



## QUESTION BANK

Name of the Department : Mechanical Engineering

Subject Code & Name : ME8593 / Design of machine elements

Year & Semester : III & V

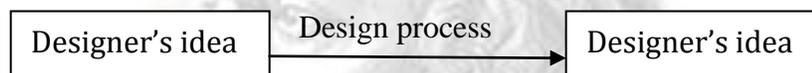
### UNIT – I: STEADY STRESSES AND VARIABLE STRESSES IN MACHINE

#### MEMBERS

#### **PART -A**

1. Define design. Nov / Dec 2016

Design is a process of activities to gather all the information necessary to realize the designer's idea as real product.



2. 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

3. List some factors that influence machine design.

- (i) Strength and stiffness
- (ii) Surface finish and tolerance
- (iii) Manufacturability
- (iv) Economic and aesthetics
- (iv) Working atmosphere
- (v) Safety and reliability cost

4. Define optimization?

Optimization is the process of maximizing a desired quantity or minimizing the unwanted one.

5. What are the various optimization methods available?

- (i) Optimization by evaluation
- (ii) Optimization by intuition



- (iii) Optimization by trial & error
  - (iv) Optimization by numerical algorithm
6. Describe material properties hardness, stiffness and resilience. NOV/DEC 17  
Hardness is the ability of material to resist scratching and indentation Stiffness is the ability of material to resist deformation under loading. Resilience is the ability of material to resist absorb energy and to resist shock and impact load.
7. What is an impact load? Give examples. Nov /dec 2015.  
If the time load application is less than one third of the lowest natural period of vibration of the part, the load is called an impact load.  
Example: Punching presses, hammers, loads exerted on cams during the motion due to eccentricity, loads imposed on gear teeth due to irregular tooth profile.
8. Define principal plane and principal stresses?  
A plane where only normal stresses act, with no shear stress acting is called principal plane. The (normal) stress acting on this plane is called principal stresses.
9. Define factor of safety? Nov / dec 2015  
The ratio between maximum stresses to working stress is known as factor of safety.  
Factor of safety =  $\frac{\text{Maximum stress}}{\text{working stress}}$
10. What are the factors to be considered in the selection of material for a machine element?  
a. Required material properties b. Manufacturing ease  
c. Material availability d. Cost
11. Why normal stress theory is not suitable for ductile materials?  
Ductile materials mostly fail by shearing. But this theory considers only tensile or compressive stresses. So this is not suitable for ductile materials.
12. State the various methods of finding stresses concentration factors?  
a. Photo elasticity method                      b. Grid method  
c. Brittle coating method                      d. Strain gauge method  
e. Finite element techniques
13. Give some methods of reducing stress concentration?  
a. Avoiding sharp corners                      b. Providing fillets  
c. Use of multiple holes instead of single holes
14. What are the factors that affect notch sensitivity? NOV/DEC 17



- a. Materials
- b. Notch radius
- c. Size of component
- d. Type of loading
- e. Grain Structure

15. What are the types of variable stresses?

- a. Completely reverse or cyclic stresses
- b. Fluctuating stresses
- c. Repeated stresses
- d. Alternating stresses

16. What are the various theories of failure?

- a. Maximum principal stress theory
- b. Maximum shear stress theory
- c. Maximum principal strain theory
- d. Maximum strain energy theory

17. 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,

$$\text{Actual endurance strength} = \text{theoretical endurance limit} \times K$$

18. What are the methods used to improve fatigue strength?

- (i) Cold working like shot peening, burnishing
- (ii) Heat treatments like induction hardening
- (iii) Pre stressing

19. What is an S-N curve? Nov/dec 2016

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.

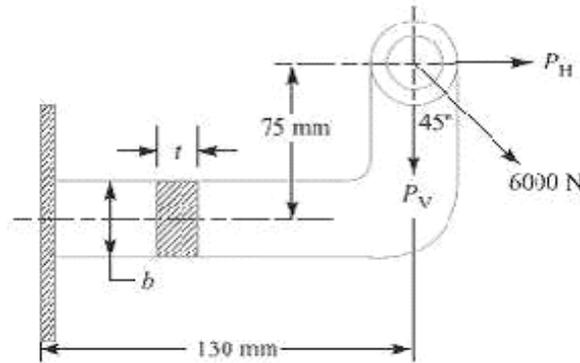
20. What is low and high cycle fatigue?

Fatigue within  $10^3$  cycles is known as low cycle fatigue. Fatigue at high number cycles is called high cycle fatigue.

