UNIT –I

STEADY STRESSES AND VARIABLE STRESSES IN MACHINE MEMBERS

PART –A

1. **What is 'Adaptive design and Optimum design? (Dec 2007, 2011, 2012)**

Adaptive design: It is a design process where a new product is developed just by making small changes to the existing product.

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

2. **List some factors that influence machine design. (Dec 2010)**

Strength, stiffness, surface finish, tolerances, manufacturability, ergonomics and aesthetics, working atmosphere, cost, safety and reliability.

3. **Describe material properties hardness stiffness and resilience. (Apr 2009, Nov 2009, Dec 2013)**

Hardness: It is the ability of the material to resist scratching and indentation

Stiffness: It is the ability of the material to resist deformation under loading

Resilience: It is the ability of the material to resist absorb energy and to resist shock and impact load.

4. **What is interchangeable manufacture?**

Manufacturing process in which the produced parts that go in to assembly may be Selected at random from a large number of plates.

5. **What are unilateral and bilateral tolerances?(May 2013)**

A unilateral tolerance is tolerance in which variation is permitted only in one direction from, the specified direction. Eg- $1800^{+0.060/-0.060}$

Bilateral tolerance is tolerance in which variartion is permitted in both direction from the specified direction. eg- $1800^{+0.060/-0.060}$

6. **Differentiate between hardness and toughness of materials. (May 2014)**

s.no	Hardness	Toughness
1.	It refers yhe energy required to deform a material	It refer the total energy which can be used before the material breaks
2.	Hardness is the characteristic of a solid material expressing its resistance to permanent deformation	Toughness is the resistance to fracture of a material when stressed
3.	Hardness is the ability to withstand localized deformation at the surface.	Toughness is the measure of a material ability to absorb energy without breaking or fracture

7. **List at least two methods to improve the fatigue strength. (Nov 2008)**
    - Annealing
    - Plastic coating
    - Cold straining

8. **Determine the force required to punch a hole of 20mm diameter in a 5mm thick plate with ultimate shear strength of 250MPa. (Nov 2014)**

Given data:

Diameter, d=20mm

Thickness, t= 5mm

Shear strength, τ = 250MPa=250N/mm^2

Solution: Force F= π d t τ = π.20.5.250 = 78.54KN

9. State the different between straight and curved beams. (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

10. Give some methods of reducing stress concentration.(Dec 2010)

i. Avoiding sharp corners.

ii. Providing fillets.

iii. Use of multiple holes instead of single hole

iv. Undercutting the shoulder parts.

11. What are the factors that govern selection of materials while designing a machine component? (Dec 2010)

- Required material properties
- Manufacturing easy
- Material availability
- Cost

12. Define stress concentration and stress concentration factor.(Apr 2009, May 2012, 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. $K_t=\sigma_{max}/ \sigma_o$

13. Explain notch sensitivity. State the relation between stress concentration factor, fatigue stress concentration factor and notch sensitivity.

Notch sensitivity (q) is the degree to which the theoretical effect of stress concentration is actually reached. The relation is, Kf = 1 + q (Kt-1)

14. What are the methods used to improve fatigue strength? (Dec 2013)

- Cold working like shot penning, burnishing.
- Heat treatment such as induction hardening, case hardening, nitrating
- Pre-stressing

15. State Rankine theory of failure and its limitations.

Rankine theory of failure: According to this theory, the failure or yielding occurs at a point in a member when the maximum principal or normal stress in a bi-axial stress system reaches the limiting strength of the material in a simple tension test.

Limitations: Since the maximum principal or normal stress theory is based on failure in tension or compression and ignores the possibility of failure due to shearing stress, therefore it is not used for ductile materials. However, for brittle materials which are relatively strong in shear but weak in tension or compression, this theory is generally used.

16. Define modulus of resilience and proof resilience. (April 2017)

The total strain energy stored in a body is commonly known as resilience. Resilience is also defined as the capacity of a strained body for doing work on the removal of the straining force.

Proof resilience is the maximum amount of strain energy stored in the body, when the body is stressed upto elastic limit.

Modulus of resilience is is the maximum amount of strain energy stored in the body per unit volume, when the body is stressed upto elastic limit.

