

GANPAT UNIVERSITY
B. Tech. Sem. - VIII Mechatronics Engineering
2MC804 Design of Mechanical Systems
(CBCS) Regular Examination April - June 2015

[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) Use of design data book is strictly restricted.

SECTION - I

Que. 1 Attempt the followings.

- (a) Define basic static capacity and rating life of bearing. Derive equation for load-life relationship for rolling contact bearing. [4]
- (b) A ball bearing used in truck carries radial load of 5 kN and the expected life for 90% of the bearings is 8000 hr. Calculate the dynamic load carrying capacity of the bearing. [4]
- (c) A set of taper roller bearing having face to face arrangement in which $F_{r1} = 800$ N, $F_{r2} = 1000$ N and $F_a = 50$ N. The axial force acting towards left to right. Assume bearing pairs to be 32007X, having $C = 40200$ N, $e = 0.46$ and $y = 1.3$ and $K_a = 1$. Calculate the equivalent load for the given bearing. [4]

OR

Que. 1 Attempt the followings.

- (a) Average life of bearing is 60 million revolutions and it is running at 1000 rpm. Find average life of bearing in hours. Also find equivalent dynamic load if the bearing selected from manufacturer's catalog of number 6205. [4]
- (b) A shaft supported by single row deep groove ball bearings which are rotates at 1200 rpm. Bearing is subjected to a radial force of 8000 N and as thrust force of 3000 N. The expected life of the bearing is 20000 hrs. The minimum acceptable diameter of the shaft is 75 mm. Select a suitable ball bearing for this application. [8]

Que. 2 Attempt the followings.

- (a) Derive equation for equivalent dynamic load for bearing under cyclic loads with neat sketch. [4]
- (b) A single row deep groove ball bearing is subjected to the work cycles as given below. If the desired rating life of the bearing is 15000 hours, select the bearing from the manufacturer's catalog. What is the average speed of the bearing? [8]

Sr. No.	Fraction of cycle	Radial Load 'F _r ' KN	Thrust Load 'F _a ' KN	Radial Factor 'X'	Thrust Factor 'Y'	Race Rotating	Service Factor	Speed rpm
1	1/10	1.5	0.25	1.0	0.0	Inner	1.2	400
2	1/5	1.0	0.75	0.56	2.0	Outer	1.8	500
3	3/5	5.0	1.1	0.56	2.0	Inner	1.5	600
4	remaining	1.0	---	1.0	0.0	Outer	2.0	800

OR

Que. 2 Attempt the followings.

- (a) Two identical ball bearings A and B are used in two different applications. The load on the bearing B is half of that on bearing A. The remaining conditions are identical. What will be the expected life of the bearing B as compared to the life of bearing A? [4]
- (b) A shaft with centrally mounted helical pinion is supported by deep-groove ball bearings at [8]

both ends. The center distance between the bearings is 100 mm. The shaft transmits 5 kW power at 3000 RPM. The pitch circle diameter of the pinion is 80 mm. The normal pressure angle and helix angle are 20° and 19° respectively. The expected life of the bearings is 8000 hours with a reliability of 95%. Calculate the dynamic basic capacity of the bearing which takes up the axial thrust, so that it can be selected from the manufacturer's catalogue based on a reliability of 90%. Take shock load factor as 1.25, radial factor of 0.56 and thrust factor is equal to 1.2.

Que. 3

(a) Attempt the followings (Any one).

(i) Classify the sliding contact bearing. Explain the working of hydrostatic bearing with neat sketch and write their applications, advantages and limitations. [4]

(ii) Explain the frictional power loss in hydrostatic step bearing and prove that it is inversely proportional to the optimum oil film thickness, start the derivation with Newton's equation of viscosity.

(b) The following data is given for a hydrostatic thrust bearing:

Shaft speed = 720 rpm, supply pressure = 5 MPa, shaft diameter = 400 mm, recess diameter = 250 mm, film thickness = 0.15 mm, viscosity of lubricant = 30 cP, specific heat of lubricant = 1.76 KJ/kg°C, and specific gravity of lubricant = 0.85, calculate: (i) load carrying capacity of the bearing, (ii) flow required in lit/min, (iii) frictional power loss, (iv) pumping power loss, and (v) temperature rise. [7]

Assume that the total power loss in the bearing is converted into frictional heat.

SECTION-II

Que. 4 Attempt the followings.

(a) Explain Johnson's method of optimum design with different three forms of equations. [4]

(b) Design a tensile bar of length, $L = 200$ mm to carry a tensile load of 5 kN for minimum cost, out of the following materials. Take factor of safety as 3. (Ref. Fig. A.) [8]

Material	Mass density ρ , (kg/m ³)	Material cost Per Unit Mass c , (Rs/kg)	Yield Strength $S_{0.2}$ (N/mm ²)
Steel	7500	14	400
Aluminium Alloy	2800	66	150
Titanium Alloy	4500	1100	800
Magnesium Alloy	1800	75	100

OR

Que. 4 Attempt the followings.

(a) Define normal specifications. Explain the procedural step of optimum design for normal specifications. [4]

(b) A thin spherical pressure vessel is subjected to an internal pressure of 4 N/mm². The mass of the empty vessel should not exceed 125 kg. If the factor of safety is 3.0, design the pressure vessel with the objective of maximizing the gas storage capacity, out of the following materials: [8]

Material	Mass density ρ , (kg/m ³)	Ultimate Tensile Strength S_{ut} , (N/mm ²)
Low Alloy Steel-15 Cr90 Mo55	7800	14
Aluminium Alloy- 74530	2800	66
Copper Alloy- Cu Ni31 Mn 1 Fe	8400	1100