Course Code: 1950320 **Roll No:** **MLRS- R19**

MARRI LAXMAN REDDY
INSTITUTE OF TECHNOLOGY AND MANAGEMENT
(AN AUTONOMOUS INSTITUTION)
(Approved by AICTE, New Delhi & Affiliated to JNTUH, Hyderabad)
Accredited by NBA and NAAC with 'A' Grade & Recognized Under Section2(f) & 12(B)of the UGC act,1956

III B.Tech I Sem Regular End Examination, January 2022

Design of Machine Members – I

(MECH)

Time: 3 Hours. **Max. Marks: 70**

Note: 1. Question paper consists: Part-A and Part-B.
2. In Part – A, answer all questions which carries 20 marks.
3. In Part – B, answer any one question from each unit.
Each question carries 10 marks and may have a, b as sub questions.

PART- A

(10*2 Marks = 20 Marks)

1.	a)	Define a tolerance and fit its types.	2M	CO1	BL1
	b)	What is factor of safety?	2M	CO1	BL1
	c)	What are the different factors affecting fatigue strength?	2M	CO2	BL1
	d)	Draw the S-N Curve.	2M	CO2	BL1
	e)	Compare the strength of the Transverse and Parallel fillet welds.	2M	CO3	BL2
	f)	Draw the schematic diagram of a zig-zag riveted joint.	2M	CO3	BL1
	g)	Specify the types of keys.	2M	CO4	BL2
	h)	What is the function of Gib?	2M	CO4	BL1
	i)	List out the types of stresses are induced in shafts.	2M	CO5	BL1
	j)	List different types of couplings.	2M	CO5	BL1

PART- B

(10*5 Marks = 50 Marks)

2	a)	Enumerate the factors to be considered in selecting the materials for the design of a machine element	5M	CO1	BL5
	b)	The principal stresses induced at a critical point consists of a tensile stress σ_1 = 200 MPa and σ_2 = 100 MPa compressive and σ_3 = 0 MPa. Determine the maximum shear stress and factor of safety if the material has yield strength of 500 MPa	5M	CO1	BL3
		OR			
3		The stresses induced at a critical point in a machine component made of steel 45C8 with yield strength of 500 MPa are: σ_x = 100 MPa, σ_y = 40 MPa and τ_{xy} = 80 MPa. Calculate the factor of safety by (a) the maximum normal stress theory, (b) the maximum shear stress theory and (c) the Distortion energy theory. Take E = 210 GPa, Poisson's ratio = 0.25	10M	CO1	BL3

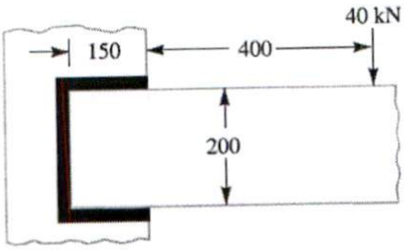
4 a) What are the different methods to reduce stress concentration? 4M CO2 BL1

b) A 40 mm diameter shaft is made of steel 50C4 with ultimate strength of 660 MPa has a machined surface. The expected reliability is 99%. The theoretical stress concentration factor for the shape of the shaft is 1.6 and notch sensitivity factor is 0.9. Determine the endurance limit of the shaft 6M CO2 BL3

OR

5 A leaf spring in an automobile is subjected to cyclical stresses. The average stress = 150 MPa, variable stress = 50 MPa, Ultimate stress = 630 MPa, Yield point stress = 350 MPa and endurance limit = 150 MPa. Estimate under what factor of safety the spring is working, by Goodman and Soderberg formulae. Take K_f = 1.65 10M CO2 BL

6 a) A bracket, as shown in Fig, carries a load of 40 kN. Calculate the size of weld, if the allowable shear stress is not to exceed 80 MPa. 5M CO3 BL3



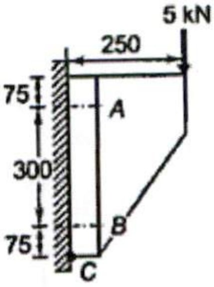
All dimensions in mm.

