Bachelor of Engineering(Mechanical Engg.) 2nd Sem Examination 2019

(3rd Year, 2nd Semester)

Machine Design III

Time – 03 Hours | Full Marks: 100

Answer any five questions

All questions carry equal marks

1. A single-row deep groove ball bearing is subjected to a 30 second work cycle that consists of the following two parts:

	Part I	Part II
Duration (s)	15	15
Radial load (kN)	50	20
Axial load (kM)	20	12
Speed (rpm)	720	1440

The static and dynamic load capacities of the ball bearing are 50 and 68kN respectively. Calculate the expected life the bearing in hours.

2. a) A ball bearing subjected to a radial load of 2000 N is expected to have satisfactory life of 15000 h at 750 rpm with a reliability of 98%. Calculate the dynamic load carrying capacity of the bearing, so that it can be selected from a manufacture's catalogue based on 90% reliability. If there are four such bearing, each with a reliability of 98% in system, what is reliability of the complete system?

b) A single-row deep groove ball bearing is subjected to a radial force of 9 kN and a thrust force of 4 kN. The shaft rotates at 1200 rpm. The expected life L_{10h} of the bearing is 20,000 h. The minimum acceptable diameter of the shaft is 75 mm. Select a suitable ball bearing for this application.

3. It is required to design a chain drive to connect a 10 kW, 900 rpm petrol engine to a conveyor. The driving sprocket is mounted on engine shaft, the driven sprocket is mounted on conveyor shaft. The conveyor shaft should run between 230 to 250 rpm. The service conditions involve moderate shocks.

   i. Select a proper roller chain and give a list of its dimension.
   ii. Determine the pitch circle diameters of the driving and driven sprockets.
   iii. Determine the number of chain links
   iv. Specify the correct centre distance between the axes of sprockets.

[Turn over

4. It is required to design a spur gear speed reducer for a compressor running at 250 rpm driven by a 7.5kW, 1000 rpm electric motor. The centre distance 250 mm. The starting torque of the motor can be assumed to be 170% of the rated torque. The gears are made of carbon steel 50C4 (S_{ut} = 700 N/mm^2). The pressure angle is 20°. The *factor of safety* is 1.8 for preliminary design based on the use of velocity factor:
   i. Design the gears and specify their dimensions.
   ii. Assume that the gears are manufactured to meet the requirements of Grade 6 calculate the dynamic load by using Buckingham's equation.
   iii. Calculate the effective load
   iv. What is the actual factor of safety against bending failure?
   v. Using the same factor of safety against pitting failure, specify suitable hardness for the gears.

5. The following data is given for a pair of parallel helical gears made of steel:
power transmitted = 15kW, speed of pinion = 720 rpm, number of teeth on pinion = 35 number of teeth on gear = 70, centre distance = 285 mm, normal module = 5 mm, face width = 50 mm, normal pressure angle =20°, ultimate tensile strength = 610 BHN, grade of machining = Gr. 6, service factor = 1.25, Calculate
   i) The helix angle ii) the beam strength iii) the wear strength iv) the static load v) the dynamic load by Buckingham's equation vi) the effective load vii) the effective factor of safety against bending failure; and viii) the effective factor of safety against pitting failure.

6. A pair of straight bevel gears is mounted on shafts, which are intersecting at right angles. The number of teeth on the pinion and gear are 30 and 45 respectively. The pressure angle is 20°. The pinion shaft is connected to an electric motor developing 20 kW rated power at 500rpm. The service factor can be taken as 1.65. the pinion and the gear are made of steel (S_{ut} = 550 N/mm^2) and heat-treated to a surface hardness of 300 BHN. The gear are manufactured in such a way that the error between two meshing teeth is limited to 20μm. The module and face width are 6 mm and 50 mm respectively.
Determine the factor of safety against bending as well as pitting.

7. Write a short notes on (any four)
   i. Polygonal action of roller chain
   ii. Wiebull distribution for the design of bearing
   iii. Distinguish between helical gear and herringbone gear
   iv. Sketch of Roller chain and explain
   v. Selection of bearing from manufacturer's catalogue.

Power rating of simple roller chain

Pinion speed (rpm)	Power (kW)								
	06 B	08A	08 B	10A	10 B	12A	12 B	16A	16 B
50	0.14	0.28	0.34	0.53	0.64	0.94	1.07	2.06	2.59
100	0.25	0.53	0.64	0.98	1.18	1.74	2.01	4.03	4.83
200	0.47	0.98	1.18	1.83	2.19	3.40	3.75	7.34	8.94
300	0.61	1.34	1.70	2.68	3.15	4.56	5.43	11.63	13.06
500	1.09	2.24	2.72	4.34	5.01	7.69	8.53	16.99	20.57
700	1.48	2.95	3.66	5.91	6.71	10.73	11.63	23.26	27.73
1000	2.03	3.94	5.09	8.05	8.97	14.32	15.65	28.63	34.89
1400	2.73	5.28	6.81	11.18	11.67	14.32	18.15	18.49	38.47
1800	3.44	6.98	8.10	8.05	13.03	10.44	19.85	—	—
2000	3.80	6.26	8.67	7.16	13.49	8.50	20.57	—	—

Service factor (K_s)

Type of driven load	Type of input power		
	IC engine with hydraulic drive	Electric motor	IC engine with mechanical drive
(i) *Smooth:* agitator, fan, light conveyor	1.0	1.0	1.2
(ii) *Moderate shock:* machine tools, crane, heavy conveyor, food mixer, grinder	1.2	1.3	1.4
(iii) *Heavy shock:* punch press, hammer mill, reciprocating conveyor, rolling mill drive	1.4	1.4	1.7

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	10615
	115	20	39700	26000	6015
	130	25	66300	40500	6215
	160	37	112000	72000	6315
	190	45	153000	114000	6415

Multiple strand factor (K_1)

Number of strands	K_1
1	1.0
2	1.7
3	2.5
4	3.3
5	3.9
6	4.6

Tolerances on the adjacent pitch

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	$63.00 + 5.00\,\phi$

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

$\left(\frac{F_a}{C_0}\right)$	$\left(\frac{F_a}{F_r}\right) \le e$		$\left(\frac{F_a}{F_r}\right) > e$		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	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