UNIT II

SHAFTS AND COUPLINGS

PART - A

1. Classify keys with its applications? (May 2012)

(a) Saddle key- It is applicable where light load is used.

(b) Sunk key – It is used to connect pulleys where is moderate load is applied.

(c) Woodruff key- Used to transmit small amount of torque in automotives.

2. Discuss the forces on key? (Dec 2012, Dec 2014)

(a) Shear force

(b) Bearing force

(c) Tensile force

3. What are the various stresses induced in shafts? (May 2014)

(a) Shear due to torsion

(b) Stress due to bending

(c) Axial stress if an axial load acts.

4. Name any two of the rigid coupling? (May 2014)

(a) Sleeve couplings

(b) Flange couplings

(c) Clamp couplings

5. What is the difference between rigid and flexible coupling? (May 2013, May 2016)

Rigid coupling: It is used in low speed applications where a good axial alignment between connecting shafts can be achieved.

Flexible Coupling: The shafts having longitudinal, lateral and angular misalignment are connected using flexible coupling.

6. How is the strength of a shaft affected by the keyway? (May2014)

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 the cross-sectional area of the shaft. It other words, the torsional strength of the shaft is reduced.

7. What is the main use of woodruff key? (Nov 2013)

It 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 key way in the hub is usually straight.

8. A shaft of 70 mm long is subjected to shear stress of 40 Mpa and has an angle of twist equal to 0.017 radian. Determine the diameter of the shaft. Take G= 80 Mpa? (Nov 2013)

Given data:

Length of the shaft, l= 750mm

Shear stress, τ= 40 N/mm^2

Angle of twist, Θ=0.017 radian

Modulus of rigidity, G=0.8 $\times 10^5$ N/mm^2

To find:

Diameter of the shaft, d

Solutions:

Torsional moment of the shaft, $M_t = (\pi/16) \times \tau \times d^3$

Angle of twist, $\Theta = (M_t \times l)/(GJ)$

Where $J = (\pi/32) \times d^4$

Angle of twist, $0.017 = (2 \times 40 \times 750)/(0.8 \times 10^5 \times d)$

d=44.11 mm

Standard diameter, d=45 mm

9. Why a hollow shaft has greater strength and stiffness than solid shaft of equal weight? (Nov 2012)

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

10. Indicate the effects of providing key ways in the shaft? (Nov 2010)

(a) It reduces strengths of the shaft because of material removal.

(b) It increases stress concentration.

11. What do you mean by stiffness and rigidity with reference to shafts? (Dec 2010)

Stiffness is the resistance offered by the shaft for twisting and rigidity is the resistance offered by the shaft for lateral bending.

12. Differentiate between keys and splines? (Nov 2011)

Key: A key is a piece of mild steel inserted between the shaft and hub or boss of the pulley to connect these together in order to prevent relative motion between them. It is always inserted parallel to the axis of the shaft. Keys are used as temporary fastenings and are subjected to considerable crushing and shearing stresses.

Splines: Sometimes, keys are made integral with the shaft which fits in the keyways broached in the hub. Such shafts are known as splined shafts or splines. These shafts usually have four, six, ten or sixteen splines. The splined shafts are relatively stronger than shafts having a single keyway. The splined shafts are used when the force to be transmitted is large in proportion to the size of the shaft as in automobile transmission and sliding gear transmissions. By using splined shafts, we obtain axial movement as well as positive drive is obtained.

13. Under what circumstances flexible couplings are used? (Nov 2012)

(a) They are used to join the abutting ends of shafts when they are not in exact alignment.

(b) They are used to permit an axial misalignment of the shafts without under absorption of the power, which the shafts are transmitting.

14. How is flexibility achieved in flexible coupling? (Nov 2010)

(a) Kinematic arrangement such as loosely fit members

(b) Using rubber such as materials

15. Suggest suitable couplings for, shafts with parallel misalignment, shafts with angular misalignment of 100, shafts in perfect alignment?

Flexible coupling such as spring coupling can be used for shafts with parallel misalignment. Universal coupling is suitable for shafts with angular misalignment of 100 . Rigid coupling can be used for shafts in a perfect alignment.

16. Define equivalent torsional moment of a shaft. (April 2017)

The expression $\sqrt{M^2 + T^2}$ is known as equivalent twisting moment and is denoted by T_e. The equivalent twisting moment may be defined as that twisting moment, which when acting alone, produces the same shear stress (τ) as the actual twisting moment.

