

(Following Paper ID and Roll No. to be filled in your Answer Book)

PAPER ID : 2536

Roll No.

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B.Tech.

(SEM. VI) EVEN THEORY EXAMINATION 2012-13

MACHINE DESIGN-II*Time : 3 Hours**Total Marks : 100*

Note :- Attempt all questions. Assume missing data and make necessary assumptions. Use of design data book is permitted.

1. Attempt any two parts : (10×2=20)
- (a) (i) Derive the expression of beam strength of a spur gear tooth.
- (ii) Derive the expression for efficiency of worm wheel drive.
- (b) A pair of spur gears is to be designed as per Lewis equation. Pinion is rotating at 1000 rpm meshes with a gear; with speed reduction of 3. Power to be transmitted is 12 kW. Starting torque of electric motor supplying power to pinion is 150% of the rated torque. The gears are made of steel with allowable bending stress is 200 MPa. Face width can be taken as 10 m. Where m is the module. Taking factor of safety of 2, determine the module and gear sizes. Specify surface hardness of gears.
- (c) A pair of spur gears with 20° full depth involute teeth needs to be designed. Input shaft rotates at 800 rpm and receives a 6 kW power. Speed reduction of output shaft is by 5 times. The gears are made of steel with $\sigma_u = 450$ MPa.

Service factor is 1.3 and the face width is ten times of the module. The gears are machined to accuracy of Grade 8. Assume a pitch line velocity of 3.6 ms^{-1} , factor of safety 2 and deformation factor 11.4 GPa. Estimate the module of the gear teeth. Determine the dynamic load by using Buckingham's equation.

2. Attempt any two parts : (10×2=20)

- (a) (i) What is virtual or formative gear ?
 (ii) A pair of helical gears transmits 5 kW. The following are its details :
 Teeth on pinion = 25, teeth on gear 50, normal module 4 mm, helix angle 20° and normal pressure angle $= 20^\circ$. Determine the axial, tangential and radial components of the tooth load if pinion rotates at 1200 rpm.
- (b) A pair of helical gears consists of 25 teeth pinion meshing with 100 teeth gear. Normal pressure angle is 20° and helix angle is 25° . The pinion rotates at 740 rpm. Normal module of gear is 5 mm and face width is 50 mm. Both pinion and gear are made of steel with allowable bending strength of 330 MPa. Gears are heat treated to a surface hardness of 380 BHN. What power can be transmitted by gears if service factor is 1.3 ? Assume velocity factor accounts for the dynamic load.
- (c) A pair of worm gear is designated as 2/55/10/5. The worm rotates at 750 rpm and normal pressure angle is 20° . Worm is made of case hardened steel, and the gear of phosphor-bronze and worm set is well lubricated. Determine the power lost due to friction when power input is 1 kW.

3. Attempt any two parts : (10×2=20)

- (a) (i) What do you mean by static load and dynamic load for a ball bearing ?
 (ii) What do you mean by load factor ? On what criterion does load factor depend ?
- (b) For a single row deep groove ball bearing, dynamic load carrying capacity of the bearing is 5590 N and static load carrying capacity of the bearing is 2500 N. Axial and radial load on the bearing are 625 N and 1250 N respectively. Determine the equivalent load and life of ball bearing if (i) inner race is rotating and (ii) outer race is rotating.
- (c) A system is using 3 identical ball bearings, each subjected to 3 kN radial load. Reliability of the system that is 1 out of 3 bearings failing during the life time of 6 million cycles is 83%. Determine the dynamic load carrying capacity of the bearing with 90% reliability.

4. Attempt any two parts : (10×2=20)

- (a) (i) What do you mean by lubrication ? Classify thick film lubrication.
 (ii) What are stable and unstable lubrications ? Explain with the help of bearing characteristic number.
- (b) Following data is given for a full hydrodynamic bearing :
 Radial load = 22 kN, journal speed = 960 rpm, unit pressure in bearing = 2.4 MPa, viscosity of lubricant = 20 cP, ratio of length to diameter = 1 and ratio of minimum film thickness to clearance = 0.2. Determine : (i) dimensions of the bearing, (ii) minimum film thickness and (iii) requirements of oil flow.

- (c) The following data is given for a 360° hydrodynamic bearing :

Length to diameter ratio = 1, Journal speed = 1350 rpm,
Journal diameter = 100 mm, diametral clearance = 100 μm ,
external load = 9 kN. The value of minimum film thickness
variable is 0.3. Find the viscosity of lubricating oil used.

5. Attempt any one part : (20)

- (a) Design a crank shaft of a single cylinder petrol engine with following specifications :

Shaft material 60C4, for which permissible stress in bending and compression can be taken as 60 MPa and 75 MPa respectively.

Maximum gas pressure on piston = 2.5 MPa,

Cylinder bore = 95 mm,

L/R ratio = 4.5 (Where L is the length of connecting rod and R is crank radius),

For crank pin : $l/d = 1$, allowable bearing pressure = 13 MPa.

For main bearings : $l/d = 1.5$, where d = crank pin diameter and allowable pressure in main bearing = 7 MPa.

Side crank carries a flywheel of 200 kg mass between two journal bearings of crank shaft.

Cylinder of engine is horizontal. Distance between two journal bearings = 200 mm.

- (b) The cylinder of a four stroke diesel engine has the following specifications :

Cylinder bore : 150 mm

The maximum pressure : 3.5 MPa

Cylinder material : Grey cast iron FG 200 ($S_{ut} = 200 \text{ MPa}$)

Factor of safety is : 6

Poisson's ratio : 0.25

Determine the thickness of the cylinder wall. Also calculate the apparent and net circumferential stresses in the cylinder wall.