Total No. of Questions : 10]

SEAT No. :

P1694

[Total No. of Pages : 7

[5058]-316

T.E. (Mechanical)

DESIGN OF MACHINE ELEMENTS - II

(2012 Pattern) (Semester - II) (End Semester)

Time : 2½ Hours] *[Max. Marks : 70*

Instructions to the candidates:

1) ***Answer five questions from following.***
2) ***Neat diagrams must be drawn wherever necessary.***
3) ***Figures to right indicates full marks.***
4) ***Use of electronic pocket calculator is allowed.***
5) ***Use of programmable calculator is not permitted.***
6) ***Assume suitable data if necessary.***

Q1) a) State & Explain different types of gear tooth failures, their causes & remedies. **[4]**

b) The following data is given for pair of parallel helical gear made up of steel. **[6]**

Power transmitted = 20 kW

Speed of pinion = 720 rpm

No. of teeth on pinion = 35

No. of teeth on Gear = 70

Center distance = 285 mm

Normal module = 5 mm

Face width = 50 mm

Normal pressure angle = 20°

Ultimate tensile strength = 600 N/mm^2

Surface Hardness = 300 BHN

Grade of Machining = Grade 6.

Service Factor = 1.25

P.T.O.

Calculate:-

i) Helix Angle

ii) The Beam strength

iii) The wear strength

$$Y' = 0.487 - \frac{2.87}{Z'}; K_v = \sqrt{\frac{5.6}{5.6 + \sqrt{V}}}.$$

OR

Q2) a) A steel pinion with 20° full depth involute teeth is transmitting 7.5 KW power at 1000 rpm from an electric motor. The starting torque of motor is twice the rated torque. The number of teeth on the pinion is 25, while the module is 4mm. The face width is 45mm. Assuming that the velocity Factor account for dynamic load, calculate: **[6]**

i) The effective load on gear tooth $Y = 0.487 - \frac{2.87}{Z}$.

ii) The bending stress in gear tooth $K_v = \frac{3}{3 + V}$.

b) With neat sketch, discuss the Force Analysis of Bevel Gear. **[4]**

Q3) a) A pair of straight Bevel gear with 20° pressure angle consists of 20 teeth pinion meshing with 30 teeth gear. The module is 4 mm while the face width is 20 mm. The pinion & gear material has surface hardness of 400 BHN. The pinion rotate at 720 rpm & receives 3 kW power from a motor. The service Factor is 1.5 & Barth Factor Dynamic Loading. Determine the factor of safety in pitting. **[6]**

b) What is preloading? Explain preloading of taper roller bearing with sketch. **[4]**

OR

Q4) a) Classify Bevel Gear. State the advantages & limitations of each type. **[4]**

b) The following data is given for a belt drive.

Diameter of pulley = 250 mm

Shaft Diameter = 20 mm

Power transmitted = 5kW

Speed = 720 rpm

Ratio of Belt tensions = 3:1

Load Factor = 3

Assume the pulley to be placed centrally with the belt tensions acting vertically downward the required reliability of the bearing is 95% with the life of 10,000 Hrs.

Find the Dynamic Load carrying capacity of bearing so that bearing are selected from manufacturer's catalogue which list dynamic load carrying capacity at 90% reliability. **[6]**

Q5) a) Deduce an expression for efficiency of warm & worm gear pair. **[6]**

b) The following Data is given for worm gear pair **[12]**

Pitch circle diameter of worm = 48 mm

Pitch circle diameter of worm gear = 192 mm

Axial pitch of worm = 18.85 mm

Pressure Angle in axial plane of worm = 20.10°

Lead of worm = 18.85 mm

Effective width of worm gear teeth = 36 mm

Worm speed = 3500 rpm.

Permissible bending stress for worm gear = $90N/mm^2$

Worm gear wear factor = $830\ kN/m^2$

Coefficient of friction between worm & worm gear tooth = 0.025

Overall heat transfer co-efficient without fan = $16W/m^2\,°C$ overall heat transfer coefficient with Fan = $15.2 + 8.25 \times 10^{-3}$ hw, $W/m^2\,°C$

Effective area of housing = $9 \times 10^{-5} \times (a)^{1.88}$, m^2

Frictional losses in bearing = 4.5% of total input power.

Where n_w = worm speed, rpm.

a = center distance in mm

Determine:-

i) The dimensions of worm gear pair.

ii) The input power rating on the basis of strength.

iii) The temperature of lubricating oil with fan.

