Course Code: 1960324 **Roll No:** **MLRS-R19**

MARRI LAXMAN REDDY
INSTITUTE OF TECHNOLOGY AND MANAGEMENT
(AN AUTONOMOUS INSTITUTION)
(Approved by AICTE, New Delhi & Affiliated to JNTUH, Hyderabad)
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III B.Tech II Sem Regular End Examination, June 2022

Design of Machine Members-II
(Mechanical Engineering)

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)	What is journal bearing? Give a classification of these bearings.	2M	CO1	L1
	b)	Write the basic modes of lubrication.	2M	CO1	L2
	c)	Distinguish between the static load carrying capacity and dynamic load carrying capacityof ball bearings.	2M	CO2	L3
	d)	Distinguish between rolling contact bearings and sliding contact bearings.	2M	CO2	L3
	e)	Define Whipping stress.	2M	CO3	L3
	f)	What are the advantages of Aluminum piston over C.I. piston?	2M	CO3	L1
	g)	What is helical torsion spring? How does it differ from helical compression spring?	2M	CO4	L3
	h)	Explain the designation of V-belt with the help of example.	2M	CO4	L2
	i)	Why are crossed helical gears not used for high power transmission?	2M	CO5	L1
	j)	Write a short note on gear drives giving their merits and demerits.	2M	CO5	L2

PART- B

(10*5 Marks = 50 Marks)

2	a)	Explain the procedure would you follow while designing a journal bearing?	5M	CO1	L2
	b)	Each bearing of an electrical motor sustains a radial load of 4 kN. Assuming (l/d)ratio of 1.1, determine the length of the bearing, if the permissible bearing pressure islimited to 1 N / mm^2.	5M	CO1	L3

OR

3		A Journal bearing with a diameter of 200 mm and length 150 mm carries a load of 20 kN when the journal speed is 150 rpm. The diametric ratio is 0.0015. If possible, the bearing is to operate at 35°C ambient temperatures without external cooling with a maximum oil temperature of 90°C. If external cooling is required, it is to be little as possible to minimize the required oil flow rate and heat exchanger size. i) What type of oil do you recommend? ii) Will the bearing operate without external cooling? iii) If the bearing operates without external cooling, determine the operating oil temperature. iv) If the bearing operates with external cooling, determine the amount of oil in kg/min required to carry away the excess heat generated over heat dissipated, when the oil temperature rises from 85°C to 90°C, when passing through the bearing.	10M	CO1	L3
4	a)	A ball bearing subjected to a radial load of 4000 N is expected to have a satisfactorylife of 12000 hours at 720 r.p.m. with a reliability of 95%.	5M	CO2	L3