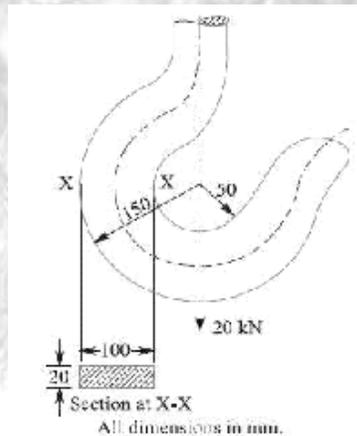
## PART -B

1. A mild steel bracket as shown in fig. is subjected to a pull of 6000N acting at 45° to its horizontal axis. The bracket has a rectangular section whose depth is twice the thickness.

Find the cross sectional dimensions of the bracket, if the permissible stress in the material of the bracket is limited to 60MPa.



2. The crank hook carries a load of 20 kN as shown in FIG. This section at X-X is rectangular whose horizontal side is 100mm. Find the stresses in the inner and outer fibers at the given section



3. (i) A shaft transmits 20 kW power and rotates at 500 rpm. The material of shaft is 50C4 and the factor of safety is 2

a. Determine the diameter of the shaft on the basis of its shear strength.

b. Determine the diameter of the shaft on the basis of its torsional rigidity, if the permissible angle of twist 30 per meter length and the modulus of rigidity of shaft material is 79300 N/mm<sup>2</sup>

(ii) A bolt is subjected to a direct load of 25kN and the shear load of 15kN. Considering the various theories of failure, Determine the suitable size of the bolt, If the material of the bolt is C15 having 200N/mm<sup>2</sup> yield strength.

4. A bar of circular cross section is subjected to alternating tensile forces varying from a minimum of 200kN to a maximum of 500kN. It is to be manufactured of material with an ultimate tensile strength of 900Mpa and an endurance limit of 700Mpa. Determine the diameter



of bar using safety factors of 3.5 related to ultimate tensile strength and 4 related to endurance limit and stress concentration factor of 1.65 for a fatigue load. Use Goodman straight line as basis for design. **Nov /dec 2015**

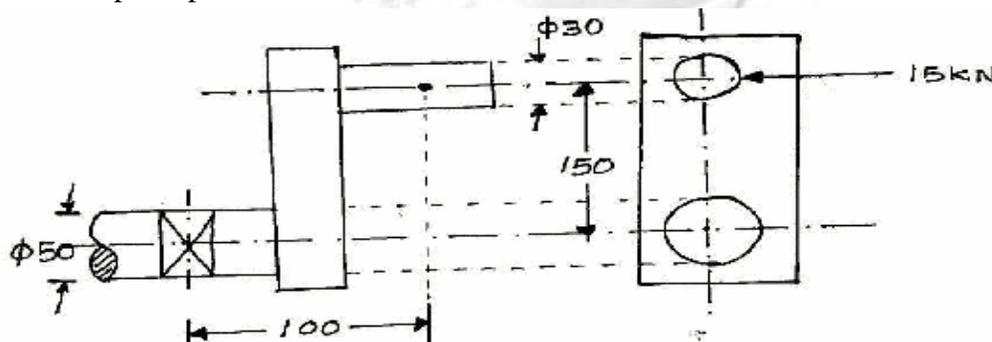
5. A hollow shaft is required to transmit 600KW at 110rpm, the maximum torque being 20% greater than the mean. The shear stress is not to exceed 63Mpa and twist in a length of 3 meter not to exceed 1.4 degrees. Find the external diameter of the shaft, if the internal diameter to the external diameter is 3/8. Take modulus of rigidity as 84Gpa.

6. A simply supported beam has concentrated load at the center which fluctuates a value from P to 4P. The span of the beam is 500mm and its cross section is circular with a diameter of 60mm. Beam material is cold drawn 0.2% carbon steel. Calculate the maximum permissible value of P for a factor of safety of 1.3.

7. A medium force fit on a 50mm shaft requires a hole tolerance of 0.25mm and a shaft tolerance of 0.016mm. The maximum interference is to be 0.042mm. How will you dimension the hole and shaft, if hole deviation is H?

8. A circular bar of 500mmlength is supported freely at its two ends. It is acted upon by a central concentrated cyclic load having a minimum value of 20KN and a maximum value of 50KN. Determine the diameter of bar by taking a factor of safety of 1.5, size effect of 0.85, surface finish factor of 0.9. The material properties of bar are given by, ultimate strength of 650MPa, yield strength of 500MPa and endurance strength of 350MPa.

9. A crank shaft bearing is loaded as shown in fig. determine the maximum principal stress, minimum principal stress and maximum shear stress.



10. A machine component is subjected to a flexible stress which fluctuates between +300 MN/m<sup>2</sup>. determine the value of minimum ultimate strength according to 1) gerber relation, 2) modified goodman relation and 3) soderberg relation.

