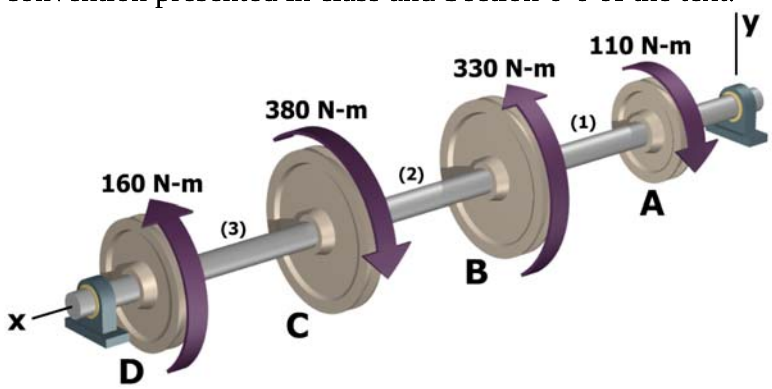
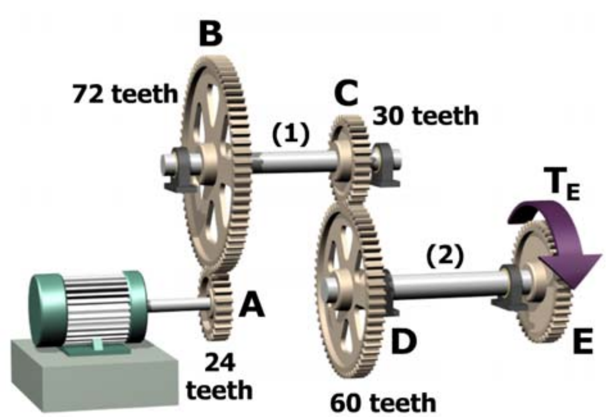
Name: ___________________________

1. (4 points) A hollow aluminum shaft with an outside diameter of 100 mm and a wall thickness of 5 mm has an allowable shear stress of 40 MPa. Determine the maximum torque T that may be applied to the shaft.

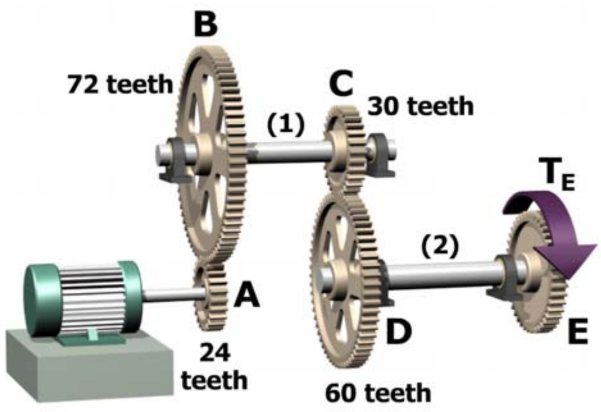
2. (6 points) A solid constant-diameter shaft is subjected to the torques shown. The bearings shown allow the shaft to turn freely. Determine the internal torque in segments (1), (2), and (3) of the shaft. Use the sign convention presented in class and Section 6-6 of the text.



3. (6 points) In the gear system shown, the motor applies a torque of 250 N-m to the gear at A. The bearings shown allow free rotation of the shafts. Determine the internal torque magnitude in shafts (1) and (2).

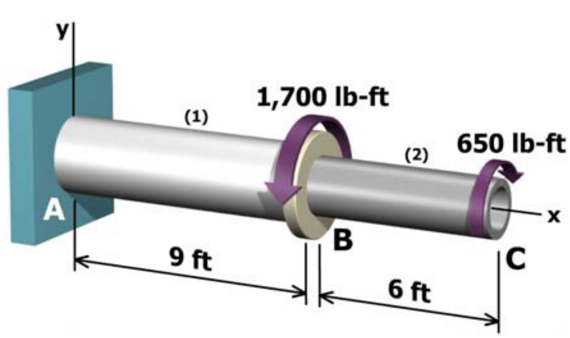


4. (6 points) In the gear system shown, the motor rotates at 21 Hz. Determine the rotation speed magnitude of shafts (1) and (2).

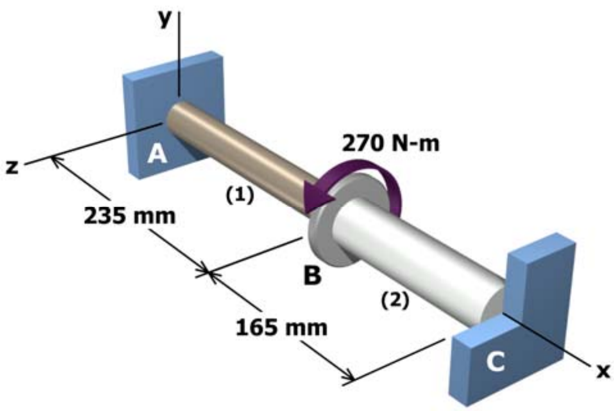


5. (7 points) The drive shaft of an automobile is being designed to transmit 280 hp at 3,500 rpm. Determine the minimum diameter required for a solid steel shaft if the allowable shear stress in the shaft is not to exceed 4,000 psi.