	selected from manufacturer'scatalogue based on 90% reliability. If there are four such bearings each with areliability of 95% in a system, what is the reliability of the complete system?			
	b) Explain how the following factors influence the life of a bearing: (i) Load (ii) Speed (iii) Temperature (iv) Reliability.	5M	CO2	L2
	OR			
5	A shaft rotating at 1440 rpm is supported by two bearings. The forces acting on eachbearing are 6000N radial load and 3500 N axial thrust. If the shaft diameter is 40mm and the expected life of the bearing is 500h, select a suitable bearing if the required reliability of the bearing is to be 99 percent.	10M	CO2	L3
6	Following data are given for the piston of a four-stroke diesel engine: Cylinder bore = 250 mm, Maximum gas pressure = 4 MPa, Allowable bearing pressure for skirt = 0.4 MPa, Ratio of side thrust on liner to maximum gas load on piston = 0.1, Width of top land = 45 mm, Width of ring grooves = 6 mm, Total number of piston rings = 4, Axial thickness of piston rings = 7 mm, Calculate: Length of skirt; and Length of piston	10M	CO3	L2
	OR			
7	Determine the dimensions of an I – Section connecting rod for a petrol engine from thefollowing data: Diameter of the piston = 110 mm, Mass of the reciprocating parts =2 kg, Length of the connecting rod from centre to centre = 325 mm, Stroke length =150 mm, Speed = 1500 rpm with possible over speed of 2500 rpm, Compression ratio= 4:1, Maximum explosion pressure = 2.5 N / mm^2.	10M	CO3	L2
8	A helical spring whose mean diameter of coils is 8 times that of the wire is to absorb 400 Nm of energy. The initial compression of the spring 50 mm and compresses by additional 70 mm while absorbing the shock. The maximum allowable stress is 400 MPa and G = 0.084 x 10^6MPa. Determine the diameter of the wire and the number of active turns. Neglect the effect of stress concentration.	10M	CO4	L2
	OR			
9	Design a flat belt drive to transmit 110 kW at a belt speed of 25 m/s between twopulleys of diameters 250 mm and 400 mm having a pulley centre distance of 1 metre. The allowable belt stress is 8.5 Mpa and the belts are available having athickness towidth ratio of 0.1 and a material density of 1100 kg/m^3. Given that the coefficient offriction between the belt and pulleys is 0.3, determine the minimum required belt width.What would be the necessary installation force between the pulley bearings and whatwill be the force between the pulley bearings when the full power is transmitted?	10M	CO4	L3
10	Design a pair of spur gear with stub teeth to transmit 55kW from 175 mm pinion running at 2500 rpm to a gear running at 1500 rpm. Both the gears are made of steelhaving B.H.N 260. Approximate the pitch by means of Lewis equation and then adjustthe dimensions to keep within the limits set by the dynamic load and wear equation.	10M	CO5	L3
	OR			
11	It is required to design a pair of spur gears with 20^0 full-depth involute teeth consisting of a 20 teeth pinion meshing with a 50 teeth gear. The pinion shaft is connected to a 22.5 KW, 1450 rpm electric motor. The starting torque of the motor can be taken as 150% of the rated torque. The material for the pinion is plain carbon steel Fe 410 (S_{ut}) = 410 N/mm^2), while the gear is made of grey cast iron FG 200 (S_{ut}) = 200 N/mm^2). The factor of safety is 1.5. Design the gears based on Lewis equation and using velocity factor to account for the dynamic load.	10M	CO5	L3

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EXAMINATION BRANCH

Academic Year	2021-22
Year & Semester	III B.Tech II sem
Regulation	MLRS R-19
Branch	Mech
Course Code	1960324
Course Name	DMM-2
Course Faculty's	S.P.Jani
Course Moderator	S.P.Jani
Date of Exam	13/6/22
Reporting Time & Sign	8.40 Am. S.P.J.

KEY PAPER

QNO	ANSWER	MARKS
1) a.	Part-A Journal Bearing A Bearing is a machine element which support another moving machine element known as journal. Bearing → Radial Bearing. → Thrust Bearing → Sliding contact → Rolling contact	1 1

QNO	ANSWER	MARKS
b)	* Hydrodynamic Lubrication * Hydrostatic lubrication * Elasto hydrodynamic lubrication * Solid film lubrication	2
c)	Static load carrying capacity of ball bearing It is defined as the static radial load or axial load which corresponds to a total permanent deformation of the ball and race at the most heavily stressed contact equal to 0.0001 times the ball diameter. Dynamic load carrying capacity of ball bearing. It is defined as the constant stationary radial load or axial load which if applied to a bearing with rotating inner ring and stationary outer ring would give the same life as that which the bearing will attain under the actual conditions of load and rotation.	1 1

QNO	ANSWER	MARKS
e,	**Whipping Stress** The lateral oscillations of the connecting rod induce inertia forces that act all along the length of the connecting rod causing bending this type of action is called whipping stress.	2
f,	**Aluminum Pistons & CI Pistons** Al alloy commonly used for pistons possessed a most important property in addition to lightness, namely, low resistance to the passage of heat.	2
g,	**Helical Torsion Spring** It is a metal rod or wire in the shape of a helix that is subjected to twisting the axis of the coil by sideways forces applied to its ends, twisting the coil tighter.	2
h,		

QNO	ANSWER	MARKS
h)	**V-belt** V-belt is designated by a grade letter followed by its inside length in mm code number, year of codij. For Ex: D3048:IS 2494: 1964. mostly belts are designated by the grade letter and inside length only such as D-3048. sometimes, the inside length may be denoted in inches as D-120.	2
i)	The crossed helical gears has lower Power Transmission capacity due to point of contact.	2
j)	**merits:-** * efficiency is very high * It is compact in construction * It can be used even for low speeds **Demerits** * They are not suitable when shafts are distant. * It requires lubrication * It has no flexibility.	1 1