Take yield strength = 0.55 ultimate strength, endurance strength = 0.5 ultimate strength , and FOS = 2. **Nov/dec 2017.**



## UNIT II SHAFTS AND COUPLINGS

### **PART -A**

1. What is a shaft?

A shaft is a rotating machine element, which transmits power from one point to another point.

2. What are the types of shaft?

- line shaft
- spindle stub shaft
- Counter shaft

3. What are the types of rigidity?

- Torsional rigidity
- Lateral rigidity

4. Why a hollow shaft has greater strength and stiffness than solid shaft of equal weight?

Stresses are maximum at the outer surface of a shaft. A hollow shaft has almost all the material concentrated at the outer circumference and so has a better strength and stiffness for equal weight.

5. What is the significance of slenderness ratio in shaft design?

If slenderness ratio is increased the shaft deviates from its “stub” behavior and it is essential to consider buckling while designing the shaft.

6. Define the term critical speed? Nov / dec 2016

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 speed

7. What is a key?

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

8. What are the types of key? NOV/DEC 17

- Saddle key
- Tangent key
- Sunk key
- Round key
- taper pins.



9. 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.

10. What types of stress are developed in the key?

Shear stress and crushing stress

11. Classify crankshafts.

Single throw crankshafts

Multi throw crankshafts

12. What are functions of crankshafts?

Crankshafts are used to convert rotary motion into reciprocating motion.

13. What are the materials used for crankshafts?

For I C engine or mild steel and automobile.

14. What is coupling?

The elements which join two shafts are coupling. It is used to connect sections of long transmissions shaft to the shaft of a driving machine. 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.

15. 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.

16. Under what circumstances flexible couplings are used? NOV/DEC 17

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

17. Where are flexible couplings used?

- Vehicle
- Stationery
- machinery
- Automotive drives
- Machine tools

18. What is the material used for flange or flange coupling?

- Cast iron



19. What is the advantage of gear coupling?

- Gear coupling is a grid coupling with some flexibility because of using curved external teeth.
- Strength of gear coupling is very high.
- Most compact coupling for high power transmission.

## PART – B

1. Design a bushed-pin type of flexible coupling to connect a pump shaft to a motor shaft transmitting 32KW at 960rpm. The overall torque is 20 percent more than means torque. The material properties are as follow;
  - a. The allowable shear and crushing stress for shaft and key material is 40Mpa and 80MPa respectively.
  - b. The allowable shear stress form C.I is 15MPa.
  - c. The allowable bearing pressure for rubber bush is 0.8N/mm<sup>2</sup>.
  - d. The material of pin is same that of shaft and key.

Draw neat sketch of the coupling.

2. Design a cast iron flange coupling for a mild steel shaft transmitting 90 kW at 250rpm. The allowable shear stress in engine shaft is 40mpa and the angle of twist is not to exceed 1° in a length of 20 diameters. The allowable shear stress in coupling bolts is 30Mpa.
3. Design a protective type of cast iron flange coupling for a steel shaft transmitting 15 kW at 200 rpm and having an allowable shear stress of 40N/mm<sup>2</sup>. The working stress in the bolt should not exceed 30N/mm<sup>2</sup>. Assume that the same material is used for shaft and key. That the crushing stress is twice the value of its shear stress. The maximum torque is 25% greater than the full load torque. The shear stress for cast iron is 14N/mm<sup>2</sup>. **nov/dec 2016**
4. Two 35mm shafts are connected by a flanged coupling. The flanges are fitted with 6 bolts on 125mm bolt circle. The shafts transmit a torque of 800Nm at 350rpm. For the safe stresses mentioned below, calculate
  1. Diameter of bolts
  2. Thickness of flanges
  3. Key dimensions
  4. Hub length and
  5. Power transmittedSafe shear stress for shaft material = 63Mpa  
Safe stress for bolt material = 56Mpa  
Safe stress for cast iron coupling = 10Mpa  
Safe stress for key material = 46Mpa
5. A transmission shaft is supported on the two bearing 450mm apart. Two pulleys C & Dare located on the shaft at distances of 100mm and 300mm respectively to the right of



the left hand bearing. Power is transmitted from pulley C to D. The diameter and weight of pulley C are 200mm & 600N and those of pulley D are 300mm & 750N. Ratio of belt tensions is 2 for both the pulleys. Power to be transmitted by the shaft is 25kW at 300rpm. The drive from C is vertically downwards while from D the drive is upward at an angle of 45 degree to the horizontal. The shaft is made of C45 steel. The shock and fatigue factor for tension and bending are 1.2 & 1.5. **Nov/dec 2017**

