



# ST. ANNE'S COLLEGE OF ENGINEERING AND TECHNOLOGY

(Approved by AICTE, New Delhi. Affiliated to Anna University, Chennai)

Accredited by NAAC

ANGUCHETTYPALAYAM, PANRUTI – 607 106

## ME 3591 DESIGN OF MACHINE ELEMENTS

### UNIT-1

#### 1. What are the steps in machine design process? ( AU NOV/DEC 2006)

- Recognition of need.
- Definition of problem
- Synthesis
- Analysis and optimization
- Evaluation
- Presentation

#### 2. Enumerate the most commonly used engineering materials and state at least one important property and one application of each? (AU APR 2009, NOV 2009, & DEC 2013)

Mechanical property	Some materials which have this property	Typical areas of application
Strength	Plain carbon steel	Machine tool spindles shafts, bolts
Hardness	Alloy steel	Gears, chain sprockets bearing
Ductility	Steel, Copper, Aluminum	Thin wires, rods
Toughness	Titanium	Aircraft parts, machine tools.

#### 3. For Ductile material, which of the strength is considered for designing a

##### A. Component subjected to static loading (AU APR/MAY 2008)

##### B. Component subjected to fatigue loading

- For component subjected to static loading yield strength is considered.
- For component subjected to fatigue loading endurance strength is considered.

#### 4. Write Soderberg equation for a machine component subjected to

##### A. Combination of mean and variable torques (AU NOV / DEC 2010)

##### B. Combination of mean and variable bending moments.

$$\tau_{sq} = \frac{\tau_y}{n} = \tau_m + K_y \cdot \frac{\tau_a - \tau_y}{\tau_{-1}}$$
$$\sigma_{sq} = \frac{\sigma_y}{n} = \sigma_m + K_f \cdot \frac{\sigma_a - \sigma_y}{\sigma_{-1}}$$



## ST. ANNE'S COLLEGE OF ENGINEERING AND TECHNOLOGY

(Approved by AICTE, New Delhi. Affiliated to Anna University, Chennai)

Accredited by NAAC

ANGUCHETTYPALAYAM, PANRUTI – 607 106

### ME 3591 DESIGN OF MACHINE ELEMENTS

#### 5. What is Gerber Theory? (AU NOV/ DEC 2009)

Gerber parabola joins endurance stress and ultimate stress (like Goodman line). According to Gerber method, the relationship between  $\sigma_m$ ,  $\sigma_a$ ,  $\sigma_u$ ,  $\sigma_{-1}$  is given by,

$$\sigma_a = \sigma_{-1} \left[ 1 - \left( \frac{\sigma_m}{\sigma_u} \right)^2 \right]$$

From the equation itself it is evident that the relationship is of parabolic nature.

#### 6. What are unilateral and bilateral tolerances? (AU APR / MAY 2013)

- A unilateral tolerance is tolerance in which variation is permitted only in one direction from the specified direction. e.g. 1800+0.000/-0.060.
- Bilateral tolerance is tolerance in which variation is permitted in both directions from the specified direction. e.g. 1800  $\begin{matrix} +0.060 \\ -0.060 \end{matrix}$

#### 7. What are fits and tolerances? (AU NOV/DEC 2010)

- Fits is the degree of tightness or looseness between the two mating parts
- Tolerance is the difference between the upper limit and lower limit of a dimension. In other words, it is the maximum permissible variation in a dimension.

#### 8. Define stress concentration and stress concentration factor. (APR/MAY 2009, MAY 2012 & MAY 2014)

- Stress concentration is the increase in local stresses at points of rapid change in cross section or discontinuities.
- Stress concentration factor is the ratio of maximum stress at critical section to the nominal stress.

#### 9. Define 'mechanical property' of an engineering material. State any four mechanical properties give their definitions and one example of the material possessing the properties. (APR/MAY 2012, 2009, NOV/ DEC 2009 & DEC 2013, 2014)

Mechanical property is a property that involves a relationship between stress and strain or a reaction to an applied force.

- Hardness is the ability of material to resist abrasion and indentation on its surface. (e.g., alloy steel)
- Strength is the ability of material to bear the applied load without failure. (plain carbon steel)
- Toughness is the ability of material to resist shock loads. (e.g. Titanium)
- Ductility is the property of material which enables it to be drawn into thin wires. (e.g., steel)

#### 10. What are the methods to reduce stress concentration? (AU NOV 2008)

- Avoiding sharp corners
- Providing fillets
- Use of multiple holes instead of single hole
- Undercutting the shoulder parts.

