Total No. of Questions : 12]

SEAT No. :

P1370

[Total No. of Pages : 7

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T.E. (Mechanical)

MACHINE DESIGN - II

(2008 Pattern) (Semester - II)

Time : 4 Hours] *[Max. Marks : 100*

Instructions to the candidates:

1) ***Answers to the two sections should be written in separate answer books.***
2) ***Answer any three questions from each section.***
3) ***Neat diagrams must be drawn wherever necessary.***
4) ***Figures to the right indicates full marks.***
5) ***Use of electronic pocket calculator is allowed.***
6) ***Use of programmable calculator is not permitted.***
7) ***Assume suitable data, if necessary.***

SECTION - I

Q1) a) Derive Stribeck's equation for the basic static capacity of bearing. State the assumption made. **[9]**

b) A single row deep groove ball bearing operates with the following work cycle : **[7]**

Element No.	Element Time,%	Radial Load 'Fr' kN	Thrust Load 'Fa' kN	Radial Factor 'X'	Thrust Factor 'Y'	Race Rotating	Service Factor	Speed rpm
1	50	3.0	1.0	0.56	1.4	Inner	1.5	720
2	20	2.5	1.0	0.56	1.6	Outer	2.0	1440
3	Remaining	No load	No load	-	-	Outer		720

If the expected life of the bearing is 14000 hours with a reliability of 95%, calculate the basic dynamic load rating of the bearing so that it

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can be selected from the manufacturers catalogue based on 90 % reliability. If there are six such bearings in a system, what is the probability that all bearing will survive for 14000 hours?

Use following relation,

$$L = 4.48\ L_{10}\ [\text{Log}_e\ (1/R)]^{1/1.5}$$

OR

Q2) a) With the help of neat sketches, explain the methods of mounting the rolling contact bearings. **[8]**

b) What is preloading of rolling contact bearing? Why it is necessary? **[4]**

c) A transmission shaft is supported by two deep groove ball bearings at two ends. The center distance between the bearings is 160 mm. A load of 300 N acts vertically downwards at 60 mm distance from the left hand bearing whereas a load of 550 N acts horizontally at 50 mm distance from the right hand bearing. Shaft speed is 3000 rpm and expected life of the bearings is 7000 hours with a reliability of 95%. It is intended to use same bearing at both ends of the shaft. Calculate dynamic load rating of the bearing so that it can be selected from manufacturer's catalogue. **[6]**

Use following relation,

$$L= 4.48\ L_{10}\ [\text{Log}_e\ (1/R)]^{1/1.5}$$

Q3) a) Derive Petroff' equation for hydrodynamic bearing. **[8]**

b) State any four important properties of lubricant .Explain the effect of temperature and pressure on viscosity of the lubricating oil. **[8]**

OR

Q4) a) Explain the significance of following variables in connection with hydrodynamic bearing : **[6]**

i) l/d ratio

ii) Unit bearing pressure

iii) Radial clearance

iv) Minimum oil film thickness

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

Journal diameter = $50^{-0.080}_{-0.119}$

Bearing diameter = $50^{+0.039}_{+0.000}$

Bearing length = 50 mm

Journal speed = 1500 rpm

Radial load = 5 kN

The bearing is machined on a lathe from bronze casting, while the steel journal is hardened and ground. The surface roughness (c.l.a.) values for turning and grinding are 3.2 and 0.8 microns respectively. For thick film hydrodynamic lubrication, the minimum film thickness should be six times the sum of surface roughness values for the journal and bearing. Determine quality and quantity of the lubricant required.

Table - 1 Dimensionless Parameters for Full Journal bearings

l/d	ho/c	ϵ	S	(r/c)f	Q / rcn$_s$l	Qs / Q	Pmax /p
1	0.03	0.97	0.00474	0.514	4.82	0.973	6.579
	0.1	0.9	0.0188	1.05	4.74	0.919	4.048
	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
	0.9	0.1	1.33	26.4	3.37	0.150	1.852

Q5) a) What is endurance strength of material? **[4]**

b) A transmission shaft carries a pulley midway between the two bearings. The bending moment at the pulley varies from 200 Nm to 600 Nm as the torsional moment in the shaft varies from 70 Nm to 200 Nm. The frequencies of variation of bending and torsional moments are equal to the shaft speed. The shaft rotates at 1440 rpm.The shaft is made of plain carbon steel (σ_{ut} = 540 N/mm^2 and σ_{yt} = 400 N/mm^2). The corrected endurance limit of the shaft is 200 N/mm^2. Determine the diameter of the shaft using a factor of safety of '2'. **[12]**

OR

Q6) a) Define : **[4]**

i) Notch sensitivity

ii) Endurance Limit

b) A solid circular shaft, 15 mm in diameter is subjected to torsional shear stress, which varies from 0 to 35 Mpa and at the same time is subjected to an axial stress that varies from – 15 Mpa to 35 Mpa. The frequency of variation of these stresses is equal to the shaft speed. The shaft is made of steel with S_{ut} = 540 Mpa and S_{yt} = 400 Mpa and corrected endurance strength of the shaft is 200 Mpa. Determine the factor of safety. **[12]**

