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B.Tech.
(SEM VI) EVEN SEMESTER EXAMINATION 2015-16
MACHINE DESIGN - II

[Time: 3 hrs.] **[Max. Marks: 100]**

Notes: *(i) Attempt all questions. (ii) Assume any missing data suitably. (iii) Use of design data book is permitted.*

Q1. Attempt any *two* parts of the following. **(10x2=20)**

(a) A pair of spur gear consists of pinion 30 teeth, running at 1000 rpm transmitting power to a 75 teeth gear. Module of gear teeth is 5 mm and face width is 60 mm. Both the gears are made of steel with σ_{ut} = 450 MPa. Gears are heat treated to a surface hardness of 350 BHN. Service factor is 1.5 and factor of safety is 2. Determine (a) beam strength, (b) wear strength of gear tooth and (c) the amount of power that can be transmitted by gears.

(b) A pair of helical gear consists of 24 teeth pinion meshing with 72 teeth gear. Normal pressure angle is 20° and helix angle is 24°. The pinion rotates at 720 rpm. Normal module of gear is 5 mm and face width is 50 mm. Both pinion and gear are made of steel with σ_{ut} = 600 MPa. Gears are heat treated to a surface hardness of 360 BHN. What power can be transmitted by gears if service factor is 1.4 and factor of safety is 2? Assume that velocity factor accounts for the dynamic load.

(c) Explain the following:
- i. What are law of gearing and conjugate action.
- ii. Differentiate between involute and cycloid tooth profiles.
- iii. Explain the virtual number of teeth in a helical gear.
- iv. With help of a neat sketch show the forces acting on a helical gear and the relationship between tangential load, axial load and radial load.

Q2. Attempt any two parts of the following. **(10x2=20)**

(a) A pair of high grade cast iron bevel gears having shaft axes at right angles is to have an angular velocity ration of 2:3. Pinion shaft rotates at 300 rpm and transmits 15 kW. Pitch circle diameter of pinion is 300 mm. Take a face width of about one fourth of the length of pitch element. Determine the module of gears. Take σ_b, allowable working stress for high grade CI as 100 MPa. Take service factor as 1.5 and factor of safety as 2.

(b) A worm-worm wheel set is designated by 2/54/10/8. The effective surface area of gear housing is 1.8 m^2 and heat transfer coefficient is 16 W/m^2 °C. If the ambient temperature is 25°C, worm shaft runs at 1000 rpm, with normal pressure angle of 20°, and power transmitted through worm is 4 kW, then what is the rise in temperature of lubrication oil?

(c) Answer the following:
- i. Force analysis of bevel gears.
- ii. Virtual number of teeth on bevel gears.
- iii. Designation of a worm wheel drive
- iv. Show the various components of normal reaction between worm and worm wheel teeth.

Q3. Attempt any *two* parts of the following. **(10x2=20)**

a) A 50 mm diameter journal bearing rotates at 1500 rpm. If L/D ratio is 1, radial clearance 0.05 mm, minimum film thickness is 0.01 mm, calculate the maximum radial load that the journal bearing can carry and still operate under hydrodynamic condition. For this load, calculate power lost in friction and the oil temperature assuming heat generated equal to heat dissipated. Assume absolute viscosity as 20 x 10^{-3}PaS, specific gravity of oil 0.88 and specific heat of oil as 2.1 kJ/kg ºC.

b) A journal bearing 160 mm long and 45 mm diameter supports a radial load of 8000N. The shaft speed is 160 rpm; oil used is SAE 60 at 25ºC inlet temperature. Using clearance ratio of 600, find the rise in temperature, maximum film pressure and minimum film thickness.

c) The following data is given for a 360º hydrodynamic bearing.
Radial load = 6 kN, Journal speed = 1260 rpm, Journal diameter = 60 mm
Minimum oil thickness = 0.0008 mm, Radial clearance = 0.04 mm
Specify the viscosity of the lubricating oil you will recommend for bearing.

Q4. Attempt any *two* parts of the following. **(10x2=20)**

a) Select a single row, radial ball bearing for a radial load of 3 kN and a thrust load of 3.75 kN operating at a speed of 1000 rpm for an average life of 5 years at 10 hrs per day. Assume safety load with no shock. The diameter of the bearing is limited to 50 mm.

b) A deep groove ball bearing has dynamic capacity of 24400 N and is to operate on the following work cycle:
Radial load of 5800 N and 200 rpm for 25% of the time
Radial load of 8900 N and 500 rpm for 20% of the time
Radial load of 3500 N and 400 rpm for remaining time
Assuming the loads are steady and the inner race rotates; find the expected average life of the bearing in hours.

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 bearing failing during lifetime of 6 million cycles is 83%. Determine the dynamic load capacity of the bearing with 90% reliability.

Q5. Attempt any *one* part of the following. **(20x1=20)**

a) Determine the dimensions of the cylinder, cylinder head and studs of a diesel engine which has following specification:
Maximum gas pressure = 5 N/mm^2, Average indicated mean effective pressure = 0.7 N/mm^2
Power = 135 kW at 600 rpm, Efficiency = 85%, Assume all other relevant data necessary.

b) Design a cast iron piston for a single cylinder four stroke engine with the following data:
Cylinder bore = 105 mm, Stroke = 1.4 x cylinder bore, Maximum gas pressure = 5.2 N/mm^2
Indicated mean effective pressure = 0.78 N/mm^2, Mechanical efficiency = 80%
Fuel consumption = 0.16 kg per brake power in kW per hour
Higher calorific value of fuel = 46300 kJ/kg, Speed = 400 rpm
Temperature at piston centre = 425ºC, Temperature at piston edge = 225ºC
Heat conductivity factor = 46.6 W/m/ºC for CI, Heat dispersed through top = 5.5% of heat produced
Permissible tensile stress for piston = 30 MPa for CI, Pressure between ring and piston = 0.04 MPa
Permissible tensile stress in rings = 80 MPa, Permissible pressure on piston barrel = 0.4 MPa
Permissible pressure on piston pin = 18 MPa, Permissible tensile stress in piston pin = 90 MPa

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