#### 11. Write short notes on the following: (AU NOV/DEC 2010)

Interchange ability- It means that parts which go into assembly may be selected at random from a large number of parts.

Tolerance- Tolerance is the difference between maximum limit and minimum limit.

Allowance- Allowance is the difference between the basic sizes of the mating parts. It is usually referred to the maximum material condition of the mating parts (hole & shaft).

Fits - Fits is the degree of tightness or looseness between the two mating parts.



## ST. ANNE'S COLLEGE OF ENGINEERING AND TECHNOLOGY

(Approved by AICTE, New Delhi. Affiliated to Anna University, Chennai)

Accredited by NAAC

ANGUCHETTYPALAYAM, PANRUTI – 607 106

### ME 3591 DESIGN OF MACHINE ELEMENTS

#### 12. What are the various theories of failure? (AU MAY 2013)

- Maximum principle stress theory
- Maximum shear theory
- Maximum principal strain theory
- Maximum strain energy theory

#### 13. What are the methods used to improve fatigue strength?(AU NOV/DEC 2010/ 2014)

- Annealing
- Plastic coating
- Cold straining

#### 14. What do you mean by optimum design?(AU NOV/DEC 2007 & 2011)

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

#### 15. What is adaptive design? Where it is used? Give examples. (AU NOV/DEC 2012)

- It is a design process where a new product is developed just by making small changes to the existing product.
- It is used where no or limited scope is available to go for an entirely new design.  
Examples: Geared bicycle, die design for a small sized product which is similar to an existing large sized product.

#### 16. What is neutral axis in bending?(AU NOV/DEC 2010)

Neutral axis refers to the beam cross section where the bending stress is neither tensile nor compressive. In other words, bending stress is zero in neutral axis.

#### 17. State the difference between straight beams and curved beams. (AU NOV/DEC 2012)

FEATURE	STRAIGHT BEAM	CURVED BEAM
Centroidal axis and neutral axis	Are coincident	Are not coincident. Neutral axis is shifted towards the centre of curvature.
Stress developed	Same throughout the section	Different at inner and outer radii of the section

#### 18. Compare the characteristics of Gerber curve, Soderberg and Goodman lines.

- Gerber curve is a parabolic drawn between endurance limit and ultimate tensile strength.
- Soderberg line is a straight line connecting endurance limit and the yield strength in variable stress diagram. Soderberg line is applicable for designing of ductile materials.
- Goodman line is a straight line connecting the endurance limit and ultimate strength in variable stress diagram. Goodman line is applicable for designing of brittle materials.

#### 19. Define limits and fits.

- Limits are the extreme maximum and minimum sizes specified by a tolerance dimension.
- Fits is the degree of tightness or looseness between the two mating parts.

#### 20. Which theory is failure is suitable for the design of brittle materials?

Maximum principal stress theory is suitable for the safe design of machine component made up of brittle material, because brittle materials are weak in tension.

### UNIT-2

#### 1. What types of stresses are induced in shafts?(AU DEC 2010 & MAY 2014)

The following stresses are induced in the shafts:

- Shear stresses due to the transmission of torque (*i.e.* due to torsional load).
- Bending stresses (tensile or compressive) due to the forces acting upon machine elements like gears, pulleys etc. as well as due to the weight of the shaft itself.



## ST. ANNE'S COLLEGE OF ENGINEERING AND TECHNOLOGY

(Approved by AICTE, New Delhi. Affiliated to Anna University, Chennai)

Accredited by NAAC

ANGUCHETTYPALAYAM, PANRUTI – 607 106

### ME 3591 DESIGN OF MACHINE ELEMENTS

- Stresses due to combined torsional and bending loads.

#### 2. How the shaft is designed when it is subjected to twisting moment only?(AU MAY 2012)

When the shaft is subjected to a twisting moment (or torque) only, then diameter of shaft may be obtained by using the torsion equation.

W.K.T.

$$\frac{T}{J} = \frac{\tau}{r}$$

where,

T = twisting moment (or torque) acting upon the shaft.

