

Name: _____

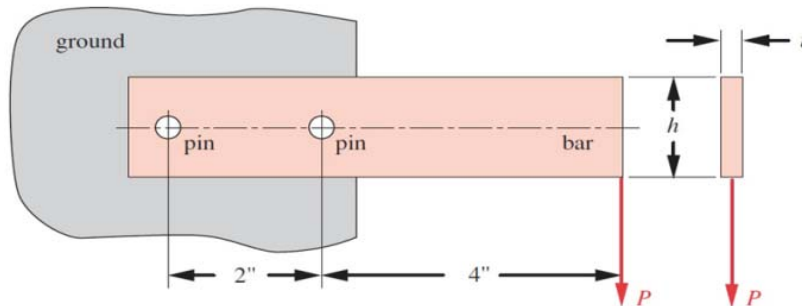
Total Points: 100

You must answer ALL problems.

Show all your work and keep it neat and clean. Highlight or box your answers or critical steps in the solution.

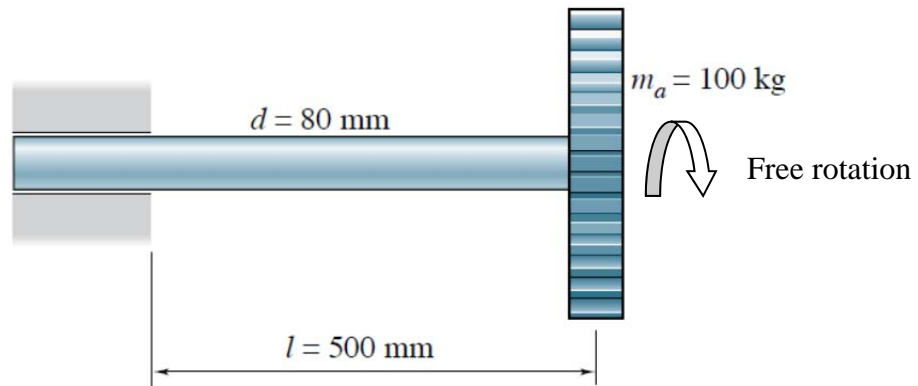
Problem 1. (25 points)

Figure below shows a bar fastened to a rigid ground plane with two 0.25-in-diameter pins. Both bar and pins are made of 1040 cold rolled steel with yield strength of 71 kpsi and ultimate tensile strength of 85 kpsi. The bar height $h = 1$ in and thickness $t = 0.25$ in. For P varying from 0 to 1500 lb, find out the safety factor of the system. For simplicity, ignore stress concentration. Assume room temperature operation and reliability of 90%.



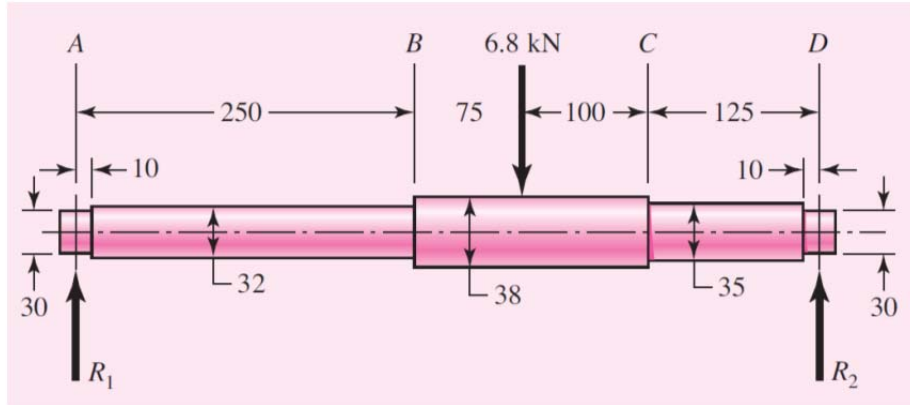
Problem 2. (25 points)

The shaft shown below rotates freely with a mass of 100 kg attached to its end. The shaft is machined from an aluminum alloy (ultimate tensile strength 75 kpsi). Find the safety factor against fatigue failure. Assume room temperature operation and 90% reliability.



Problem 3. (25 points)

Figure below shows a rotating shaft simply supported in ball bearings at A and D and loaded by a force F of 6.8 kN. Find out the life of the part assuming 99% reliability and room temperature. The material is machined from steel with $S_{ut} = 690$ MPa and $S_y = 580$ MPa. The fatigue stress concentration factor is $K_f = 1.55$ at point B and 1.45 at point C .



Dimensions are given in mm

Problem 4. (25 points)

Figure below shows a system where gears 3 and 4 are used to for torque transmission. The resultant gear force, $P_A = 600$ lb, acts at an angle of 20° from the y axis. The yield stress for the shaft, which is made of cold-drawn steel, is 71,000 psi and the ultimate stress is 85,000 psi. The shaft is solid and of constant diameter. The desired safety factor is 2. Determine the shaft diameter assuming 90% reliability and room temperature operation. For simplicity, ignore the gear weights.

