

**2 MARKS QUESTIONS WITH ANSWER**  
**UNIT - III**  
**DESIGN OF MACHINE ELEMENTS**

**1) 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.

**2) What are the types of keys?**

Sunk key, Saddle key, Tangent key, Round key and taper pins

**3) 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.

**4) List the various failures occurred in sunk keys.**

- i). Shear failure
- ii). Crushing failure

**5) How sunk keys are provided?**

Sunk keys are provided half in the keyway of the shaft and half in the keyway of the hub or boss of the pulley.

**6) List out the various types of sunk keys.**

The various types of sunk keys are,

- a. rectangular sunk key
- b. square sunk key
- c. parallel sunk key
- d. gib head key
- e. feather key
- f. woodruff key

**7) What is a keyway?**

Keyway is a slot or recess in a shaft and hub of the pulley to accommodate a key.

**8) What is a gib head key? What is its advantage?**

- A rectangular sunk key with a head at one end is known as gib head key.
- It is usually provided to facilitate the removal of key.

**9) What is a feather key?**

- a. A key attached to one member of a pair and which permits relative axial movements is known as feather key.
- b. It is a special type of parallel key which transmit a turning moment and also permits axial movements.

**10)What is a woodruff key?**

- a. Woodruff key is a piece from a cylindrical disc having segmental cross section. A woodruff key is capable of tilting in a recess milled out in the shaft by a cutter having the same curvature as the disc from which the key is made.
- b. They are largely used in machine tools and automobile constructions.

**11)What are the advantages and dis advantages of a woodruff key?**

The advantages and dis advantages of a woodruff key are,

- a. It accommodates itself to any taper in the hub or boss of the mating piece.
- b. It is useful on tapering shaft end. Its extra depth in the shaft prevents any tendency to turn over in its keyway.

**12)What are the two types of saddle keys?**

The two types of saddle keys are,

- a. Flat saddle key
- b. Hollow saddle key

**13)What are splines?**

The keys are made integral with the shaft which fits in the keyways broached in the hub. Such shafts are known as splined shafts. These shafts usually have four, six, ten or sixteen splines. These splined shafts are relatively stronger than shaft having a single keyway.

**14)What are round keys?**

The round keys are circular in section and fit into holes drilled partly in the shaft and partly in the hub.

**15)List the advantages of splines over keys?**

The advantages of splines over keys are, splines can be used when both axial movements as well as positive drive is to obtained.

It is used when the force is to be transmitted is large in proportion to the size of the shaft as in automobile transmission and sliding gear transmission.

**16) What are the various forces acting on sunk key?**

The various forces acting on sunk key are,

- a. Force due to fit of the key in its keyway
- b. Forces due to torque transmitted by the shaft

**17) What is the effect of keyway cut into shaft?**

The keyway cut into the shaft reduces the load carrying capacity of the shaft. This is due to the stress concentration near the corners of the keyway and reduction in cross sectional area of the shaft. In other words, the torsional strength of the shaft is reduced.

**18) Write the equations for failure modes of a key?**

**Shearing of a key**

$$\text{Torque} = f \times d/2 = l \times w \times \tau \times d/2$$

**Crushing of a key**

$$\text{Torque} = f \times d/2 = l \times t/2 \times \sigma_c \times d/2$$

Where,

- a. L- Length of the key
- b. W- Width of the key
- c. t- Thickness of the key
- d. d- Diameter of the shaft
- e.  $\tau$ - Shear stress &  $\sigma_c$  - crushing stress

**19) 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.

**20) 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.

**21) What are the purposes in machinery for which couplings are used?**

- a) To provide the connection of shafts of units those are manufactured separately such as motor and generator.
- b) To provide for disconnection for repairs or alterations.
- c) To provide misalignment of the shafts or to introduce mechanical flexibility.
- d) To reduce the transmission of shock from one shaft to another.
- e) To introduce protection against over load.

**22) List out the requirements of a shaft coupling?**

The requirements of a shaft coupling are,

- a. It should be easy to connect or disconnect
- b. It should transmit the full power of the shaft
- c. It should hold the shaft in perfect alignment
- d. It should have no projecting parts

**23) What is rigid coupling? What are its types?**

Rigid coupling is used to connect two shafts which are perfectly aligned. The types are

- a) Sleeve or muff coupling
- b) Clamp or split muff or compression coupling
- c) Flange coupling

**24) What is flexible coupling? What are its types?**

Flexible coupling is a type of coupling used to connect two shafts having both lateral and angular misalignments. The types are

- a. Bushed pin type coupling
- b. Universal coupling
- c. Oldham's coupling

**25) What is a flange coupling?**

Flange coupling is a coupling having two separate cast iron flanges. Each flange is mounted on the shaft end and keyed to it. The faces are turned up at right angles to the axis of shaft. One of the flanges has a projected portion and other face has a corresponding recess. This helps to bring the shaft into line and maintain alignment.

