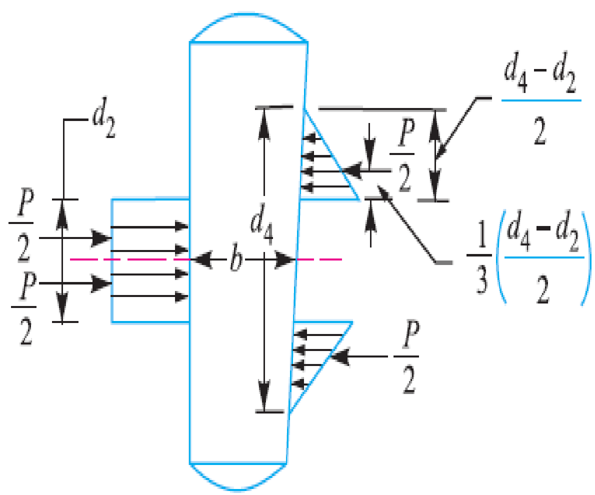
WINTER – 19EXAMINATION

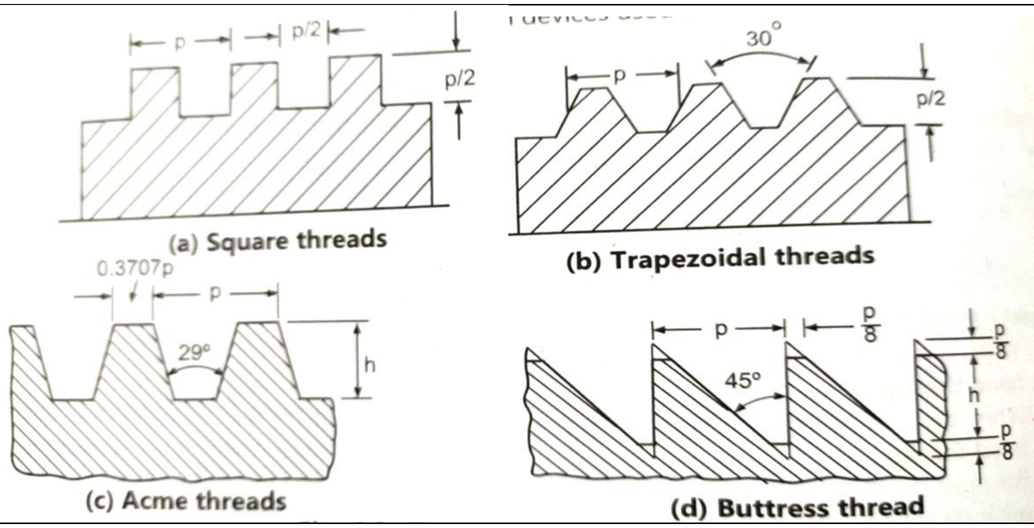
Subject Name: Elements of Machine Design **Model Answer** **Subject Code: 22564**

Important Instructions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in themodel answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may tryto assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given moreImportance (Not applicable for subject English and Communication Skills.
4) While assessing figures, examiner may give credit for principal components indicated in thefigure. The figures drawn by candidate and model answer may vary. The examiner may give credit for anyequivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constantvalues may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

Q. No.	Sub Q. N		Marking Scheme
1.		**Attempt anyFIVE of the following**	**10 Marks**
	a)	**Define factor of safety for ductile and brittle material.**	
	Ans	**Factor of safety for ductile material:** It is defined as ratio of yield stress to the working stress or $\text{For Ductile Material,} \quad \text{Factor of safety} = \frac{\text{Yield stress}}{\text{working stress / Designstress}}$	01 M
		Factor of safety for Brittle material : It is defined as ratio of ultimate stress to the working stress /permissible /design stress or $\text{For Brittle material,} \quad \text{Factor of safety} = \frac{\text{Ultimate stress}}{\text{working stress / Designstress}}$----------	01 M
	b)	**List four properties desirable for spring material(Any Four)**	
	Ans	1)High Resilience 2) High ductile 3)High static strength 4) High fatigue strength 5) Non corrosive	1/2 M each
	c)	**List four applications of knuckle joints (Any Four)**	
	Ans	1) Link of bicycle chain, 2) Tie bar of roof truss, 3) Link of suspension bridge 4)Valve mechanism, 5) Fulcrum of lever, 6) Joint for rail shifting mechanism	1/2 M each
	d)	**Name four types of keys(Any Four)**	
		1) Sunk keys 2) Gibb-head key 3)Feather key 4)Woodruff key 5)Saddle keys 6)Tangent keys 7)Round keys 8) Splines Key	1/2 M each
	e)	**List any four application of power screw.**	
	Ans	1) Machine Vice 2) power press 3) Universal testing machine 4) C clamps etc. OR 1)To raise the load 2) To clamp the work-piece 3) to load specimen 4)to obtain accurate motion	1/2 M each
	f)	**Classify springs**	