UNIT- III

TEMPORARY AND PERMANENT JOINTS

PART - A

1. **How is a bolt designated? Give example. (Dec 2006,Apr 2009)**

   A thread is designated with Letter M followed by Nominal diameter in mm and Pitch in mm [for fine pitches only].If coarse pitches are used then P value is omitted.

   Thus M20×2.5 means, Nominal diameter is 20mm, 2.5mm pitch, fine thread.

   M20 means, 20mm nominal diameter with coarse threads

2. **Why are ACME threads preferred over square thread for power screw?(Nov 2014)**

   ACME threads is easier to machine and it is stronger than square threads. ACME threads are thicker and wider and operate better in environments with dirt and debris.

3. **What are the various initial stresses developed due to screwing up in bolted joints? (Dec 2010)**

   - Tensile stresses
   - Torsional shear stress
   - Shear stress
   - Compressive and bending stress

4. **Under what force, the big end bolts and caps are designed.(Dec 2011)**

   The big end bolts and caps are designed for inertia force due to reciprocating parts

5. **What is gib? Why it is provided in a cotter joint?(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
   - Increase the bearing area of contact between the mating surfaces.

6. **What are the different types of cotter joints? (May 2014)**
    - Socket and spigot cotter joint
    - Sleeve and cotter joint
    - Gip and cotter joint
7. **Why are welded joints preferred over riveted joints? (Nov 2003, Apr2008, Apr 2009)**

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.

8. **Define the term self locking of power screws? (Apr 2004,Dec 2012, May 2013)**

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 is screw is known as self locking screw. The efficiency of the self locking screw is less than 50%.

9. **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? (Nov 2008)**

It is the 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

10. **Name the possible modes of failure of riveting joint. (Nov 2008, Dec 2012,May 2012)**

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

11. What is meant by the efficiency of the riveted joint? (Dec 2010)

The efficiency of a riveted joint is defined as the ratio of the strength of riveted joint to the strength of the un-riveted or solid plate.

η = Least of Tearing Resistance, Shearing resistance and Crushing Resistanace

$$p \times t \times \sigma_t$$

Where, p = Pitch of rivets, t= thickness of plate and σ_t = Permissible Tensile stress of the plate material.

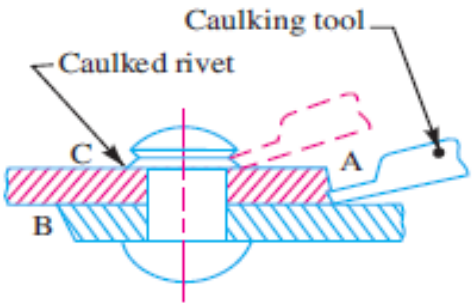
12. What are the reason of replacing riveted joint by welded joint in modern equipment.(Dec 2010)

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

13. State the two types of eccentric welded connection (Dec 2013)

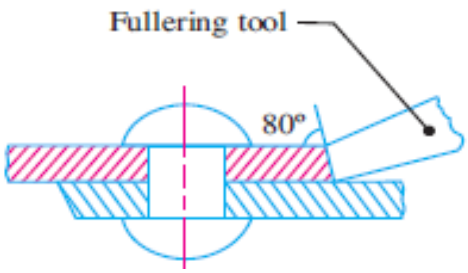
- Welded connections subjected to moment in a plane of the weld
- Welded connections subjected to moment in a plane normal to the plane of the weld.