b) Two plates of 6 mm thickness are to be joined by a double riveted zig – zag lap joint. Design the joint, if the allowable strengths of mild steel are 100 MPa in tension, 70 MPa in shear and 130 MPa in crushing. Find the efficiency of the joint. Sketch the joint. 5M CO3 BL3

OR

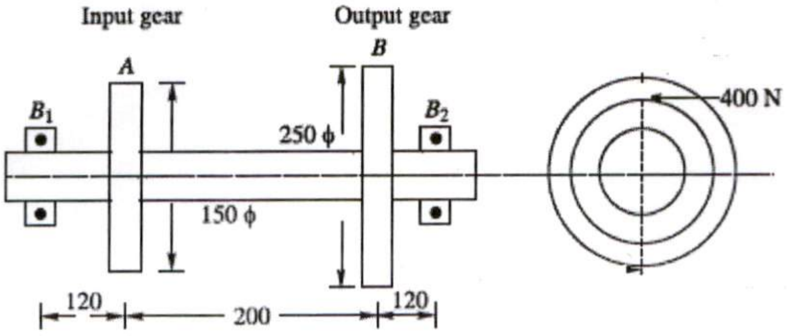
7 A bracket for supporting the traveling crane is shown in Figure . The bracket is fixed to the steel column by means of four identical bolts, two at A and two at B. The bolts are made of steel 40C8 and the factor of safety is 5. Determine the major diameter of the bolts on the basis of maximum shear stress theory. Discuss the nature of stresses induced in the bolts. 10M CO3 BL3

Figure 1



8 Design a sleeve and cotter joint to resist a tensile load of 40 kN. The material of the rod and sleeve is Fe 490 and material of the cotter is Fe 330. Allowable crushing stress is 1.4 times allowable tensile stress. Allowable shearing stress is 0.8 times allowable tensile stress for all three components. Tensile stress for muff = 490 MPa, cotter = 330 MPa 10M CO4 BL6

	OR			
9	Design a knuckle joint to transmit 150 kN. The design stresses may be taken as75 MPa in tension, 60 MPa in shear and 150 MPa in compression.	10M	CO4	BL6
10	Design a muff coupling for joining shafts transmitting 8 kW at 400 rpm. The shaft and the key are made of steel with 45 MPa and 80 MPa allowable stresses in shear and crushing, respectively. The material of the sleeve is CI, with allowable shear stress 10 MPa.	10M	CO5	BL6
	OR			
11	A countershaft in a gear box supports two spur gears, as shown in figure 1. Pitch-circle diameters of gears A and B are 150 mm and 250 mm, respectively. Both gears have 20° pressure angle involute teeth. The tangential load on smaller gear is 400 N. Determine the shaft diameter. The shaft is made of 30 C8, with yield strength of 400 MPa and an ultimate strength 500 MPa. Take factors Kb and Kt as 1.5 and 2.0, respectively.	10M	CO5	BL3



Ball bearings B_1 and B_2

---oo0oo---

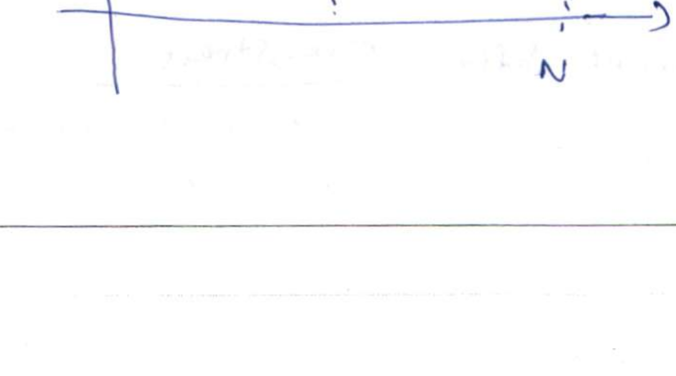
MARRI LAXMAN REDDY
INSTITUTE OF TECHNOLOGY AND MANAGEMENT
(AN AUTONOMOUS INSTITUTION)
(Approved by AICTE, New Delhi & Affiliated to JNTUH, Hyderabad)
Accredited by NBA and NAAC with 'A' Grade & Recognized Under Section2(f) & 12(B)of the UGC act,1956

