Dr Siddhartha — 11/5/2023

National Institute of Technology, Hamirpur (H.P.)

B.Tech. 3rd Year

End-Semester Examination (Session 2022-23)

Branch: Mechanical Engineering **Semester:** 6th
Course Name: Machine Design-II **Course Code:** ME-321
Time Allowed: 3 hours **Maximum Marks:** 50

Instruction to candidates:

- **Assume any missing data if you think but with little explanation.**
- **Use of Machine design data book is allowed.**

1. Design a worm gear reducer. The loading is steady and intermittent (less than 3 hrs per day). It is required to transmit 11 kW of power from an electric motor running at 1500 rpm to a machine running at 75 rpm. Suggest designation of worm gear pair. Few recommendations for the design of gear pair are -

   Material for worm: case hardened and ground alloy steel, 16Ni80Cr60 with S_{up} = 700 N/mm^2, Material for worm gear: phosphor bronze with S_{ug} = 240 N/mm^2, Face width of the worm gear is 0.73 times the pitch circle dia of worm, Service factor = 1.25, Factor of safety = 1.5, dynamic factor = $\frac{6}{(6+V_g)}$, Diametral quotient = 10, Coefficient of friction between worm and worm gear teeth for given materials is 0.03.

   [10]

2. —

   A. Find the extreme value of contact stress in the tooth of helical gear pair, for which helical pinion is required to transmit 30 kW of power at 30 revolution per second. Other details for designing the gear pair made of steel are as following:

Face width: 36 mm	Velocity factor = $6/(6+V)$
Normal pressure angle: 20°	Load distribution factor: 1.0
Normal module: 4 mm	Application factor: 1.0
Angle of helix: 30°	Modulus of elasticity : 207000 MPa
Ratio of speed: 4	Poisson's ratio: 0.292
Number of teeth on helical pinion: 20	Factor of safety: 1.0

   [7]

   B. Define transverse circular pitch, transverse module and transverse pressure angle for helical gears. If the face width, helix angle and normal module are b, ψ and m_n, respectively, show

(8)

$$b \geq \frac{\pi m_n}{\sin \psi}$$

[3]

3. For a pair of straight bevel gears, the number of teeth on gear and pinion are 45 and 30, respectively. The tooth system is 20° full-depth involute. The gear pair is mounting on shafts, intersecting at right angles. The load distribution factor and application factor are 1.2 and 1.25, respectively. The pinion shaft is linked to an electric motor generating 15 kW of rated power at 1000 rpm. The pinon and gear, both are made of alloy steel (S_{ut} = 1455 N/mm^2) and heat treated to a surface hardness of 400 BHN. The face width and module are 50 mm and 6 mm, respectively. The gears are generated and finished to meet the specifications of grade 8. The deformation factor is 11500e, N/mm. Determine the factor of safety against bending as well as pitting failure. Assume, the dynamic load accounts by Buckingham's equation. Refer table from data book for Lewis form factor.

[10]

4.

A. If the required bearing life is 5000 hours at a reliability of 99%, select a deep-groove ball bearing for a shaft of 40 mm diameter running at a speed of 1000 rpm. The maximum operating temperature is 40°C and the inner race rotates. The axial and radial loads are 1.2 kN and 2.5 kN, respectively. Assume, load with light shock for which, service factor equals to 1.2.

[7]

B. Differentiate between the basic static capacity and basic dynamic capacity of a ball bearing. What is their significance in the selection of the bearings?

[3]

5. If the room and oil temperatures are 22°C and 85°C, respectively and the bearing is lubricated by oil rings, design a bearing and journal to support a load of 5.5 kN at 650 rpm using a hardened steel journal and bronze backed babbit bearing.

[10]