# 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  $n_{max} > n_{input} > n_{min}$  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.

 $\frac{nmax}{nmin} \le 8$   $imax = \frac{nmax}{nmin} \le 2$   $imin = \frac{nmax}{nmin} \le \frac{1}{4}$   $n_1, n_2, n_3....n_z \text{ constitute a geometric progression then, } n_z/n1 = \emptyset^{z-1}, \emptyset \text{ is a progression ratio.}$ 

#### **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 ( $\phi$ )

 $N_2 = N_1 x$  and  $N_3 = N_2 x$ 

## Where N<sub>1</sub> = First step rpm, N<sub>2</sub>, N<sub>3</sub> – Adjacent rpm, ø- 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

$$Z = P_1(X_1) P2(X_2) P3(X_3) P4(X_4)$$
  
Where X<sub>1</sub>=1,X2= P<sub>1</sub>, X<sub>3=</sub>P<sub>1</sub>P<sub>2</sub>  
X<sub>4</sub>=P<sub>1</sub>P<sub>2</sub>P<sub>3</sub>

24. What is the formula for % derivation?

The formula for % derivation is given by,

% derivation = 
$$\frac{(nobt - n2)}{ne} \times 100$$

 $n_{obt}$  – 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.  $z_{min}$  17 for 20°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 limitationsNumber of teeth on gearPitch line velocity38) 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.