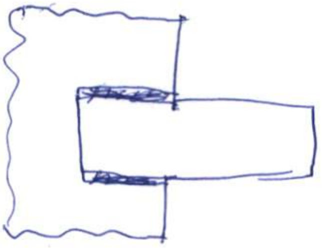
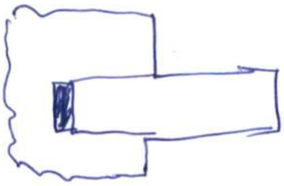
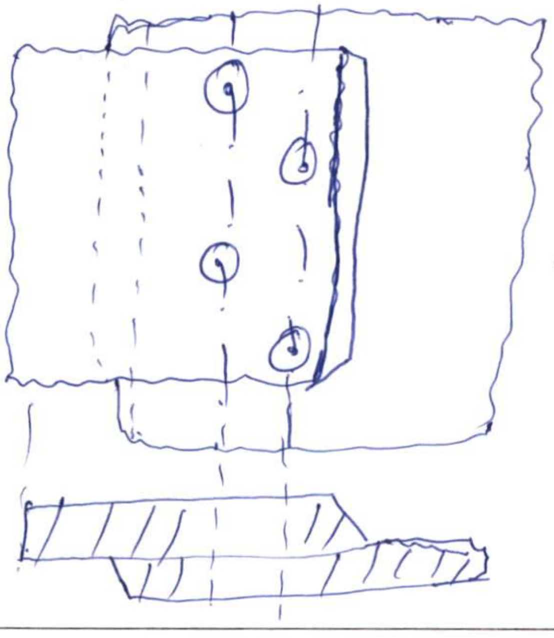
EXAMINATION BRANCH

Academic Year	2021-22
Year & Semester	3rd B.Tech $ I sem
Regulation	MLRS-R19
Branch	Mech
Course Code	1950320
Course Name	Design OF machine members-1
Course Faculty	S.P.Jani
Course Moderator	S.P.Jani
Date of Exam	5/1/22
Reporting Time & Sign	8.45A.M

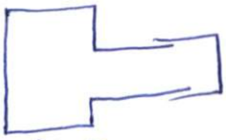
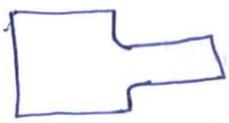
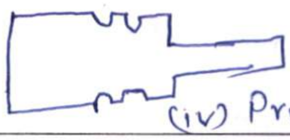
SCHEME OF VALUATION

QNO	ANSWER	MARKS
1, a.	Part-A The Permissible limit or limit of variation in a Physical dimension. ~~limit~~ Fit:	1
	The degree of tightness or looseness b/w the two mating Parts is know as a fit. types (i) Clearance fit, (ii) Interference fit. (iii) Transition fit	1
b)	FOS Factor oF Safty = $\frac{\text{max. stress}}{\text{working (or) design stress}}$	2

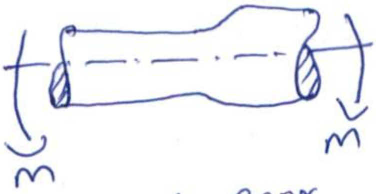
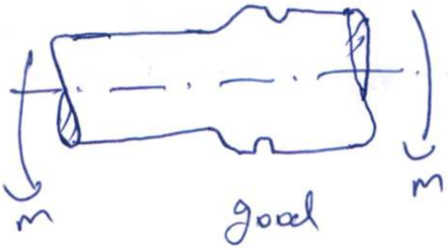
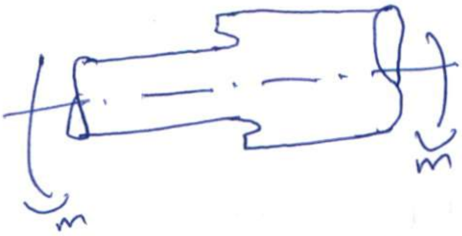
QNO	ANSWER	MARKS
c)	Factors affecting fatigue strength: (i) The effect of stress concentration (ii) The influence of size factor (iii) surface processing state (iv) loading experience (v) Chemical composition (vi) heat treatment and microstructure (vii) inclusions (viii) surface properties and residual stress	(any 4) 2 mark
d)	S-N curves It's describes the relation b/w cyclic stress amplitude and number of cycles to failure.  	2

