Exam. Sheet NO. _____

GANPAT UNIVERSITY
B. Tech. VIII Sem. Mechatronics Engineering
CBCS Regular Examination May - 2014
2MC804 - Design of Mechanical Systems

[Time: 3 Hour] [Total Marks: 70]

Instructions:

(1) Attempt all questions.
(2) Assume suitable data if necessary.
(3) Figures to the right indicate full marks
(4) Only scientific calculator is allowed.
(5) Design data book is not allowed.

SECTION - I

Que: 1 Attempt the followings.

(a) Explain procedure for selection of bearing from manufacturing catalogue. [4]

(b) A machine having a basic static capacity of 3000 N. A constant k is of 0.4. Diameter of the roller is of 30 mm and length of roller is of 50 mm. Find the number of rollers used in the bearings. [4]

(c) Determine the dynamic load capacity for a taper roller bearing if the desired life for 90% of the bearings is 8000 hr and the speed is 300 rpm. The equivalent radial load of the bearing is 5854.16 N. [4]

OR

Que: 1

(a) Explain the taper roller bearing with neat sketch using usual nomenclature. [3]

(b) A belt drive system having the following configuration: [9]
Shaft diameter = 25 mm, diameter of the pulley = 300 mm, power transmitted = 7.5 kW, rotational speed = 720 rpm, ratio of belt tensions = 3:1.
Select a suitable radial deep-groove ball bearing for a life of 10000 hrs. Assume the pulley to be placed centrally with the belt tensions acting vertically downwards. The service factor can be taken as 3.

Que. 2

(a) Explain utility of Weibull distribution. Explain three parameter Weibull distribution. [3]

(b) Derive the equation for pressure distribution on annular area and load carrying capacity of hydrostatic bearing with neat sketch. [9]

OR

Que. 2

(a) A single row deep groove ball bearing is subjected to the cyclic loading. The bearing run for 36, 90, 324, and 72 million revolutions for sequential work cycles for 1.8, 3.9096, 7.5, and 2.4 kN respectively. Find the equivalent dynamic load and rating life of the bearing. [3]

(b) A ball bearing operates on a work cycle consisting of three parts: a radial load of 3000 N at 720 rpm for 30 percent of the cycle, a radial load of 7000 N at 1440 rpm for 40 percent of the cycle and a radial load of 5000 N at 900 rpm for the remaining part of the cycle. The basic dynamic capacity of the bearing is 30700 N. Calculate: [9]
(i) The rating life of the bearing in hours, (ii) The average speed of rotation, and (iii) The life of the bearing with 95 percent reliability.

Que. 3

(a) **Attempt the followings (Any one).** [4]
(i) Explain working principle of hydrodynamic bearing with neat sketch and also write their applications, advantages, and limitations.

(ii) Explain pressure distribution in hydrodynamic journal bearing with neat sketch.

(b) The following data is given for a hydrostatic step bearing of a vertical turbo generator: [7]
Thrust load = 500 KN, shaft speed = 1000 rpm, supply pressure = 6 MPa, ratio of recess diameter to shaft diameter = 0.6, oil film thickness = 0.15, viscosity of lubricant = 170 SUS, specific heat of lubricant = 2.09 kJ/ kg °C, and specific gravity of lubricant = 0.86. Calculate: (i) shaft and recess diameter, (ii) flow rate of lubricant in lit/min, (iii) frictional power loss, (iv) pumping power loss, and (v) temperature rise.
Assume that the total power loss in the bearing is converted into frictional heat.

SECTION – II

Que:4 Attempt following.

(a) Explain the PDE and SDE related to Johnson's method of optimum design. [3]

(b) In a light weight equipment, a shaft is transmitting a torque of 900 Nm and is to have a rigidity of 90 Mn/degree. Assume a factor of safety of 1.5 based on yield stress. Design the shaft with minimum weight. What will be the change in design for minimum cost. Assume maximum shear stress thory of failure. Use the following data for the material. [9]

Material	Mass density (kg/m^3)	Material cost (Rs / N weight)	Yield strength (MPa)	Shear modulus (GPa)
Steel Alloy	8500	16	130	80
Aluminum Alloy	3000	32	50	26.7
Titanium Alloy	4800	480	90	40
Magnesium Alloy	2100	32	20	16

OR

Que:4

(a) Explain Johnson's method of optimum design. [3]

(b) Find the volume of the spring, ignoring the effect of stress concentration and curvature. A spring supports an initial load of 244 N. The coil diameter is 6 mm and space limitations indicate that the maximum mean diameter of the coil should be 50 mm. When the spring is further deflected by 11 mm, the torsional shear stress must not exceed 505 MPa. Also suggest an optimum wire diameter and number of active turns for minimum volume of the spring material. Determine the volume ratio of the two springs. Assume modulus of rigidity as 79 GPa. [9]

Que.5 Attempt following.