QNO	ANSWER	MARKS
	Part-B	
2. a)	Design of Journal Bearing * Determine length by using l/d ratio * Check bearing pressure $p = W/l.d$ * Assume lubricant, t_o. * Determine the operating value of ZN/p for Assumed bearing Temp and check this value with. * Assume a clearance ratio c/d * Determine μ * Determine Q_g * Determine Q_d * Artificial cooling rate and mass.	5

QNO	ANSWER	MARKS
b)	Cr.dl $W = 4KN$ $= 4 \times 10^3 N$ $l/d = 1.1$ $P = 1 N/mm^2$ $A = l \times d$ $= 1.1 \times d \times d$ $= 1.1 d^2$ $P = \frac{W}{A}$ $1 = \frac{4 \times 10^3}{1.1 d^2}$ $d^2 = 3636.36$ $d = 60mm$ $l/d = 1.1$ $l = 1.1 \times 60$ $l = 66.33mm$	1 4 1 2

QNO	ANSWER	MARKS
3.	Design Procedure all Steps Should write.	
	① l/d	
	② $P = W/l.d$	2
	③ $\frac{Zn}{P}$	2
	Bearing modulus	
	4, c/d ratio	1
	5, $\mu = \frac{33}{10^P}\left(\frac{ZN}{P}\right)\left(\frac{d}{c}\right)+K$	2
	⑥ $Q_g = \mu w v$	1
		1
	⑦ $Q_d = C \cdot A (t_b - t_a)$	
	⑧ Artificial cooling rate & mass	1
	$Q_t = m s t$	

QNO	ANSWER	MARKS
4, a	Gr.D W = 4000N N = 720rpm L_H = 12000 hours x = 1.5 ~~Equal~~ Equivalent dynamic load $W_e = W \times *$ $= 4000 \times 1.5$ $= 6000N$ $\frac{L_{95}}{L_{90}} = \left(\frac{0.0513}{0.1054} \right)^{0.8547} = 0.54$ $L_{90} = L_{95} / 0.54$. $L_{90} = 81.45\%$. $C = W \left(\frac{L_{90}}{10^6} \right)^{1/k} = 39.5kN$	3 2

QNO	ANSWER	MARKS
b) (i)	**Load** The magnitude of load usually decides the size of bearing, Generally roller Bearings Can carry heavier loads than ball bearings having the same external dimensions. Deep groove ball bearings, Cylindrical roller bearings are especially employed for radial loads.	1
(ii)	**Speed** For very high speed applications Generally deep groove ball bearings may be preferred..	1
(iii)	**Temprature:** At Elevated temperature, the hardness of the bearing materials is reduced and thus the dynamic load carrying capacity is also reduced as a consequence. the reduction in dynamic load carry capacity at different temp. is taken into account for determining the life rating of bearing.	1

QNO	ANSWER	MARKS
(iv)	Reliability:-	
	The reliability (R) is defined as the ratio of the number of bearings which have successfully completed L million revolution as the ratio of the number of bearings under test.	2
	$\log_e(1/R) = (L/a)^b$	
	$L/L_{90} = 0.85\,[\log_e(1/R)]^{1/1.17}$	
5)	Given	
	$N = 1440$ rpm	
	$W_R = 6000N$	
	$W_a = 3500N$	2
	$d = 40mm$	
	$L_H = 500h$	
	$R = 99\%$.	

QNO	ANSWER	MARKS
	$C = \left[\frac{L}{L_{10}}\right]^{1/k} \cdot PW$	2
	$B = \left[\frac{L_{90}}{L_{99}}\right]^{1/k} \times XVW_R + YW_A$	2
	DB - 20.8 ↓ To find correct bearing.	4
6)	G.D $D = 250mm$ $p = 4MPa$ $P_K = 0.4MPa$ $n_r = 4$ $t_2 = 0.7 t_1$ $= 7mm$ $b_1 = 1.2 t_H$ $= 45mm$ $l = ?$ $L = ?$	2