QNO	ANSWER	MARKS
e,	 $P = 2 \times 0.707 \times s \times l \times \tau$  $P = 0.707 \times s \times l \times \sigma_t$	2
f.	Double riveted zig-zag joint 	2

QNO	ANSWER	MARKS
g,	Types of keys (i) Square key (ii) Feather key (iii) Gib-head key (iv) Rectangular key (v) Saddle key (vi) wood ruff key (vii) Tangent key any four	2
h.	Gib Gib and cotter joint are used for rods of square or rectangular cross-section. The end of one rod fits the end of the other rod which made in the form of a strap.	2
I	Shaft (i) Shear stress (ii) Bending stress (iii) Stress due to combined torsional & bending load.	2

QNO	ANSWER	MARKS
7.	~~R~~ Types OF Coupling (i) Rigid coupling Sleeve or muff Split muff Flange protected unprotected marine. (ii) Flexible Bushed pin-type universal Oldham coupling	2
	Part - B	
4. a.	Methods OF Reducing stress concentration:-  (i) Poor  (ii) good.  (iii) Preferred  (iv) Preferred.	2

Methods OF reducing stress concentration in lines tend to bunch up.

QNO	ANSWER	MARKS
	 ~~g~~ poor  good  preferred. methods OF Reducing in Cylindrical members with Shoulders.	2
b)	Gvd $d = 40mm$ $\sigma_u = 660MPa = 660 N/mm^2$ ~~1,2=62N/mm²~~ $k_f = 1.6$ $q = 0.9$ $\sigma_u = ?$ $FOS = \frac{\text{ultimate stress}}{\text{working stress}}$ $R_f = 0.814$ $\sigma_u = \frac{\sigma_e}{fos}$	1 1

QNO	ANSWER	MARKS
	Calulation	3
	Ans : $112.62 N/mm^2$	1
2a,	Selection OF materials for Engineerig Purposes (i) Availability OF the material (ii) Suitability OF the materials for the working condition in service. A The cost of the materials.	5
b,	$\sigma_1 = 200mPa$ $\sigma_2 = 100mPa$ $\sigma_3 = 0$ $\sigma_{yt} = 500mPa$	
	$(\sigma_1 - \sigma_2) , (\sigma_2 - (\sigma_3)) ; ((\sigma_3) - \sigma_1) \leq \frac{\sigma_{yt}}{Fos}$	2
	$(200-100), (100-(-0), (0-200) \leq \frac{500}{Fos}$	
	$(100, 100, -200)$ $-200 \leq \frac{500}{Fos}$	2

$\boxed{FOS = 2.5}$ 1

QNO	ANSWER	MARKS
	~~$\tau_{max} = \frac{0.5\sigma_y}{FOS}$~~ ~~$\tau_{max} = \frac{0.5 \times 500}{2.5}$~~ ~~$\boxed{\tau_{max} = 100 N/mm^2}$~~	
3.	$\sigma_y = 500 MPa$ $= 500 N/mm^2$ $\sigma_x = 100 MPa = 100 N/mm^2$ $\sigma_y = 40 MPa = 40 N/mm^2$ $\tau_{xy} = 80 MPa = 80 N/mm^2$ FOS = ? (i) maximum normal stress theory $\sigma_{t1} = \frac{\sigma_{yt}}{FOS}$ $\sigma_{t1} = \frac{\sigma_x + \sigma_y}{2} + 1/2 \sqrt{(\sigma_x - \sigma_y)^2 + 4\tau_{xy}^2}$ $= \frac{100+40}{2} + 1/2 \sqrt{(100-40)^2 + 4(80)^2}$ $\sigma_{t1} = \frac{140}{2} + 1/2 \sqrt{3600 + 25600}$	3