6. A Shaft is supported on bearing A & B 800mm between centers. A 20 degree spur gear having 600mm pitch diameter is located 200mm to the right of the left hand bearing A and 700mm diameter pulley is mounted 250mm towards left of the bearing B. The gear is driven by a pinion with a downward tangential force while the pulley drives a horizontal belt having 180 degree wrap angle. The pulley also serves as a flywheel and weight 2000N. The maximum belt tension is 3000N and tension ratio is 3:1. Shear stress is 40 N/mm<sup>2</sup>
7. A mild steel shaft transmits 23kW at 200 rpm. It carries a central load of 900N and is simply supported between the bearings 2.5 m apart. Determine the size of the shaft, if allowable shear stress is 42MPa and the maximum tensile or compressive stress is not exceed 56MPa. What size of the shaft will be required, if it is subjected to gradually applied loads?
8. A shaft made of AISI 1030 cold drawn steel ( $\sigma_u = 520$  MPa and  $\sigma_y = 440$  MPa) transmits 50 KW at 900 rpm through a gear. Select an appropriate square key for the gear. **nov/dec 2017.**

### UNIT III

#### TEMPORARY AND PERMANENT JOINTS

#### **PART -A**

1. What are the purposes of screws? Nov / dec 2016

To secure members

To transmit power

2. What is a stud?

A stud is a bolt in which the head is replaced by a threaded end. It passes through one of the parts to be connected and is crewed into the other part.

3. How is bolt designated?

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



4. How is a bolt designated? Give example.

A thread is designated with Letter M followed by Nominal diameter in mm and Pitch in mm [for fine pitches only]  $Md \times p$

If coarse pitches are used then P value is omitted. Thus  $M20 \times 2.5$  means, Nominal diameter is 20mm, 2.5mm pitch, fine thread.

$M20$  means, 20mm nominal diameter with coarse threads.

5. What is the meaning of bolt  $M24 \times 2$ ?

Bolt nominal diameter,  $d=24\text{mm}$  and bolt pitch,  $p=2\text{mm}$

6. State the advantages of threaded joints?

- High clamping
- Small tightening force requirement
- Easy manufacturing
- Simple design

7. Define the term self locking of power screws?

If the friction angle is greater than helix angle of the power screw, the torque required to lower the load will be positive, indicating that an effort is applied to lower the load. This type of screw is known as self locking screw. The efficiency of the self locking screw is less than 50%.

8. 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.

9. Why are welded joints preferred over riveted joints? NOV/DEC 17

Material is saved in welded joints and hence the machine element will be light if welded joints are used instead of riveted joints. Leak proof joints can be easily obtained by welded joints compared riveted joints.

10. How is welding classified?

1. Forge welding
2. Electric resistance welding
3. Fusion welding

11. What are the types of welded joints?

1. Butt joints
2. Lap joints
3. T joints
4. Corner joints
5. Edge joints



12. Define butt and lap joint?

1. Butt joint is made by welding the ends or edges of two plates.
2. Lap joint is made by two plates are overlapping each other for a certain distance. Then welded. Such welding is called fillet weld.

13. Define Tee joint and corner joint?

T joint: the two plates are arranged in shape which means the plates are located at right angles to each other.

Corner weld: Two plates are arranged at right angles such that it forms an angle.

14. 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.

15. What is the minimum size for fillet weld? If the required weld size from strength consideration is too small how will you fulfill the condition of minimum weld size?

It is defined as the minimum size of the weld for a given thickness of the thinner part joined or plate to avoid cold cracking by escaping the rapid cooling.

16. When will the weld deposit be weaker?

When the components are made of high carbon steel or alloy steel, the weld becomes weaker.

17. What is a rivet?

A rivet is a round bar provided with a head on one side and a tail on the other side.

18. Name the possible modes of failure of riveting joint.

1. Crushing of rivets
2. Shear of rivets
3. Tearing of the plate at the edge
4. Tearing of the plate between rivets.

19. Define circumferential joint.

The ends of the plates are joined to the required length of the shell and to close its ends.

20. What is known as proof load in bolts? NOV/DEC 17.

Proof load is defined as the maximum tensile force that can be applied to a bolt that will not result in plastic deformation. In other words, the material must remain in its elastic region when loaded up to its proof load. Proof load is typically between 85-95% of the yield strength.

21. What is preloading of bolts? Nov / dec 2015.

Preload is the tension created in a fastener when it is tightened. This tensile force in the bolt creates a compressive force in the bolted joint known as clamp force. For practical purposes,

the clamp force in an unloaded bolted joint is assumed to be equal and opposite of the preload.

22. State the advantages of welded joints. Nov /dec 2015

In welding filler plates, gusseted plates, connecting angles etc, are not used, which leads to reduced overall weight of the structure. Welded joints are more economical as less labor and less material is required. The efficiency of welded joint is more than that of the riveted joint.

