BITS Pilani, K.K.Birla Goa Campus

FIRST SEMESTER 2022-2023

ME F314 Design of Machine Elements

MIDTERM EXAMINATION (OPEN Book)

DATE: 02/11/2022 Duration: 90 min Maximum Marks: 100

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 shaft made of 1040 HR Steel is used to transmit power of 7 kW at 1500 rpm. Find the torque transmitted by the shaft in Nmm. Using Maximum Shear Stress Theory, determine the diameter of the shaft in mm. Use factor of safety of 1.75. Round up your answer to select a standard 02- series deep groove ball bearing. **[15M]**

QUESTION 2: A stepped, stationary bar with diameter, D = 44 mm has a shoulder with fillet radius, r = 2 mm and small diameter, d =40 mm. It is subjected to repeated bending moment at the fillet fluctuating between 500 Nm to 2000 Nm. Assume material of bar as steel AISI 1080 HR, but the fillet should be assumed as machined. Find factor of safety using Soderberg's criteria and yielding factor of safety. How will the bar fail? Comment on life of the bar. Use the formula given below , if required.

[30M]

$$\sqrt{a} = 0.246 - 3.08(10^{-3})S_{ut} + 1.51(10^{-5})S_{ut}^2 - 2.67(10^{-8})S_{ut}^3 \qquad 50 \le S_{ut} \le 250 \text{ kpsi}$$

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

(6–35)

QUESTION 3: A 02 series deep groove ball bearing of 40 mm bore is selected for a shaft. Specify appropriate minimum and maximum diameter for the shaft to provide force fit / shrink fit. Show the calculations for hole also. **[15M]**

QUESTION 4: A 02 series single row deep-groove ball bearing is to be selected for the following application condition. Radial load =7kN, Axial load = 2.1 kN, Design life = 15kh, Design speed = 600 rev/min, Outer ring rotating, Design reliability = 92%, a_f =1. Specify the smallest bore size that can satisfy these conditions. Also find realised reliability for the bearing selected.

HINT: USE d =50 mm as initial guess. Use E 11.10 for the purpose of calculations. [40M]