

## UNIT -1

### TRANSMISSION SYSTEMS USING FLEXIBLE ELEMENTS

#### 1. What are the factors controlling selection of a transmission drive?

The factors are,

- a) Amount of power to be transmitted
- b) Velocity ratio
- c) Service conditions
- d) Centre distance
- e) Space availability
- f) Efficiency
- g) Nature of load
- h) Cost, etc

#### 2. What are the main types of belt drives?

Flat belt drive, ribbed belt drive, round belt drive and timing belt drive are the main types of belt drives.

#### 3. What are the various types of flat belt drives?

Open belt drive, crossed belt drive, belt drive with idler pulley, quarter turn belt drive, compound belt drive, fast and loose pulley drive and stepped pulley drive are the various types of flat belt drives.

#### 4. What is slip in a flat belt drive?

When the friction grip between the pulley and belt is insufficient, the driver will have some forward motion without belt. This phenomenon is called as slip.

#### 5. What is creep in a flat belt?

Due to difference in tensions on tight and slack side, the belt undergoes a change in length as it passes around a pulley. To compensate for these different strains the belt moves relative to the surface of the pulley. This relative movement is called creep.

#### 6. Why tight side of the belt should be at the bottom side of the pulley?

If the tight side of the belt is at the bottom side of the pulley and the slack side is at the top side, then the sag caused by the self weight of the belt, for long centre distance drive will increase the arc of contact of belt with pulley and hence the effect of power transmission is increased.

#### 7. What are the different types of belt materials?

Leather, rubber, cotton and canvas, nylon, balata etc., are the different types of belt materials.

**8. What is ply in belt?** Ply in belt is one of a layer of fabrics of the belts. Belt strips called plies are cemented together so as to increase thickness and are specified according to the number of the constituent layers.

### **9. Explain crowning of pulleys.**

To keep the belt running on the face pulley, it is necessary that then face to be crowned. It is used to avoid the belt to run off sideways.

### **10. What are the factors upon which the coefficient of friction between the belt and the pulley depends?**

The factors are,

- a) Materials of the belt
- b) Slip
- c) Speed

The value of  $\mu$  varies from 0.25 to 0.3.

### **11. What is the condition to transmit maximum power in a flat belt drive?**

Maximum power transmitted is one third of maximum tensions developed as centrifugal tension.

### **12. How to calculate the design HP in flat belt drive?**

The design HP in flat belt drive is calculated as follows.

Design HP = (Rated HP \* Service factor) / (Arc of contact factor \* Diameter factor)

### **13. What are the advantages of flat belt drive?**

The advantages of flat belt drives are

- a) They are more flexible and absorb shock loads and vibration.
- b) They are relatively cheap and easy to maintain.
- c) They can be used in dusty or abrasive atmosphere
- d) The design of flat belt drive is simple and inexpensive.
- e) They can be used for long distance, even up to 15km.
- f) They are quiet and efficient.

### **14. What are the major drawbacks of a flat belt drive?**

The major drawbacks of a flat belt drive are

- a) Change in velocity ratio (due to creep and slip) during power transmission.
- b) More space requirement.
- c) Limitation on speed reduction.
- d) It is not suitable for other than horizontal position.

### **15. write the advantages of V-belt.**

The advantages of V-belts are,

- a) High velocity ratio.
- b) Possibility of employment with smaller centre distance.
- c) Reliability of drive in any position.
- d) Smoothness of operation

**16. What is the meaning of a V-belt designated as B- 2286 – IS 2494?**

B – Represents cross section

2286 – Represents its nominal length

IS2494 – Represents Indian Standard code

**17. State reasons for the V-belt drive being preferred to flat belt drives.**

According to the following reasons, the V- belt drive is preferred to flat belt drive.

- a) Replacement of V- belt is easy, because V- belts available according to the standards.
- b) Power transmitted by the V- belts is more.
- c) For smaller centre distance V- belts are suitable.
- d) Efficiency is high, when compared to flat belt.

**18. When do we prefer V-belt?**

V- belt drive is preferred, when the distance between the shafts is too short, high amount of power has to be transmitted, vertical and angular position power drive and high speed applications.

**19. What is meant by chordal action in chain drives? (Apr. 2004)**

When chain passes over a sprocket, it moves as a series of chords instead of a continuous arc in case of a belt drive. When the driving sprocket rotates at a constant speed, the driven rotates at a varying speed due to continuously varying radius of the chain line.

**20. What is slack adjuster? (Nov.2004)**

It is a movable bearing which is employed for regulating chain sag and tensions in order to get alignment. The movable bearings are in the form of slides in which the sprocket shafts are installed.

**21. Write the common types of chains.**

Roller chains, bushed chains and silent chains are the common types of chains.

**22. What are silent chains? (Apr. 2005)**

Silent chains consist of special profile plates corresponding to the profile of sprocket teeth. As the name implies they are relatively quieter in operation. Silent chains are also known as inverted toothed chains.

**23. How are chains classified?**

Chains are classified as follows.

- a) power transmitting chains
- b) Hauling chains
- c) Load or lifting chains

## 24. What are the possible failures of a chain drive?

The possible failures of a chain drive are,

- a) Extensive chain elongation
- b) Failure of joints and plates
- c) Wear of sprocket teeth
- d) Fatigue failure of links
- e) Chipping and breaking of rollers
- f) Pitting at the surface of the rollers and bushes etc

## 25. How are timing belts made?

A timing belt is made of rubberized fabric with steel wire to take the tension load. It has teeth that fit into grooves cut on the periphery of the pulleys. These belts are coated with a nylon fabric.

## 26. What are the advantages of chain drive?

The advantages of chain drive are,

No slip between chain and sprocket

- a) Efficiency of the drive is high
- b) Possibility of driving several sprockets using a single chain
- c) Drive the compact

## 27. What are the advantages of the chain drives over the belt drives?

The following are the advantages of chain drives

- a) No slip between chain and sprocket
- b) Reduced load on the shafts than in belt drives
- c) Higher efficiency
- d) They can be operated at adverse temperature and atmospheric conditions

## 28. How are chains designated?

According to BIS (IS:2403-1967) the roller chains are designated as per roller diameter and number of stands in the chains

### Example:

IS:2403-1967- represents single strand chain with roller diameter 5mm

10.0 D IS: 2403-1967 – represents double strand chain with roller diameter 12.17mm

24.0 T IS: 2403-1967 – represents triple strand chain with roller diameter 25.5 mm

## 29. How the wire ropes are designated?

The wire ropes are designated by a number,

- a) Specifying the number of strands and number of wires in each strand
- b) The wire diameter
- c) Type of construction
- d) Wire material grade

**30. What are the stresses induced in a wire rope?**

The stresses induced in a wire rope are

- a) A wire rope is generally subjected to the following stress
- b) Direct stress due to axial loads
- c) Bending stresses due to bending of rope over sheaves
- d) Stresses due to acceleration or retardation of moving masses
- e) Stresses during starting

**31. Name the different types of wire ropes. ( Apr. 2004)**

The different types of wire ropes are, regular lay and lang lay

**Regular lay ropes:**

When the wires in the strand are twisted in the opposite direction to that of the strands, the rope is said to be regular lay rope.

