(16)

Program: B. Sc. Eng. (IPE)
Semester: 6th

Date: 20 February 2023 (Morning)
Time: 10:00 AM – 11:30 AM

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF MECHANICAL AND PRODUCTION ENGINEERING

Mid Semester Examination
Course Code: IPE 4609
Course Title: Product Design I

Summer Semester: 2021 - 2022
Full Marks: 75
Time: 1 Hour 30 Minutes

There are **three** questions. Answer **all** of them. The symbols have their usual meanings. Marks of each question and corresponding CO and PO are written in the brackets. This is a **CLOSE BOOK Exam**. **Assume reasonable design data if necessary.** Programmable calculators are not allowed.

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1 (a) A gear reduction unit uses the countershaft shown in the **Figure 1**. Gear *A* receives power from another gear with the transmitted force F_A applied as shown in figure. The power is transmitted through the shaft and delivered through gear *B* through a transmitted force F_B at the pressure angle shown in figure. **(25)** **(CO1) (PO2, PO3)**

a) Determine the force F_B, assuming the shaft is running at a constant speed.
b) Find the bearing reaction forces, assuming the bearings act as simple supports.
c) Draw shear-force and bending-moment diagrams for the shaft. If needed, make one set for the horizontal plane and another set for the vertical plane.
d) At the point of maximum bending moment, determine the bending stress and the torsional shear stress.
e) At the point of maximum bending moment, determine the principal stresses and the maximum shear stress.

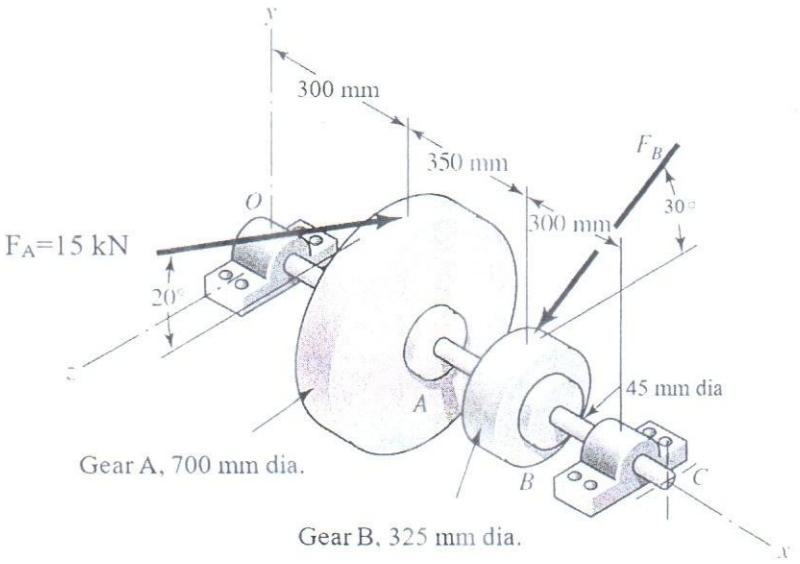

Figure 1

2. The cantilevered bar in the **Figure 2** is made from a brittle material and is statically loaded with F_x=600 lbf, F_y=500 lbf, and F_z=-150 lbf. Design the minimum factor of safety for yielding. Use both the maximum-shear-stress theory and the distortion-energy theory, and compare the results. The material is 1018 CD steel. (25) (CO1) (PO2, PO3)

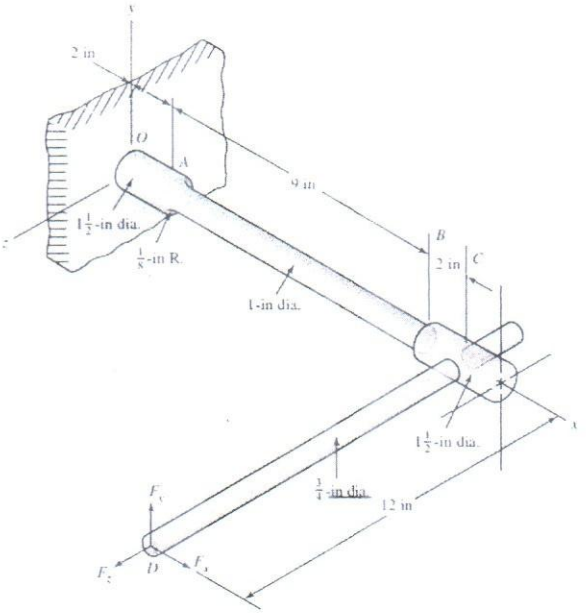

Figure 2

3(a) Discuss Failure theories of Ductile material. (10) (CO1) (PO1)

3(b) **Figure 3** shows a steel eyebolt, loaded with a force F=350 N. The bolt is formed from wire of diameter d = 7 mm to a radius R_i = 10 mm in the eye and at the shank. Estimate the stresses at the inner and outer surfaces at section *B-B*, located along the line between the radius centers. (15) (CO1) (PO2, PO3)

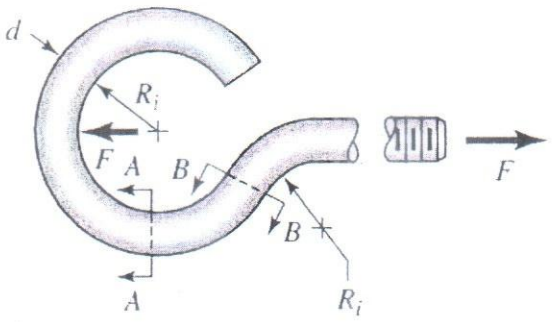

Figure 3