SECTION - II

Q7) a) Draw a neat labeled sketch of cone clutch. **[4]**

b) A centrifugal clutch transmitting 20 KW at 750 rpm consist of four shoes, the clutch is to be engaged at 500 rpm. The inner radius of drum 165 mm. The radius of centre of gravity of shoe is 140 mm, when the clutch is engaged. The coefficient of friction is 0.3 while the permissible pressure on friction lining is 0.1 N/mm^2. Assume shoe subtended angle is 70° Calculate, **[12]**

i) Mass of each shoe

ii) Dimensions of friction lining

OR

Q8) a) Explain self locking & self energizing brake. **[4]**

b) A Caliper disk brake is to designed for front wheel of sport car. 'The required braking capacity of each brake is 450 N-m. The inner & outer radii of friction pads are 100 mm & 150 mm respectively. The coefficient of friction between the pads & rotating disk is 0.4 while the limiting intensity of pressure is 1.1 N/mm^2. Determine the required number of pads if, the pads are annular segments with subtended angle 60° per pad at centre of disk. Draw the sketch showing disk & annular pads. **[8]**

Q9) a) What are the effects of increasing & decreasing pressure angle in design of gear pair. **[4]**

b) A spur gear pair with 20° full depth involute tooth profile consist of 18 teeth pinion meshing with 36 teeth gear .the pinion & gear is made of steel with ultimate tensile strength 600 N/mm^2 & 510 N/mm^2 respectively, the module is 5 mm while the face width is 10 × module. The surface hardness of pinion & gear are 330 BHN & 280 BHN respectively. **[14]**

Calculate :

i) Beam strength

ii) Wear strength

iii) Rated power that the gear can transmit and

iv) Maximum static load on gear.

Use following Data -

- Servicefactor - 1.5,
- Factor of safety – 2
- pinion speed – 1440 rpm
- Lewis form factor – Y = 0.484 - 2.87/Z
- Velocity factor - $V = \frac{5.6}{5.6 + \sqrt{V}}$.

OR

Q10) a) What is formative number of teeth in helical gear. Derive the expression for formative number of teeth in helical gear. **[4]**

b) A helical pinion 14 teeth made of alloy steel with S_{ut} =800N/mm^2 is mesh gear made of plain carbon steel with S_{ut} = 720 N/mm^2 . The gear is required to transmit 30KW power from an electric motor running at 720 rpm to machine at 225 rpm. The application factor & load concentration factor are 1.3 & 1.1 respectively while the factor of safety is 2.0 The face width is 10 × normal module & tooth system is 20° full depth involute . The deformation factor is 11000 × e N/mm. Design the gear pair by using velocity factor & Buckingham's equation for dynamic load. Also suggest the surface hardness for gear pair.

Use following Data-

Lewis form factor – $Y = 0.484 - \frac{2.87}{Z}$

Velocity factor – $V = \frac{5.6}{5.6 + \sqrt{V}}$

For grade 7, $e = 11 + 0.9\ [Mn + 0.25\ \sqrt{d}\ ]$ um

Load stress factor $K = 0.16\ [BHN/100]^2$

Buckingham s equation - $P_d = \frac{21V(bC.\cos^2\psi + P_{t\max})\cos\psi}{21V + \sqrt{bc.\cos^2\psi + P_{t\max}}}$

Standard module in mm, 1, 1.25, 2, 3, 4, 5, 6, 8, 10, 12, 14

Q11) a) What are different types of mounting of bevel gear. Explain any one with sketch. **[4]**

b) A pair of bevel gear with 20° full depth involute tooth profile consist of 24 teeth pinion meshing with 48 teeth gear. the axes of pinion & gear are right angle to each other . The module at large end of the tooth is 6 mm while the face width is 50 mm .The gear pair is made of gray cast iron FG220. The teeths are generated, the surface hardness of gear pair is 250 BHN. The application factor & factor of safety are 1.5 & 2.0 respectively. The pinion rotates at 300 rpm. Assuming velocity factor accounts for dynamic load, Determine **[12]**

i) Beam strength

ii) Wear strength

iii) Maximum static load on gear. and

iv) Rated power that the gear can transmit

OR

Q12) a) In a design of worm gear pair why worm gear governs the design. **[3]**

b) A double start worm made of case hardened alloy steel l6Ni80Cr60 (S_{ut} = 700N/mm^2) is to mesh with worm gear to be made of phosphor bronze (S_{ut} = 240N/mm^2). The gear pair is required to transmit 5kW power from an electric motor running at 1500rpm 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 l0. 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. **[13]**

Use 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 × 10^{-4} × $(a)^{1.7}$ m^2, where a = centre distance in mm

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