QNO	ANSWER	MARKS

$R = P_b \times D \times l$

$R = 0.4 \times \pi (250)^2$

$= 0.4 \times 250 \times l$

$R = 100l$

$R = \frac{4\pi D^2}{4} \times P$

$= 0.1 \times \frac{\pi \times (250)^2}{4} \times 4$

$R = 19634.95$

$19634.95 = 100l$

$l = 196.34 mm$

4

$L = l(4t_2 + 3b_2) + b_1$

$b_2 = 0.75 t_2$

$= 0.75 \times 7$

$= 5.25 mm$

$L = 19634 + (4 \times 7 + 3 \times 5.25) + 45$

$L = 285.09 mm$

4

QNO	ANSWER	MARKS
7)	C.D.P $D = 110mm$ $m_R = 2kg$ $l = 325mm$ $Stroke = 150mm$ $N_1 = 1500rpm$ $N_2 = 2500rpm$ $P = 2.5N/mm^2$ $I_{xx} = \frac{419}{12} t^4$ $I_{yy} = \frac{131}{12} t^4$ $\frac{I_{xx}}{I_{yy}} = 3.2$ $F_C = F_L = \frac{\pi D^2}{4} \times P$ $= \frac{\pi \times 110^2}{4} \times 2.5$ $F_L = 23758.29N$ $K_{xx} = \sqrt{\frac{I_{xx}}{A}}$	2

QNO	ANSWER	MARKS
	$= \sqrt{\frac{419t^4}{12} \times \frac{1}{11t^2}}$	3
	$= 1.48t$	
	$r = 150/2 = 75$ mm	
	$L = l = 325$mm	
	$23758.3 = \frac{\sigma_c A}{1+\alpha\left(L/k_{xx}\right)^2}$	3
	$= \frac{320 \times 11t^2}{1+\frac{1}{7500}\left(\frac{325}{1.48t}\right)^2}$	
	$t =$	
	$B = 4t$	
	$H = 5t$	
	$H_1 = 1.2H$	2
	$H_2 = 0.85H$	

QNO	ANSWER	MARKS
8,	(a.i) $D/d = C = 8$ $U = 400\ N\text{-}m$ $= 400 \times 10^3\ N\text{-}mm$ $y_1 = 50mm$ $y' = 70mm$ $y_2 = y_1 + y'$ $= 120mm$ $\tau = 400\ N/mm^2$ $G = 84 \times 10^3\ N/mm^2$ $d = ?$ $n = ?$ Energy absorbed U = mean load × distance $= \frac{F_1 + F_2}{2} \times y'$ $400 \times 10^3 = \frac{F_1 + F_2}{2} \times 70$ $F_1 + F_2 = 11428.57\ N$	2 2

QNO	ANSWER	MARKS

$$\frac{F_1}{y_1} = \frac{F_2}{y_2}$$

$$\frac{F_1}{50} = \frac{F_2}{120}$$

$$F_1 = 0.417 F_2$$

$$\therefore F_2 = 8.067\ kN$$

max load $F_2 = 8.067$

$\therefore$ max deflection $y = 120mm$ — 1

$$\tau = \frac{8 K F_{CK}}{\pi d^2}$$

$k = 1.18$ — 2

$$400 = \frac{8 \times 8.067 \times 10^3 \times 8 \times 1.18}{\pi d^2}$$

$d = 22mm$ — 1

$D = C \times d$

$= 176mm$

QNO	ANSWER	MARKS
	$y = \frac{8FD^3n}{Gd^4}$	
	$120 = \frac{8 \times 8.067 \times 10^3 \times 176^3 \times n}{84 \times 10^3 \times 22^4}$	2
	$n = 6.71$	
	$n = 7$	
10,	C.D	
	$P = 55\ KW$	
	$= 55 \times 10^3 W$	
	$N_1 = 2500 rpm$	1
	$N_2 = 1500 rpm$	
	$d_1 = 175 mm$	
	material – SBHN 260	
	Step-1	
	$a = \frac{d_1 + d_2}{2}$	2

QNO	ANSWER	MARKS
	$i = \frac{n_1}{n_2}$ Calculate d_1 / d_2 $F_t = \frac{M_t}{d_1/2}$ $M_t = \frac{60 \times P}{2\pi N}$ $F_D = F_t \times K_s \times C_v$ $V = \frac{\pi d_1 n_1}{60 \times 1000}$ Step-2 material Selection Step-3 To Find module & Facewidth $Z_1 = 20$ Assume. $Z_2 = i Z_1$ \ y' value assume.	2

QNO	ANSWER	MARKS
	Step-4 Check wear strength $F_W > F_D$	2
	Step-5 Dynamic load $F_b > F_d$	2
	Step-6 Basic dimensions Find.	1
11)	Same like Problem (10) Follow the design Procedure	

QNO	ANSWER	MARKS