Ref:Ex/ME/5/T/322/2024

Bachelor of Engg(MechanicalEngg). 3rd yr. 2ndSemester Exam 2024

Subject : Machine Design III   Time : Three hours// Full marks : 100

Answer any five questions

All questions carry equal marks

1. It is required to design a chain drive to connect a 12 kW, 1600 RPM electric motor to a transmission shaft running at 400 RPM. The operation involved in moderate shocks.
   i. Specify the number of teeth on the driving and driven sprocket.
   ii. Select at proper roller chain.
   iii. Calculate the PCDs of the driving and the driven sprockets.
   iv. Determine the number of chain links.
   v. Specify the correct center distance.

   Assume center distance is 40 times the pitch of the chain.
2. A ball bearing operates on the following work cycle :

Element No.	Radial Load (N)	Speed (RPM)	Element Time (%)
1	3000	720	30
2	7000	1440	50
3	5000	900	20

   The dynamic load carrying capacity of the bearing is 25kN. Calculate the average speed of rotation, the equivalent radial load and the bearing life.
3. i). Select a radial ball bearing to fit a portion of a shaft where the design diameter may be from 15 mm to 25mm, according to bearing selected. It must withstand a radial load of 839.5 N and a thrust load of 310 N and should have a L_{10} life of 2000 hr. at 5500rpm.

   ii). State whether the selected bearing can be used for 5 years (8 hr./day, 5 days/week, 50 weeks/year.) If not, what bearing would you recommend?

4. i).What is the difference between shat and axle?

   ii). In a railway wagon, the maximum load on a pair of wheels is 100 kN : one wheel takes 70 kN the other 30 kN. The distance between the rails is 1.45 m and between the centers of the axle boxes is 1.9 m. Find the diameter if the axle at the wheel. Consider the safe stress as 77 MPa.
5. Write short notes on :
   a. Polygonal effect of chain
   b. failures of the chain
   c. Stribeck equation
   d. Lewis equation.

[Turn over

6. A pair of spur gear consist of a 24 teeth pinion, rotating at 1000 RPM and transmitting power to a 48 teeth gear. The module is 6 mm, while the face width is 60 mm. Both the gears are made of steel with an ultimate tensile strength of 450 N/mm^2. They are heat treated to a surface hardness of 250 BHN. Assume that velocity factor accounts for the dynamic load. Calculate Beam Strength, Wear Strength and the rated power that the gears can transmit. If service factor and factor of safety are 1.5 & 2 respectively.

Table 1 Dimensions and breaking loads of roller chains

ISO chain number	Pitch p (mm)	Roller diameter d_1 (mm)	Width b_1 (mm)	Transverse pitch p_t (mm)	Breaking load for single strand chain (kN)
06 B	9.525	6.35	5.72	10.24	10.7
08 B	12.70	8.51	7.75	13.92	18.2
10 B	15.875	10.16	9.65	16.59	22.7
12 B	19.05	12.07	11.68	19.46	29.5
16 B	25.40	15.88	17.02	31.88	65.0
20 B	31.75	19.05	19.56	36.45	98.1
24 B	38.10	25.40	25.40	48.36	108.9
28 B	44.45	27.94	30.99	59.56	131.5
32 B	50.80	29.21	30.99	58.55	172.4
40 B	63.50	39.37	38.10	72.29	272.2

Table 2 Power rating for simple roller chain

Pinion speed (r.p.m.)	Power (kW)				
	06 B	08 B	10 B	12 B	16 B
50	0.14	0.34	0.64	1.07	2.59
100	0.25	0.64	1.18	2.01	4.83
200	0.47	1.18	2.19	3.75	8.94
300	0.61	1.70	3.15	5.43	13.06
500	1.09	2.72	5.01	8.53	20.57
700	1.48	3.66	6.71	11.63	27.73
1000	2.03	5.09	8.97	15.65	34.89
1400	2.73	6.81	11.67	18.15	38.47
1800	3.44	8.10	13.03	19.85	—
2000	3.80	8.67	13.49	20.57	—