**Lang lay ropes:**

When the wires in the strand are twisted in the same direction to that of the strands, the rope is said to be lang lay rope.

**32. What is the meaning of wire designated 6\*12/6/1?**

6- Refers number of strands.

12/6/1 – refers the number of wires in the strand ( $12 + 6 + 1 = 19$ )(i.e. 19 wires are formed by 12 wires over 6 wires with 1 core wire).

**33. What is the effect of centre distance and diameter of pulley on the life of a belt? (Dec. 2005)**

The life of the belt is the function of centre distance between the driver and driven shafts as well the diameter of the pulleys because the shorter CD, the more often the belt will be subjected to bending stress while running around the pulleys and is damaged by antiquing. Hence longer belt will last more than shorter one.

**34. What are the various losses in the power transmission by belts? (Dec. 2005)**

The various losses in the power transmission by belts are,

- a) Slip and creep of the belt on the pulleys
- b) Windage or air resistance to the movement of belt and pulleys
- c) Bending of the belt over the pulleys
- d) Friction in the bearings of pulley

**35. What are flexible drives? Why they are called so?**

The belt, chain and rope drives are called as flexible drives. Flexible drive means that the centre distance between driver and driven can be changed conveniently during design. The power transmitting members of the drives are more flexible to take shock loads.

**36. Define law of belting.** The law of belting states that the centre of the belt approaching the pulley must be in a plane perpendicular to axis of rotation.

**37. State the effects of slip and creep on the belt drive.**

The effect of creep is small and is generally neglected. The effect of slip (power loss) at slow speed is small. But at high speeds slip produce considerable loss of power and cannot be neglected.

**38. What is centrifugal tension in a belt drive?**

When the belt runs over the pulley, some centrifugal force is created due to the belt velocity, which increases the belt tension on both tight as well as the slack side. The increase of tension due to centrifugal force is called centrifugal tension.

**39. What is centrifugal tension in a belt drive?**

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**40. What are the factors affecting the belt life?**

The belt value is very much affected by the following factors

- a) Decrease in small pulley diameter
- b) Increase in belt thickness
- c) Increase in tight side tension
- d) Too large centre distance
- e) Service and environmental conditions
- f) Fluctuation in load etc..

**41. Why is thin belt preferred instead of thick one?**

Thick belts stretch more at outer layers when move pulley. This produces high amount of cyclic stresses. To prevent excessive fatigue stress in belts, a thin wide belt is always preferred over the thicker one

**42. Discuss various stresses induced in belts.**

The belts are subjected to tensile stresses due to tension in the belt whether it is in tight side or slack side. When the Belt passes over pulley, it is subjected to bending stress. When the belt runs at high speed, in addition it also subjected to tensile runs at high speed, in addition it also subjected to tensile (Centrifugal) stress.

**43. Why is larger of the two pulleys to be placed at the bottom in a vertical drive?**

In a vertical drive the belt tension at the top of the belt on each side of the pulley is greater than the tension at the bottom, by an equal to the weight of the freely hanging belt. It is preferable to have the larger pulley at the bottom, so that an increased arc of contact may offset the loss of tension.

**44. What is the safety velocity ratio for flat belt and V- belt drive?**

The safe velocity ratio for flat drives is less than or equal to three and for V- belt drive, it is ten.

**45. State the assumption made while deciding the cross section of pulley arm.**

The cross section of each arm of the pulley is decided by assuming that a cantilever fixed at the boss of the pulley and loaded at the rim and each arm takes an equal share of the BM.

**46. What is chain drive?**

The chain drive consists of an endless chain running over two or more sprockets to transmit power. The chain consists of large number of links connected by pin joints and the sprockets are toothed wheels with a special tooth profile

**47. list the applications of the chain drives.**

Chain drives are widely used in machine tools, material handling equipments, bicycles, wood working , machinery, construction machinery, agricultural machinery, rolling mills, coal cutter etc

**48. What is limit value of angle of contact of a chain drive?**

The limiting value of angle of contact of a chain drive is not less than 120.

**49. What is backsliding in chain drives?**

Wear in the chain joints leads to an increase in pitch length of the links. This increases the chain length. Now the chain compensates for its greater length, by moving up and outward on tooth flanks and eventually out of mesh. This is known as back sliding in chain drives.

**50. Roller chains are designed to fail not in tension but by wear – Explain.**

If the chain is designed to fail in tension, then the increase in length produces backsliding which is accompanied by jerky motion and noise. This condition is undesirable for proper functioning of the chain. The failure due to wear is not sudden. So the roller chains are designed to fail by wear not by tension.

**51. When do we prefer silent chain over roller and bush chain?**

Silent chains are preferred over roller and bush chains for high speed applications, smooth and noiseless operations and for more reliable operations

**52. How is tension in chain adjusted?**

Chain tension is adjusted by moving the axis of the sprocket and

- a) Employing an adjustable idler sprockets or pulleys

**53. Why is odd number of teeth for sprocket preferred?**

In order to distribute wear evenly as all the chain links, it is the usual practice to have odd numbers of teeth on the smaller sprocket and an even number of pitches in the chain

**54. Name some applications for wire rope drive**

Wire rope drive is best suited for the applications where large amount of power is to be transmitted over a larger distances. They are extensively used in elevators, mine hoists, cranes, conveyors, hauling devices, suspension bridges, tram ways etc

## UNIT II

### SPUR GEARS AND PARALLEL AXIS HELICAL GEARS

1. What are the advantages of using non-metallic gears?

The advantages of using non –metallic gears are,

Noiseless operation.

Low weight.

Corrosion free.

Damping of shocks and vibrations.

. What are the common profiles used for gear tooth?

The common profiles used for gear tooth are,

In volute.

Cycloidal.

3. What is backlash?

Backlash is defined as the play between a mating pair of gear teeth in assembled condition. It is the amount by which the width of the tooth space exceeds the thickness of the meshing. Tooth measured on pitch circle.

4. Explain under cutting in gears?

While generating gear teeth, if there is interference of the cutter with the rotating job, then recess is cut at the root of the gear. Tooth, which is known as undercutting. This happens when the cutter extends beyond the base circle of the pinions having small number of teeth.

5. Give the requirements of gear materials?

Low cost

Easy to manufacture.

High strength.

High wear resistance.

Low coefficient of friction.

6. Compare cycloid and involutes profiles.

	INVOLUTE PROFILE	CYCLOID PROFILE
PRESSURE ANGLE	constant	
RUNNING	smooth	
MANUFACTURING	easy	
VELOCITY RATIO	Small variation in center distance does not affect velocity ratio.	Does not permit any variation in center distance.