	Ans	1) Helical springs: Compression helical spring, Tension helical spring 2) Conical and volute springs 3) Torsion springs 4) Laminated or leaf springs 5)Disc or Belleville springs 6) Special purpose springs	1/2 M each
	g)	**Give four applications of gear drive. (Any Four)**	
	Ans	1) Gear box of vehicle 2)Machine tool 3)Gear mechanism of wrist watch 4) Dial Indicator 5) Cement mixing unit 4) Diff. Mechanism of automobiles	1/2 M each
2.		**Attempt anyTHREE of the following**	**12 Marks**
	a)	**Write the meaning of following material designation.**	
	Ans	1)40C8 : Plain carbon steel carbon 0.4% of average, manganese 0.8% 2)SG 700/2 : spheroidal Graphite cast iron with Min UTS 700N/mm2 and elongation 0.2 % 3)Fe E200 : Steel with yield strength of 200N/mm2 4)X10Cr18Ni9 : high alloy steel carbon 0.10% of average, chromium 18%, Nickel 9%,	1 Mark each
	b)	**Explain the failure of cotter in bending with suitable sketch and strength equation**	
	Ans	**Bending failure of cotter:** Theoretically .It is assumed that the load is uniformly distributed over the various cross-sections of the joint. But in actual practice, this does not happen and the cotter is subjected to bending. In order to find out the bending stress induced, it is assumed that the load on the cotter in the rod end is uniformly distributed while in the socket end it varies from zero at the outer diameter (*d*4) and maximum at the inner diameter (*d*2), as shown in Fig. 	2 Marks fig.

		The maximum bending moment occurs at the centre of the cotter and is given by $M_{max} = \frac{P}{2}\left(\frac{1}{3}\times\frac{d_4 - d_2}{2} + \frac{d_2}{2}\right) - \frac{P}{2}\times\frac{d_2}{4}$ $= \frac{P}{2}\left(\frac{d_4 - d_2}{6} + \frac{d_2}{2} - \frac{d_2}{4}\right) = \frac{P}{2}\left(\frac{d_4 - d_2}{6} + \frac{d_2}{4}\right)$ We know that section modulus of the cotter, $Z = t \times b^2 / 6$ $\therefore$ Bending stress induced in the cotter, $\sigma_b = \frac{M_{max}}{Z} = \frac{\frac{P}{2}\left(\frac{d_4 - d_2}{6} + \frac{d_2}{4}\right)}{t \times b^2 / 6} = \frac{P\,(d_4 + 0.5\,d_2)}{2\,t \times b^2}$ This bending stress induced in the cotter should be less than the allowable bending stress of the cotter.	2 Marks
	c)	**Write Lewis equation for strength of gear tooth give meaning of each term**	
	Ans	Lewis equation for strength of gear tooth : **W_T = 6w.b. Pc. Y = 6w.b.πm. y** **Where,** W_T = Tangential load acting at the term , 6w = Beam strength of the tooth , b = Width of the gear face Pc = Circular pitch m = Module Y = Lewis form factor or tooth form factor.	2 Marks for equation & 2 Marks for notations
	d)	**Draw freehand sketches of thread profiles (any four) with full details**	
	Ans		1 Marks for each type
3.		**Attempt any <u>THREE</u> of the following:**	**12marks**
	a)	Explain maximum principal stress theory and maximum shear stress theory with their uses.	
	Ans	**1. <u>Maximum Principal (Normal) Stress Theory (Rankine's Theory):</u>** According to this theory, the failure or yielding occurs at a point in a member when the maximum principal (Normal) stress in a bi-axial stress system reaches the limiting strength of the material in a simple tension test.	

Since, for ductile material the limiting strength is the stress at yield point & for brittle material the limiting strength is the ultimate stress.

∴ According to the above theory, taking FOS into consideration,

The maximum principal (Normal) stress (σ_{t1}) in a bi-axial stress system is given by, 2 marks

$$\sigma_{t1} = \frac{\sigma_{yt}}{FOS} \qquad \ldots for\ ductile\ material$$

$$\sigma_{t1} = \frac{\sigma_{ut}}{FOS} \qquad \ldots for\ brittle\ material$$

Application:
Designing of machine components of brittle material.
Examples:
Spindle of screw jack, machine bed, C-frame, Overhang crank.

2. **Maximum Shear Stress Theory (Guest's or Tresca's Theory):**

According to this theory, the failure or yielding occurs at a point in a member when the maximum Shear Stress in a bi-axial stress system reaches a value equal to shear stress at yield point in a simple tension test.

∴ According to the above theory, taking FOS into consideration,

The maximum principal (Normal) stress (σ_{t1}) in a bi-axial stress system is given by,

$$\tau_{max} = \frac{\tau_{yt}}{FOS}$$

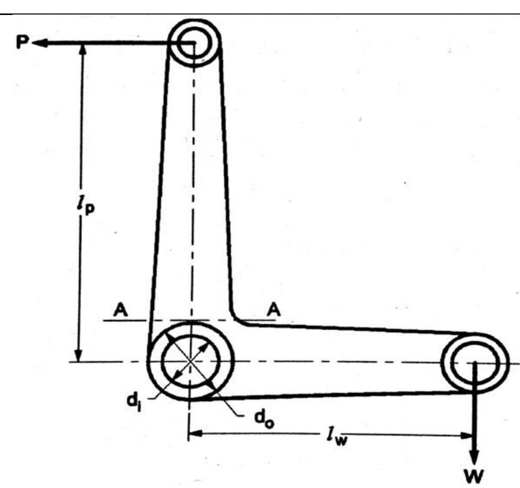
Since, the shear stress at yield point in a simple tension test is equal to one-half the yield stress in tension. 2 marks

$$\tau_{max} = \frac{\sigma_{yt}}{2 \times FOS}$$

Application:
Designing of machine components of ductile material.
Examples:
Spring, key, crank shaft, propeller shaft.