**26) What are the different types of flange coupling?**

The different types of flange coupling are,

- a. Unprotected type flange coupling
- b. Protected type flange coupling
- c. Marine type flange coupling

**27) What is the difference between rigid and flexible coupling?**

**Rigid coupling** - It is used to connect two shafts which are perfectly aligned

**Flexible coupling** - It is used to connect two shafts having both lateral and angular misalignment.

**28) Differentiate between a cotter joint and a knuckle joint?**

- Cotter joint is used to connect two rigid rods for transmitting motion without rotation. This joint is subjected to axial forces.
- Knuckle joint is used for connecting two rods and transmitting axial force. These joint permits a small amount of flexibility.

**29) What are the main functions of the knuckle joints?**

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

**30) What is knuckle joint?**

Knuckle joint is used to connect two rods which are under the action of tensile loads.

**31) What are the various methods of failure of knuckle joint?**

The various methods of failure of knuckle joint are,

- a. Failure of solid rod in tension
- b. Failure of knuckle pin in shear
- c. Failure of single eye or rod end in shear
- d. Failure of single eye or rod end in tension
- e. Failure of forked end in shear
- f. Failure of single eye or rod end in crushing
- g. Failure of forked end in tension
- h. Failure of forked end in crushing

**32) Define shaft?**

A shaft is a rotating machine element which is used to transmit power from one place to another. It is used for the transmission of torque and bending moment.

**33) Differentiate between shaft and axle?**

An axle though similar in shape to the shaft is a stationary machine element and is used for transmission of bending moment only. It simply acts as a support for some rotating body.

**34) What is a spindle?**

A spindle is a short shaft that imparts motion either to a cutting tool or to a work piece.

**35) 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.

**36) What are the materials used for shafts?**

- a. For ordinary shaft - mild steel
- b. For high strength shafts - alloy steel such as nickel,
  - i. Ni-Cr steel and Cr-v steels

**37) What are the types of shafts and give their importance?**

**Transmission shafts** - These shafts transmit power between the source and the machine absorbing power. These shafts carry machine parts such as pulleys, gears, etc. They are subjected to bending in addition to twisting.

**Machine shafts** - These shafts form an integral part of the machine itself. The crankshaft is an example of machine shaft.

**38) What are the various types of stresses induced in the shafts?**

The various types of stresses induced in the shafts are

- a. Shear stress due to transmission of torque
- b. bending stresses
- c. stresses due to combined torsional and bending loads

**39) What are the standard sizes of transmission shafts?**

The standard size of transmission shafts are,

- a. 25 mm to 60 mm with 5 mm steps

- b. 60 mm to 110 mm with 10 mm steps
- c. 110 mm to 140 mm with 15 mm steps
- d. 140mm to 500 mm with 20 mm steps
- e. Standard length-5 m, 6 m, and 7 m.

**40) On what basis shafts are designed?**

- a. Based on rigidity and stiffness
- b. Based on strength
- c. Based on critical speed.

**41) Differentiate the hollow shaft over a solid shaft?**

The hollow shafts are used in marine work. These shafts are stronger per kg of material and they may be forged on a mandrel, thus making the material more homogeneous than a solid shaft.

**42) Give examples for shafts subjected to axial load in addition to torsion and bending loads.**

The examples are

- a. Propeller shaft of ships.
- b. Shafts for driving worm gears
- c. Main shafts of Kaplan turbine.

**43) What are the desirable properties for the material for shaft and axles?**

The desirable properties for the material for shaft and axles are

- a. Sufficient high strength
- b. A low sensitivity to stress concentration.
- c. Ability to withstand heat and case hardening treatment.
- d. Good machinability.

**44) Write the formula for equivalent torque and bending moment when the shafts are subjected to fluctuating loads.**

$$\text{Equivalent torque } T_e = \left( (K_m M)^2 + (K_t T)^2 \right)^{1/2}$$

$$\text{Equivalent bending moment } M_e = 1/2 \left[ k_m M + \left( (K_m M)^2 + (k_t T)^2 \right)^{1/2} \right]$$

Where,

$k_m$  = combined shock and fatigue factor for bending

$K_t$  = combined shock and fatigue factor for torsion.

**45)How the shafts are designed when it is subjected to twisting moment only?**

When the shaft is subjected to torque only, then it is designed based on torsion equation.

**46)Why rotating shafts are generally made with circular cross section?**

Stress distribution pattern will be uniform throughout the circular cross section

**47)Define torsional stiffness of a shaft.**

Torsional stiffness of shaft is defined as the resisting strength of a shaft to torsional load. Mathematically it can be calculated by the formula

$$T/180=GJ/l$$

**48)What are the ways of improving lateral rigidity of shafts?**

The ways of improving lateral rigidity of shafts are,

- a. Maintaining proper bearing clearances
- b. Correct gear teeth alignment.

**49)Define critical speed of a shaft.**

Rotating shaft tends to vibrate violently in transverse directions at certain speed is known as critical speed or whirling speed. When the natural frequency of vibration is equal to speed of shaft resonance will occur. Such a value of natural frequency is called critical speed or whirling speed.

**50)State any two reasons for preferring hollow shafts over solid shafts.**

The two reasons for preferring hollow shafts over solid shafts are

- a. For same weight of shaft, hollow shaft can transmit 1.5 times the torque transmitted by solid shaft.
- b. For a particular power transmission, hollow shaft requires minimum weight.