力学与航空航天工程系
DEPARTMENT OF MECHANICS AND AEROSPACE ENGINEERING

Deadline: 23:00pm of next Monday (2022/03/21)
Please send your homework into TA's mailbox: 12132430@mail.sustech.edu.cn.
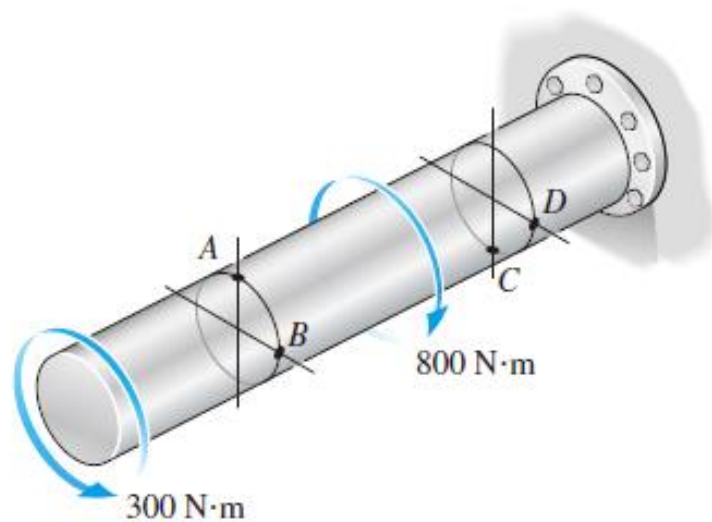
MECHANICS OF MATERIALS

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SPRING, 2022

Homework-IV

Problem 1

P5–1. Determine the internal torque at each section and show the shear stress on differential volume elements located at $A, B, C,$ and D.
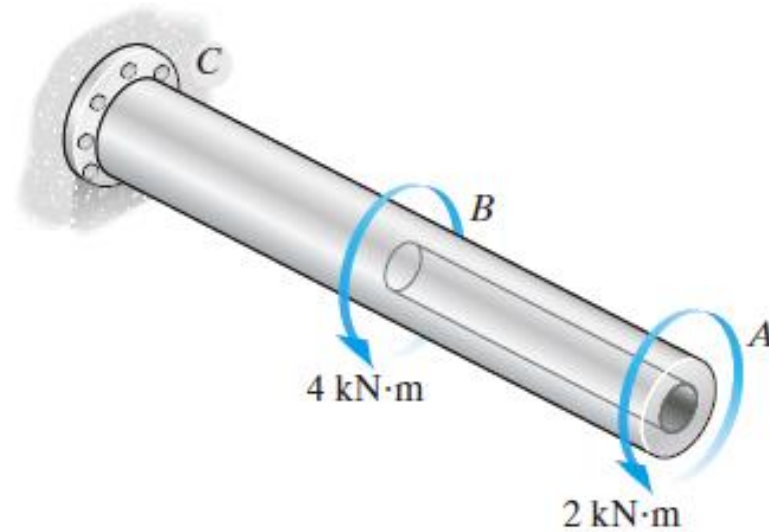
微元

800 N·m

300 N·m

P5–1

Homework-IV

Problem 2

F5–3. The shaft is hollow from A to B and solid from B to C. Determine the maximum shear stress in the shaft. The shaft has an outer diameter of 80 mm, and the thickness of the wall of the hollow segment is 10 mm.
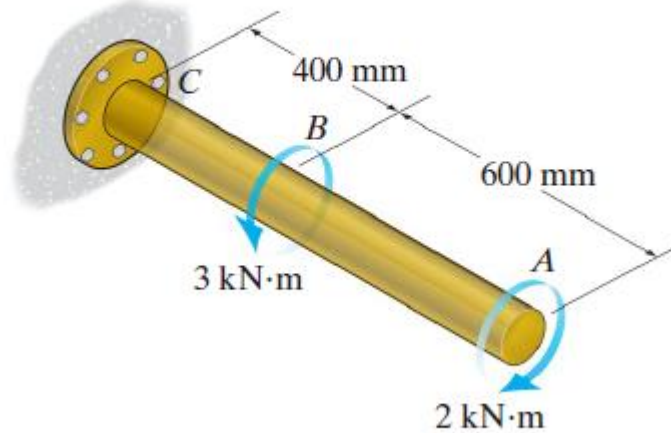