b) Write general design procedure of the bell crank lever. (any four steps)

Ans



1. **Find the effort (P) required to raise the load (W),**
   Taking moment about the fulcrum F, we have,

$$W \times l_w = (P) \times l_p$$

2. **Find reaction at fulcrum pin at F,**

$$R_F = \sqrt{W^2 + P^2}$$

Find:

3. **Design of fulcrum pin:**

   i. Fulcrum pin is designed by considering under bearing pressure,

$$P_b = \frac{R_F}{l_f . d_f}$$

where, l_p = length of fulcrum pin.

d_p= diameter of fulcrum pin.

Find :l_p, d_p.

   ii. Fulcrum pin is subjected to double shear,

$$\tau = \frac{R_F}{2A} = \frac{R_F}{2.\frac{\pi}{4}{d_p}^2}$$

Find: τ Check the shear stress induced in the fulcrum pin.

1 marks for any four steps each

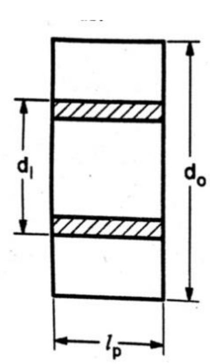
4. **Diameter of boss of lever:**

The boss of the lever is subjected to bending stress due to bending moment of lever.

Let,

d_i = inner diameter of the boss of the lever/ diameter of hole in lever.

d_o = outer diameter of the boss of the lever/ diameter of boss at fulcrum.



A brass bush of 3 mm thickness is pressed into the boss of the fulcrum as a bearing so that renewal become simple when wear occurs.

$d_i = d_p + 2 \times 3$

$d_i = d_p \ldots (if\ bush\ is\ not\ used)$

$d_i = 2 \times d_p$

$B.M. = M = W \times l_w = P \times l_p$

$$Z = \frac{I}{y} = \frac{l_p(d_o{}^3 - d_i{}^3)/12}{d_o/2}$$

$$\therefore \sigma_b = \frac{M}{Z}$$

Check the σ_b induced in the lever arm at the fulcrum.

5. **Design of lever to find dimensions:**

The lever is subjected to B.M. ,

The maximum B.M. acts near the boss,

$$M = P \times \left[l_p - \frac{d_o}{2}\right] or = W \times \left[l_w - \frac{d_o}{2}\right]$$

$$\therefore \sigma_b = \frac{M}{Z}$$

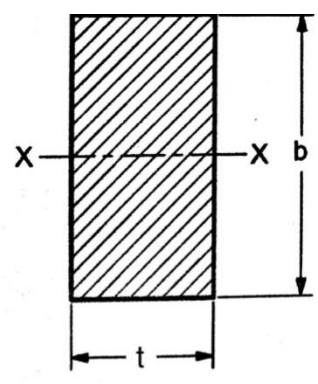
i. Consider rectangular cross-section of the lever,

$$Z = \frac{I}{y} = \frac{\frac{tb^3}{12}}{\frac{b}{2}} = \frac{tb^2}{6} \qquad (b = 3t)$$

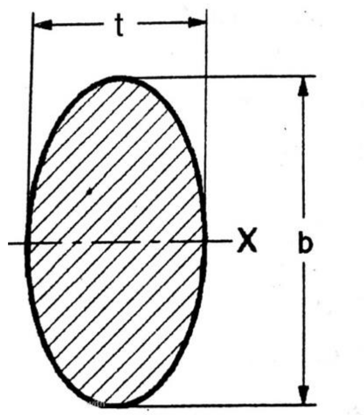
where,

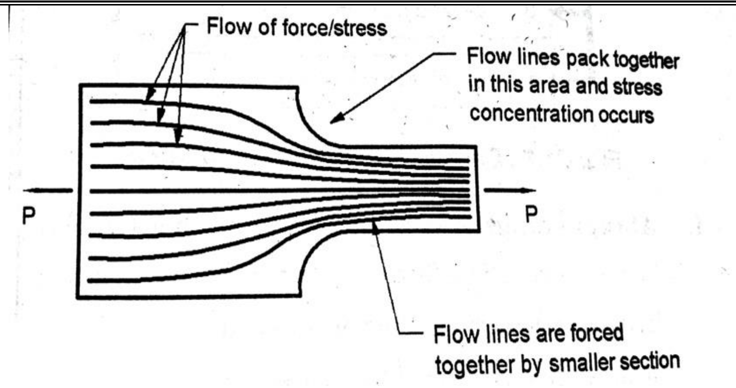
b = depth of the lever.

t = thickness of the lever.