J = polar moment of inertia

$\tau$  = shear stress,  $r$  = radius

#### 3. Define equivalent twisting moment and equivalent bending moment. State when these two terms are used in design of shafts. (AU MAY 2012)

Equivalent twisting moment:

- The equivalent twisting moment may be defined as that twisting moment, which when acting alone, produces the same shear stress ( $\tau$ ) as the actual twisting moment.
- By limiting the maximum shear stress ( $\tau_{max}$ ) equal to the allowable shear stress ( $\tau$ ) for the material.

$$T_e = \sqrt{M^2 + T^2} = \frac{\pi}{16} \times \tau \times d^3$$

Equivalent bending moment:

- The equivalent bending moment may be defined as that moment which when acting alone produces the same tensile or compressive stress ( $\sigma_b$ ) as the actual bending moment.
- By limiting the maximum normal stress [ $\sigma_{bmax}$ ] equal to the allowable bending stress ( $\sigma_b$ ).

$$M_e = \frac{1}{2} [M + \sqrt{M^2 + T^2}] = \frac{\pi}{32} \times \sigma_b \times d^3$$

#### 4. A hollow shaft has greater strength and stiffness than solid shaft of equal weight.

Explain.(AU APR/MAY 2008 & DEC 2012,2019)

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

#### 5. What is a key? State its function.(AU APR/ MAY 2006)

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

#### 6. Name any two of the rigid and flexible coupling.(AU MAY 2013, 2014,DEC2016)

Rigid coupling

- Sleeve couplings
- Flange couplings
- Clamp couplings

Flexible coupling

- Universal coupling
- Oldham's coupling
- Pushed pin type coupling



## ST. ANNE'S COLLEGE OF ENGINEERING AND TECHNOLOGY

(Approved by AICTE, New Delhi. Affiliated to Anna University, Chennai)

Accredited by NAAC

ANGUCHETTYPALAYAM, PANRUTI – 607 106

### ME 3591 DESIGN OF MACHINE ELEMENTS

**7. Under what circumstances flexible couplings are used? (AU NOV/DEC 07, 08, 09, 2010 & 2012 )**

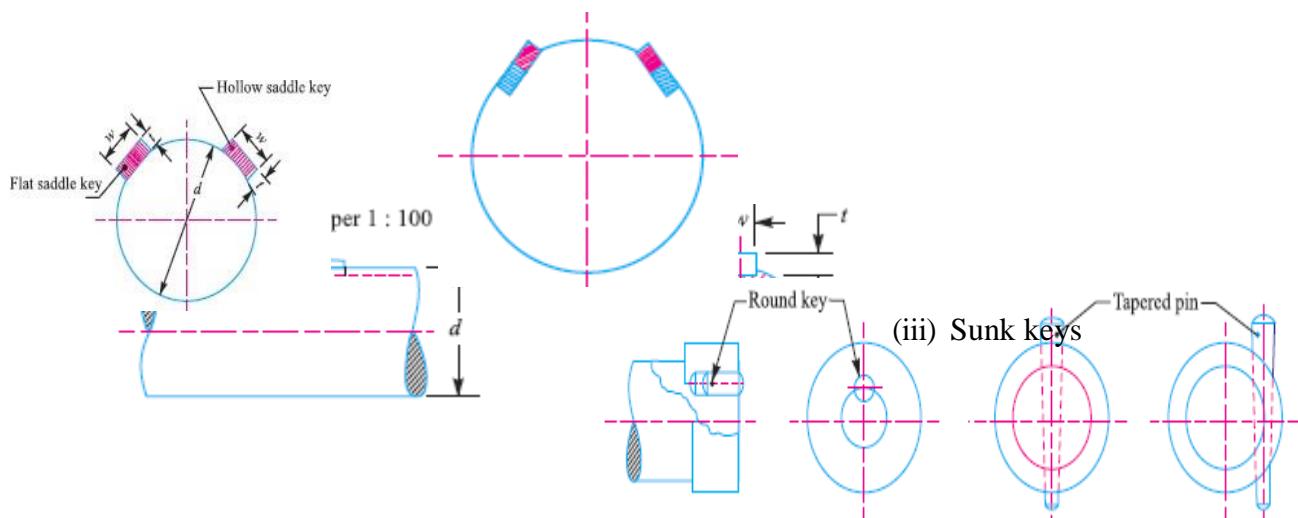
- They are used to join the abutting ends of shafts when they are not in exact alignment.
- They are used to permit an axial misalignment of the shaft without under absorption of the power, which the shafts are transmitting.

**8. How are the keys classified? Draw neat sketches of different types of keys and state their applications. (AU APR/ MAY 07 & 08)**

The keys are classified into four types.

(i) saddle keys

(ii) Tangent keys



(iv) Round keys and taper pins.

**9. What is the main use of woodruff keys?(AU MAY 2013 & 2014)**

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

**10. What is the effect of keyway cut into the shaft?(AU DEC 2010)**

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

**11. Why maximum shear stress theory used for shaft? (AU NOV 2009)**

Since the shaft is made of ductile material, thus the maximum shear stress is used.