C

B

4 kN·m

A

2 kN·m

F5–3

Homework-IV

Problem 3

F5–9. The 60-mm-diameter steel shaft is subjected to the torques shown. Determine the angle of twist of end A with respect to C. Take G = 75 GPa.
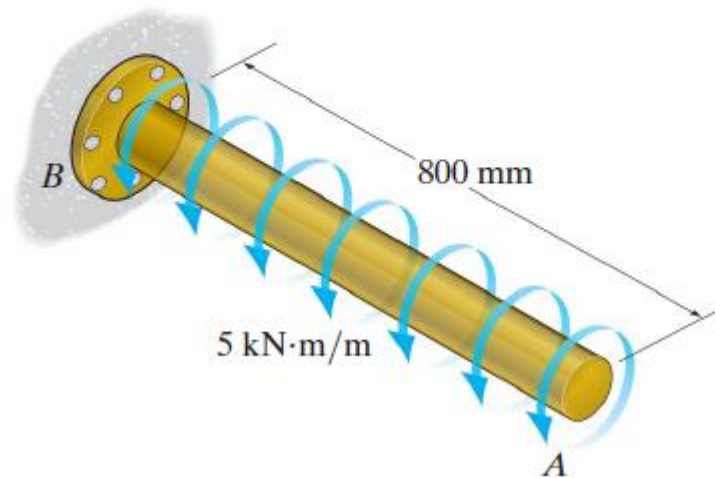
400 mm

C

B

600 mm

3 kN·m

A

2 kN·m

F5–9

Homework-IV

Problem 4

F5–13. The 80-mm-diameter shaft is made of steel. If it is subjected to the uniform distributed torque, determine the angle of twist of end A. Take $G = 75$ GPa.

800 mm

5 kN·m/m

B

A

Homework-IV

Problem 5

5–78. The A992 steel shaft has a diameter of 60 mm and is fixed at its ends A and B. If it is subjected to the torques shown, determine the absolute maximum shear stress in the shaft.
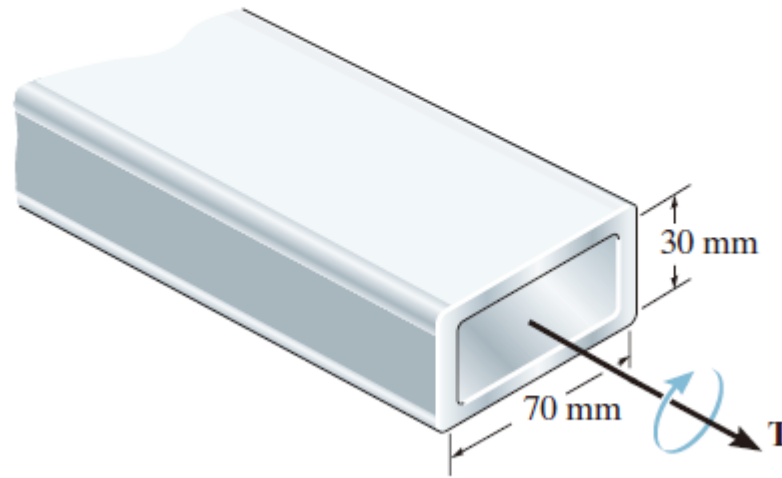
200 N·m