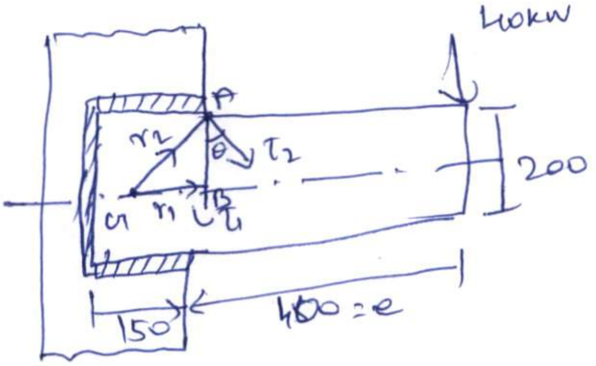
$\sigma_{t1} =$ ~~70~~ 155.44 MPa

QNO	ANSWER	MARKS
	$155.44 = \frac{500}{FOS}$ $\boxed{FOS = 3.21}$ (ii) max. Shear Stress $\tau_{max} = 1/2 \sqrt{(\sigma_x - \sigma_y)^2 + 4\tau^2}$ $\tau_{max} = \tau_{yt} / FOS$ $\tau_{max} = \frac{\sigma_{yt}}{2 \times FOS}$ $\tau_{max} = \cancel{1/2}\ 85.44\ N/mm^2$ $85.44 = \frac{500}{2 \times FOS}$ $FOS = \frac{500}{85.44 \times 2}$ $\boxed{FOS = 2.92}$	3

QNO	ANSWER	MARKS
~~(iii) En~~	(iii) Energy theory $\left(\frac{\sigma_{yt}}{FOS}\right)^2 = \sigma_{t_1}^2 + \sigma_{t_2}^2 - 2\sigma_{t_1} \times \sigma_{t_2}$ $\sigma_{t_1} = \frac{\sigma_x}{2} + 1/2\sqrt{\sigma_x^2 + 4\tau_{xy}^2}$ $\sigma_{t_1} = \frac{100}{2} + 1/2\sqrt{100^2 + 4(80^2)}$ $\sigma_{t_1} = 144.33$ N/mm² $\sigma_{t_2} = \frac{\sigma_y}{2} + 1/2\sqrt{\sigma_y^2 + 4\tau_{xy}^2}$ $= 40/2 + 1/2\sqrt{40^2 + 4(80)^2}$ = ~~349.84 N/mm²~~ 102.46 N/mm2 $\left(\frac{\sigma_{yt}}{FOS}\right)^2 = 144.33^2 + 102.46^2 - 2(144.33) \times (102.46)$ $= 31329.20 - 29576.10$ $\left(\frac{500}{FOS}\right)^2 = 1753.09.$ ~~$\frac{500}{FOS} = 41.86$~~ $\boxed{FOS = 3.1}$	4

QNO	ANSWER	MARKS
5)	G.D $\sigma_m = 150$ mpa $\sigma_v = 50$ mpa $\sigma_u = 630$ mpa $\sigma_y = 350$ mPa $\sigma_e = 150$ mpa FOS = ? $K_t = 1.65$ Goodman: $\frac{1}{FOS} = \frac{\sigma_m}{\sigma_u} + \frac{\sigma_v \times K_t}{\sigma_e}$ $= \frac{150}{630} + \frac{50 \times 1.65}{150}$ $\frac{1}{FOS} = 0.238 + 0.55$ $\frac{1}{.788} = FOS$ $\boxed{FOS = 1.26}$ Soderberg $\frac{1}{FOS} = \frac{\sigma_m}{\sigma_y} + \frac{\sigma_v \times K_t}{\sigma_e} = \cancel{\frac{150}{630}} \frac{150}{350} + \frac{50 \times 1.65}{150}$ $\frac{1}{FOS} = 0.428 + 0.55$ $\frac{1}{.978} = FOS$ $\boxed{FOS = 1.022}$	5 5

