PNS School of Engineering & Technology

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Internal Assessment Examination-2022(5th Semester)

Subject : Th-2-Design of Machine Elements (Question & Answer)

Branch : Mechanical Engineering

1. Answer the following questions (any Five). [2 x 5]

(a) Define creep and fatigue with suitable examples.

Ans. **Creep :** When a part is subjected to a constant stress at high temperature for a long period of time, it will undergo a slow and permanent deformation called Creep.

Ex. : I.C. Engines, Boiler and Turbines.

Fatigue : Fatigue is the property of matter by virture of which the material fails under stress less than yield stress due to cyclic nature of stress.

Ex. : Shafts, connecting rods, springs, gears etc.

(b) Write different mechanical engineering material used in design.

Ans.
- ❖ Commonly used Ferrous aloys are carbon steel, low-alloy steel, tool steel, stain less steel and cast inon.
- ❖ Non ferrous alloys are Aluminum alloys, Nickel aloys, Titanium alloys.

(c) What do you mean by Fastening and write types of Fastening ?

Ans. A Fastening is a hardware device that mechanically joins two or more objects together.

The types of fastening i.e. joints are :

- ❖ Permanent fastening.

Ex. : Welded joints, riveted joints, brazed joints and soldered joints.

- ❖ Temporary fastening.

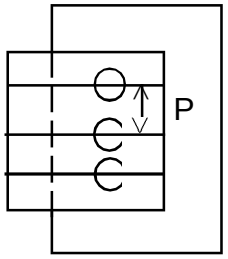
Ex. : Serewed joints, bolted joints, key cotter joints and splined joints.

(d) Define Pitch and Back Pitch of Riverted joints.

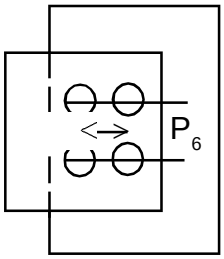
Ans. **Pitch :** It is the distance from centre fo one rivet to the centre of next rivet. It is usually denoted by 'P'.

Back Pitch :

It is the perpendicular distance between the centre lines of the successive rows. It is usually denoted by 'Pb'.



(Fig. Pitch)



(Fig. Back Pitch)

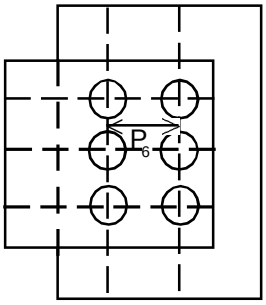
(e) Define chain Riveted & Zig-Zag Riveted joints

Ans. **Chain Riveted Joints :**

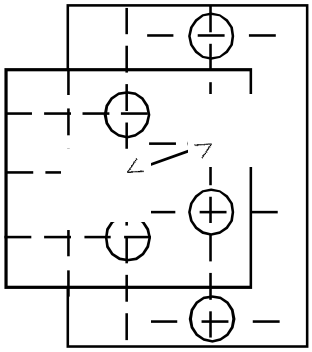
When the rivets in the various rows are opposite to each other, then the joint is said to be Chain riveted.

Zig-Zag Riveted joints :

If the rivets in the adjacent rows are staggered in such a way that every rivet is in the middle of the two rivets of the opposite row, then the joint is said to be Zig-Zag riveted.



(Fig. :Chain riveted)



(Fig. : Zig-Zag riveted)

(f) Write the difference between Shaft and Axle ?

Ans. **Shaft :**

- ❖ A Shaft is a rotating machine element.
- ❖ A Shaft is subjected to twisting moment and bending moment.

Axle :

- ❖ An Axle is stationary machine element.
- ❖ An Axle is subjected to bending moment only

(g) What is the function of key and write types of key ?

Ans. Function of key : A key is a piece of mild steel inserted between the shaft and hub or boss of the pulley to connected together in order to prevent relative motion between them. Keys are used as temporary fastening and are subjected to crushing and shearing stresses.

Types of Keys : The keys are classified into the following types :

1. Sunk Keys
2. Saddle Keys
3. Tangent Keys
4. Round Keys
5. Splines

2. Answer the following questions (any Two) [5 x 2]

(a) Briefly explain General Procedure of Machine Design.

Ans. The general procedure to solve a design problem is as follows :

(i) Recognisation of need :

Aim or purpose for which the machine is to be designed should be recognized.

(ii) Mechanism :

Select the possible mechanism or group of mechanism which will give the desired motion.

(iii) Analysis of forces :

Find the forces acting on each member of the machine and the energy transmitted by each member.

(iv) Material selection :

Select the matrial best suited for each member of the machine.