14. What is caulking and fullering?

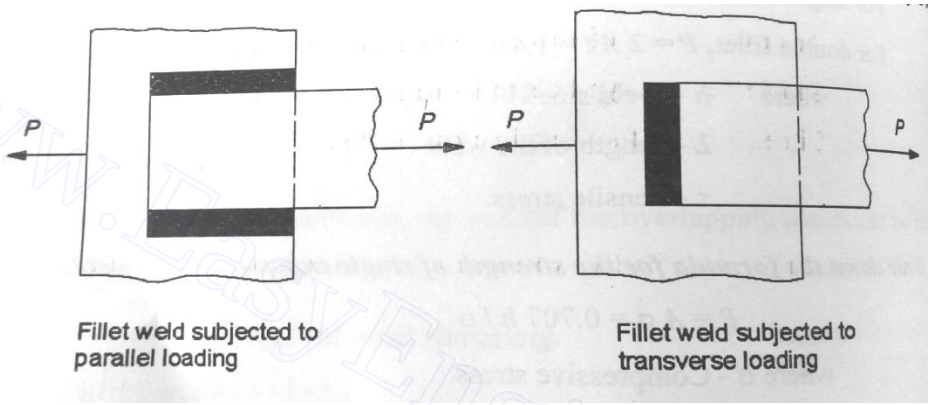


In order to make the joints leak proof or fluid tight in pressure vessels like steam boilers, air receivers and tanks etc. a process known as caulking is employed. In this process, a narrow blunt tool called caulking tool, about 5 mm thick and 38 mm in breadth, is used. The edge of the tool is ground to an angle of 80°. The tool is moved after each blow long the edge of the plate, which is planed to a bevel of 75° to 80° to facilitate the forcing down of edge. It is seen that the tool burrs down the plate at A in Fig. forming a metal to metal joint. In actual practice, both the edges at A and *B* are caulked. The head of the rivets as shown at *C* are also turned down with a caulking tool to make a joint steam tight. A great care is taken to prevent injury to the plate below the tool.

Fullering: A more satisfactory way of making the joints staunch is known as fullering which has largely superseded caulking. In this case, a fullering tool with a thickness at the end equal to that of the plate is used in such a way that the greatest pressure due to the blows occur near the joint, giving a clean finish, with less risk of damaging the plate. A fullering process is shown in Fig.



15. Differentiate with a neat sketch the fillet welds subjected to parallel loading and transverse loading. (Apr-04, May-14)



UNIT-IV

ENERGY STORING ELEMENTS AND ENGINE COMPONENTS

PART - A

1. **Why springs are used in the machine? (Dec 2010)**

   Springs are used in the machines to provide cushioning effect or reduce the effect of shock or impact loading.

2. **State any two functions of springs. (Dec 2006)**

   To measure forces in spring balance, meters and engine indicators.

   To store energy.

3. **What is surge in springs? (May 2013)**

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

4. **What is meant by semi elliptical leaf spring? (May 2014)**

   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.

5. **What is the purpose of flywheel that is used in an IC engine? (Dec 2013)**

   A flywheel is a heavy rotating mass which is placed between the power source and the driven member to act as a reservoir of energy. The primary function of flywheel is to act as an "energy accumulator". It will absorb energy when demand is less than the supply of energy and will release it when the demand is more than the energy being supplied.

6. **How does the function of flywheel differ from that of governor? (Dec 2012)**

Governor regulates the mean speed of an engine when there are variations in the load, e.g. when the load on the engine increases, it becomes necessary to increase the supply of working fluid. On the other hand, when the load decreases, less working fluid is required. The governor automatically controls the supply of working fluid to the engine with the varying load condition and keeps the mean speed within certain limits.

Flywheel does not maintain a constant speed, it simply reduces the fluctuation of speed. In other words, a flywheel controls the speed variations caused by the fluctuation of the engine turning moment during each cycle of operation. It does not control the speed variations caused by the varying load.

7. Define the co-efficient of fluctuation of speed in case of flywheel. (Nov 2014)

When the fly wheel absorbs energy, its speed increases and when it releases the energy, its speed decreases. N_1 and N_2 be the maximum and minimum speeds and N is the average speed.

The difference between the maximum and minimum speeds during a cycle is called the maximum fluctuation of speed. The ratio of the maximum fluctuation of speed to the mean speed is called coefficient of fluctuation of speed.

$$C_s \text{ or } K_s = (N_1 - N_2) / N$$

8. Under what circumstances Bellevellie springs used? (Dec 2010)

When large force is applied and deflection must be small. When space availability is small.

9. Distinguish between close coiled and open coiled springs. (Nov 2014)

Open coiled spring;

The wires are coiled such that there is a gap between the two consecutive turns. Helix angle is larger than 10^0.Both torsional and bending stresses are significant.

Closed coiled spring:

The wires are coiled very closely, each turn is nearly at right angles to the axis of helix. Helix angle is smaller than 10^0. Torsional Stresses are predominant.