B

1 m

500 N·m

D

1.5 m

C

A 1 m
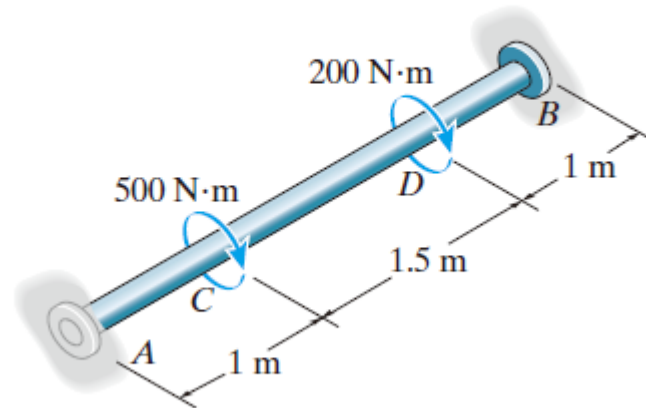
Prob. 5–78

Homework-IV (6 problems)

Problem 6

5–118.   The 304 stainless steel tube has a thickness of 10 mm. If the applied torque is $T = 50 \text{ N} \cdot \text{m}$, determine the average shear stress in the tube. The mean dimensions are shown.

30 mm

70 mm

T

Probs. 5–117/118

Average Mechanical Properties of Typical Engineering Materials[a]

(SI Units)

Materials		Density ρ (Mg/m³)	Modulus of Elasticity E (GPa)	Modulus of Rigidity G (GPa)	Yield Strength (MPa) σ_Y			Ultimate Strength (MPa) σ_u			% Elongation in 50 mm specimen	Poisson's Ratio ν	Coef. of Therm. Expansion α $(10^{-6})/°C$
					Tens.	Comp.[b]	Shear	Tens.	Comp.[b]	Shear			
Metallic													
Aluminum Wrought Alloys	2014-T6	2.79	73.1	27	414	414	172	469	469	290	10	0.35	23
	6061-T6	2.71	68.9	26	255	255	131	290	290	186	12	0.35	24
Cast Iron Alloys	Gray ASTM 20	7.19	67.0	27	–	–	–	179	669	–	0.6	0.28	12
	Malleable ASTM A-197	7.28	172	68	–	–	–	276	572	–	5	0.28	12
Copper Alloys	Red Brass C83400	8.74	101	37	70.0	70.0	–	241	241	–	35	0.35	18
	Bronze C86100	8.83	103	38	345	345	–	655	655	–	20	0.34	17
Magnesium Alloy	[Am 1004-T61]	1.83	44.7	18	152	152	–	276	276	152	1	0.30	26
Steel Alloys	Structural A-36	7.85	200	75	250	250	–	400	400	–	30	0.32	12
	Structural A992	7.85	200	75	345	345	–	450	450	–	30	0.32	12
	Stainless 304	7.86	193	75	207	207	–	517	517	–	40	0.27	17
	Tool L2	8.16	200	75	703	703	–	800	800	–	22	0.32	12
Titanium Alloy	[Ti-6Al-4V]	4.43	120	44	924	924	–	1,000	1,000	–	16	0.36	9.4
Nonmetallic													
Concrete	Low Strength	2.38	22.1	–	–	–	12	–	–	–	–	0.15	11
	High Strength	2.37	29.0	–	–	–	38	–	–	–	–	0.15	11
Plastic Reinforced	Kevlar 49	1.45	131	–	–	–	–	717	483	20.3	2.8	0.34	–
	30% Glass	1.45	72.4	–	–	–	–	90	131	–	–	0.34	–
Wood Select Structural Grade	Douglas Fir	0.47	13.1	–	–	–	–	2.1[c]	26[d]	6.2[d]	–	0.29[e]	–
	White Spruce	3.60	9.65	–	–	–	–	2.5[c]	36[d]	6.7[d]	–	0.31[e]	–

[a] Specific values may vary for a particular material due to alloy or mineral composition, mechanical working of the specimen, or heat treatment. For a more exact value reference books for the material should be consulted.

[b] The yield and ultimate strengths for ductile materials can be assumed equal for both tension and compression.

[c] Measured perpendicular to the grain.

[d] Measured parallel to the grain.

[e] Deformation measured perpendicular to the grain when the load is applied along the grain.