# MCEN6018 Advanced Strength of Materials Assignment (2024)

Problem Statement

Consider a shaft with two fillets subjected to a bending load, F, at its mid-span, as shown in Figure 1. The shaft, machined from alloy steel and heat-treated to achieve a hardness of 320 BHN, rotates at 2000 rpm, while the applied load remains static.

(a) When the bending load, F = 100 kN, and the shaft is not transmitting power, use the charts to determine the stress concentration factor [1].
(b) Under the same condition as (a), use any software to do a Finite Element Analysis (FEA). Compare the stress concentration factor from the FEA prediction with that obtained using the charts in (a).
(c) Use the stress concentration factor from the FEA prediction in (b) to calculate the factor of safety with respect to having infinite fatigue lifetime.
(d) Modify the FEA model to add stress concentration relieving features [2] to reduce the stress concentration. Perform an optimisation to minimise the stress concentration. Document and comment on how much reduction you have achieved.
(e) With the addition of stress concentration relieving grooves and under the same bending load (F = 100 kN) without power transmission, calculate the factor of safety with respect to achieving infinite fatigue lifetime.
(f) With the addition of stress concentration relieving grooves and under a bending load while the shaft being actively transmitting power (P = 800 kW), determine the maximum allowable bending load for a factor of safety of 2.5 with respect to infinite fatigue lifetime.
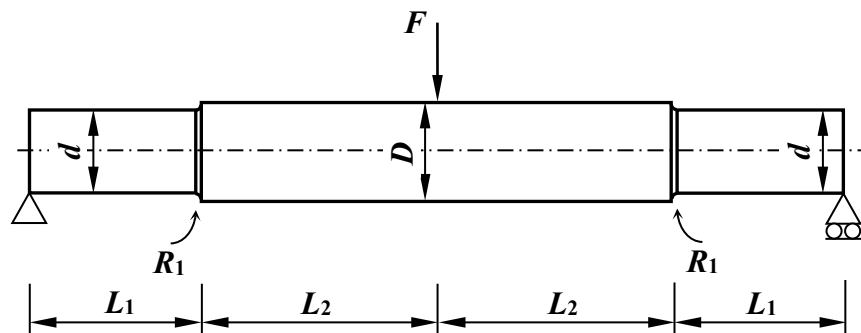
Given: D = 120 mm; d = 100 mm; L_1 = 200 mm; L_2 = 250 mm; R_1 = 5 mm.

Figure 1. A rotating alloy steel shaft.

Group or Individual Work

The completion of this assignment is to be done individually.

Submission

Submit your completed assignment as a PDF through the Blackboard Turnitin Assignment portal. Note that there is no requirement to submit your FEA models. The deadline for submission is **Sunday, 28 April 2024, at 23:59 PM**.

Suggested Timeline

Week 3	Learn Ansys and FEA
Week 4	
Week 5	
Week 6 (Tuition free)	Parts (a)-(e)
Week 7	
Week 8	Part (f)
Week 9	Finish and submit

References

1. Peterson RE. Stress Concentration Design Factors: Charts and Relations Useful in Making Strength Calculations for Machine Parts and Structural Elements. Wiley; 1953.

2. González-Mendoza JM, Alcántara-Montes S, Silva-Lomelí JdJ, Cruz-Alejo Cdl, Ocampo-Ramírez A. Size optimization of shoulder filleted shafts with relief grooves for improving their fatigue life. IngenIería e InvestIgacIón. 2017;37(3):85-91.