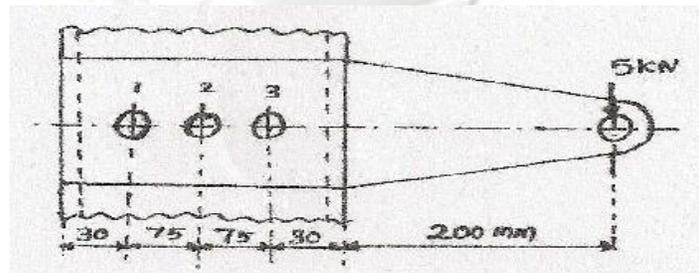
### PART – B

1. The cylinder head of a steam engine with 250mm bore is fastened by eight stud bolts made of 30C8 steel. Maximum pressure inside the cylinder is 1MPa. Determine the bolt size and approximate tightening torque. Take 20% over load. Assume  $y=300\text{MPa}$ . (16)

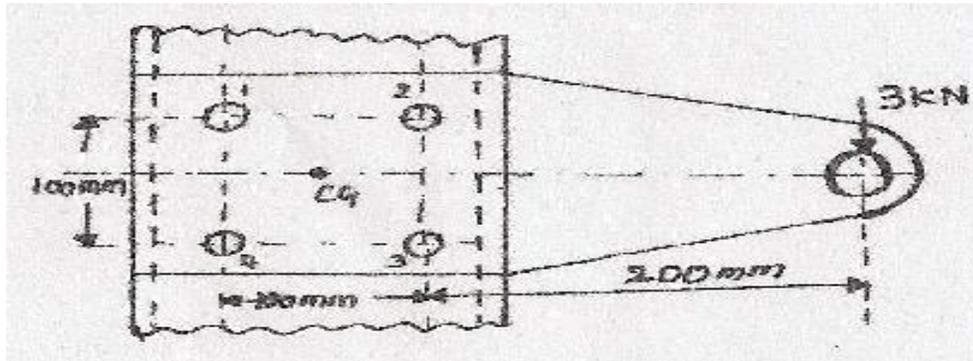
2. A steam of effective diameter 300mm is subjected to a steam pressure of  $1.5\text{N/mm}^2$ . The cylinder head is connected by 8 bolts having yield point 330MPa and endurance limit at 240MPa. The bolts are tightened with an initial per load 1.5 times the steam load. A soft copper gasket is used to make the joint leak proof. Assuming a factor of safety 2, find engine size of bolt required. The stiffness factor for copper gasket may be taken as 0.5. (16)

3. A steam engine cylinder has an effective diameter of 350mm and the maximum steam pressure acting on the cylinder cover is  $1.25\text{N/mm}^2$ . Calculate the number and the size of studs are required to fix the cylinder cover. Assume the permissible stress in the stud  $70\text{N/mm}^2$ . (16)

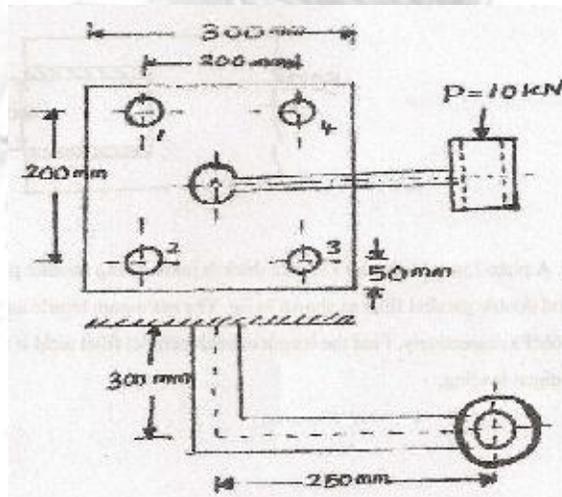
4. Find the suitable bolt for the application shown in fig. (16) **nov/dec 2017.**



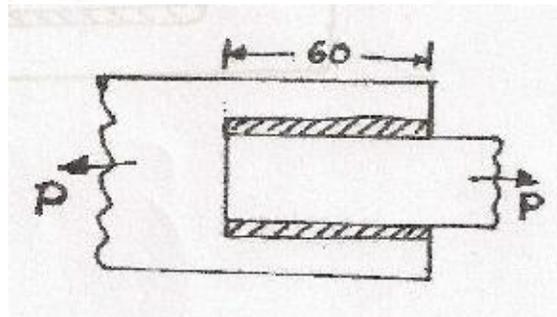
5. A steel plate subjected to a force 3KN and fixed to a vertical channel by means of four identical bolts is shown in fig. The bolts are made of plain carbon steel 45C8 ( $S_{yt}=380\text{N/mm}^2$ ) and the factor of safety is 2. Determine the nominal diameter of the bolt. (16)



6. A rigid steel bracket subjected to a vertical force of 10 kN is shown in fig. It is fastened to a vertical sanction by means of four identical bolts. Determine the size of the bolts by maximum shear stress theory. The maximum permissible shear stress in any bolts is limited to 50 N/mm<sup>2</sup>.