ii. For elliptical section,

		$Z = \frac{I}{y} = \frac{\frac{\pi t b^3}{64}}{\frac{b}{2}} = \frac{\pi t b^2}{32}$ where, t = minor axis of ellipse. b = major axis of ellipse. 	
	c)	State any four applications of spring.	
	Ans	**Applications of spring: (Any Four)** 1. In automobile suspension. 2. In railway suspension. 3. In shot blasting machine. 4. In clocks and toys to store energy. 5. In spring balance and engine indicator to measure force. 6. In clutch, brakes, spring loaded valves, etc.	1 mark for one applica- tion any four each
	d)	Define stress concentration. Explain any four methods to reduce it with neat sketch.	
	Ans	**Stress Concentration:** Whenever the machine component changes the shape of its cross section the stress distribution pattern no longer holds good and the neighborhood of the discontinuity is different. The stresses induced in the neighborhood are much higher than the stress induced in the other part of the component. This abrupt change in cross section or the discontinuity form is called stress concentration. It is for all kinds of stresses caused due to keyways, grooves, notches, roughness or scratches.	Fordefinition 2 marks for stress concen- -tration

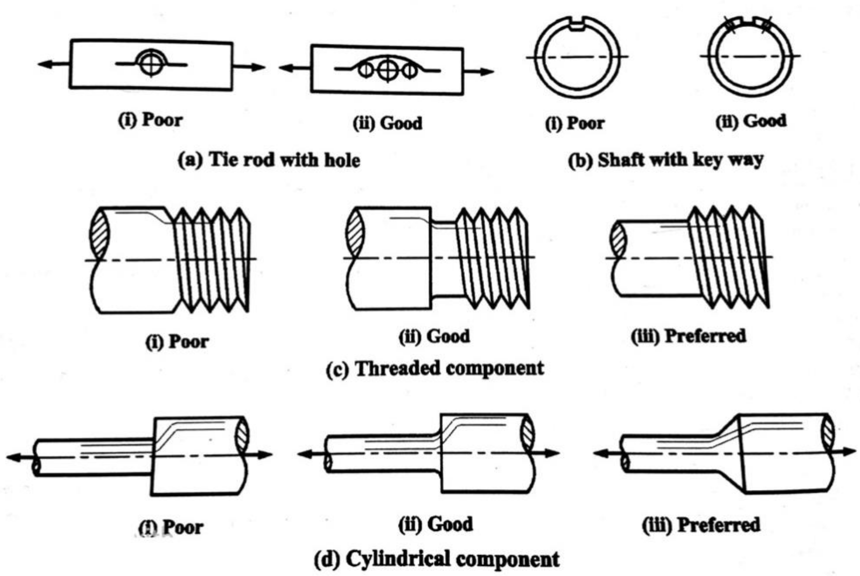


The effect of stress concentration cannot be completely eliminated but its effect can be reduced by altering the geometry of the component.

So the following methods are adopted to reduce the effect of stress concentration:

2 marks for methods to reduce them

1. Providing additional holes and notches.
   a. Use of multiple notches.
   b. Drilling additional holes.
   c. Removing roughness.
2. By providing fillet radius to the corners of the members and under and notches for the members in bending.
3. Reduction in stress concentration of the threaded component.
4. By drilling small holes near the large holes or providing additional holes in the shafts.
5. By providing taper cross sections to the members having sharp corners.



e) Define the following terms with respect to spring:

Ans

i) Free length:

It is the length of the spring in free or unloaded condition.

It is denoted by 'L_f'.

Free length = Solid Length + Maximum Compression + clearance between adjacent coils.

		Free length = L_f = n'd + δ_{max} + 0.15 x δ_{max} = n'd + δ_{max} + (n'-1) x 1mm. The clearance between two adjacent coils is taken as 1mm sometimes it is taken as 15% of the maximum deflection. **ii) Solid length:** When the compression spring is compressed until the coil comes in contact or touches each other, then the spring is said to be in solid condition. This length of spring is known as solid length. It is denoted by 'L_s'. Solid length = L_s = n'd where n' = total number of coils or turns. d = diameter of wire in mm. **iii) Spring index:** It is defined as the ratio of mean diameter of coil to the diameter of wire. It is denoted by 'C'. Spring index = C = $\frac{D_m}{d}$ Where, D_m = Mean diameter of coil in mm. d = wire diameter in mm. **iv) Spring rate:** The spring rate/ spring stiffness is defined the load required per unit deflection of the wire. It is denoted by 'K'. Spring rate/ Spring Stiffness = K = $\frac{W}{\delta} = \frac{W}{S}$ (N/mm) where W = axial load in N. δ = maximum deflection in mm	1 Mark for each term
Q.4		**Attempt any <u>TWO</u> of the following:**	12 marks

	a)	Explain importance of shape and size in aesthetic design.	
	Ans	The aesthetic characteristics is a very important for all design elements. The aesthetics is the property to have good performance along with the better appearance for the satisfaction of the customer. In the buyer's market, have a number of products with same identical parameters, but the appearance of the of the product plays a major role in attracting the customers. The aesthetic has a produce with the extent which contributes varies from product to product. This is important for the designer to have develop the shape of a product so that customer get attracted towards it and the appearance should be pleasing. For example the cars are designed in the form of aerodynamic shape, this aesthetic forms helps in the performance by getting less resistance of air as well as the appearance which extent in contribution. The shape is also the important aesthetic criteria that the products develops and designed should not be bulky in size which will affect the performance as well as the appearance of the product. The designer thus have the choice to minimize the shape and can form smaller size product designs rather than bulky designs. Thus, aesthetics helps to get the better appearance and performance which extent its contributions from product to product.	6 marks
	b)	The pull in the tie rod of a roof truss is 44 kN. Design a suitable adjustable screw joint. The permissible tensile and shear stresses are 75 MPa and 37.5 MPa respectively.	6 marks
	Ans	**Let,** d_c = core diameter of tie rod. d = do = nominal (maximum) diameter of tie rod D = Outside diameter of coupler nut. l = Length of coupler nut. D_1 = Inside diameter of coupler. D_2 = Outside diameter of coupler. L = Total length of coupler = 0.6 d	