7. What is interchangeability of gears?

In a gear drive, the ability of replacing a failed gear by a similar gear without affecting the functionality of the drive is called interchangeability of gears.

8. Define the pitch circle with reference to spur gear.

The imaginary diameter of the circle which allows pure rolling without slipping is known as pitch circle for the spur gear.

9. What are the general characteristics of spur gearing?

The general characteristics of spur gearing are,  
Transmit torque between parallel shafts.  
Teeth are parallel to axis.  
Line contact takes place during mating.  
Can be used as sliding gears in gearboxes.  
Easy to design and manufacture.

10. When do you use non-metallic gears?

For reducing noise, non-metallic gears are used. Manufacturing cost of non-metallic gears is low.

11. State the advantages of the gear drives over other type of drives.

The advantages of the gear drives" over other types of drives over other types of drives are,  
Gear drives are positive drives.  
Suitable for shorter centre distance.  
The gear drives are better than others in case of amount of power transmission and efficiency.  
Change of speed is very easy in gear drives.

12. What are the commonly used gear tooth systems?

The following four systems of gear tooth are commonly used in practice.

14.5degree composite system.

14.5degree full depth involutes system.

20 degree full depth system.

20 degree stub involutes system.

27. What are the advantages of toothed gears over other types of transmission system?

The advantages of toothed gears over other types of transmission system are,  
Drive is compact.  
High efficiency.  
Constant velocity ratio.  
Reliability in operation.

15. What are the applications's of spur gears?

The spur gears are used in sliding gearboxes, machine tools, automobiles, material handling equipments, rolling mills, marine Power plants, etc.

16. What is working depth of tooling gear tooth?

It is radial distance between the addendum and the dedendum . Circle of a gear. It is equal to the sum of addendum and duodenum.

17. What is tooth thickness of a spur gear?

It is the width of the tooth measured along the pitch circle.

18. Define seizure/scaring.

Under heavy load, the temperature of the lubricating oil rapidly rises and its viscosity falls. As a result, the oil film breaks and the teeth engage each other. Then as the gears rotate, softer particles are torn away from teeth, leaving scares and scratches on the surface.

19. How will you select the material for pinion teeth?

The teeth of pinion undergo more number of cycles than those of gear. This may cause quicker wear. The shape of pinion tooth gives lesser beam strength than that of gear tooth. Hence the material of the smaller wheel (pinion) should possess mechanical properties somewhat higher than the material of the mating gear.

20. Write the design procedure for non metallic gears.

Maximum permissible linear velocity for non-metallic gear is limited to 12 m/sec. Due to overheating, non-metallic pinions are usually run with cast iron gear. Pinion alone is designed in a gear pair with only beam strength checked. In general, for non-metallic materials  $\sigma_b = \sigma_u/n$ .

21. How will you design a gear when the material for gear and pinion are same?

If the materials for both pinion and gear are same, pinion alone is designed because pinion is weaker than gear. If different materials are used pinion is designed first and then both pinion and gear are checked.

22. What are the assumptions made in driving Lewis equation?

The assumptions are,  
Gear tooth is a cantilever with tip load.  
Only pair of teeth takes the entire load.

23. What is meant by stub tooth?

Stub tooth has shorter addendum and duodenum than the standard tooth. Hence stronger gear drive will be more compact.

37. Write the types of failures caused in a gear.

Tooth breakage.  
Surface failure.  
Abrasion.  
Seizure/scaring.  
Pitting.

23. Define transmission ratio with ratio with reference to spur gear.

Transmission of a spur gear defined as the ratio between number of teeth on a driver and number on driver.

$$\text{Transmission ratio, } i = \frac{Z_2}{Z_1}.$$

Where,

Z<sub>2</sub>- Number of teeth on driven wheel.      Z<sub>1</sub>- Number of teeth on driver on pinion.

24. What are the various materials used for the production of gears?

The materials used for production of gears are,

Metallic materials

Plain carbon steels.

Alloy steels.

Cast iron.

Bronze (Worm wheel)

Non metallic materials

Wood.

Synthetic resins.

Compressed papers.

25. State the advantages of involutes profile.

The advantages of involutes profile are,

a) It allows slight alternations in center distance of two gears without change in velocity ratio.

b) Easy to manufacture by cutting or generating.

c) The pressure angle is constant along the profile.

26. Give the applications of cycloid gears.

Cycloidal gears are used in gear pumps and blowers. Clocks and watches and in certain of instruments in case where the question of interference and strength are prime considerations.

26. Define circular pitch.

This is the distance measured on the circumference of the pitch circle from a Point of one tooth to the corresponding point on the adjacent tooth. It is denoted by  $P_c$

$$P_c = \frac{\pi D}{N}$$

Where, D – Pitch circle dia of gear.

N – Number of teeth on the gear.

27. What are the advantages of cycloidal gearing?

The advantages of cycloidal gearing are,

Cycloidal tooth is stronger than involutetooth for the same pitch, as given more root area.

Interface is inherently absent in cycloidal gearing.

27. What points must be considered while designing a gear drive?

The following points are considered for designing a gear drive.

Power to be transmitted.

Speed of the driver.

Velocity ratio.

Center distance.

28. What are favorable characteristics associated with internal gears.

The favorable characteristics associated with internal gears are,

Stronger tooth due to greater base width.

More teeth in contact.

Less sliding action and hence less wear.

Higher efficiency. Smoother operation,

29. What is suggested by Buckingham for wear load?

$$\text{Wear load, } F_w = \frac{D_p b Q W(N)}{\text{unit}}$$

$D_p$  – pitch circle diameter of pinion (mm).

$b$  - Face width of pinion (mm).

$Q$  - Velocity ratio factor.

$W$  - Load stress factor.

30. What are factors acting on helical gear?

The forces are,

Tangential forces are,

$$F_t = \frac{2T}{d}$$

Radial force,

$$F_r = F_t \tan \phi$$

Axial force,

$$F_a = F_t \tan \alpha$$

Where,

$T$  – Torque transmitted.

$d$  – Pitch circle diameter of the gear.

$\phi$  - Pressure angle in the diametric place.

$\alpha$  – Helix angle.

31. Why are the gears drives is called as positive drives?

In gear drives, no slip occurs (like in the belt drives) and no variation in velocity ratio takes place. So they are called as positive drives. In this drives has a number of projections (called teeth) on its periphery, which will fit into the corresponding recesses on the periphery of the driver (called tooth spaces).

32. What do you mean by tooth system?

A tooth system is a standard which specifies the relationships involving addendum, working depth, tooth thickness and pressure angle. The standards were planned to attain interchangeability of gears of all tooth numbers but of same pressure angle and pitch (Module).