7. A plate 60 mm and 10 mm thick is weld to another plate by two parallel fillet welds as shown in fig. Determine the shaft load that the weld joint can carry. The allowable working stress in shear for the weld material is 75 N/mm<sup>2</sup>. (16 nov /dec 2015)





## UNIT IV ENERGY STORING ELEMENT

### PART -A

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. What are the applications of spring?
  - (i) Automobiles
  - (ii) Railway wagons.
  - (iii) Valves and
  - (iv) Watches
3. State any two functions of springs. Nov / dec 2016
  - (i) To measure forces in spring balance meters and engine indicators
  - (ii) To store energy
4. What are the various types of springs?
  - i. Helical spring
  - ii. Leaf spring
  - iii. Spiral springs
  - iv. Disc spring or Belleville springs
5. Classify the springs.
  - (i) Close coiled or tension helical spring
  - (ii) Open coil or compression helical spring
6. How will you find whether the given helical spring is a compression spring or tension spring?  
Ends of compression springs are flat whereas for tension springs hooks will be provided at the ends. Coil will be slightly open to compression in a compression spring whereas in tension spring coil are very close.
7. What are conical springs?  
It is made of round wire wound in the shape of cone.
8. What is spring index?  
The ratio of mean or pitch diameter to the diameter of the wire for the spring is called spring index.
9. What are active coils?



Those coils which are free to deflect under load called active coil.

10. What are the end conditions of the spring?

- i. Plain end
- ii. Plain and ground end
- iii. Squared end
- iv. Squared and ground end.

11. What is fly wheel?

Fly wheel is a machine element used to minimize the fluctuation of speed in an engine.

12. What is the function of the fly wheel? NOV/DEC 17, Nov / dec 2016

A fly wheel used in machine service as reservoir which stores energy during the period when the supply of energy is more than the requirement and releases it during the period when the requirement of energy is more than the supply.

13. What is the application of flywheel?

In some cases the power is supplied at uniform rate. While the requirement of power from the driven machinery is variable. Eg: punching press driven by the electric motor, rolling mill driven by an electric motor. In this case the flywheel store energy during the idle portion of the work cycle by increasing its speed and delivers this energy. During the peak load period of punching.

14. State any two type of flywheel.

- i. Disc type
- ii. Web type.

15. What is flywheel effect?

The mass moment of inertia required for the fly wheel is termed as flywheel effect.

16. Define coefficient of fluctuation of speed in the case of flywheel?

Coefficient of fluctuation of speed is the ratio of maximum change of speed to mean speed of the flywheel.

17. Define the term fluctuation of energy.

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

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

- i. Tensile stress due to centrifugal force
- ii. Tensile bending stress caused by restraint of the arms and
- iii. The shrinkage stresses due to unequal rate of cooling of casting.



19. What are the stresses induced in flywheels arms?

- i. Tensile stress due to centrifugal force
- ii. Bending stress due to torque
- iii. Stress due to belt tension

20. 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 and keeps the mean speed within the limits. It does not control the speed variation caused by the varying load. A flywheel does not maintain constant speed.

21. What is nipping of leaf spring? Nov / dec 2015.

Extra full-length leaf and the graduated-length leaf before the assembly are called a nip. Such pre-stressing, achieved by a difference in radii of curvature, is known as nipping. Nipping is common in automobile suspension springs.

## PART – B

1. A single cylinder double acting steam engine delivers 185kW at 100rpm. The maximum fluctuation of energy per revolution is 15% of energy developed per revolution. The speed variation limited to 1% either way from the mean. The mean diameter of the rim is 2.4m. Design a cast iron flywheel for the engine. (**Apr 01, Dec 07, Nov 08**)

2. Design a CI flywheel for a four stroke engine developing 150kW at 200rpm. Calculate the mean diameter of the flywheel if hoop stress is not to exceed 4MPa. Total fluctuation of speed is to be 4% of mean speed. Work done during power stroke is 1.5 times average work done during the cycle. Density of CI is 7200 kg/m<sup>3</sup>. (**Nov 03**)

3. A multi cylinder engine is to run at a constant load at a speed of 500rpm on drawing the crank effort diagram to seek of 1cm = 2500Nm and 1cm = 600, the area above and below the mean torque line were measured and found to be in order +1.60, -1.72, +1.68, -1.91, +1.97 and -1.62. If the speed is to be kept within limits of  $\pm 1\%$  of the mean speed, design the suitable type of flywheel. (**Dec 06 & Apr 09**)