Given, $P = 44 \times 10^3$ N

$\sigma_t = 75$ N/mm^2

$\tau = 37.5$ N/mm^2

$\sigma_c = 90$ N/mm^2 ----- (Assumed)

We know that, for threaded component

$P_d = 1.3 \times P = 1.3 \times 44 \times 10^3 = 57.2 \times 10^3$ N

Here we use turnbuckle as a adjustable screw joint.

i] Diamenter of Rod :-

$$\sigma_t = \frac{P_d}{A} = \frac{P_d}{\frac{\pi}{4} d_c^2}$$

$$\therefore 75 = \frac{57.5 \times 10^3}{\frac{\pi}{4} d_c^2}$$

$\therefore d_c = 31.16$ mm ≈ 32 mm

$\frac{d_c}{d_o} = 0.84$ $\therefore d_o = 38.095$ mm ≈ 40 mm

ii] Length of Coupler Nut (l) :-

$$\tau = \frac{P_d}{A} = \frac{1.3 \times P}{\pi d_o \cdot l}$$

$\therefore l = 12.138$ mm

But $l = 1.25\, d = 50$ mm

iii] Outside diameter of coupler nut (D) :-

$$\sigma_t = \frac{P}{\frac{\pi}{4}(D^2 - d^2)}$$

$\therefore D = 50.705 = 52$ mm

But $D = 1.25 \times d = 50$ mm $\therefore$ Design is safe

		iv] **Outside diameter of Coupler (D_2) :-** $\sigma_t = \frac{P}{A} = \frac{P}{\frac{\pi}{4}(D_2^2 - D_1^2)}$ But, $D_1 = d + 6 = 40 + 6 = 46$ mm $\therefore 75 = \frac{44 \times 10^3}{\frac{\pi}{4}(D_2^2 - 46^2)}$ $\therefore D_2 = 53.5$ mm $= 54$ mm But, $D_2 = 1.5\, d = 1.5 \times 40 = 60$ mm v] **Length of coupler Nut** $= L = 6 \cdot d = 240$ mm vi] **Thickness of coupler** $= t = 0.75\, d = 30$ mm vii] **Thickness of coupler nut** $= t_1 = 0.5\, d = 20$ mm	
	c)	A Lathe receives power from an overhung shaft situated exactly above the lathe pulley by means of the belt drive. A pulley weighing 400 N and of diameter 270 mm is fixed on the shaft. The centre to centre distance between the two shaft supporting bearing is 900 mm. the maximum power required by machine is 5 kW at 200 rpm. The belt tension ratio is 2.5. Determine the diameter of the shaft. Allowable shear stress for shaft material is 40 N/mm^2.	6 marks

$P = 5 \times 10^3$ Watt

$N = 200$ rpm

$W_P = 400$ N

$D = 270$ mm

$\frac{T_1}{T_2} = 2.5$

$\tau = 40$ N/mm²

$$\text{Power} = \frac{2\pi N T}{60}$$

$$5 \times 10^3 = \frac{2\pi \times 200 \times T}{60}$$

$$\therefore T = 238.732 \text{ N.m}$$

$$T = 238.732 \times 10^3 \text{ N.mm}$$

$$\frac{T_1}{T_2} = 2.5 \qquad \therefore T_1 = 2.5 \times T_2$$

$$T = (T_1 - T_2) \times R$$

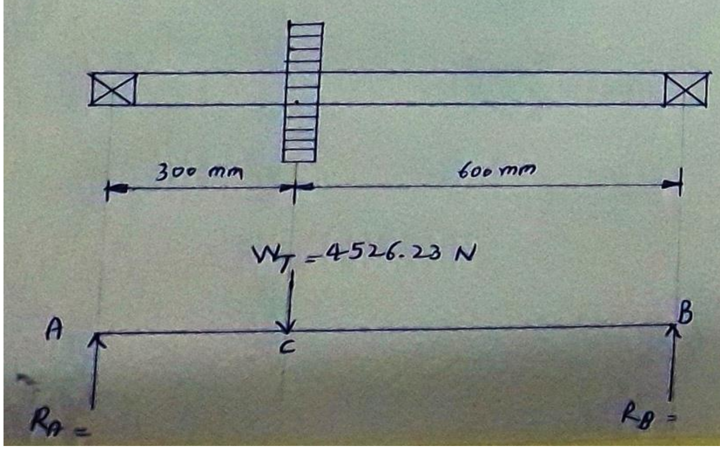
$$238.732 \times 10^3 = (2.5\,T_2 - T_2) \times \frac{270}{2}$$