33. What are the factors affecting strength of a gear tooth?

The factors affecting the strength of a gear tooth are strength of the material used shape and size of gear tooth, circumferential velocity, errors. In teeth profile, the amount and nature of load, etc.,

34. What are types of failures normally occur in a gear tooth?

The types of failures normally occur in a gear tooth are,  
Breakage of the tooth due to static and dynamic load.  
Surface destruction (Wear, pitting, seizure, etc.)

35. Write short notes on stress concentration in gears.

Stress concentration occurs at a place where tooth joins the bottom load and it's influenced by the fillet radius pressure angle and positions of the load on the tooth.

### UNIT- III BEVEL AND WORM GEARS

1. What is the helix angle of a herringbone gear?

The helix angle of a herringbone gear ranges from  $25^\circ$  to  $40^\circ$

2. What is the virtual number of teeth in helical gears?

Virtual number of teeth is the number of teeth on equivalent spur gear in the normal plane. The tooth profile of equivalent spur gear tooth is identical to the tooth profile of the helical gear tooth in the normal plane.

3. What is the specific feature of meter gear?

Meter gear is the special type of crown gear in which the shaft angle is  $90^\circ$  and the pitch angles of the pinion and gear are equal and each angle is equal to  $45^\circ$

4. What is the virtual number of teeth in bevel gears?

Virtual number of teeth is the number of teeth on a spur gear having radius equal to the back cone radius. The profile of the tooth in the equivalent spur gear is identical to the profile of the bevel gear tooth in the transverse plane.

5. Why the efficiency of worm gear drive is comparatively low?

Meshing of wheel teeth and worm wheel occur with sliding action. Hence, friction and heating occurs. This makes the efficiency of the power transmission low.

6. When the number of start of a worm is increased in a worm gear drive and how it affects the other parameters and the action of the drive?

When the number of start of a worm is increased in a worm gear drive it increases the efficiency of the drive. Number of teeth in a worm wheel =  $I * Z$  (Z- Number of starts, I- Velocity ratio)

7. What are hypoid gears?

The axes are non parallel and non-intersecting and the tooth are curved then it is called hypoid gears.

8. List out the different types of failures in worm gear drives.

- a) Seizure
- b) Pitting
- c) Rupture

9. What are face gears?

Spur gear pinion meshes with a ring gear having conjugate teeth cut into the face of it. The advantage is that spur gear cutters and gear shapers can be used to produce face gears.

10. What types of materials are used in worm wheels?

Normally worms are made integral with the shaft. Smaller worm wheels are made from solid blanks while larger ones are made from fabricated blanks.

11. What is correction gear? Correction of gear teeth is done to avoid undercutting when the number of teeth is below a specified limit. It is done by a correction factor 'x' or addendum modification coefficient. The gears whose teeth are corrected by a correction factor are called correction gear.

**12. What is crown gear?**

When the bevel gear connects two shafts whose axes intersect at an angle greater than a right angle and one of the bevel gears has a pitch of  $90^\circ$ , then it is known as crown gear.

**13. What is the main disadvantage of helical gear drive?**

The helical gears in drive will produce axial thrusts. The axial thrusts can be eliminated by the use of double helical gears. Both hands produce axial thrusts which are equal and opposite to each other, so they nullify each other.

**14. What is herringbone gear?**

A gear fabricated such that half of its width is cut with helix I one direction and other half of the teeth are cut in opposite direction is called herringbone gear.

**15. Define the following gears.**

A) Zero bevel gear.                      B) Hypoid gear.

- Zero bevel gears are a patented bevel gear, having curved teeth with a zero spiral angle.
- Hypoid gear is similar to spiral gear but with the axis of the pinion is offset from the axis of the gear. In hypoid gears, pitch surfaces are hyperboloids of revolution.

**16. Define back cone radius for a bevel gear.**

It is the length of the pitch of the cone. It is also called as pitch cone radius.

**17. Name the materials used for the manufacture of worm and worm wheel.**

Materials for worm- Low carbon alloy steel, medium carbon alloy steel.

Materials for worm wheel- Cast iron, tint less brass and bronze.

**18. How efficiency if worm drive can be increased?**

Worm gear efficiency can be increased by either,

- a) Increasing the lead angle
- b) Using multi start worm with small diameter
- c) Improving finish, lubrication, etc
- d) Using rigid, non- yielding worms with a smooth, ground or polished flanks

**19. What are the profiles used for worm?**

Trapezoidal profile, Arcmedian spiral profile, CAVEX, special profile designed by Brown and Bostock- Renk

**20. In which gear drive self locking is available?**

Self locking is available in worm and worm wheel. Condition for self locking is the friction angle of the surfaces in contact is greater than the lead angle of the worm.

**21. What is single enveloping and double enveloping worm?**

In the worm gear drive, to increase the length of the line of contact the wheel surface or worm surface or both is made to concave shape.

**22. Why heat dissipation is a very important aspect in design of worm gear drive?**

In most of the worm gear units, the power transmitting capacity is limited by the heat dissipation ability of the casting. Due to sliding between worm thread and worm wheel tooth a great amount of heat is generated. The generated heat has to be dissipated for proper functioning of the gear drive. So the heat dissipation is a very important factor in design of worm gear drive.

**23.** Write the advantages of helical gears over spur gears.

One primary disadvantage of spur gears is that their initial contact upon meshing is a line contact. Instantaneous line contact produces shock effect which results in reduced load capacity and noisy operation. The problem is alleviated when helical gears are used because the initial contact point which becomes a line of increasing length as contact continues.

**24.** Write the different types of bevel gears.

- a) Straight bevel
- b) Zero bevels
- c) Spiral bevel
- d) Face bevel
- e) Skew bevel
- f) Hypoid bevel

**25.** What is the mounting height of a bevel gear?

It is the distance of the back of the boss from the cone center.

**26.** Where do we use skew helical gears?

When the helical gears are based on the non-parallel, non-intersecting shafts and mesh with each other, they form a skew gearing or crossed helical gearing. These gears are used to drive cam shafts and auxiliaries on small internal combustion, feed mechanism on machine tools, distributor drive of automobile engines, etc.

**27.** What is cone distance and face angle of a bevel gear?

Cone distance is the length of the pitch cone element. It is also called as pitch cone radius.

Face angle is the angle subtended by the face of the tooth at the cone centre. The face angle is equal to the pitch angle plus addendum angle. It is denoted by  $\Phi$

**28.** What is the distance of bevel gear?

It is the length of the pitch cone element. It is also called as pitch cone radius.

**29.** Differentiate between the normal pitch and axial pitch in helical gears.

The axial pitch is the distance parallel to the axis between similar faces of adjacent teeth, whereas normal pitch is the distance between similar faces of adjacent teeth along a helix on the pitch cylinders normal to the teeth.

