B.M.E [Evening] Fourth yr .1st semester Supple Exam: 2017 Ref No: Ex/ME/5/T/412/2017(S)

Machine Design III

Time: Three hours Full Marks : 100

Missing data, if any , may be assumed.

Answer any five questions

1. (a) What is the polygonal action in roller chain? How will you reduce it? 10

   (b) It is required to design a chain drive to connect a 12kW, 1400 rpm electric motor to a centrifugal pump running at 700 rpm. The service conditions involve moderate shock. **[Refer Table 1 to Table 4]**

   I. Select a proper roller chain and give a list of its dimension.

   II. Determine the pitch circle diameters of driving and driven sprockets.

   III. Determine the number of chain links,

   IV. Specify the correct center distance between the axes of sprocket.

2. (a) State and derive Petroff's Equation mentioning the assumption.

   (b)A 100 mm diameter shaft is supported by a bearing of 80 mm length with a diametral clearance of 0.10 mm. It is lubricated by oil having viscosity of 45 MPa-sec. The shaft rotates at 640 r.p.m and carries a radial load of 4200 kN. Estimate the bearing coefficient of friction and power loss using Petroff's approach. 10+10

3. (a) A ball bearing is operating on a work cycle consisting of three parts – a radial load of 3000 N at 1440 rpm for one quarter cycle, a radial load of 5000 N at 720 rpm for one half cycle, and radial load of 2500 N at 1440 rpm for the remaining cycle. The expected life of the bearing is 10000 hours. Calculate the dynamic load carrying capacity. 6

   (b) The following data is given for a 360 degree hydrodynamic bearing:

   Radial load = 4 kN, journal speed = 1500 rpm, journal diameter = 50 mm, bearing length = 50 mm, radial clearance =0 .06 mm, viscosity of the lubricant = 28 cp. Assume that the total heat generated in the bearing is carried by the total oil flow in the bearing, calculate (i)coefficient of friction (ii)power lost in friction(iii)minimum oil film thickness (iv) flow requirement in litres per min. (v)temperature rise. **[Refer Table 5]** 14

4. (a) Define ' static load carrying capacity of a ball bearing.' State and derive Stribeck,s Equation. 10

   (b) A single-row deep groove ball bearing is subjected to a radial load of 8kN and an axial load of 3 kN. The shaft rotates at 1200 rpm. The expected life of the bearing is 20000 hours. The minimum diameter of the shaft is 75 mm. Select a suitable ball bearing for this application. The values of X and Y factors are 0.56 and 1.80.

   [Ref Table 6] 10

5. (a) Assuming the relevant velocity profile of the fluid flow between two parallel plates, prove that $1/2\pi\ p_i\ [(R_o^2-R_i^2)/\log_e (R_o/R_i)]$ is the load carrying capacity of a hydro-static bearing, where p_i is the inlet pressure and R_o and R_i are the outer are inner radii respectively. 10

(b) Following data are given for a hydrostatic thrust bearing:

Thrust load = 500 kN, Shaft speed = 720 rpm ,Shaft diameter = 500 mm, Recess diameter = 300 mm, Film thickness = 0.15 mm ,Viscosity of lubricant = 160 SUS , Specific gravity = 0.86.

Calculate: (a) Supply pressure (b) Flow requirement (c) Power loss 10

6. (a)Prove that the shrinkage pressure **P** and interference ∂ are related by $\partial = \frac{PD_2}{E}\left[\frac{2D_2^2(D_3^2-D_1^2)}{(D_3^2-D_2^2)(D_2^2-D_1^2)}\right]$, where the terms have usual meaning. 10

(b) A high pressure cylinder consists of a steel tube with inner and outer diameters are 25 mm and 45 mm respectively. It is jacketed by an outer steel tube having an outer diameter 65 mm. The tubes are assembled by shrinking process in such a way that maximum principal stress induced in any tube is limited to 90 N/mm^2. Calculate the shrinkage pressure and **original dimensions of the tube.[E = 207 kN/mm^2]** 10