(v) Design of Elements :

Find the size of each member of the machine by considering the force acting on the member and the permissible stresses for the material used.

(vi) Modification :

Modify the size of each member of the machine by considering the force acting on the member and the permissible stresses for the material used.

(vii) Detailed Drawing :

Draw the detailed drawing of each component and the assembly of the machine with complete specification for the manufacturing process.

(b) A double riveted double cover butt joint in plates 20mm thick is made with 25mm diameter rivets at 100mm pitch. The permissible stresses are :

σ_t = 120MPa, τ = 100Mpa, σ_c = 150MPa

Find the efficiency of joint, taking the strength of the rivet in double shear as twice than that of single shear.

Ans. Given data : t = thickness = 20mm

d = diameter of rivet = 25mm

p = pitch = 100mm

σ_t = 120MPa = 100mm

τ = 100 MPa = 120 N/mm^2

σ_c = 150MPa = 150 N/mm^2

(i) Tearing resistance of the plato :

We know Pt = (p-d) t x σ_t = (100-25) x 20 x 120

or Pt = 180,000 N

(ii) Shearing resistance of the rivet.

We know, $P_s = n \times 2 \times \frac{\pi}{4} d^2 \times \tau$

$= 2 \times 2 \times \frac{\pi}{4} \times (25)^2 \times 100$ ($\because n = 2$)

or P_s = 196375N

(iii) Crushing resistance of the rivet :

We know, $P_c = n \times d \times t \times \sigma_c$

= 2 x 25 x 20 x 150 (n=2)

or, Pc = 150,000N

Strength of the rivet = Least of Pt, Ps and Pc

= 150,000 N.

Efficience of joint : (η)

We know, the strength of the un-riveted or solid plate,

P = p x t x σ_t

= 100 x 20 x 120

or P = 240,000 N

$$\therefore \eta = \frac{\text{Least of Pt, Ps and Pc}}{P} = \frac{150{,}000}{240{,}000}$$

Or $\boxed{\eta = 0.625 = 62.5\%}$

(c) A solid circular shaft is subjected to a bending moment 3000N-M and torque of 10,000 N-M. The shaft is made of 45C8 steel having ultimate tensile stress of 700MPa and a ultimate shear stress of 500MPa. Assuming a factor of safety as 6. Determine the diameter of shaft.

Ans. Given data : $M = 3000$ N-m $= 3 \times 10^6$ N-mm

$T = 10{,}000$ N-m $= 10 \times 10^6$ N-mm

$\sigma_U = 700\text{MPa} = 700\text{N/mm}^2$

$\tau_U = 500\text{MPa} = 500\text{N/mm}^2$

fos = 6

We know, allowable tensite stree,

$$\tau_t \text{ or } \tau_b = \frac{\tau_U}{\text{fos}} = \frac{700}{6} = 116.7 \text{ N/mm}^2$$

And Allowable Shear stress

$$\tau = \frac{\tau_U}{\text{fos}} = \frac{500}{6} = 83.3 \text{ N/mm}^2$$

Let, d = diameter of shaft in mm

According to maximum shear stress theory, equivalent twisting moment

$$Te = \sqrt{M^2 + T^2} = \sqrt{(3 \times 10^6)^2 + (10 \times 10^6)^2} = 10.44 \times 10^6 \text{ N-mm}$$

Also, we know, equivalent twisting moment (Te)

$$Te = \frac{\pi}{16} \tau \times d^3 \Rightarrow 10.44 \times 10^6 = \frac{\pi}{16} \times 83.3 \times d^3$$

$$\Rightarrow d = \sqrt[3]{\frac{10.44 \times 10^6 \times 16}{\pi \times 83.3}}$$

$$\Rightarrow \boxed{d = 86\text{mm}}$$

According to maximum normal stress theory, equivalent bending moment,

$$Me = \frac{1}{2}\left[M + \quad\right] = \frac{1}{2}\left[\quad\right]$$

$$= \frac{1}{2}\left[3 \times 10^6 + 10 \quad\right] = 6.72 \times 10^6 \text{ N-mm}$$

Also, we know, equivalent bending moment (Me)

$$Me = \frac{\pi}{32} \times \sigma_b \times d^3 = \frac{\pi}{32} \times 116.7 \times d^3 = 6.72 \times 10^6$$

$$\Rightarrow d = \sqrt{\frac{6.72 \times 10^6 \times 32}{\pi \times 116.7}}$$

$$\Rightarrow \boxed{d = 83.7 \text{ mm}}$$

Taking the larger of the two values, we have

$$\boxed{d = 86 \text{ say } 90\text{mm.}}$$