**12. Discuss the function of coupling. Give at least three practical applications.(AU MAY 2009)**

- 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.

The practical applications are

a. Vehicle



## ST. ANNE'S COLLEGE OF ENGINEERING AND TECHNOLOGY

(Approved by AICTE, New Delhi. Affiliated to Anna University, Chennai)

Accredited by NAAC

ANGUCHETTYPALAYAM, PANRUTI – 607 106

### ME 3591 DESIGN OF MACHINE ELEMENTS

- b. Stationary machinery
- c. Automotive drives
- d. Machine tools.

#### 13. What are the various factors involved in good shaft coupling?(AU DEC 2010)

- It must be able to accommodate misalignment of shafts
- It is ease of assembly and dismantling
- Long life

#### 14. How is flexibility achieved in flexible coupling?(AU NOV/DEC 2010)

- Kinematic arrangement such as loosely fit members
- Using rubber such as materials

#### 15. What types of stresses are developed and forces of keys?(AU APR/ MAY 2008)

- Shear stress and crushing stress

Forces on keys are;

- Shear force
- Bearing force
- Tensile force

#### 16. Differentiate between keys and splines. (AU DEC 2006, APR 08, & DEC2011)

Keys	Splines
A shaft which is having single keyway. Keys are used in couplings.	A shaft which is having multiple keyways. Splines are used in automobiles and machine tools.

#### 17. Difference between rigid and flexible coupling.(DEC 2017,2016,2019)

Rigid couplings provide a rigid connection; the two shafts are firmly connected, and the coupling allows for a smooth transmission of torque throughout the system. Flexible couplings create flexible connections, and the components can lose some of the torque power through the interaction.

#### 18. why is hollow shaft preferred to solid shafts?(DEC2019)

Hollow shafts are stronger than solid shafts having same weight because. The stiffness of hollow shaft is less than that of solid shaft. The strength of hollow shaft is more than that of solid shaft.

### UNIT-3

#### 1. What do you understand by the single start and double start threads? (AU DEC 2011)

- Single – start means that there is only one “ridge” wrapped around the cylinder of the screw’s body.
- Each time that the screw’s body rotates one turn ( $360^0$ ), it has advanced axially by the one pitch distance.
- “Double – start” means that there are two “ridges” wrapped around the cylinder of the screw’s body.
- Each time that the screw’s body rotates one turn ( $360^0$ ), it has advanced axially by the two pitch distance.

#### 2. State three conditions where tap bolts are used.(AU DEC 2010)

- One of the parts being joined has enough thickness to accommodate a threaded hole.





## ST. ANNE'S COLLEGE OF ENGINEERING AND TECHNOLOGY

(Approved by AICTE, New Delhi. Affiliated to Anna University, Chennai)

Accredited by NAAC

ANGUCHETTYPALAYAM, PANRUTI – 607 106

### ME 3591 DESIGN OF MACHINE ELEMENTS

- Insufficient space for a nut.
- Material is strong enough so that the threads have long life.

#### **3. What are the different stresses developed in a bolt due to initial tightening? (AU DEC 2010)**

- Tensile stress
- Torsional shear stress
- Shear stress across the threads
- Crushing stress on threads
- Bending stress

#### **4. What is preloading of bolted joints? (DEC 2019)**

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.

#### **4. What is a stud? (AU NOV 2009)**

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 screwed into the other part.

#### **5. How is a bolt designated? Give examples. (AU DEC 2006 & APR 2009)**

A bolt is designated with

- Letter 'M' followed by
- Nominal diameter in mm and
- Pitch in mm (for fine pitches only)

It is given by  $Md \times P$

If coarse pitches are used, then 'p' value is omitted. Thus, M 20 X 2.5 means.

- Nominal diameter is 20 mm
- 2.5 mm pitch, fine thread.

M20 means, 20mm nominal diameter with coarse threads.

#### **6. Give two examples of bolted joints subjected to a fatigue load. (AU DEC 2010)**

- Bolts in crankshaft
- Bolts used in the head of a cylindrical pressure vessel with repeated filling and discharging.

#### **7. What is the meaning of bolt M24 x 2? (AU APR 2008)**

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

#### **8. What are the reasons of replacing riveted joint by welded joint in modern equipment? (AU DEC 2010)**

Material is saved in welding 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.

#### **9. What are the advantages of welded joints compared with riveted joints? (AU MA 2013, DEC 2019)**

- Welded joints are lighter in weight and have higher joining efficiency
- Welded joints are leak proof and economical from point of view of cost of material and labours.
- The design of welded assemblies can easily and economically modify to meet the changing product requirement.
- The production time is less for welded assemblies.