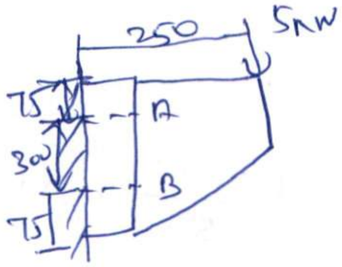
QNO	ANSWER	MARKS
b ~~a)~~ b)	$t = 6mm$ $\sigma_t = 100mPa$ $d = 6\sqrt{t}$ $\tau = 70mPa$ $= 14.69$ $\sigma_c = 130mPa$ $d = 15mm$	
	Data missing so give the mark accordiy to the Following step. (design Procedure enough)	
	(i) Tearing resistance of the Plate $P_t = (p-d)t \times \sigma_t$	1
	(ii) Shearing resistance of the rivet $P_s = \pi/4 \, d^2 \tau$	1
	(iii) Crushing resistance $P_c = d \times t \times \sigma_c$	1
	efficiency $\eta = \dfrac{\text{least of } P_t, P_s \text{ and } P_c}{P}$	2

QNO	ANSWER	MARKS
6, a,	$P = 40kN = 40 \times 10^3 N$ $b = 200mm$ $l = 150mm$ $\tau = 80 MPa$  $x = \frac{l^2}{2l+b} = \frac{150^2}{2 \times 150 + 200}$ $x = 45mm$ $J = t\left[\frac{(b+2l)^3}{12} - \frac{l^2(b+l)^2}{b+2l}\right]$ $= 0.707s\left[\frac{(200+(2 \times 150))^3}{12} - \frac{150^2(200+150)^2}{200+2(150)}\right]$ $= 0.707s(10416666.6 - 5512500)$	2

$J = 3467245.75$

QNO	ANSWER	MARKS
	$e = 400 + 150 - 45$ $e = 505$ mm $r_1 = 150 - 45 = 105$ mm $AB = 200/2 = 100$ mm $r_2 = \sqrt{AB^2 + BG^2}$ $r_2 = \sqrt{100^2 + 105^2}$ $r_2 = 145$ mm $\cos\theta = r_1/r_2 = \frac{105}{145}$ $\cos\theta = 0.724$ $A = 2 \times 0.707s \times l \times 0.707s \times b$ $= 0.707\,bs(2l+b)$ $= 0.707s(2 \times 150 + 200)$ $A = 353.5S$ $\tau_1 = P/A = \frac{40 \times 10^3}{353.5S} = 113.15/S$ $\tau_2 = \frac{P \times e \times r_2}{J} = \frac{40 \times 10^3 \times 505 \times 145}{3467245.75} = \frac{844.7}{S}$	2

QNO	ANSWER	MARKS
	$\tau = \sqrt{\tau_1^2+\tau_2^2+2\tau_1\tau_2\cos\theta}$	
	$80 = \sqrt{\left(\frac{113.15}{s}\right)^2+\left(\frac{844.7}{s}\right)^2+2\left(\frac{113.15}{s}\right)\left(\frac{844.7}{s}\right)0.724}$	
	$= \sqrt{\cancel{\frac{12802.7}{s^2}}+}$	
	$= \sqrt{\left(\frac{113.15}{s}\right)^2+\left(\frac{844.7}{s}\right)^2+\frac{138396}{s^2}}$	1
	$80 = \frac{113.15}{s^2}+\frac{844.7}{s^2}+\frac{372.01}{s^2}$	
	$80 = \frac{1329.86}{s^2}$	
	$\boxed{\cancel{s = 4.0771\,mm}}$	
	$\boxed{s = 5mm}$	

QNO	ANSWER	MARKS
7)	 $P = 5\,kN = 5\times10^3 N$ $L = 300$ mm	5
	Design Procedure and ~~the~~ max shear stress theory discuss.	5
8.	Design of Sleeve and cotter Joint ① Failure of the rods in tension $P = \pi/4 \times d^2 \times \sigma_t$ (1mark) $d = ?$ (ii) Failure of the rod in tension $P = [\pi/4\,(d_2)^2 - d_2 \times t]\sigma_{tc}$ (2mark) (iii) ~~Failure of~~ outside dia of sleeve $P = [\pi/4\,[d_1^2 - d_2^2] - (d_1 - d_2)t]\sigma_{tm}$ (2mark) C.I.d $\sigma_{tm} = 490$ mPa. $\sigma_{tc} = 330$ MPa $\sigma_{cm} = 1.4\sigma_{tm}$ $\sigma_{cc} = 1.4\sigma_{tc}$ $\tau_m = 0.8\sigma_{tm}$ $\tau_c = 0.8\sigma_{tc}$ $P = 40\times10^3 N$	2