10. Mention any four types of springs. (May 2012)

Helical Spring
Conical Spring
Spiral Spring
Disc or Bellville Spring
Leaf Spring.

11. Why leaf springs are made in layers instead of single plate? (Dec 2010)

Leaf springs are made in layers because,

1. To have equal stress

2. To achieve economical design

12. Define spring Index and stiffness. (DEC 2011)

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 the deflection.

13. What are different styles of end for helical compression spring? (Nov 2009)

Plain end

Plain and ground

Squared

Squared and ground

14. Why piston end of a connecting rod kept smaller than the crank pin end? (Dec 2010)

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

15. At what angle of the crank the twisting moment is maximum in the crankshaft? (Dec 2011)

The crank angle for maximum twisting moment lies between 250 and 350 from TDC for petrol engines and between 300 and 400 for diesel engine.

16. What are the forces acting on connecting rod? (April 2017)

The external forces acting on connecting rod are

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

UNIT-V

BEARINGS

PART - A

1. **How are bearings classified? (Dec 2010 & MAY 2014)**

   Depending upon the type of contact

   a. Rolling element bearing
   b. Sliding contact bearing

   Depending upon the type of rolling element

   a. Ball bearing
   b. Roller bearing

2. **What is a journal bearing? List any two applications. (Nov 2006, May 2013 & May 2014)**

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

3. **Classify the sliding contact bearings according to the thickness of layer of the lubricant between the bearing and the journal.(May 2012)**

   a. Thick film type
   b. Thin film type
   c. Hydrostatic bearings
   d. Hydrodynamic bearings

4. **For a journal bearing, the maximum operating temperature must be less than 80^{o}C. why?(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 therby affecting the bearing performance and life.

5. **What is known as self acting bearing? (NOV 2007)**

   The pressure is created within the system due to rotation of the shaft known as self acting bearing.**In hydro dynamic bearing, what are factors which influence the formation of wedge fluid film? (Nov 2014)**

1. The contact surfaces must meet at a slight angle to allow the formation of the lubricant wedge.
2. The fluid viscosity must be high to maintain an adequate film thickness to separate the contacting surfaces at operating speeds.

6. **Explain the term dynamic load carrying capacities of rolling contact bearing. (Dec 2012)**

   The basic dynamic load rating is defined as the constant stationary radial load (in case of radial ball or roller bearings) or constant axial load (in case of thrust ball or roller bearings) which a group of apparently identical bearings with stationary outer ring can endure for a rating life of one million revolutions (which is equivalent to 500 hours of operation at 33.3 r.p.m.) with only 10 per cent failure.

7. **What are the types of radial ball bearing? (May 2012)**
   1. Deep groove ball bearing
   2. Self angular ball bearing
   3. Angular contact ball bearing
   4. Filing notch bearing.

8. **What is the application of thrust bearing? (Dec 2010)**

   Thrust bearings are used to support axial loads imposed on the rotaing elements.

9. **What is meant by life of anti-friction bearing? (Apr 2008 & May 2013)**

   For an individual rolling bearing, the number of revolutions which one of the bearing rings makes in relation to the other rings under the prevailing working conditions before the first evidence of fatigue develops in the material of one of the rings or rolling elements.

10. **List any four advantages to rolling contact bearings over sliding contact bearings. (Apr 2009)**

    1. Starting friction is low
    2. Lubrication is simple
    3. It requires less axial space

11. **State the disadvantages of thrust ball bearing. (Apr 2009)**

    1. High initial cost
    2. Less capacity to withstand shock
    3. Noisy operation at very high speed.
    4. Life is finite

12. **Define static capacity of bearing. (Nov 2014)**

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

13. **Explain the term dynamic load carrying capacities of rolling contact bearing**. **(Nov 2004)**

    It is defined as the radial load in radial bearings that can be carried for a minimum life of one million revolutions.

14. **What are the modes of failure of rolling contact bearing? (Dec 2010)**

1. Flaking or surface fatigue, 2. Peeling, 3. Scoring, 4. Fretting, 5.Creep

15. What are anti friction bearings? (April 2017)

Advantage of a rolling contact bearing over a sliding bearing that it has a low starting friction. Due to this low friction offered by rolling contact bearings, these are called antifriction bearings.