4. The turning moment diagram of a multi cylinder engine is drawn with a scale of (1mm = 1°) on the abscissa and (1mm = 250N-m) on the ordinate. The intercepted areas between the torque developed by the engine and mean resisting torque of the machine, taken in order from one end are -350, +800, -600, +900, -550, +450 and -650mm<sup>2</sup>. The engine is running at a mean speed of 750rpm and the coefficient of speed fluctuation is limited to 0.02. a rimmed flywheel made of grey cast iron, whose density is 7100 kg/m<sup>3</sup> is provided. The



spokes, hub and shaft are assumed to contribute 10% of the required moment of inertia. The rim has rectangular cross section and the ratio of width to thickness is 1.5. Determine the dimensions of rim. (Nov 09)

5. A punching press pierces 30 holes per minute in a plate 12k N-m of energy per hole during each revolution. Each piercing takes 35% of the time needed to make one revolution. The punch receives power through a gear reduction until which in turn is fed by a motor driven belt pulley 750mm diameter and turning at 250rpm. Find the power of the electric motor if overall efficiency of the transmission unit is 80%. Design a cast iron flywheel to be used with the punching machine for a coefficient of fluctuation of speed is 0.05, if the space consideration limits the maximum diameter to 1.3m. Allowable shear stress in the shaft material = 48MPa, Allowable tensile stress for cast iron = 5 MPa Density of Cast iron = 7200 kg/m<sup>3</sup> **Apr 08, nov/dec 2017**

6. A spring loaded safety valve for a boiler is required to blow-off at a pressure of 1.5 N/mm<sup>2</sup>. The diameter of the valve is 60mm. Design a suitable compression spring for the safety valve, assuming spring index to be 6, and 25mm initial compression. The maximum lift of the valve is 15mm. The shear stress in the spring material is to be limited to 450MPa. Assume the valve of  $G = 0.84 \times 10^5$  MPa. (Nov 04)

7. A semi- elliptic leaf spring is of 1m long and is required to resist a load of 50kN. The spring has 15 leaves, of which three are full length leaves. The width of central band is 100mm. All the leaves are to be stressed to 420MPa. The ratio of total depth to width is 3. Take  $E = 2.1 \times 10^5$  MPa. Determine (i) The thickness and width of the leaves. (ii) The initial gap that should be provided between the full length and gradual leaves before assembly. (iii) The load exerted on the band for the assembly. (Nov 04)

8. A locomotive spring has an overall length of 1.1m and load of 75kN at its centre. The spring has 3 full- length leaves and 15 graduated leaves with central band 100mm wide. All leaves are to be stressed to 420 N/mm<sup>2</sup> when fully loaded. The ratio of the spring depth to width is to be approx is 2. take  $E = 2.1 \times 10^5$  N/mm<sup>2</sup>. Determine (i) Width and thickness of the leaves (ii) The initial space that should be provided between the full length and graduated leaves before the band load is applied. (iii) What load is exerted on the band after the spring is assembled?

## UNIT V

### BEARINGS AND MISCELLANEOUS ELEMENTS

#### **PART -A**

1. What is bearing?

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



2. State the components of rolling contact bearings?
  1. Outer race
  2. Inner race
  3. Rolling element
  4. Retaining cage
3. Classify the roller bearings?
  1. Cylinder roller bearings
  2. Needle roller bearing
  3. Taper roller bearing
4. List any four advantages to rolling contact bearings over sliding contact bearings?
  1. Starting friction is low
  2. Lubrication is simple
  3. It requires less axial space and more diametric space
  4. Heavier loads and higher speeds are permissible
5. State the advantages of thrust ball bearing?
  1. High initial cost
  2. Less capacity to withstand shock
  3. Noisy operation at very high speed
  4. Life is finite
  5. Design of bearing housing is complicated
6. What is load rating?

The load carrying capacity of a rolling element bearing is called load rating.
7. Explain the term Dynamic load carrying capacities of rolling contact bearing?

Dynamic load rating is defined as the radial load in radial bearings that can be carried for a minimum life of one million revolutions.
8. List any six types of bearing materials?
  1. Lead base babbitt
  2. Tin base babbitt
  3. Leaded bronze
  4. Copper lead alloy
  5. Gun metal
  6. Phosphor bronze



9. What is the advantage of Teflon which is used for bearings?

Teflon has high fatigue strength, hardness and more resistant to abrasive.

10. What is journal bearing? Nov / dec 2015.

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

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

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

12. 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

13. What is known as self acting bearing?

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

14. What are seals? What are the main types of seals?

Seals and gaskets are elements used to control or prevent leakage from a controlled environment.