$$\therefore T_2 = 1178.92 \text{ N} \quad \& \quad T_1 = 2947.31 \text{ N}$$

Now, Total weight $= W_T = W_P + T_1 + T_2$

$$= 400 + 1178.92 + 2947.31$$

$$\therefore W_T = 4526.23 \text{ N}$$



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$\Sigma F_y = 0 \quad \therefore R_A + R_B = 4526.233 \text{ N}$
$\Sigma M_A = 0 \quad -(W_T \times 300) + R_B \times 900 = 0$
$\therefore R_B = 1508.744 \text{ N} \quad \& \quad R_A = 3017.48 \text{ N}$
Now, find Moments at A, B & C
$M_A = 0$
$M_C = R_B \times 600 = 905.24 \times 10^3 \text{ N.mm}$
$M_B = 0$
$\therefore M = 905.24 \times 10^3 \text{ N.mm}$
Now, $T_{eq} = \frac{\pi}{16} \tau d^3 = \sqrt{M^2 + T^2}$
$\therefore \frac{\pi}{16} \times 40 \times d^3 = \sqrt{(905.24 \times 10^3)^2 + (238.73 \times 10^3)^2}$
$\therefore d = 49.21 \text{ mm}$
$\therefore d = 50 \text{ mm}$ .... diameter of shaft
</td><td></td></tr>
<tr><td>5.</td><td></td><td>Attempt any<u>TWO</u> of the following</td><td>12 Marks</td></tr>
<tr><td></td><td>a)</td><td>A flanged protective type coupling is required to transmit 7.5 KW at 720 rpm. Assume the following stresses for the coupling components. Permissible shear stress for shaft, bolt & key material = 33 N/mm^2. Permissible crushing stress for bolt & key material = 60 N/mm^2.
Find:
(i) Diameter of shaft
(ii) Diameter of key
(iii) Diameter of bolt</td><td></td></tr>
<tr><td></td><td>Ans</td><td>P = 7.5 KW
N= 720rpm
τ = 33 N/mm^2
σ = 60 N/mm^2
Step 1)Find Torque
P = $\frac{2\pi NT}{60}$</td><td></td></tr>
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$$T = \frac{7.5\times10^3 \times 60}{2\times\pi\times720}$$

T= 99.47N.m= 99.47$\times$ 10^3N.mm

Step 2) We also know that

T= $\frac{\pi}{16} \times \tau \times d^3$

99.47$\times$ 10^3N.mm= $\frac{\pi}{16} \times 33 \times d^3$

d^3 = 15351.41**d = 24.85 mm=25mm**

Step 3)Design of hub

Outer diameter of hub

D= 2d = 2$\times$25 = 50 mm

Length of hub, L= 1.5d =1.5 $\times$25= 37.5mm

Let, now check induced shear stress

$$T= \frac{\pi}{16} \times \tau c \times \frac{[D^4 - d^4]}{D}$$

99.47$\times$ 10^3= $\frac{\pi}{16} \times \tau c \times \frac{[50^4 - 25^4]}{50}$

$\tau c = 4.32\ N/mm2$

Since induced shear stress is less than permissible value 33N/mm2 the design is safe

Step 4)Design of key, here Rectangle key is used

from table W=10mm

t= 8mm

Length of key is taken as length of the hub = L = 37.5mm

Let us now check induced stresses

T = l × w × Ʈ × $\frac{d}{2}$

99.47$\times$ 10^3= 37.5× 10 × Ʈ × $\frac{25}{2}$

Ʈ =21.22≤ 33N/mm^2

99.47$\times$ 10^3 = l × $\frac{t}{2}$ × σ_{ck} × $\frac{25}{2}$

99.47$\times$ 10^3 = 37.5 × $\frac{8}{2}$ × σ_{ck} × $\frac{25}{2}$

σ_{ck} = 53.05≤ 60N/mm^2

Design is safe.

Step 5) Design for flange

		$t_f = 0.5\ d = 0.5 \times 25 = 12.5mm$ Now, check induced shear stress in flange $T = \frac{\pi D^2}{2} \times \tau \times tf$ $99.47 \times 10^3 == \frac{\pi 25^2}{2} \times \tau \times 12.5$ $\tau = 8.10\ N/mm^2$ Flange is safe. **Step 6) Design for bolts** Number of bolts is n = 3 $D_1 = 3d = 3 \times 25 = 75mm$ Bolts are subjected to shear stress $T = \frac{\pi}{4} \times d1^2 \times tb \times n \times \frac{D1}{2}$ $99.47 \times 10^3 = \frac{\pi}{4} \times d1^2 \times 33 \times 3 \times \frac{75}{2}$ $d\ 1^2 = \frac{99.47 \times 103}{2915.79}$ $d\ 1^2 = 34.11$ $d1 = 5.84mm$ Assume coarse thread nearest to standard diameter M6 **step 7)** Outer diameter of the flange, $D_2 = 4d = 4 \times 25 = 100mm$ **Step 8)** Thickness of protective circumferential flange, $tp = 0.25d = 0.25 \times 25 = 6.25mm$	
	b)	The lead screw of lathe has ACME thread of 60 mm outside diameter & 8 mm pitch. It supplies drive to a tool carriage which need an axial force of 2000 N. A collar bearing with inner & outer radius as 30 mm & 60 mm respectively is provided. The coefficient of friction for the screw thread is 0.12 & collar is 0.10. Find the torque required to drive the screw & the efficiency of the screw.	
	Ans	$d_0 = 60mm$ $W = 2000N$ $D_2 = 30mm$ $D_1 = 60mm$ $p = 8mm$ $\mu = 0.12$ $\mu_2 = 0.10$ **To Find**	

T=?

η =?