**30.** What are the types of failure in worm gear drives?

- a) Seizure
- b) Pitting
- c) Surface wear

**31.** What is irreversibility in worm gears and how is it obtained?

The worm drive is so designed that the gear cannot turn the worm although the worm can turn the gear. If the worm wheel is unable to drive the worm, the phenomenon is called irreversibility. It is obtained by having the friction angle or worm angle greater than the lead angle.

**32.** When do we use bevel gears? Bevel gears are used to transmit power from one shaft to another, when the two shafts intersect each other by any angle.

**33.** Give the applications of bevel gear.

Bevel gears are used in

- Rear axle drives of automobiles
- Vertical spindle of a drilling machine
- Elevating screws of cross rail of planner
- Milling & shaping machine

**34.** What are the advantages of spiral bevel gears over straight teeth bevel gears?

The advantages of the curved tooth spiral gears over the straight ones are in general the same of helical gears over spur gears, namely lesser noise, greater contact ration, gradual engagement of the mating teeth, greater load carrying capacity, lesser vibrations.

**35.** What are the advantages of hypoid gears over straight teeth bevel gears?

The advantage of hypoid gears are comparatively smoother action and possibly of extending the shafts past each other. So the bearings can be used on both sides of the gear and the pinion. This makes the drive more rigid and hence higher power can be transmitted than bevel gears.

**36.** Differentiate between spiral bevel gears and hypoid gears.

The spiral and hypoid gears are similar and most important difference being that the pinion gear set is offset above or below the gear axis.

**37.** What is the difference between angular gears and miter gears?

The bevel gears with shaft angle  $90^\circ$  are miter gears and the bevel gears with any other shaft angles are termed as angular gears.

**38.** Define the following terms for bevel gears.

- A) Pitch angle            B) Face angle

Pitch angle:

It is the angle made by the pitch line with the axis of the shaft.

Face angle:

It is the angle subtended by the face of the tooth at the cone centre.

Face angle = Pitch angle + addendum angle.

**39.** State the approximation suggested for finding the radius or equivalent spur gear of any bevel gear.

The equivalent spur gear of a straight tooth bevel gear is obtained by developing the tooth from along a back cone. The back cone is considered as the radius of equivalent spur gear at the mean face width on the pitch cone.

**40.** What are the factors decide the direction of axial thrust acting on a spiral bevel gear?

- a) Hand of the spiral
- b) Direction of rotation
- c) Whether the gear is a driver or a driven member

**41.** When do you prefer worm and worm wheel drive?

- a) In large reduction in velocity ratio is required
- b) Self locking specialty is required
- c) To connect non-intersecting perpendicular shafts



42. What are the types of bevel gears?

- Miter gears
- Angular bevel gears
- Crown gears

43. What are the types of worms?

- Cylindrical or straight worm
- Single enveloping worm
- Double enveloping worm

44. What are the losses of power in worm gear drive?

The losses in worm gear drive are friction loss and oil churning loss.

45. On what basis gear cutter is selected?

The cutter is selected on the basis of gear tooth system, module and number of teeth to be cut.

46. When will you use web and arm type construction for gears?

**Web type construction:**

Gears up to 250mm circle diameter

**Arm type construction:**

Gears having PCD more than 250mm

47. Define the term axial pitch and normal pitch in worm gearing.

Axial pitch is the distance between a point on a worm thread and corresponding point on the adjacent thread measured parallel to the axis of the worm.

Normal pitch is the distance between a point on a wheel thread and corresponding point on the adjacent thread measured perpendicular to helix.

48. What are the different criteria of deciding power to be transmitted by the worm gearing?

The power transmitting capacity of worm gearing is decided by the strength, the ability to resist wear and abrasion and the heat dissipating capacity of the drive.

49. Why dynamic loading is rarely considered in worm gear drives?

Because of sliding between the worm and worm gear teeth, the dynamic forces are not so severe as in the regular forms of worm gearing. So the dynamic loading is rarely considered in worm gear drives.

50. Differentiate between normal pitch and axial pitch in helical gears.

The axial pitch is the distance parallel to the axis between similar faces of adjacent teeth, where as normal pitch is the distance between similar faces of adjacent teeth along a helix on the pitch cylinders normal to the teeth.

## Unit IV

### DESIGN OF GEAR BOXES

1.) What are the principles to be followed to obtain optimum design in multi speed gear box?

To avoid excessively large diameter of the wheel and also to limit the pitch line velocity of the gear, the following principles are considered.

- Number of gears on the last shaft (spindle) should be minimum
- Number of gears on the shaft should not be more than 3, though in exceptional it may be 4.
- It is preferable to have  $n_{\max} > n_{\text{input}} > n_{\min}$  in all stages except in the first stage.

2.) What is dipping or splashing in speed reducer?

In low power and low speed reduction units, the gears are lubricated in an oil path by dipping or splashing. For this purpose, one of the mating gears or a ring is partly immersed in the oil contained in the reduction unit housing. In powerful and high speed reduction units, oil is pressure fed to the meshing gears using a pump.

3.) What is speed reducer?

Speed reducer is a gear mechanism with a constant speed ratio, contained in a separate casing and intended to reduce the angular speed of the output shaft as compared with that of input shaft.

4.) Write the classification of speed reducer.

The speed reducer are classified into,

- a) Type of drive: Spur helical, bevel, worm gears
- b) Number of stages: Single stage, double stage
- c) Arrangement of shafts: Horizontal vertical, parallel, co-axial, intersecting.

5. What are the 'spacers' as applied to a gear box?

Spacers are sleeve like parts used to maintain the distance between the gears and the bearing.

6. What does the ray diagram of gear box indicate?

The ray diagram (and) speed diagram or structural diagram indicates the speed of driving shaft, driven shaft and intermittent shaft and the gear ratios of various gear sets.

7. What are the main components of gear box? The main components of the gear box are

- a) Shafts are mounting gear.
- b) Bearing for supporting the shafts
- c) Proper housing to support the bearing, hold lubricants, protects the unit from dirt and dust.
- d) Spacers
- e) Oil seals

8. What are the possible arrangements to achieve 12 speeds from a gear box?

The possible arrangements to achieve 12 speeds from a gear box are,

1x2x2x3, 1x2x3x2, 1x3x2x2.

9. What is mean by tooth system?

A tooth system is a standard which specifies the relationships involving addendum, working depth, tooth thickness and pressure angle.

10. Define backlash.

The backlash is the amount by which the width of a tooth space exceeds the thickness of the engaging tooth measured on the pitch circles.

11. What is step ratio?

The ratio between the adjacent speeds in a multi speed gear box is called step ratio.

12. Why are the steps if speed arranged in the geometric progression in a machine tool gear box?

The steps of speeds of a gear box of machine tools are arranged in geometric progression because it provides,

- a) Constant loss economic cutting speed in the whole rpm range.
- b) Constant loss of productivity in the whole rpm range.
- c) Better design feature.
- d) Compact design. Etc.

