Total No. of Questions—**12**] [Total No. of Printed Pages—**8+4**

Seat No.	

T.E. (Mechanical) (II Sem.) EXAMINATION, 2014

MACHINE DESIGN—II

(2008 PATTERN)

Time : Four Hours **Maximum Marks : 100**

N.B. :— (*i*) Answers to the two Sections should be written in separate answer-books.

(*ii*) Answer any *three* questions from each Section.

(*iii*) Neat diagrams must be drawn wherever necessary.

(*iv*) Figures to the right indicate full marks.

(*v*) Use of electronic pocket calculator is allowed.

(*vi*) Use of programmable calculator is not permitted.

(*vii*) Assume suitable data, if necessary.

SECTION I

1. (*a*) Explain different types of failures in Rolling Contact Bearings. Also give causes of each type of failure and corresponding remedies. [9]

P.T.O.

(*b*) A shaft roating at constant speed is subjected to variable load. Equivalent stationary radial bearing load is 3 kN, 2 kN and 1 kN for 10%, 20% and 30% of the cycle respectively and no load for rest of the cycle. If total life expected is 20×10^6 revolutions at 95% reliability, calculate Dynamic Load rating of the bearing. [7]

Or

2. (*a*) Write short notes on : [8]

(*i*) Lubrication and Mounting of Rolling Element Bearings

(*ii*) Preloading of Rolling Element Bearings.

(*b*) A shaft with centrally mounted right hand helical pinion is supported on two deep groove ball bearings at both ends. Centre distance between two bearings is 100 mm. Pinion is rotating in anticlockwise direction when viewed from right side of the pinion and is transmitting 5 kW power at 3000 rpm in horizontal direction. Pitch circle diameter of pinion is 80 mm. Normal pressure angle and helix angle are 20° and 19° respectively. The required reliability of bearing is 95% with life 8,000 hours.

Find dynamic load carry capacity of bearing to select it from manufacturer's Catalogue which is based on 90% reliability. Assume : [8]

Shock factor (Ka) = 1.3,

Radial load factor (X) = 0.56

Thrust factor (Y) = 1.25

Use the following relation :

$$L = 4.48\ L_{10}[\text{Log}_e(1/R)]^{1/11.17}.$$

3. (*a*) What are the essential properties of a good lubricant ? Explain each property and its significance in connection with the lubrication. [6]

(*b*) The following data is given for 360° hydrodynamic bearing : [10]

- Radial load = 3 kN
- Journal diameter = 50 mm
- Bearing length = 50 mm
- Journal speed = 1490 rpm
- Radial clearance = 50 microns
- Viscosity of lubricant = 23.4375 cP.

Calculate Minimum oil film thickness, coefficient of friction, power lost in friction and flow rate.

l/d	ho/c	ε	S	(r/c)f	$Q/rcn_s l$	Qs/Q	P_{max}/P
1.0	0.2	0.8	0.0446	1.70	4.62	0.842	3.195
	0.4	0.6	0.121	3.22	4.33	0.680	2.409
	0.6	0.4	0.264	5.79	3.99	0.497	2.066
	0.8	0.2	0.631	12.8	3.59	0.280	1.890

Table 1 : Dimensionless parameters for Full Journal Bearings

Or

4. (*a*) Explain the significance of the following variables in connection with hydrodynamic bearing : [8]

(*i*) l/d ratio

(*ii*) Unit bearing pressure

(*iii*) Radial clearance

(*iv*) Minimum oil film thickness.

(*b*) Derive Petroff' equation for hydrodynamic bearing. [8]

5. (*a*) With supporting sketch, differentiate between Repeated stress, Completely reversed stress and Fluctuating stress along with *one* practical example for each type. [9]

(*b*) A plate made up of 50C4 (S_{ut} = 580 N/mm^2) is to have uniform thickness but its width is 100 mm in half of its length and 50 mm in remaining half length. Otherwise stress concentration at the abrupt change in width is reduced by providing fillet radius of 5 mm at the junction. The plate is subjected to completely reverse axial stress of 50 kN. Theoretical stress concentration factor and notch sensitivity are 2.27 and 0.8 respectively. Surface finish factor, size factor, load factor, reliability factor and factor of safety are 0.75, 0.85, 0.923, 0.897 and 3 respectively. Determine the plate thickness for infinite life. [9]