Types are static seals, dynamic seals

15. How is "O" ring designated?

An "O" ring is designated as "internal diameter  $\times$  thickness"

16. What is a connecting rod?

Connecting rod is a machine member, which used to transmit power from a reciprocating member to rotary one or vice versa.

17. What are materials used for connecting rod?

Mild steel and alloy of aluminum for light duty. Alloy steels of molybdenum and chromium are used for heavy duty.

18. What are the stresses set up in an IC engine connecting rod?

1. Tensile stress
2. Compressive stress
3. Bending stress due to inertia force.



19. What type of external forces act on connecting rod?

The external forces acting on connecting rod are

1. Forces due to gas or steam pressure and inertia of reciprocating parts
2. Inertia forces.

20. Why I- section is chosen for the connecting rod? Nov / dec 2015.

The "I" section of the connecting rod is used due to its lightness and to keep the inertia forces as low as possible. It can also withstand high gas pressure.

23. What type of bearings can take axial load ? NOV/DEC 17

Foot step bearing

24. List the advantages of hydrostatic bearings. NOV/DEC 17

1. Hydrostatic and Aerostatic spindles have similar theoretical rotational accuracy.
2. The overwhelming advantage of oil hydrostatic bearings is their extremely high damping ratio.
3. Damping Ratio is extremely important when hard and brittle materials are machined, regardless of process (grinding, turning, or milling).

25. Classify the types of bearing. Nov / dec 2016

1. Based on the type of load acting on the shaft
  - a. Radial bearing
  - b. Thrust bearing
2. Based on the nature of contact
  - a. Sliding contact bearing
  - b. Rolling contact bearing or antifriction bearing

26. Define reliability of bearing. Nov / dec 2016

Predicted bearing life is a statistical quantity in that it refers to a bearing population and a given degree of reliability. The basic rating life is associated with 90% reliability of bearings built by modern manufacturing methods from high-quality materials and operated under normal conditions.

## PART – B

1. Design a journal bearing for the centrifugal pump from the following data. Load on the journal=20KN, speed of the journal =900 rpm. Type of oil is SAE 10 for which the absolute viscosity at 55<sup>0</sup>C=0.017kg/m-s, Ambient temperature of oil is 15.5<sup>0</sup>C, Maximum bearing pressure for the artificial cooling, if the rise of temperature of oil be limited 10<sup>0</sup>C.Heat dissipation coefficient=1232W/m<sup>2</sup>/<sup>0</sup>C. **nov/dec 2016.**

2. A punching machine takes 25 working strokes per minute and is capable of punching 25mm diameter holes in 18mm thick steel plates having ultimate shear strength of 300MPa. The punching operation takes place during 1/10<sup>th</sup> of revolution of the crank shaft. Estimate the power needed for the driving motor, assuming the mechanical efficiency of 95%. Determine the



suitable dimension for the rim cross-section of the fly wheel, which is to rotate at 9 times the speed. The permissible coefficient of fluctuation of speed is 0.1. The diameter of the fly wheel must not exceed 1.4m owing to space restrictions. Check for the centrifugal stress induced in the rim.

3. A bearing for an axial flow compressor is to carry a radial load of 2500N and thrust of 1500N. The service imposes light shock and the bearing will be in use for 40 hours/week for 5 years. The speed of the shaft is 1000rpm. Select the suitable ball bearing for the purpose and give the required tolerances on the shaft and housing. Diameter of the shaft is 50mm.

4. Design a journal bearing for a centrifugal pump with the following data. Diameter of the journal = 150mm, Load on bearing = 40kN, Speed of journal = 900rpm.

5. Select a suitable deep groove ball bearing for supporting a radial load of 10kN and an axial load of 3kN for a life of 4000hrs at 800rpm. Select from series 63. Calculate the expected life of the selected bearing.

6. Design a mild steel connecting rod with an I-section for a single cylinder IC engine from the following data: Diameter of the piston = 0.104m, Weight of reciprocating parts = 18.2 N, Length of connecting rod –center to center = 0.314m, Stroke length = 0.14m, speed of the engine = 1500rpm, maximum explosion pressure = 2.28MPa. Assume that the maximum thrust takes place at TDC during the explosion stroke. Assume also any missing data sketch the connecting rod.

7. Design a journal bearing for a 49.9 mm dia journal. It is ground and hardened and is rotating at 1500 rpm in a bearing of diameter and length 50mm. the inlet temperature of oil 65°C. Determine a) maximum radial load that the journal can carry b) power loss. **Nov/Dec 2017**

8. A deep groove ball bearing no.6308 selected for a particular application, carries a radial load of 2900 N and a thrust load of 1800 N ; both being steady. The inner race of the bearing rotates at 900 rpm. The bearing is required to have a minimum life of 9000 hours. Check whether the bearing selected can serve the purpose. **Nov/Dec 2017**