13. What is ray diagram?

Ray diagram is a graphical representation of speed ratios between adjacent shafts from input shafts to output shaft. The ray diagram shows at a glance the kinematics arrangement, shaft speed at different stages and torque at various speeds. The ray diagram also gives information about number of shafts, number of gears, speed ratio and combination of gears in engagement.

14. What are the methods of lubrication in the speed reducer?

The methods of lubrications in the speed reducer are,

- a) Splash lubrication: Low power and low speed reduction units.
- b) Pressure- fed oil lubrication: Powerful and high speed reduction units.

15. Explain the saw tooth diagram and list the advantage of geometric progression.

$$\frac{n_{max}}{n_{min}} \leq 8$$

$$i_{max} = \frac{n_{max}}{n_{min}} \leq 2$$

$$i_{min} = \frac{n_{max}}{n_{min}} \leq \frac{1}{4}$$

$n_1, n_2, n_3, \dots, n_z$  constitute a geometric progression then,  $n_z/n_1 = \phi^{z-1}$ ,  $\phi$  is a progression ratio.

16. What is gear box?

A gear box is a device employed for stepped regulation of the input speed and to give required output speed or speeds. It consists of gears, shafts, levers, keys, bearings etc., are assembled in a housing.

17. What is the use of gear box in a machine tool ?

The gear box is used in a machine tool to get,

- a) Required torque and speed.
- b) Multi speed in more number of steps.
- c) Change in the direction of rotation.

18. Give the application of the speed reducer.

The speed reducer are used in turbine generators, between motor and machine tools, in rolling mills, between engine and road wheels in automobile and in many industrial processing like cement factories, paper – plants, chemical industries etc.

19. What is geometric progression ratio in a gear transmission?

If the speed steps in a gear box are arranged in a manner to have the ratio at adjacent speeds in constants, then the progression ratio (step ratio) is called geometric progression ratio ( $\phi$ )

$$N_2 = N_1 \times \phi \quad \text{and} \quad N_3 = N_2 \times \phi$$

Where  $N_1$  = First step rpm,  $N_2, N_3$  – Adjacent rpm,  $\phi$ - geometric progression ratio.

20. Distinguish between structural diagram and ray (speed) diagram

The structural diagram show the general arrangement of the gear transmission but ray diagram gives the gear arrangement for the required output speed.

21. What are the various components required for the automobile speed reducer?

Cashing shafts, lay shafts, splined shaft, bearings, gears keys, spacers are the various components required for the automobile speed reducers.

22. Explain the term “progression ratio” referring to the gear box.

To provide required cutting rod and feed rate in machine tools, consider the speeds in geometric series.

Let,  $N_{\min}$  = Minimum speed

$N_{\max}$  = Maximum speed

Z = Number of speeds required

Then  $[N_{\max}/N_{\min}] = \phi^{(z-1)}$

Where  $\phi$  – step ratio or progression ratio. The standard progression ratios are available according to preferred series.

**23.** Write the structural formula for gear box design.

The structural formula for gear box design is given by

$$Z = P_1(X_1) P_2(X_2) P_3(X_3) P_4(X_4)$$

$$\text{Where } X_1=1, X_2= P_1, X_3= P_1P_2$$

$$X_4= P_1P_2 P_3$$

**24.** What is the formula for % derivation?

The formula for % derivation is given by,

$$\% \text{ derivation} = \frac{(n_{obt} - n_e)}{n_e} \times 100$$

$n_{obt}$  – Obtainable speed rpm

$n_e$  – calculated speed rpm

**25.** Give some examples for speed raisers.

Some example for speed raisers are automobile gear box, machine tool gear box, blower and radial compressor.

**26.** Classify speed reducers.

Speed reducers are classified as follows.

- a) Number of reductions
- b) Arrangement of shafts
- c) Type of gears
- d) Gear train arrangement
- e) Geared motor speed reducer
- f) Variable (multi speed) speed reducers.

**27.** What are the steps of speed arranged in geometric progression in machine tool gear box?

The steps of speeds arranged in geometric progression in a machine tool gear box are,

- a) Constant loss of economic cutting speed in whole rpm range
- b) Constant loss of productivity in the whole rpm range
- c) Better design feature
- d) Compact design etc.

**28.** Why is geometric progression suited for better design of a gear box? When we use geometric progression for speed steps, all the rpm values are obtained by single transmission i.e., by changing gears between two shafts. A particular step of speed is obtained by engaging different pairs of gears between shafts by shifting the levers, keys or clutches. This gives easy, convenient and economically feasible speed changing. The above design is possible only if the rpm values life in a geometric progression.

**29.** What are the minimum information required to design a stepped gear box?

The minimum information required to design a stepped gear box are,

- a) The highest output rpm ( $N_{max}$ )
- b) The lowest output rpm ( $N_{min}$ )
- c) The number of steps ( $Z$ ) between  $N_{min}$  and  $N_{max}$
- d) The number of stages in which  $Z$  speed steps to be achieved.
- e) The input speed or speeds.

**32** How is the best structural diagram selected?

By considering the following factors,

- Transmission ratio restriction  $i_g < 8$  or equal to 8,
- Minimum total shaft size .
- The number of gears in the last shaft should be minimum.
- Speed reduction should be maximum possible in the last stage.
- Number of gears on a shaft should not more than three, in exception case it may be four

**33.** What are the general requirements for a gear transmission for gear transmission to perform properly?

The general requirements for a gear transmission to perform properly are,

- The number of teeth on smallest gear should be such that there is no undercutting (i.e.  $Z_{min} \geq 17$  for  $20^\circ FDI$ )
- If the gear pairs on parallel shaft have same module, then sum of the number of teeth on mating gear pairs must be same
- The spacing between adjacent gears on a shaft should be such that one gear pair gets completely disengaged before the next begins to engage.
- The number of teeth of adjacent gear must differ by at least four.

**34)** How can the size of gear box be reduced?

The radial dimensions can be reduced by making coincidence of the axes of shaft of adjacent group. Also maintaining  $(i_{max}/i_{min})=1$  helps to reduce radial dimension .axial dimensions are generally reduced by arranging single transmissions between groups and by using link gears.

**35)** What are link gears in gears in gear box?

The gears which act as driving members in one transmission group and driven in another transmission group in a gear box is called link gears. These link gears are used to reduce the axial dimensions of the gear box.

**36) What is the characteristic of a transmission group?**

The characteristic of a transmission group denotes the number of steps of spindle in rpm in a geometric progression ratio, by which two adjacent rpm values of the particular transmission group are separated.

**37) What are the necessities to limit the transmission ratio?**

The necessities to limit the transmission ratio are,

- Space limitations
- Number of teeth on gear
- Pitch line velocity

**38) What is the composite layout of a gear box?**

A gear box size can be reduced by using composite gearing. A drive with only one gear which has a dual function of being driven as well as driver is called single composite gearing .whereas a drive with two dual function gears is called double composite gearing .