$t = d_2/4$

QNO	ANSWER	MARKS
	(iv) width OF cotter. $P = 2b \times t \times \tau_c$	1
	(v) Distance OF the rod From the beginnig to the cotter. $P = 2a \times d_2 \times \tau_c$	1
	(vi) Failure OF sleeve end in Sheer. $P = 2(d_1 - d_2) c \times \tau_m$	1
9,	G.D $\sigma_c = 150$ mPa $= 150 N/mm^2$ $P = 150 kN = 150 \times 10^3 N$ $\sigma_t = 75 N/mm^2$ $\tau = 60 N/mm^2$	1
	(i) Failure OF the solid rod, in tension $P = \pi/4 \times d^2 \times \sigma_t$ $d = 52mm$ $d_1 = 52mm$ $d_2 = 104mm$ $d_3 = 1.5d = 78mm$	2

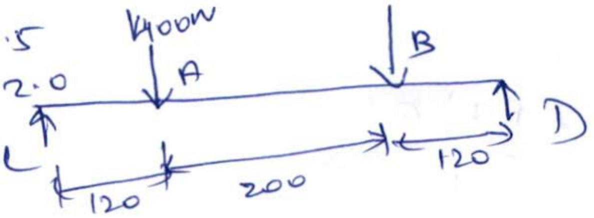
$t = 65mm$

$t_1 = 40mm$

$t_2 = 26mm$

QNO	ANSWER	MARKS
	(ii) Failure of the knuckle pin in shear. $P = 2\times \pi/4 \times d_1^2 \times \tau$	1
	(iii) Failure of the single eye in tension $P = (d_2-d_1)\, t \times \sigma_t$	1
	(iv) Failure of the single eye in shearing $P = (d_2-d_1)\, t \times \tau$	1
	(v) in crushing $P = d_1 \times t \times \sigma_c$	1
	(vi) Failure of the forked end in tension $P = (d_2-d_1)\, 2t_1 \times \sigma_t$	1
	(vii) Failure of forked end in shear $P = (d_2-d_1)\, 2t_1 \times t$	1
	(viii) Failure of the forked in crushing $P = d_1 \times 2t_1 \times \sigma_c$	1

QNO	ANSWER	MARKS
10.	$P = 8\,kW$ $= 8 \times 10^3\,W$ $N = 400\,rpm$ $\tau_{sh} = 45\,mPa$ $\sigma_c = 80\,mPa$ $\tau_{sl} = 10\,mPa$	2
	(i) Design of shaft $T = \frac{P \times 60}{2\pi N}$ $P = \pi/16\,\tau_s \times d^3$	2
	(ii) Design of sleeve $D = 2d + 13$ $L = 3.5d$ $P = \pi/16\,\tau_c \left(\frac{D^4 - d^4}{D}\right)$	2
	(iii) Design of key $t = w$ $l = L/2$ $P = l \times w \times \tau_s\, d/2$ $P = l \times t/2 \times \sigma_{cs} \times d/2$	4

QNO	ANSWER	MARKS
11)	$D_A = 150mm$ $D_B = 250mm$ P = 400N σ_y = 400MPa σ_u = 500MPa	2
	$K_B = 1.5$ $K_t = 2.0$  	2
	$T = \frac{P \times 60}{2\pi N}$ $F_A = \frac{T}{R_A}$ $F_B = \frac{T}{R_B}$	2
	Take moment L & D and find Bearing Reaction ~~AA =~~ $T_e = \sqrt{(K_m \times M)^2 + (K_t \times T)^2}$ $T_e = \pi/16 \times \tau \times d^3$ d = ?	4