#### **10. Write down the expression for strength of parallel fillet weld in terms of permissible shear stress, leg of weld and length of welded joint.**

$P = 0.707 \times l \times r$  Where  $l$  is the length of the weld,  $r$  is tensile stress.



## ST. ANNE'S COLLEGE OF ENGINEERING AND TECHNOLOGY

(Approved by AICTE, New Delhi. Affiliated to Anna University, Chennai)

Accredited by NAAC

ANGUCHETTYPALAYAM, PANRUTI – 607 106

### ME 3591 DESIGN OF MACHINE ELEMENTS

**11. What is the minimum size for fillet weld? If required weld size from strength consideration is too small how will you fulfil the condition of minimum weld size? (AU DEC 2008)**

- 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.
- Size of the fillet weld,  $h = \sqrt{2} \times \text{throat thickness } (t)$

**12. Name the possible modes of failure of riveted joint. (AU NOV/DEC 2008, 2009 & MAY 2012)**

- (i) Crushing of rivets
- (ii) Shear of rivets
- (iii) Tearing of the plate at the edge
- (iv) Tearing of the plate between rivets.

**13. What do you mean by efficiency of a riveted joint? The efficiency of a riveted joint is always less than 100% give your comment. (AU DEC 2010)**

The efficiency of a riveted joint is defined as the ratio of the joint at the weakest mode of failure to the strength of unpunched plate in one pitch length of the joint.

$$\eta = \frac{\text{strength of the joint in the weakest mode}}{\text{strength of the unpunched plate}}$$
$$= \frac{\text{least of } F_t, F_s, \text{ and } F_c}{p \times t \times \sigma_t}$$

**14. Distinguish between cotter joint and knuckle joint. (AU DEC 2014)**

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

**15. Why are ACME threads preferred over square thread for power screw? (AU NOV 2014)**

Acme thread is easier to machine and is stronger than the square thread. Acme thread is thicker and wider and they operate better in environment with dirt and debris.

**16. How are welding processes classified? (AU NOV/DEC 2010)**

- Forge welding
- Electric resistance welding and
- Fusion welding.

**17. State the two types of eccentric welded connections. (AU NOV/DEC 2013)**

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

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

**18. What is gib? Why is it provided in a cotter joint? (AU NOV/DEC 2013)**

Gib is an element made of mild steel with thickness equal to the cotter.

A gib is used in combination with the cotter to provide the following advantages.

Reduce bending of socket end and Increase the bearing area of contact between the mating surfaces.

**19. Write the advantages & disadvantages of threaded fasteners. (AU NOV/DEC 2010)**

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

**20. What are the disadvantages of welding? (AU APR/MAY 2013 ; AU NOV/DEC 2014)**

Since there is an uneven heating and cooling during fabrication, therefore the members may get distorted or additional





## ST. ANNE'S COLLEGE OF ENGINEERING AND TECHNOLOGY

(Approved by AICTE, New Delhi. Affiliated to Anna University, Chennai)

Accredited by NAAC

ANGUCHETTYPALAYAM, PANRUTI – 607 106

### ME 3591 DESIGN OF MACHINE ELEMENTS

stresses may develop.

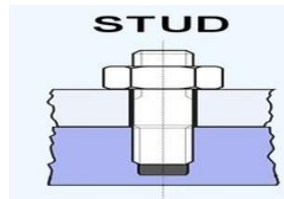
It requires a highly skilled labour and supervision.

Since no provision is kept for expansion and contraction in the frame, therefore there is a possibility of cracks developing in it.

The inspection of welding work is more difficult than riveting work.

joint becomes loose. The failure of rivets in such a manner is also known as bearing failure.

#### 21. Sketch a stud.



#### 22. Under what force, the big end bolts and caps are designed? (AU NOV/DEC 2011)

The big end bolts and caps are designed for inertia force ( $F_t$ ) due to reciprocating parts.

#### 23. State the advantages of threaded joints (AU NOV/DEC 2007; AU NOV/DEC 2016)

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

#### 24. Define the term self-locking of power screws (AU NOV/DEC 2012 AU APR/MAY 2013)

If the friction angle ( $\phi$ ) is greater than helix angle ( $\alpha$ ) 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%.

#### 25. Why are welded joints preferred over riveted joints? (AU APR/MAY 2008 ; AU APR/MAY 2009)

Material is saved in welding 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 with riveted joints.