**39) What are the steps involved in a gear box design?**

The steps involved are,

- Design of the power to be transmitted and the velocity ratio
- Design of shafts
- Selection of rolling contact bearings or design of sliding bearings
- Design of casing with all details
- Providing bearing covers

**40) What are the reasons for power loss in gear box?**

The reasons for power loss in a gear box are,

- Friction in teeth arrangement
- Friction in bearings
- Splashing of lubricant oil.

**41) What are the main components of gear box?**

The gear box consist of casing, shafts, bearing, gears, keys, spacers, levers, oil level indicator, heat dissipating fins etc

**42) What are purposes served by the housing in a gear box?**

The housing for a gear box serves the following purposes,

- They are act as a reservoir for the lubricant give necessary cooling
- Surface to dissipate heat provide necessary support to the shafts
- Protect the gears from dust, moisture, etc.

## UNIT V

### DESIGN OF POWER SCREWS, CLUTCHES AND BRAKES

#### 1) What is the meant by positive clutch?

A clutch which transmits power from the driving shaft to the driven shaft by means of jaws or teeth is called positive clutch. jaw clutch are superior to friction clutches in that they ensure exact contact (without slipping) ,produce equality in angular velocities of the connected shafts.

#### 2) Why cone clutches better than disc clutches?

Since cone discs are having large frictional areas and wedging action, they can transmit a larger torque than disc clutches with same outside diameter and actuating force and hence cone clutches are preferred to disc clutches .but usually cone clutches are mainly used in low peripheral speed applications .

#### 3) Give the essential three elements in internal shoe rim clutch.

It consist essentially of three elements

- The mating frictional surface.
- The means of transmitting the torque to and from the surface.
- The actuating mechanism

#### 4) How clutches are classified?

Clutches are classified into

- Expanding-ring
- Centrifugal
- Magnetic
- Hydraulic
- Pneumatic

#### 5) Define expanding ring clutch.

The expanding ring clutch is often used in textile machinery, escalators and machine tools where the clutch may be located within the driving pulley. Expanding ring clutches benefit from centrifugal effects .Transmits high torque, even at low speed and require both positive engagements and sample release force.

#### 6) Define centrifugal force.

The centrifugal clutch is used mostly for automatic operation .if no spring is used the torque transmitted is proportional to the square of the speed .this is particularly useful for electric motor drives where during starting the driven machine comes upto speed without shock.

#### 7) What are the functions of friction clutch?

The flow of mechanical power is controlled by means of clutch. The clutch is a mechanical device which is used to connect or disconnect the source of power from the remaining parts of power transmission system at the will of the operator.



**8) What are the different characteristics of clutch?**

The different characteristics of clutch are

- They do not slip
- No heat is generated
- They cannot be engaged at high speeds
- Sometimes they cannot be engaged when both shafts are at rest
- Engagement at any speed is accompanied by shock

**9) Classify clutches based on the coupling methods (NOV 2004)**

Based on the coupling methods, clutches are classified as follows.

- Positive
- Over running
- Friction
- Magnetic
- Fluid coupling

**10) What is the difference between a coupling and clutch? (APR.2004)**

Clutch is the coupling that permits the smooth connection and disconnection of two shafts during rotation at the operators will. Coupling is the rigid connection between two shafts for power transmission.

**11) Distinguish difference between a wet and dry operation of clutches (APR.2004)**

Dry clutch: Friction and torque capacity are high ,but heat dissipation is more difficult .

Wet clutch To dissipate the heat, a lubricant is provided .this reduces the  $\mu$  and torque carrying capacity.

**12) Name four materials used for lining of friction surfaces in clutches (APR.2005)**

The four materials used for lining of friction surface in clutches are,

- Organic materials like leather, wood, cork or felt in conjugation with cast iron, steel or brass.
- Metals like nodular iron, stainless steel,monel metal and aluminium
- Materials like asbestos, moulded or woven with metal chips of brass or copper.

**13) Define brakes.**

A brake is defined as a mechanical device which is used to absorb the energy possessed by a moving system or mechanism by means of friction .the primary purpose of the brake is to slow down or completely stop the motion of a moving system ,such as a rotating drum, machine or vehicle.

**14) List out five important characteristics of the brake lining.**

The five important characteristics of the brake lining are,

- High coefficient of friction
- Low wear rate
- High heat resistance ,high heat dissipation capacity
- Adequate mechanical strength

**15) What are the materials used for brake lining?**

Cast iron on cast iron ,bronze on cast iron ,steel on cast iron ,wood on cast iron are the materials used for brake lining.

**16) List the classification of the mechanical brake.**

The mechanical brake are classified as follows

- Block brake
- Internal/external shoe brake
- Disc brake
- Band brake

**17) Define braking torque.**

The braking torque depends upon the amount of energy absorbed by the brake. That is a mechanism system of mass  $m$  moving with velocity  $v_1$  is allowed down to velocity  $v_2$ .

**18) Define internal expanding brake.**

It consists of a shoe which is pivoted at one end and subjected to an acting force  $p$  at the other end .a friction lining is fixed on the shoe and the complete assembly of shoe lining and pivot is placed inside the brake system.

**19) What is fade? (NOV2004)**

The coefficient of friction gradually rises , reaches a peak value and falls rapidly as drum temperature is increased .This rapid fall is known as fade

**20) Explain the desirable properties of friction material used for the lining of brake shoes (APR.2004)**

Desirable properties of friction material,

- Should have high coefficient of friction
- Should retain braking capacity at temperature up to 300 Celsius
- Should have high heat conductivity

**21. Why in automobile, braking action when travelling in reverse is not as effective as when moving forward? (Apr.2004)**

If the movement due to friction force aids the application of brake, the brake is known as self-energizing. If the direction of rotation of the drum is reversed, friction force would oppose the application of brake. That's why braking action when travelling in reverse is not as effective as moving forward.

**22. Why should the temperature rise be kept within the permissible range in brakes? (Apr.2004) or define thermal considerations of a brake.**

The energy absorbed by the brake is converted into heat, which increases the temperature at the rubbing surfaces, when the temperature increases the co-efficient of friction decreases adversely affecting the torque capacity of the brake. So the temperature rise should be kept within the permissible range in brake.

**23. Define cone clutches?**

A cone clutch consists of inner and outer conical working surface. The outer cone is keyed to the driving shaft while the inner cone is free to slide axially on the driven shaft due to splines.

**24. What are the desirable properties of friction material to be used for clutches (Dec 2005)?**

The desirable properties of friction of material to be used for clutches are;

a) A high and uniform co-efficient of friction. b) The ability to withstand high temperatures together with good heat conductivity.c) Good resiliency.

d) High resistance to wear, scoring and galling.

e) Resistance against environmental conditions such as moisture , salt water and fungi.

f) Adequate mechanical and thermal strengths.