Step 1) Mean diameter of screw

$d = d_0 - \frac{p}{2} = 60 - \frac{8}{2} = 56mm$

$\tan\alpha = \frac{p}{\pi d} = \frac{8}{\pi \times 56}$

$\tan\alpha = 0.045$

angle for ACME thread $2\beta = 29^0 \beta = 14.5^0$

$\mu 1 = \tan\emptyset 1 = \frac{\mu}{\cos\beta}$

$\mu 1 = \tan\emptyset 1 = \frac{\mu 0.12}{\cos 14.5}$

$\mu 1 = \tan\emptyset 1 = 0.1239$

Step 2) Torque required to overcome friction of screw

$T_1 = W \frac{\tan\alpha + \tan\emptyset 1}{1 - \tan\alpha . \tan\emptyset 1} \times d/2$

$T1 = 2000 \times \frac{0.045 + 0.1239}{1 - 0.045.0.1239} \times 56/2$

T1= 9576N.mm

Step 3) Assuming uniform wear to overcome collar friction

$R = \frac{R1 + R2}{2} =$

$R = \frac{30+60}{2} = 45mm$

$T_2 = \mu \times W \times R = 0.10 \times 2000 \times 45 = 9000N.mm$

T = T1 +T2 = 9576 + 9000 = 18576 N.mm

Step 4)

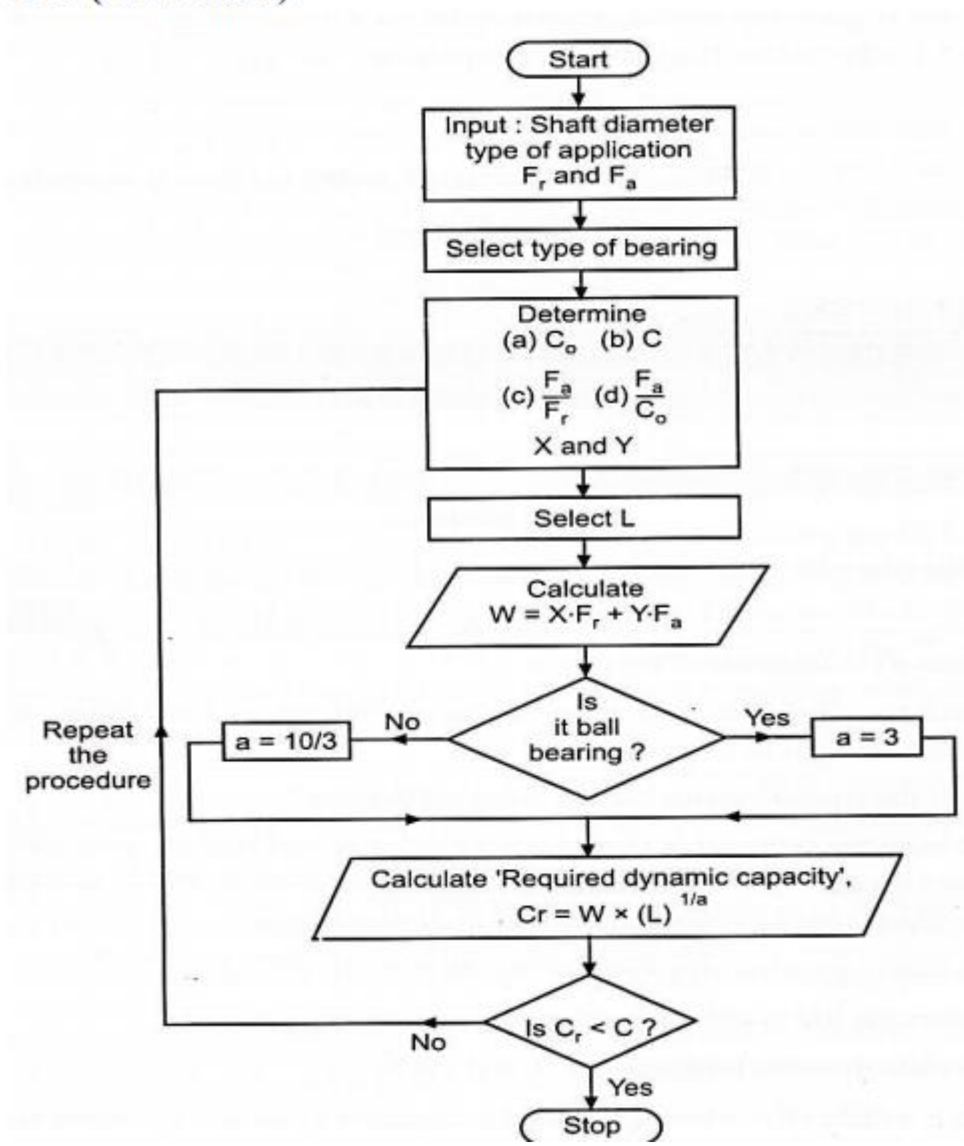
$\eta = \frac{T0}{T} = \frac{W\tan\alpha \times \frac{d}{2}}{T}$

$\eta = \frac{T0}{T} = \frac{2000 \times \tan\alpha \times \frac{56}{2}}{18576}$

η=0.1371=13.71%

	c)	**State the steps involved in selection of proper ball bearing from manufacturer's catalogue.**	
	Ans	1) Calculate radial and axial forces and determine dia. of shaft. 2) Select proper type of bearing. 3) Start with extra light series for given diagram go by trial of error method 4) Find value of basic static capacity (co) of selected bearing from catalogue. 5) Calculate ratios Fa/VFr and Fa/Co.	