Is fan is necessary. Comment.

OR

Q6) a) In a design of worm gear pair why worm gear governs the design. **[4]**

b) The following data refers to worm gear drive used for transmitting 20 kW power from input speed of 1450 rpm. The reduction ratio is 20:5 while the material for worm gear is bronze K = 2.4 MPa. **[14]**

Diameter Factor = 10

Service Factor = 2

Number of starts on worm = 2

Permissible bending strength of worm gear material = 275 MPa

Wear load factor = 2.4 MPa.

Coefficient of friction = 0.026.

Velocity factor $\frac{6}{6+V9}$

Form factor for normal pressure angle of 14.5° = 0.314

Norm gear width = 0.73 × worm PCD.

Factor of safety = 1.

Standard first preference values of module are as follows:-

1, 1.025, 1.6, 2, 2.5, 3.15, 4.5, 6.8, 10, 12, 16, 20 mm.

Design worm & worm gear Drive. Would you recommend blower for gear box? If it is not possible to fit blower then what will be new value of module for worm gear.

Q7) a) A Horizontal Flat belt drive is used to transmit 25kW power from an electric motor running at 1440 rpm to a centrifugal water pump expected to run at 720 rpm. The required center distance is 4.5m. Select the flat belt for the drive. Using following data: **[12]**

Recommended Range of belt speed = 17.8 m/s $\leq$ V $\leq$ 22.9 m/sec.

Load correction factor = Fa = 1.2

Power rating per ply per mm width at 180° arc of contact & V = 10m/sec.

For HI speed belt –0.023 kW/ply/mm.

Standard pulley dia :- 90, 100, 112, 125, 140, 160, 180, 200, 224, 250, 280, 315, 355, 400, 450, 500, 560, 630, 710, 800, 900, 1000, 1120, 1250 mm. Arc of contract correction factor (Fa).

Arc of contact Q	120°	130°	140°	150°	160°	170°	180°
Fa	1.33	1.26	1.19	1.13	1.08	1.04	1.00

Standard Belt width

Num. of ply	Standard belt width b, mm
4	40, 44, 50, 63, 76, 90,100, 112, 125, 152
5	76, 100, 112, 125,152

b) What are different belt tensioning methods, Explain any one with neat sketch? **[4]**

OR

Q8) a) Derive the condition for maximum power transmission capacity of belt drive based on belt strength & friction capacity. **[6]**

b) Show that maximum power transmission capacity of belt occurs at velocity of belt $V=\sqrt{\frac{Fi}{3m}}$; where Fi is the initial tension in the belt & m is mass per unit length of belt. **[6]**

c) What are different modes of roller chain failure. **[4]**

Q9) a) The following data gives a 360 °C hydrodynamic Bearing

Radial load = 10 kN

Journal speed = 1450 rpm.

I/d ratio = 1

Bearing length = 50mm

Radial clearance = 20 microns

eccentricity = 15 microns

Specific gravity of lubricant = 2.09 kJ/kg °C.

Calculate:

i) The minimum oil flim thickness.

ii) The coefficient of friction.

iii) The power lost in friction.

iv) The Viscocity of lubricant in Cp.

v) The total flow rate of lubricant in l/min.

vi) The side leakage &

vii) The average temperature if make up oil is supplied at 30 °C. **[13]**

b) Write short notes on Additives for mineral oil. **[3]**

OR

Q10)a) A 50 mm dia. hardened & ground steel Journal rotate at 1440 rpm. In a lathe turned bronze bushing of 50 mm length. For Hydrodynamic Lubrication the minimum oil film thickness should be five times the sum of surface roughness of Journal & bearing. If the class of fit is H8 d8 & the Viscocity of lubricant is 18Cp Determine: **[11]**

i) The maximum radial load that the journal can carry & still operate under hydrodynamic condition.

ii) The quantity of lubricating oil required.

iii) The side leakage

iv) The temperature rise considering side leakage surface Roughness

Element	Machining method	Surface Roughness (LA)
Shaft	Grinding	1.6 microns
Bearing	Turning/Boaring	0.8 microns

Tolerance

Diameter (mm)	Tolerance (mm)	
	H8	d8
50	T0.046	–0.100
50	0.000	–0.196

Take ρ = 860 Kg/m^3 &

Cp = 2.09 kJ/kg °C

b) Derive the Petroff's equation for hydrodynamic bearing. Also state its limitation. **[5]**