Department of Mechanical Engineering
Faculty of Engineering and Architecture

Scientific calculators are allowed
Return the entire question booklet and the answer sheets to the instructor

October 14, 2023

Duration: 120 minutes

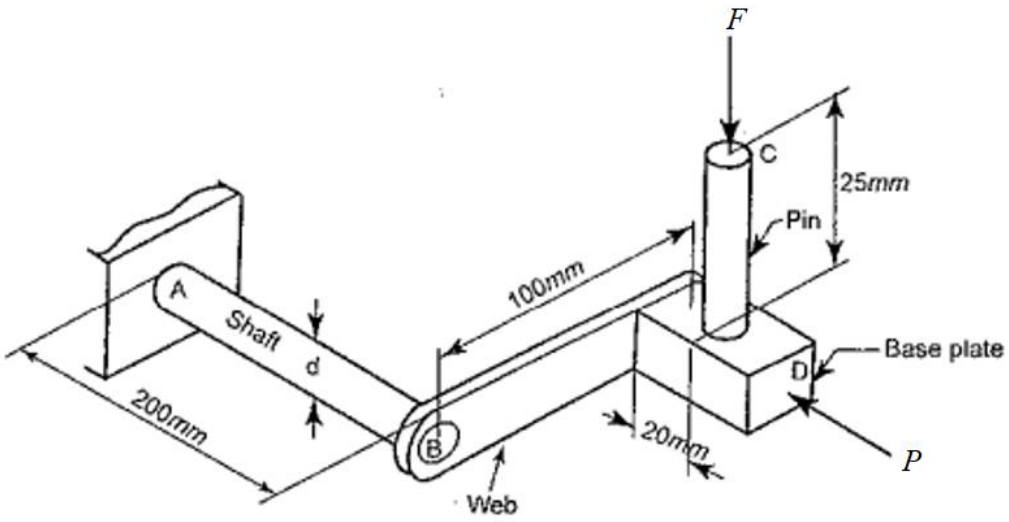
Question	Grade
1	/50
2	/50
Total	

Name	
Student ID	

Good luck

Problem #1: (50)

The shaft of the crank lever is fixed at *A* and loaded by forces through a vertical pin and base plate as shown in the figure below. The pin is subjected to vertical cyclic force *F* that varies between F_{max} = 8kN and F_{min} = 0 at *C*. An axial cyclic load *P* that varies between P_{max} = 5 kN and P_{min} = 0 is acting at *D* on the base plate which may be considered as axial force acting on the shaft. The shaft is machined and made from AISI 1020 steel, S_{ut} = 400 MPa, S_y = 300 MPa.



a) Determine the required diameter of the shaft in order to resist against failure by yielding from the first cycle using distortion energy theory and a safety factor *n* = 3.

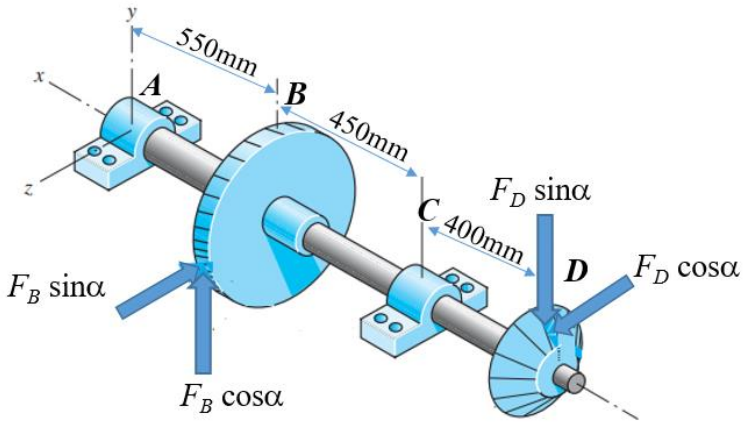
b) For *d* = 60 mm, determine the fatigue factor of safety for failure at $N = 10^5$ cycles using Goodman criterion.(Assume the fatigue stress concentration factors K_f = 2 and K_{fs} = 1.5 at the fixed end)

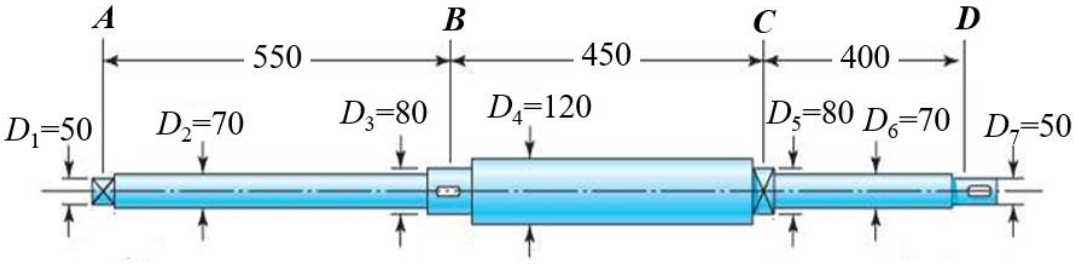
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Problem #2: (50)

The figure below shows a countershaft with gears *B* and *D* supported by two bearings *A* and *C*. Gear *B* of diameter d_B = 500 mm receives power from other gear with transmitted force F_B = 12 kN applied at the pressure angle $\alpha = 20^o$. The power is transmitted through the shaft and delivered through gear *D* of diameter d_D = 375 mm through a transmitted force F_D = 16kN at the pressure angle $\alpha = 20^o$. The shaft is machined and made form AISI 1050 CD steel, S_{ut} = 690 MPa, S_y = 580 MPa. The keyseats are cut with standard endmills. All shoulder fillets have a radius of 4 mm. Do the following:

a) Sketch the bending moment diagrams (M_z and M_y and their resultant bending moment M) and torsion diagram for the shaft.
b) Determine the minimum fatigue factor of safety for infinite lifetime using the Goodman failure criterion. Also, check for first cycle yielding.
c) If infinite life is not predicted, determine the required dimensions for the shaft to predict infinite lifetime using DE-Goodman criterion.





All fillets 4mm
Dimensions in millimetres