Or

6. (*a*) What is the significance of each modifying factor that is used for Endurance Strength while designing any component subjected to fluctuating stress ? [9]

(*b*) A cold drawn steel rod of circular cross-section is subjected to variable bending moment from 565 Nm to 1130 Nm. Axial load varies from 4500 N to 13500 N. Effect of stress concentration can be neglected. If factor of safety is 3, determine

diameter of rod using maximum shear stress theory. Assume the following data : [9]

- S_{ut} = 550 N/mm^2
- S_{yt} = 470 N/mm^2
- Surface Finish Factor = 0.82
- Size Factor = 0.8
- Reliability factor = 0.897.

SECTION II

7. (*a*) Draw a labeled sketch of Multi-plate clutch. [4]

(*b*) A cone clutch is used to transmit 15 kW power at 1440 rpm Coefficient of friction between contacting surfaces is 0.3. The permissible intensity of pressure is 0.23 N/mm^2. The semicone angle is 12.5°. The mean radius of friction surface is twice the face width. Assuming uniform pressure condition, determine :

(*i*) Dimensions of the friction surfaces

(*ii*) The axial force required

(*iii*) Force required to disengage the clutch. [12]

Or

8. (*a*) Explain the parameters to be considered for the selection of the friction lining for brakes. [6]

(*b*) A four-wheeler has a total mass of 900 kg. The moment of inertia of each wheel is about a transverse axis through its centre of gravity is 0.5 kg-m^2. The rolling radius of the wheel is 0.35 m. The rotating and reciprocating parts of the engine and the transmission system are equivalent to a moment of inertia of 2.2 kg-m^2 rotating at 5 times the speed of the road wheel speed. The car is travelling at a speed of 80 km/hr on a plane road. When the brakes are applied, the car decelerates at 0.4 g. There are brake on all four wheels. Determine :

(*i*) The energy absorbed by brake.

(*ii*) The torque capacity of the brake. [10]

9. (*a*) Explain the standard systems of gear tooth. [4]

(*b*) Design a pair of spur gear with 20° full-depth involute teeth based on Lewis equation. The velocity factor is to be used to account for dynamic load. The pinion shaft is to be connected to 10 kW, 1400 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 gear is made of plain carbon steel 40C8 (S_{ut} = 600 N/mm^2). The factor of safety as 1.5. Design the gears, determine their dimensions and suggest suitable surface hardness for the gears.

Use the following data :

(*i*) Lewis form factor, $Y = 0.484 - \frac{2.87}{Z}$

(*ii*) Velocity factor $C_v = \frac{3}{3 + V}$

(*iii*) Load Stress factor, $K = 0.16 \left(\frac{BHN}{100}\right)^2$ N/mm^2

(*iv*) Number of teeth on pinion : 18. [12]

Or

10. (*a*) Derive a relation for virtual number of teeth for a helical gear. [4]

(*b*) A pair of helical gear consist of 24 teeth pinion rotating at 5000 rpm and supplying 2.5 kW power to a gear. The speed reduction is 4 : 1. The normal pressure angle and helix angle are 20° and 23° respectively. Both the gears are made of hardened steel (S_{ut} = 750 N/mm^2). The service factor, factor of safety and load concentration factor are 1.5, 2.0 and 1.0 respectively. The gears are finish as per grade –4.

(*i*) In initial stage of gear design assume velocity factor accounts dynamic load and face width is 10 X module and assume pitch line velocity V = 10 m/s, for estimating normal module.

(*ii*) Select first preference module and calculate dimensions of gears.

(*iii*) Determine the dynamic load by Buckingham's equation also calculate factor of safety in bending.

(*iv*) Specify the surface hardness at factor of safety 2.0.