#### 26. What are the different types of cotter joints? (AU APR/MAY 2014)

- Socket and spigot cotter joint
- Sleeve and cotter joint
- Gib and cotter joint

#### 27. When will the edge preparation need? (AU NOV/DEC 2006)

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

#### 28. What is heat affected zone in welded joint? List the effects due to that. (AU NOV/DEC 2010)

Heat affected zone refers to the area of the base metal whose microstructure and properties are changed due to the heat produced by the welding process. Cracks are possible in the heat affected zone and hence weld quality is affected.

#### 29. What are the different applications of screwed fasteners? (AU NOV/DEC 2016)

- Screw jack
- Presses
- Clamping device
- Lead screw
- Vices



## ST. ANNE'S COLLEGE OF ENGINEERING AND TECHNOLOGY

(Approved by AICTE, New Delhi. Affiliated to Anna University, Chennai)

Accredited by NAAC

ANGUCHETTYPALAYAM, PANRUTI – 607 106

### ME 3591 DESIGN OF MACHINE ELEMENTS

#### 30. What is preloading of bolts?(AU NOV/DEC 2016)

In pressure vessels and cylinder covers, it is essential to apply an initial tightening torque to make a joint leak proof. It is called preloading.

#### 31. Determine the safe tensile load for a bolt of M20; assume safe tensile stress of 40MPa. (AU APR/MAY 2012)

For M20, Stress area,  $A_c = 245 \text{ mm}^2$   
(PSGDB.5.42)

Safe tensile load,  $P = \sigma \times A_c = 9800 \text{ N}$

### UNIT-4

#### 1. What is the function of a spring? In which type of spring the behavior is non-linear? (AU DEC 2006)

- To measure the forces in spring balance, meters and engine indicators.
- To store energy

#### 2. Discuss the materials and practical applications and the various types of springs. (AU MAY 2012)

##### Materials of the spring:

- High carbon steels.
- Medium carbon alloy steel.
- Phosphor bronze
- Brass

##### Practical applications of springs:

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

##### Various types of springs:

- Helical spring
- Spiral spring
- Leaf spring
- Conical spring
- Disc spring or Belleville spring

#### 3. How will you find whether the given helical spring is a compression spring or tension spring?(AU NOV 2013)

- Ends of compression springs are flat whereas for tension springs, hooks will be provided at the ends.
- Coils will be slightly opened to facilitate compression springs whereas in tension springs. Coils are very close.

#### 4. Why leaf springs are made in layers instead of single plate.(AU NOV 2010)

To have equal stress and to achieve economical design, leaf springs are made in layers.

#### 5. What is nipping in a leaf spring? Discuss its role. List the materials commonly used for the manufacture of the leaf springs.(AU NOV 2004)

- Pre stressing of leaf springs is obtained by a difference of radii of curvature known as nipping.
- The initial gap can be adjusted so that under maximum load conditions the stress in all the leaves will be same or, if desired the stress in the full length leaves may be less.
- Plain carbon steel having 0.9 to 1% carbon in annealed condition is normally used for leaf springs.
- Chrome vanadium and silica manganese steels are used for the better grade springs.



## ST. ANNE'S COLLEGE OF ENGINEERING AND TECHNOLOGY

(Approved by AICTE, New Delhi. Affiliated to Anna University, Chennai)

Accredited by NAAC

ANGUCHETTYPALAYAM, PANRUTI – 607 106

### ME 3591 DESIGN OF MACHINE ELEMENTS

**6. What is the effect of increase in wire diameter on the allowable stress value?(AU NOV 2010)**

Increase in wire diameter will increase the spring rate but it reduces the spring index.

**7. Why is piston end of a connecting rod kept smaller than the crank pin end?(AU NOV 2010)**

The piston end of the connecting rod experiences less bending moment than the crank end. Hence, on the basis of 'beam of uniform strength', the piston end of the connecting rod is smaller.

**8. What is meant by semi elliptical spring?(AU NOV 2010)**

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

**9. State any two applications of leaf spring?(AU NOV 2008)**

- Structural spring
- Energy absorbing spring

**10. Define coefficient of fluctuation of speed and energy.(AU NOV 08, 09, DEC 10 & NOV 14)**

The difference between maximum speed and minimum speed during a cycle is called maximum fluctuation of speed.

The ratio of maximum fluctuation of speed to the mean speed is called coefficient of fluctuation of speed,  $K_s$ .

The difference between maximum and minimum energy during the cycle is called fluctuation of energy.

$$\frac{\Delta E}{\Delta E} = \frac{E_{max} - E_{min}}{E} = \frac{\Delta E}{E}$$

**11. What are the different styles of end for helical compression spring?(AU NOV 2010)**

- Plain end,
- Plain and ground,
- Squared,
- Squared and ground.