7. (a) The cylindrical pressure vessel of internal diameter 2500 mm is subjected to an operating pressure 1 MPa. The yield strength of the material is 210 MPa and corrosion allowance is 3mm. Efficiency of the welded joint is 90%. One end of the vessel is torispherical [crown radius= 2000 mm] and the the other end is elliptical [2:1]. Determine the thickness of the cylindrical shell, torispherical head and elliptical head. FOS = 1.5 and knuckle radius is 6% of crown radius. 15

(b) Why spherical pressure vessel is called ideal pressure vessel? 5

8. Write short notes on: (any four) 4X5

(i) Viscosity and its measurement (ii) Tower's Experiment (iii) Clavarino's Equation(iv) Equivalent bearing load (v)Failures of roller chain (vi) Silent chain (vii)'Thin pressure vessel 'and 'thick pressure vessel'

Principal dimensions (mm)			Basic load ratings (N)		Designation
d	D	B	C	C_0	
70	90	10	12100	9150	61814
	110	13	28100	19000	16014
	110	20	37700	24500	6014
	125	24	61800	37500	6214
	150	35	104000	63000	6314
	180	42	143000	104000	6414
75	95	10	12500	9800	61815
	115	13	28600	20000	16015
	115	20	39700	26000	6015
	130	25	66300	40500	6215
	160	37	112000	72000	6315
	190	45	153000	114000	6415

Table: 6

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 simplo 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 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 4 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 5 *Dimensionless performance parameters for full journal bearing with side flow*

$\left(\frac{l}{d}\right)$	ε	$\left(\frac{h_o}{c}\right)$	S	ϕ	$\left(\frac{r}{c}\right)f$	$\left(\frac{Q}{rcn_s l}\right)$	$\left(\frac{Q_s}{Q}\right)$	$\left(\frac{p}{p_{max}}\right)$
∞	0	1.0	∞	(70.92)	∞	π	0	–
	0.1	0.9	0.240	69.10	4.80	3.03	0	0.826
	0.2	0.8	0.123	67.26	2.57	2.83	0	0.814
	0.4	0.6	0.0626	61.94	1.52	2.26	0	0.764
	0.6	0.4	0.0389	54.31	1.20	1.56	0	0.667
	0.8	0.2	0.021	42.22	0.961	0.760	0	0.495
	0.9	0.1	0.0115	31.62	0.756	0.411	0	0.358
	0.97	0.03	–	–	–	–	0	–
	1.0	0	0	0	0	0	0	0
1	0	1.0	∞	(85)	∞	π	0	–
	0.1	0.9	1.33	79.5	26.4	3.37	0.150	0.540
	0.2	0.8	0.631	74.02	12.8	3.59	0.280	0.529
	0.4	0.6	0.264	63.10	5.79	3.99	0.497	0.484
	0.6	0.4	0.121	50.58	3.22	4.33	0.680	0.415
	0.8	0.2	0.0446	36.24	1.70	4.62	0.842	0.313
	0.9	0.1	0.0188	26.45	1.05	4.74	0.919	0.247
	0.97	0.03	0.00474	15.47	0.514	4.82	0.973	0.152
	1.0	0	0	0	0	0	1.0	0
$\left(\frac{1}{2}\right)$	0	1.0	∞	(88.5)	∞	π	0	–
	0.1	0.9	4.31	81.62	85.6	3.43	0.173	0.523
	0.2	0.8	2.03	74.94	40.9	3.72	0.318	0.506
	0.4	0.6	0.779	61.45	17.0	4.29	0.552	0.441
	0.6	0.4	0.319	48.14	8.10	4.85	0.730	0.365
	0.8	0.2	0.0923	33.31	3.26	5.41	0.874	0.267
	0.9	0.1	0.0313	23.66	1.60	5.69	0.939	0.206
	0.97	0.03	0.00609	13.75	0.610	5.88	0.980	0.126
	1.0	0	0	0	0	–	1.0	0