BITS Pilani, K.K.Birla Goa Campus

FIRST SEMESTER 2022-2023

ME F314 Design of Machine Elements

MIDTERM EXAMINATION (OPEN Book)

DATE: 26/12/2022 Duration: 180 min Maximum Marks: 120

NOTE:

1. Write the answers in proper SI unit. Answers without units will not be considered and subsequent steps will not be evaluated.
2. Use of textbook by Shigley's Mechanical Engineering Design is only permitted.
3. Solve the paper in the tabular form only with minimum column width for reference and remarks column. Keep more space for calculations.

Reference	Calculations	Remarks

QUESTION 1

A journal bearing has a shaft dimeter of 65 .00mm with unilateral tolerance of -0.03 mm. The bushing bore has a diameter of 65.10 mm with unilateral tolerance of 0.06 mm. The bushing is 32.5 mm long and supports a load of 5 kN. The journal speed is 600rev/min. For minimum clearance assembly find minimum oil-film thickness, power loss due to friction, and maximum lubricant film pressure. (Use SAE 30 oil with operating temperature of 70^0C as lubricant.)

[20M]

QUESTION 2:

A commercial, enclosed, spur gear set, of 20^0 pressure angle, has 26 teeth on the pinion and 50 teeth on the gear. Gears are meshed external. Power source is transmitting power with MEDIUM shock and transmission occurs to the driven machine with moderate shock. The module is 3.5 mm and face width = 60 mm. The pinion rotates at 320 rpm and its cycle life is $3*10^8$ revolutions at a reliability of 95%. Take quality number as 8 . Material is a thoroughly hardened steel grade 2, with Brinell hardness of 270 core and case for both gears. Use a design factor (Safety factor, S_F) of 2.0, size factor K_s = 1. Assume gears to be uncrowned. Use C_{pm} = 1, temperature factor Y_θ = 1 and rim thickness factor, K_B = 1. Use the data for S_c at 10^7cycles and 99 % reliability from Figure 14-5 of textbook. Find the power rating of the gearset for these conditions using AGMA Method.

USE following equations: $Y_N = 1.3558N^{-0.0178}$ $Z_N = 1.4488N^{-0.023}$ **[50M]**

Question 3:

A stepped rotating shaft has fully corrected endurance limit, Se =230 MPa. The dimensions of the shaft are D=35 mm, d = 32 mm and fillet radius of 2 mm. Material of shaft is SAE 1080 HR. This shaft is undergoing reversed bending stress in the fillet of σ_{rev} (nominal) 0f 240 MPa. Use equation below , if required.

Estimate:

1. Fatigue stress concentration factor
2. Number of cycles to failure **[10M]**

$$\sqrt{a} = 1.24 - 2.25(10^{-3})S_{ut} + 1.60(10^{-6})S_{ut}^2 - 4.11(10^{-10})S_{ut}^3 \qquad 340 \le S_{ut} \le 1700\ \text{MPa}$$

Question 4:

For a certain application to store energy, helical compression spring is to be used. There are space limitations and hence maximum 39 mm compression is allowed. Maximum supported load is 120 N. The space constraints put the design a limitation of maximum allowable solid length of 50 mm and free length 120mm. As per the recommended design conditions, factor of safety in static condition must equal or exceed 1.2, ξ =0.15. Assume the following conditions:

1. Material music wire A228,
2. Spring operating over a rod of 17 mm diameter with diametral allowance of 1.25 mm and set.
3. Squared and ground ends.

Assume initial value of wire diameter d = 1.9 mm. Estimate the wire diameter for these conditions. Perform maximum 5 iterations. Tabulate the results. **[20M]**

Question 5:

A single square-thread power screw has an input power of 3.5 kW at a speed of 60rpm. The screw has a diameter of 25 mm and a pitch of 2.5 mm. The frictional coefficients are 0.1 for the threads and 0.075 for the collar, with a collar friction radius of 35 mm. Find the axial resisting load F and the combined efficiency of the screw and collar. **[5M]**

Question 6:

Figure shows an internally expanding brake with inside rim diameter of 350mm and dimension R =120 mm. calculate the braking torque and maximum pressure for each shoe. Take F =1500 N, b =35 mm, f =0.25. Assume drum rotation as counter clockwise.

[15M]