**12. At what angle of the crank the twisting moment is maximum in the crankshaft?(AU DEC 2010)**

The crank angle for maximum twisting moment usually lies between  $25^\circ$  and  $35^\circ$  from TDC for petrol engines and

between  $30^\circ$  and  $40^\circ$  for diesel engines.

**13. What is spring index? Or Define the term spring rate.(AU NOV 2010)**

The ratio of mean or pitch diameter to the diameter of wire for the spring is called spring index. Stiffness is the ratio of load to deflection.

$$\text{Stiffness, } q = \frac{\text{load}}{\text{deflection}} = \frac{P}{y}$$

**14. What type of stresses is produced in a disc flywheel?(AU NOV / DEC 2010)**

- Radial stress
- Tangential stress

**15. What is the main function of a flywheel in an engine?( AU MAY 2012&DEC2019)**

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

#### PUNCHING PRESS

Flywheel stores power to exert on the Ram (Tonnage). It reduces the load on the Motor.

**16. In what way does a flywheel differ from that of a governor?(AU NOV 2010)**



## ST. ANNE'S COLLEGE OF ENGINEERING AND TECHNOLOGY

(Approved by AICTE, New Delhi. Affiliated to Anna University, Chennai)

Accredited by NAAC

ANGUCHETTYPALAYAM, PANRUTI – 607 106

### ME 3591 DESIGN OF MACHINE ELEMENTS

- 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.

#### 17. Define 'coefficient of fluctuation of speed' and 'coefficient of steadiness'. (AU NOV 2010)

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

$$K_f = \frac{W_{max} - W_{min}}{W_{mean}} \text{ Or } \frac{2(W_{max} - W_{min})}{W_{max} + W_{min}}$$

- Co-efficient of steadiness is the reciprocal of the co-efficient of fluctuation of energy.

#### 18. What is surge in springs?

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

#### 19. What are constant widths and constant strength springs?

- If the leaf spring has a shape of uniformly varying width (say lozenge shape) the bending stress at all section remains uniform.
- This situation is also identical as before in case of varying thickness, the thickness should vary non-uniformly with length to make a beam of uniform strength ( $L/h^2 = \text{constant}$ )
- These leaves requires lesser material, have more resilience compared to constant width leaf.
- These types of springs are called leaf springs of uniform strength.

#### 20. What is the objective of the nipping of the leaf springs?

- The main objective of nipping in leaf spring is to compensate the stress level by pre-stressing.
- Pre-stressing is achieved by a difference in the radius of curvature is known as nipping.

#### 21. Write the advantage of Belleville springs?

- Keep bolted joints tight
- Efficient use of space
- High spring loads with small deflections
- Self-damping
- Long service life

#### 22. What is Wahl factor and why it is required?

- The stress factor which has the effect of direct shear and change in coil curvature is known as Wahl's factor.
- The Wahl factor provides a simple method to find out resultant stresses in spring, the resultant shear stress is maximum at the inside radius of the coil.

#### 23. Define a) co-efficient of fluctuation of speed b) co-efficient of fluctuation of energy. MAY 2016

- Co-efficient of fluctuation of speed is the ratio of the maximum change of speed to mean the speed of the flywheel.
- Co-efficient of fluctuation of energy is ratio of fluctuation of energy to the mean energy is called co-efficient of fluctuation of energy.

#### 24. Define surge in a spring? (DEC 2018)

A helical spring of rate 12N/mm is mounted on the top of another spring of rate 8 N/mm. find the force required to give a deflection of 50mm.



## ST. ANNE'S COLLEGE OF ENGINEERING AND TECHNOLOGY

(Approved by AICTE, New Delhi. Affiliated to Anna University, Chennai)

Accredited by NAAC

ANGUCHETTYPALAYAM, PANRUTI – 607 106

### ME 3591 DESIGN OF MACHINE ELEMENTS

#### UNIT-5

#### 1. What is bearing and how are they classified? (AU N/D 2010 & MAY 2014, DEC 2016, 2018)

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

Classification of bearings:

Depending upon the type of contact

- Rolling element bearing
- Sliding contact bearing

Depending upon the type rolling element

- Ball bearing and
- Roller bearing

Depending upon load to be carried

- Radial
- Angular contact, and
- Thrust bearing

#### 2. What are journal bearings? Give a classification of these bearings. (AU NOV 06, MAY 13, & 14)

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

Classification of Journal bearings:

Depending upon the nature of contact:

- Full journal bearing
- Partial bearing
- Fitted bearing.