Table 3

Dimensions (mm)			Ratings (N)		Designation
d	D	B	C	C_0	
12	21	5	1430	695	61801
	28	8	5070	2240	6001
	32	10	6890	3100	6201
	37	12	9750	4650	6301
15	24	5	1560	[illegible]	61802
	32	9	5590	2500	6002
	35	11	7800	3550	6202
	42	13	11400	5400	6302
17	26	5	1680	930	61803
	35	10	6050	2800	6003
	40	12	9560	4500	6202
	47	14	13500	6550	6303
	62	17	22900	11800	6403
20	32	7	2700	1500	61804
	42	8	7020	3400	16004
	42	12	[illegible]	[illegible]	[illegible]
	47	14	[illegible]	[illegible]	[illegible]
	52	15	[illegible]	[illegible]	[illegible]
	72	19	[illegible]	[illegible]	[illegible]
25	37	7	3120	[illegible]	61805
	47	8	7610	4000	16005
	47	12	11200	5600	6005
	52	15	14000	6950	6205
	62	17	22500	11400	6305
	80	21	35800	19600	6405

Table 4 *X and Y factors for single-row deep groove ball bearings*[3]

$\left(\frac{F_a}{C_0}\right)$	$\left(\frac{F_a}{F_r}\right) \leq e$		$\left(\frac{F_a}{F_r}\right) > e$		e
	X	Y	X	Y	
0.025	1	0	0.56	2.0	0.22
0.040	1	0	0.56	1.8	0.24
0.070	1	0	0.56	1.6	0.27
0.130	1	0	[illegible]	[illegible]	[illegible]
0.250	[illegible]	0	[illegible]	[illegible]	[illegible]
0.500	1	0	0.56	1.0	[illegible]

Table 5

F_a/C_0	$F_a/F_r \le e$		$F_a/F_r > e$		e
	X	Y	X	Y	
0.025	1	0	0.56	2.0	0.22
0.040	1	0	0.56	1.8	0.24
0.070	1	0	0.56	1.6	0.27
0.130	1	0	0.56	1.4	0.31
0.250	1	0	0.56	1.2	0.37
0.500	1	0	0.56	1.0	0.44

Table 6

z	Y	z	Y	z	Y
15	0.289	27	0.348	55	0.415
16	0.295	28	0.352	60	0.421
17	0.302	29	0.355	65	0.425
18	0.308	30	0.358	70	0.429
19	0.314	32	0.364	75	0.433
20	0.320	33	0.367	80	0.436
21	0.326	35	0.373	90	0.442
22	0.330	37	0.380	100	0.446
23	0.333	39	0.386	150	0.458
24	0.337	40	0.389	200	0.463
25	0.340	45	0.399	300	0.471
26	0.344	50	0.408	Rack	0.484

Table 7 Service factor (K_s)

Type of input power	Type of driven load		
	Smooth	Moderate shock	Heavy shock
(i) I.C. Engine with hydraulic drive	1.0	1.2	1.4
(ii) Electric motor	1.0	1.3	1.5
(iii) I.C. Engine with mechanical drive	1.2	1.4	1.7

Table 8 Tooth correction factor (K_2)

Number of teeth on the driving sprocket	K_2
15	0.85
16	0.92
17	1.00
18	1.05
19	1.11
20	1.18
21	1.26
22	1.29
23	1.35
24	1.41
25	1.46
30	1.73

Table - 9

Grade	e (microns)
1	$0.80 + 0.06\,\phi$
2	$1.25 + 0.10\,\phi$
3	$2.00 + 0.16\,\phi$
4	$3.20 + 0.25\,\phi$
5	$5.00 + 0.40\,\phi$
6	$8.00 + 0.63\,\phi$
7	$11.00 + 0.90\,\phi$
8	$16.00 + 1.25\,\phi$
9	$22.00 + 1.80\,\phi$
10	$32.00 + 2.50\,\phi$
11	$45.00 + 3.55\,\phi$
12	$63.00 + 5.00\,\phi$

Take deformation factor (C) = 11400 N/mm^2 in all cases.

Table 1: Lewis Form factor (Y) , z = no of teeth pinion/gear