Name: Entry No. :

Indian Institute of Technology Delhi
MCL211: Design of Machines
(Semester 1, 2016 – 2017)

MINOR 1

Time: 60 minutes **Max. Marks: 30**

You are allowed one A4 size sheet in your own handwriting in the classroom.

1) A kinematic slideway design is shown in Figure 1. Three balls are rigidly attached to the slider. Two balls are placed in a V-groove and the third ball is placed on a flat surface.
   a) Explain how a single DOF constraint is provided by a sphere on a flat. (1)
   b) How many DOFs are constrained when a ball is placed on a V-groove? Explain with proper illustration. (2)
   c) What is (are) the DOF(s) of the slideway shown in the figure? How the other DOFs are constrained. Explain with proper illustration? (3)
   d) What will happen if the third ball is placed in another V-groove? Explain how exact-constraint design is better than overconstraint design. (3)
   e) Design a support using balls so that an object can move only in a plane. What is the DOFs required and what is the minimum number of balls required to achieve the required DOFs? Explain with suitable sketches and drawings. (3)

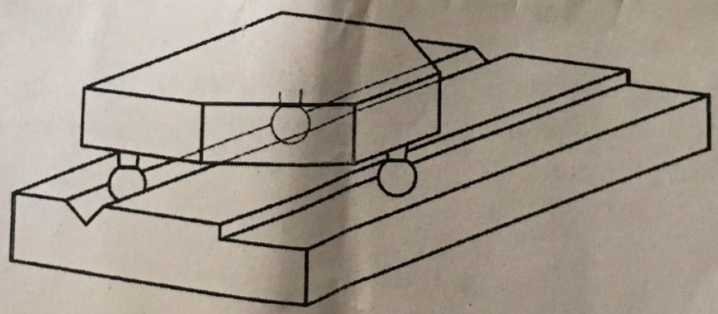

Figure 1

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2) An SKF 6210 angular-contact ball bearing has an axial load F_a of 2.8 kN and a radial load F_r of 3.4 kN applied with the outer ring stationary. The basic static load rating C_o is 20 kN and the basic load rating C_{10} is 35 kN. Calculate the equivalent radial load F_e and subsequently estimate the L_{10} life at a speed of 1000 rev/min. (8)

		$F_a/(VF_r) \le e$		$F_a/(VF_r) > e$	
F_a/C_o	e	X_1	Y_1	X_2	Y_2
0.084	0.28	1.00	0	0.56	1.55
0.110	0.30	1.00	0	0.56	1.45
0.17	0.34	1.00	0	0.56	1.31
0.28	0.38	1.00	0	0.56	1.15
0.42	0.42	1.00	0	0.56	1.04
0.56	0.44	1.00	0	0.56	1.00

3) A shaft is loaded in bending and torsion such that M_a = 70 Nm, T_a = 45 Nm, M_m = 55 Nm, and T_m = 35 Nm. For the shaft, S_u = 700 MPa and S_y = 560 MPa, and a fully corrected endurance limit of S_e = 210 MPa is assumed. Let K_f = 2.2 and K_{fs} = 1.8. With a design factor of 2.0, determine the minimum acceptable diameter of the shaft using the DE-Goodman criterion. (6)

4) Two typical constructions of mounting bearings to take thrust load are shown in Figures 4.1 and 4.2. Explain the salient features of both the constructions. Which design will be preferred based on kinematic design principles and why? (4)

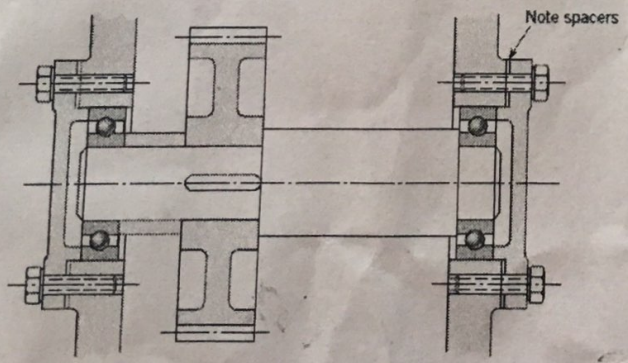

Figure 4.1

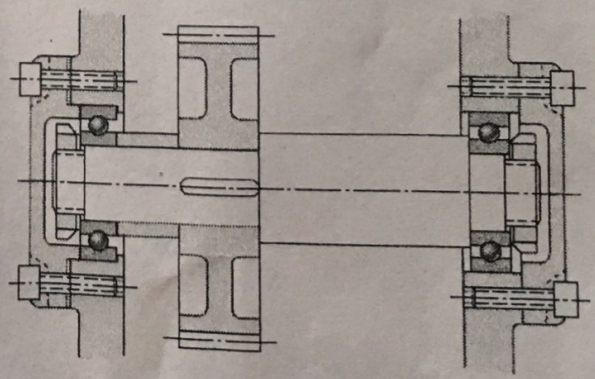

Figure 4.2