Depending upon the nature of lubrication:

- Thick film type
- Thin film type
- Hydrostatic bearings
- Hydrodynamic bearing.

#### 3. Classify the sliding contact bearing according to the thickness of layer of the lubricant between the bearing and the journal. (AU MAY 2012)

- Thick film type
- Thin film type
- Hydro static bearings
- Hydrodynamic bearings

#### 4. For a journal bearing the maximum operating temperature must be less than 80°C. Why? (AU DEC 2010)

- Temperature rise will result in the reduction of the viscosity of the oil used in the bearing.
- It would lead to metal to metal contact thereby affecting the bearing performance and life.

#### 5. What is the advantage of Teflon which is used for bearings? (AU APR/MAY 2010)

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

#### 6. List any four advantages to rolling contact bearing over sliding contact bearings. (AU APR/MAY 2009, 2016)



## ST. ANNE'S COLLEGE OF ENGINEERING AND TECHNOLOGY

(Approved by AICTE, New Delhi. Affiliated to Anna University, Chennai)

Accredited by NAAC

ANGUCHETTYPALAYAM, PANRUTI – 607 106

### ME 3591 DESIGN OF MACHINE ELEMENTS

- Starting friction is low
- Lubrication is simple
- It requires less axial space and more diametrical space
- Heavier loads and higher speeds are permissible.

#### 7. Explain the term **Dynamic load capacity of rolling contact bearing.** (AU NOV /DEC 2014)

Dynamic load rating is defined as the radial load in radial bearings (or thrust load in thrust bearing) that can be carried for minimum life of million revolutions.

#### 8. What are the types of radial ball bearing?(AU MAY 2012)

- Deep groove ball bearing
- Self-aligning ball bearing
- Angular contact ball bearing
- Filling notch bearing
- Double row bearing

#### 9. What is the application of thrust ball bearing?(AU NOV / DEC 2010)

- Thrust ball bearings are used to support axial loads imposed on the rotating elements.

#### 10. What is known as self- acting bearing?(AU NOV/DEC 2017)

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

#### 11. State the disadvantages of thrust bearing.(AU NOV / DEC 2009)

- High initial cost
- Less capacity to withstand shock
- Noisy operation at very high speed
- Life is finite
- Design of bearing housing is complicated

#### 12. Define static capacity of bearing.(AU NOV / DEC 2014)

It is defined as load acting on the non- rotating bearing under permanent deformation is 0.0001 times the ball or roller diameter.

#### 13. What are the modes of failure of roller contact bearings?(AU DEC 2010)

- Flaking or surface fatigue
- Peeling
- Scoring
- Fretting
- Creep

#### 14. State any points to be considered for selection of bearings.(AU DEC 2010)

- Calculate the radial and axial forces acting on the bearing.
- Calculate the shaft diameter
- Determine the radial load factor (X) and thrust load factor (Y)

#### 15. What are the materials commonly used for manufacturing contact bearing?(AU DEC 2010)

- Lead based babbitt
- Tin based babbitt
- Leaded bronze
- Copper lead alloy
- Gun metal
- Phosphor bronze

#### 16. In what respect the flywheel differ from that of a governor?(AU NOV 2010)





## ST. ANNE'S COLLEGE OF ENGINEERING AND TECHNOLOGY

(Approved by AICTE, New Delhi. Affiliated to Anna University, Chennai)

Accredited by NAAC

ANGUCHETTYPALAYAM, PANRUTI – 607 106

### ME 3591 DESIGN OF MACHINE ELEMENTS

- 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..

#### 17. What is self-aligning ball bearing? State its unique feature.

- Self-aligning ball bearings have two rows of balls and a common sphere raceway in the outer ring.
- The bearings are insensitive to angular misalignment of the shaft relative to the housing.

#### 18. Difference between sliding contact and rolling contact bearings. (DEC 2019)

Generally, sliding contact bearings have higher friction force, consume higher energy and release more heat, but they have larger contact surface, so normally used in low-speed high load applications. In anti-friction (rolling contact) bearings friction is less. One object just rolls over each other. Rolling contact bearing is suitable for high speed application. Maintenance is less and long life.

#### 19. List the advantages of hydrostatic bearing. (DEC 2017)

Hydrostatic bearings have the advantage of very low friction at low speeds and allow a work table to be positioned with extremely high accuracy. There is also the advantage of very high damping and stiffness in the normal direction to the feed motion. The further advantage is the absence of wear.

\*\*\*\*\*