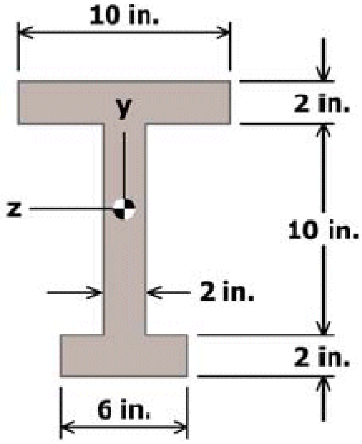
6. (8 points) The compound shaft shown consists of aluminum segment (1) and steel segment (2). Aluminum segment (1) is a tube with an outside diameter of D_1 = 4.00 in., a wall thickness of t_1 = 0.25 in., and a shear modulus of G_1 = 4,000 ksi. Steel segment (2) is a tube with an outside diameter of D_2 = 2.50 in., a wall thickness of t_2 = 0.125 in., and a shear modulus of G_2 = 12,000 ksi. The compound shaft is subjected to torques applied at *B* and *C*. Determine the rotation angle of *C* with respect to the support at *A*. Use the sign convention presented in class and Section 6-6 of the text.



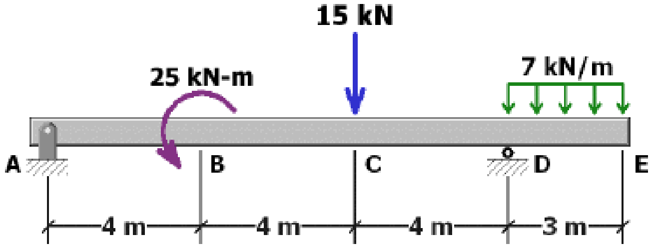
7. (10 points) The composite shaft shown consists of a solid brass segment (1) and a solid aluminum segment (2) that are connected at flange B and securely attached to rigid walls at A and C. Brass segment (1) has a diameter of 18 mm and a shear modulus of 39 GPa. Aluminum segment (2) has a diameter of 24 mm, and a shear modulus of 28 GPa. If a concentrated torque of 270 N-m is applied to flange B, determine the torque magnitude in segments (1) and (2).



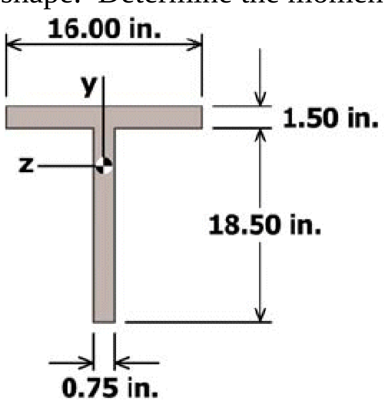
8. (5 points) The dimensions of the shape are shown. Determine the centroid location measured from the bottom of the shape.



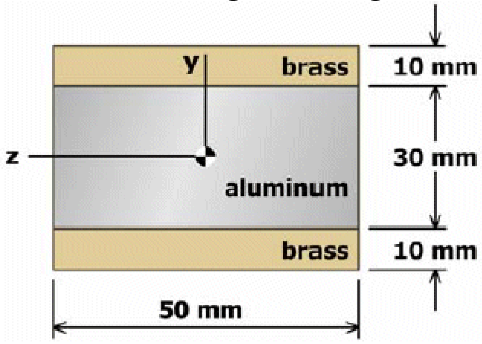
9. (12 points) Use the graphical method to construct the shear-force and bending-moment diagrams for the beam shown. Label all significant points on the diagram, and identify the maximum moment(s) along with the respective location(s). Clearly distinguish straight-line and curved portions of the diagrams.



10. (8 points) The dimensions of the shape are shown. The centroid is 15.59 inches from the bottom of the shape. Determine the moment of inertia about the *z* axis.



11. (12 points) A composite beam is made of two brass [E = 100 GPa] plates bonded to an aluminum [E = 75 GPa] bar. The beam is subjected to a bending moment of 1,750 N-m acting about the z axis. Determine the maximum bending stress magnitude in the brass plates.