		6) Calculate values of radial and thrust factors.(X & Y) from catalogue. 7) For given application find value of load factor Ka from catalogue. 8) Calculate equivalent dynamic load using relation. Pe = (XVFr + YFA) Ka. 9) Decide expected life of bearing considering application. Express life in million revolutions L10 10) Calculate required basic dynamic capacity for bearing by relation. 11) Check whether selected bearing has req. dynamic capacity, IF it not select the bearing of next series and repeat procedure from step-4 **OR** **OR (flowchart)**	



6.		**Attempt any<u>TWO</u> of the following**	**12 Marks**
	a)	A plate 75 mm wide & 12.5 mm thick is to be joined with another plate by single transverse & parallel fillet weld. Maximum tensile & shear stresses are 70 N/mm^2& 56 N/mm^2 respectively. Find the length of each parallel fillet weld if joint is subjected to 90 KN.	
	Ans	Given data	

		W= 75KN t = 12.5mm τ= 56 N/mm^2 σt =70 N/mm^2 P= $90\times10^3 N/mm^2$ **Step 1) Load carried by single transverse** P_1= 0.707× s × l_1× σ t P_1= 0.707 × 12.5 × 62.5×70 ……………………………(l_1 =75-12.5 =62.5) P_1= 38664.06 N **Step 2) Double parallel fillet weld** P_2= 1.414 × S × l_2× τ P_2= 1.414 × 12.5 × l_2× 56 P_2= 989.8 × l_2 **Step 3) P= P_1 + P_2** 90×10^3 = 38664.06 + 989.8 × l_2 l_2= 51.86mm l_2= 51.86+ 12.5 l_2 = 64.36 mm	**2 Marks** **2 Marks** **2 Marks**
	b)		
	Ans	W= 1000N δ = 25mm C = $\frac{D}{d}$ = 0.6 $\tau = 420$ mm G=84×10^3 N/mm^2 **Step 1)** Mean diameter of spring coil $K=\frac{4C-1}{4C-4}+\frac{0.615}{4C-4}$ $K=\frac{4\times5-1}{4\times5-4}+\frac{0.615}{4\times5-4}$ K= 1.31 **Step 2)** Maximum shear stress $420 = K\frac{(8\times W\times C)}{\pi d^2} = 1.31 \times \frac{(8\times1000\times5)}{\pi d^2}$ d = 6.3mm	

		From table take d = 6.401 or same value also considered $D = C \times d = 5 \times 6.401 = 32.005$ Outer diameter of spring $D_0 = D + d = 32.005 + 6.401 = 38.406$ mm **Step 3)** number of turns of the coil $\delta = \frac{8WC^3 n}{G.d}$ $25 = \frac{8 \times 1000 \times 5^3 n}{84 \times 10^3 \times 6.401}$ $n = \frac{25}{1.86}$ $n = 13.44 = 14$ **Step 4)** for square and ground ends n'= n+2 = 14+2 =16 **Step 5) Free length** $L_f = n'd + \delta + 0.15 \times \delta = 16 \times 6.401 + 25 + 0.15 \times 25 = 131.2$ mm **Step 6) Pitch of the coil** $= \frac{free\ length}{n' - 1} = \frac{131.2}{16-1} = 8.76$ mm	
	c)	A hollow transmission shaft having inside diameter 0.6 times outside diameter, is made up of plain carbon steel 40C8 & having permissible shear stress equal to 65 MPa. A belt pulley, 1000 mm in diameter is mounted on a shaft, which overhangs the left hand bearing by 250 mm. The belt are vertical power transmit to the machine shaft below the pulley. The tension on tight & slack side of belt are 3 kN& 1 kN respectively, while weight of pulley is 500 N. The angle of rap of the belt on pulley is 180°. Calculate outside & inside diameter of shaft.	
	Ans	**Given data** d = 0.6 D $T_1 = 3 \times 10^3$ N $T_2 = 1 \times 10^3$ N W_t =500N $\tau = 65 MPa$ $\theta = 180^0$ Diameter of the pulley, D=1000mm K= d/D =0.6 **Step 1) Find torque**	

		$T = (T1-T2)R = (3000-1000) \times 500 = 1 \times 10^6$ N.mm Total weight on the pulley $W_t = T1 + T2 + W = 3000+1000+500 = 4500$ N **Step 2) Bending moment** $M = W_t \times 250 = 4500 \times 250 = 1.125 \times 10^6$ N.mm **Step 3) Find equivalent twisting moment** $T_{eq} = \sqrt{M^2 + T^2} = \sqrt{(1.125 \times 10^6)^2 + (1 \times 10^6)^2} = 1.50 \times 10^6$ N.mm $T_{eq} = \frac{\pi}{16} \times \tau \times d_0^3 \times (1 - K^4)$ $1.56 \times 10^6 = \frac{\pi}{16} \times 65 \times d_0^3 \times (1-0.6^4)$ $d_0 = 51.97 = 55$mm $di = 0.6 \times 55 = 33$ mm	**02 Marks** **02 Marks** **02 Marks**