(a) Explain factor affecting on pitting failure. [3]

(b) It is required to design a pair of spur gear with 20^0 full depth involute teeth based on Lewis equation. The velocity factor is to be used to account for dynamic load. The pinion shaft is connected to a 10 HP, 1440 rpm motor. The starting torque of the motor is 150% of the rated torque. The speed reduction is 4.:1. The pinion as well as the gear are made of plain carbon steel 40c8 (S_{ut} = 600 N/mm^2). The factor of safety can be taken as 1.5. Design the gear, specified their dimension and suggest suitable surface hardness for the gear. [8]

OR

Que.5

(a) Explain at least four application of worm gear box. [3]

(b) A planetary gear train is shown in **Fig.1**. The sun gear A rotates in a clockwise direction and transmit 7.5 KW power at 1440 rpm to the gear train. The number of teeth on sun gear A, planet gear B and the fixed ring C are 40, 80 and 180 respectively. The module is 4 mm and the pressure angle 20^0 . Draw a free body diagram of forces acting on each gear and calculate the torque that the arm D can deliver to its output shaft. [8]

Que:6 Attempt following. [12]

(a) Explain four application of rimmed gear.

(b) A steel spindle of a machine tool transmits 5 kW power at 880 rpm. The angular deflection should not exceed 0.23° per meter of the spindle. If the modulus of rigidity for the material of the spindle is 85 GPa. Find the diameter of the spindle.

(c) Explain following:

1. Face width of gear and its important
2. Module of gear and its important

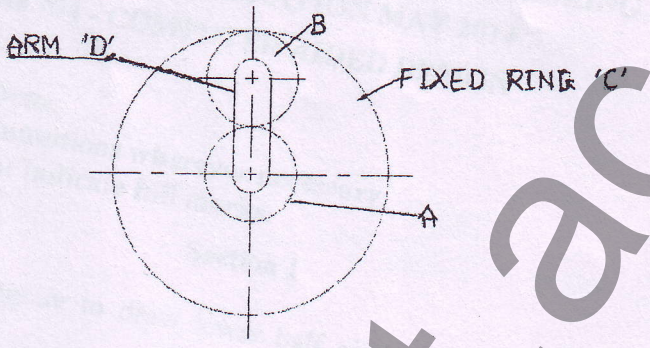

Fig. 1

Table 1: Radial and thrust factors for single –row deep groove ball bearing

F_a/C_0	F_a/C_0		$(F_a/VF_r) \geq e$		e
	X	Y	X	Y	
0.025	1	0	0.56	2.0	0.22
0.04	1	0	0.56	1.8	0.24
0.07	1	0	0.56	1.6	0.27
0.13	1	0	0.56	1.4	0.31
0.25	1	0	0.56	1.2	0.37
0.5	1	0	0.56	1.0	0.44

Table 2: Dimensions and basic capacities of single-row deep-groove ball bearing

Bearing Number	Principal Dimensions		Basic Capacity	
	Bore 'd' mm	Width 'B' mm	Static 'C_0' kN	Dynamic 'C' kN
6005	25	12	6.55	11.20
6205	25	15	7.80	14.00
6305	25	17	11.60	22.50
6405	25	21	19.3	35.80

Table 3: Value of Lewis Form Factor

Z	Y	Z	Y	Z	Y	Z	Y	Z	Y	Z	Y
16	0.295	20	0.320	24	0.337	28	0.352	33	0.367	40	0.389
17	0.302	21	0.326	25	0.340	29	0.355	35	0.373	45	0.399
18	0.308	22	0.330	26	0.344	30	0.358	37	0.380	50	0.408
19	0.314	23	0.333	27	0.438	32	0.364	39	0.386		

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