**25. What is meant by a self-energizing brake?**

When the moment of applied force ( $f.I$ ) and the moment of the frictional force ( $\mu.R_n .C$ ) are in the same direction, the frictional force helps in applying the brake. This type of brakes is known as self engineering brake.

**26. What is a cam?**

Cam is a mechanical member having miscellaneous contour surface which transmit a desired motion to follower by direct contact. With help of cam, it is very easy, accurate and efficient to produce a motion with required velocity and acceleration.

**27. Why are cam mechanisms preferred?**

The cam mechanisms are preferred over other types because the use of cam makes it possible to obtain an unlimited variety of motions and the cams perform satisfactorily year after year. The mechanical movements from cams are not readily obtained by other types of mechanisms.

**28. Define the following terms of a cam: a) Trace point b) Stroke**

Trace point - This is a reference point on the follower which is used in the laying out the theoretical curve or pitch curve of the cam.

Stroke -This is the maximum movement of the follower away from the cam shaft from its initial position. This also known rise or lift or throw of the cam.

**29. Define the following:a) Pitch point b) Jerk**

Pitch point It is the point on the cam pitch curve having the highest pressure angle.

Jerk or pulse The instantaneous time rate of change of acceleration is called as jerk or pulse ( i.e., sudden changes in follower acceleration.)

**30. What are the fundamental laws of a cam design?**

Any cam design for operation at other than very low speed must be designed with following consideration:

a) The cam function must continuous through the first and second derivatives of displacement across the entire interval of  $360^{\circ}$ .

b) The jerk function must be finite across the entire interval of  $360^{\circ}$  (i.e., the displacement, velocity and acceleration functions must have no discontinuity in them.)

**31. What is meant by plate cam and cylindrical cam?**

Plate cams - Cam are in the forms of plates with its edges having desired contour.

Cylindrical cams - Cams are cylindrical in shape having a groove cut along the cylindrical surface to direct the movement of the follower.

**32. What is meant by displacement diagram?**

Displacement diagram is a graphical representation of series follower displacement during rotation of the cam through one cycle of input motion. In such diagram, the abscissa represents one cycle of input motion (one revolution) and the ordinate represents the follower travel.

**33. Compare flat, knife and roller follower.**

Knife-edge follower is subjected to excessive wear due to sliding motion. If the load on the follower is small, this follower can be used. The roller follower has rolling contact, so wear is less. The roller and knife-edge follower guides are subjected to side thrust. The flat-faced follower as no side thrust.

**34. What are the parameters influenced the cam size?**

The cam size depends upon, a) Pressure angle b) Curvature of the cam profile and c) Diameter of the cam shaft.

For same pressure angle, the cam size depends on the type of follower motion.

**35. What are the commonly used cam-follower motions?**

The commonly used cam-follower motions are

- a) Constant velocity motion
- b) Simple harmonic motion
- c) Double harmonic motion
- d) Parabolic motion.
- e) Cycloidal motion
- f) Cubic curve motion, etc...

**36. Why is the uniform velocity follower motion not suitable for high speed cams?**

In a high speed cam mechanism, the uniform velocity follower motion generates undesirable forces and vibrations. So it is not suitable for high speed cams.

**37.** What is the advantage of having parabolic motion for follower over harmonic motion?

Parabolic motion for follower is advantageous over simple harmonic motion because at high speed, the SHM has vibratory disturbances at the beginning and end of the stroke due to sudden inertia forces.

**38.** Which type of follower motion is best and why?

The cycloidal motion of the follower provides the best possible follower motion for high speed operations. Because the acceleration curve is a sine curve and it became abrupt only if the curve is adjacent to dwell period. Even the abruptness is not severe compare to other type of motions.

**39.** What is pressure angle of a cam?

It is the angle between normal to cam profile and line of action of cam follower at the point of contact. The pressure angle represents steepness of the cam profile. The pressure angle is limited to  $30^{\circ}$  for smooth follower action.

**40.** What is the importance of pressure angle in cam design?

The size of the angle is important because,

- a) Increasing pressure angle increases the side thrust and this increase the forces exerted on cam and follower
- b) If the pressure angle is too large, jamming of follower takes place.
- c) Reducing the pressure angle increases the cam size.

**41.** What is the maximum limit of pressure angle?

The general, the maximum pressure angle should be  $30^{\circ}$  or less for a translating roller follower and  $45^{\circ}$  or less for a oscillating roller follower.

**42.** What are the main factors influencing cam forces?

The main factors influencing cam factors are displacement of follower, cam speed; dynamic forces due to backlash and flexibility, linkage dimensions, pressure angle, frictional forces and spring forces.

**43.** What are the types of failures in cams?

Cam often fails due to wear or surface fatigue action. Due to rolling and sliding or combination of both the wear and fatigue failure occur in cams.

**44.** How can surface stresses be reduced by redesign of cam?

The surface stresses can be reduced through redesign of cam by,

- a) Increasing the cam size.
- b) Changing to an offset or swinging follower.
- c) Reducing the cam speed.
- d) Increasing the cam rise angle.
- e) Increasing the thickness of the cam.
- f) Using more suitable cam curve or modifying the curve at critical points.

**45.** What are the parameters required to design a plate cam?

To design a plate cam with reciprocating follower, the geometric parameters required are,

- a) Prime circle radius.
- b) Minimum width of the follower face and
- c) Offset of the follower face.

**46.** When does the interference occur in cams?

The interference is occurred in the cams when the radius of roller is too large or when the cam profile is too sharp. Interference usually occurs in cams fitted with flat followers.

**47.** What is the influence of profile errors in the cam operation?

During cam manufacturing several surfaces imperfections may occur, such as profile errors, waviness and roughness. These surface irregularities may induce shock, noise, wear and vibrations to the cam and follower systems.

**48.** Define pitch curve of a cam.

The pitch curve of a cam is the locus generated by trace points as the follower moves relative to the cam. For a knife edge follower the pitch curve and the cam profile are same. For a roller follower cam they are separated by the radius of roller.

**49.** What is a clutch and why it is necessary?

A clutch is a machine used to connect a driving member with drive member. The clutch is required for the following:

- a) To connect and disconnect at with, without stopping.
- b) To avoid overloading of the driving member.

**50.** What are the different friction linings used in the clutches?

The following friction linings are commonly used in clutches.

- a) Woven.
- b) Asbestos lining.
- c) Moulded asbestos pads, sintered metal pads, etc.

**51.** How the power is transmitted by clutches?

In clutches, power transmission is achieved through interlocking, friction and wedging.

**52.** Differentiate clutches with flange couplings.

Flange coupling are used as permanent connecting elements, whereas clutches are used as temporary connecting elements and hence periodical engagement is possible in clutches connection.

Flange couplings are having less number of parts such as flanges, bolts, keys etc., whereas the clutches consists comparatively of large number of parts such as friction discs, springs, bolts, keys, supporting plates and so on.