Use the following data :

- Lewis form factor $Y' = 0.484 - \frac{2.87}{Z'}$
- For grade 4; $e = 3.20 + 0.25\ (m_n + 0.25\sqrt{d}\,)$
- Buckingham's equation $P_d = \frac{21V\left(bC.\cos^2\psi + P_{t\max}\right)\cos\psi}{21V + \sqrt{bc.\cos^2\psi + P_{t\max}}}$
- Velocity factor $C_v = \frac{5.6}{5.6 + \sqrt{V}}$

First preference module (mm) — 1.0, 1.25, 1.5, 2.0, 2.5, 3, 4, 5, 6, 8, 10, 12, 16 and 20. [12]

11. (*a*) Derive an expression for beam strength of straight bevel gear tooth. [6]

(*b*) The dimension of a pair of bevel gears are given in Fig. 1. The gear G delivers 5 kW power at 500 rpm to the output shaft. The bearing A and B are mounted on the output shaft in such a way that the bearing B can take radial as well

as thrust load, while the bearing A can only take radial load. Determine the reactions at the two bearings. [12]

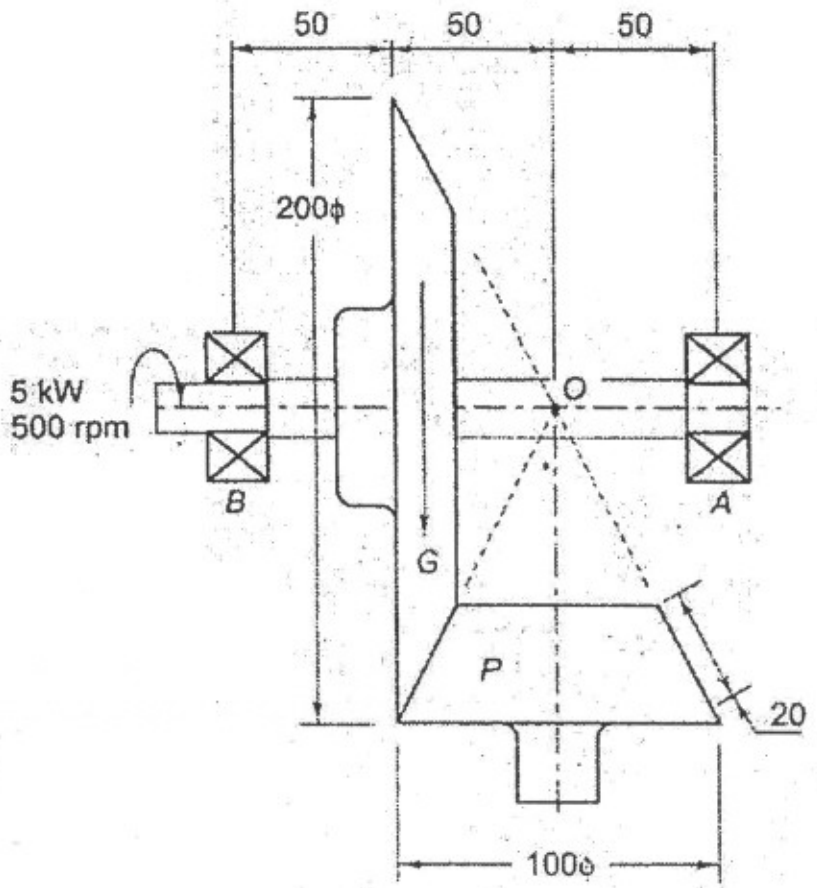

Fig. 1

Or

12. (*a*) Explain force analysis for a worm gear derive. [6]

(*b*) A double start worm made of case hardened alloy steel 16Ni80Cr60 (S_{ut} = 700 N/mm^2) is to mesh with worm gear to be made of phosphor bronze (S_{ut} = 240 N/mm^2). The gear pair is required

to transmit 5 kW power from an electric motor running at 1500 rpm to a machining running at 75 rpm. The service factor is 1.25, while the factor of safety required is 2.0. The face width of worm gear is 0.73 times the pitch circle diameter of worm. The worm gear factor is 0.685 N/mm^2, while the diametrical quotient is 10. The normal pressure angle is 14.5°. If the coefficient of friction between worm and worm gear teeth is 0.03, design the gear pair and find the power lost. Would you recommend a fan for the gear box ? Assume the permissible temperature rise is 50°C.

Use the following data :

- Lewis form factor, $Y = 0.39 - \frac{2.15}{Z_G}$
- Velocity factor, $C_v = \frac{6}{6 + V_G}$
- Area of housing, $A = 1.14 \times 10^{-4} \times (a)^{1.7}\ m^2$,

where a = centre distance in mm. [12]