the wave propagation dies out
b. By using springs having high natural frequency.

29. What are the disadvantages of using helical spring of non-circular wires?

a. The quality of the spring is not good
b. The shape of the wire does not remain constant while forming the helix. It reduces the energy absorbing capacity of the spring.
c. The stress distribution is not favorable as in circular wires. But this effect is negligible where loading is of static nature.

30 Why concentric springs are used?

a. To get greater spring force with in a given space
b. To insure the operation of a mechanism in the event of failure of one of the spring

31. What is the advantage of leaf spring over helical spring?

The advantage of leaf spring over helical spring is that the end of the spring may be guided along a definite path as it deflects to act a structural member in addition to energy absorbing device.

32. Write notes on the master leaf & graduated leaf?

The longest leaf of the spring is known as main leaf or master leaf has its ends in the form of an eye through which bolts are passed to secure the spring.

The leaf of the spring other than master leaf is called the graduated leaves.

33. What is meant by nip in leaf springs?

By giving greater radius of curvature to the full length leaves than the graduated leaves, before the leaves are assembled to form a spring thus a gap or clearance will be left between the leaves. This initial gap is called nip.

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

Closed coil helical spring	Open coil helical spring
The spring wires are coiled very closely, each turn is nearly at right angles to the axis of helix	The wires are coiled such that there is a gap between the two consecutive turns.
Helix angle is less than 10^o	Helix angle is large ($>10^o$)

UNIT - V

1. What is bearing?

Bearing is a stationery machine element which supports a rotating shafts or axles and confines its motion.

2. Classify the types of bearings.

i. Depending upon the type of load coming upon the shaft:
   a. Radial bearing
   b. Thrust bearings.

ii. Depending upon the nature of contact:
   a. Sliding contact
   b. Rolling contact bearings or Antifriction bearings.

3. What are the required properties of bearing materials?

Bearing material should have the following properties.

i. High compressive strength
ii. Low coefficient of friction
iii. High thermal conductivity
iv. High resistance to corrosion
v. Sufficient fatigue strength
vi. It should be soft with a low modulus of elasticity
vii. Bearing materials should not get weld easily to the journal material.

4. What is a journal bearing?

A journal bearing is a sliding contact bearing which gives lateral support to the rotating shaft.

5. What are the types of journal bearings depending upon the nature of contact?

1. Full journal bearing
2. Partial bearing
3. Fitted bearing.

6. What are the types of journal bearing depending upon the nature of lubrication?

1. Thick film type
2. Thin film type
3. Hydrostatic bearings
4. Hydrodynamic bearing.

7. What is known as self – acting bearing?

The pressure is created within the system due to rotation of the shaft, this type of bearing is known as self – acting bearing.

8. What is flywheel?

Flywheel is a machine elements used to minimize the fluctuation of speed in a engine.

9. What is the function of flywheel?

A flywheel used in machine serves as a reservoir which stores energy during the period when the supply of energy is more than the requirement and releases it dulling the period when the requirement of energy is more than the supply.

10. Define the term 'fluctuation of speed' and 'fluctuation of energy'.

The ratio of maximum fluctuation of speed to the mean speed is called co efficient of fluctuation of speed.

The ratio of fluctuation of energy to the mean energy is called coefficient of fluctuation of energy.

11. State the type of stresses induced in a rim flywheel?

1. Tensile stress due to centrifugal force
2. Tensile bending stress caused by the restraint of the arms and
3. The shrinkage stresses due to unequal rate of cooling of casting.

12. What are the stresses induced in flywheel arms?

1. Tensile stress due to centrifugal force.
2. Bending stress due to torque.
3. Stress due to belt tension.

13. How does the function of flywheel differ from that of governor?

A governor regulates the mean speed of an engine when there are variations in the mean loads. It automatically controls the supply of working fluid to engine with the varying load condition & keeps the mean speed with contain limits. It does not control the speed variation caused by the varying load. A flywheel does not maintain const speed.

14. What is the application of leaf spring?

The leaf springs are used in automobiles as shock absorbers for giving suspension to the automobile and it gives support to the structure.

15. Define flat spiral spring.

A flat spiral spring is a long thin strip of elastic material wound like a spiral. These springs are frequently used in watch springs, gramophones, e.t.c

16. What are the differences between helical torsion spring and tension helical springs?

Helical torsion springs are wound similar to that of tension springs but the ends are shaped to transmit torque. The primary stress in helical torsion spring is bending stress whereas in tension springs the stresses are torsional shear stresses.

17. Define helical springs.

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

18. What are the different types of helical springs?

The different types of helical springs are

a. Open coil helical spring
b Closed coil helical spring