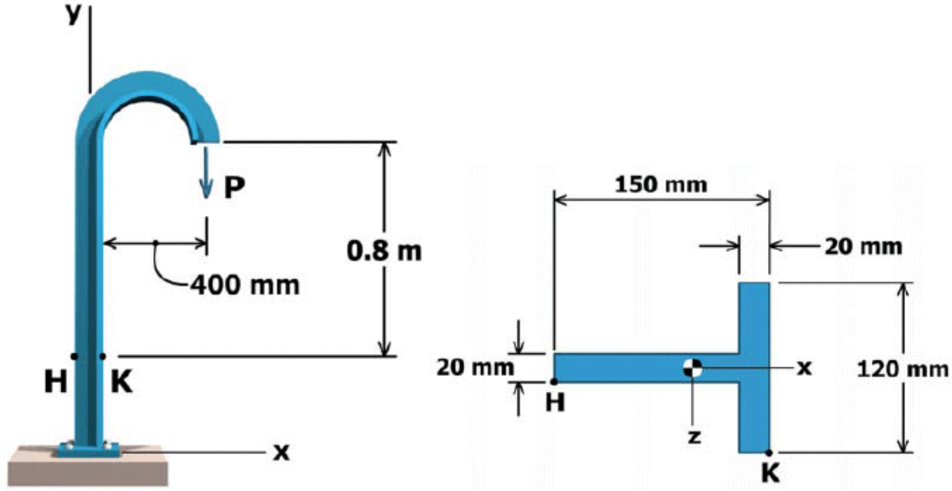
12. (6 points) A WT305×41 standard steel shape is subjected to a tension force P=134.9 kN that is applied 250 mm above the bottom surface of the tee shape. Using the attached table, determine the following items.

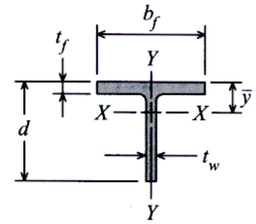
The vertical distance from the bottom surface to the centroid of the tee shape = ____________ mm

The moment of inertia that would be relevant to this problem = ____________ mm^4

The bending moment caused by the applied load P = ____________ Nm

13. (10 points) The tee shape is used as a post that supports a load of P = 25 kN. Note that the load P is applied 400 mm from the flange of the tee shape. The centroid is 49 mm left of point K, and the moment of inertia around the *z* axis is 10,761,666.67 mm^4. Determine the normal stresses at point H.





Shapes Cut from Wide-Flange Sections or WT Shapes

Designation	Area A	Depth d	Web thickness t_w	Flange width b_f	Flange thickness t_f	Centroid $\bar{y}$	I_x	S_x	r_x	I_y	S_y	r_y
	in.^{2}	in.	in.	in.	in.	in.	in.^{4}	in.^{3}	in.	in.^{4}	in.^{3}	in.
WT12×47	13.8	12.2	0.515	9.07	0.875	2.99	186	20.3	3.67	54.5	12.0	1.98
WT12×38	11.2	12.0	0.440	8.99	0.680	3.00	151	16.9	3.68	41.3	9.18	1.92
WT12×34	10.0	11.9	0.415	8.97	0.585	3.06	137	15.6	3.70	35.2	7.85	1.87
WT12×27.5	8.10	11.8	0.395	7.01	0.505	3.50	117	14.1	3.80	14.5	4.15	1.34
WT10.5×34	10.0	10.6	0.430	8.27	0.685	2.59	103	12.9	3.20	32.4	7.83	1.80
WT10.5×31	9.13	10.5	0.400	8.24	0.615	2.58	93.8	11.9	3.21	28.7	6.97	1.77
WT10.5×25	7.36	10.4	0.380	6.53	0.535	2.93	80.3	10.7	3.30	12.5	3.82	1.30
WT10.5×22	6.49	10.3	0.350	6.50	0.450	2.98	71.1	9.68	3.31	10.3	3.18	1.26
WT9×27.5	8.10	9.06	0.390	7.53	0.630	2.16	59.5	8.63	2.71	22.5	5.97	1.67
WT9×25	7.33	9.00	0.355	7.50	0.570	2.12	53.5	7.79	2.70	20.0	5.35	1.65
WT9×20	5.88	8.95	0.315	6.02	0.525	2.29	44.8	6.73	2.76	9.55	3.17	1.27
WT9×17.5	5.15	8.85	0.300	6.00	0.425	2.39	40.1	6.21	2.79	7.67	2.56	1.22
WT8×28.5	8.39	8.22	0.430	7.12	0.715	1.94	48.7	7.77	2.41	21.6	6.06	1.60
WT8×25	7.37	8.13	0.380	7.07	0.630	1.89	42.3	6.78	2.40	18.6	5.26	1.59
WT8×20	5.89	8.01	0.305	7.00	0.505	1.81	33.1	5.35	2.37	14.4	4.12	1.56
WT8×15.5	4.56	7.94	0.275	5.53	0.440	2.02	27.5	4.64	2.45	6.2	2.24	1.17
	mm^2	mm	mm	mm	mm	mm	10^6 mm^4	10^3 mm^3	mm	10^6 mm^4	10^3 mm^3	mm
WT305×70	8900	310	13.1	230	22.2	75.9	77.4	333	93.2	22.7	197	50.3
WT305×56.5	7230	305	11.2	228	17.3	76.2	62.9	277	93.5	17.2	150	48.8
WT305×50.5	6450	302	10.5	228	14.9	77.7	57.0	256	94.0	14.7	129	47.5
WT305×41	5230	300	10.0	178	12.8	88.9	48.7	231	96.5	6.04	68.0	34.0
WT265×50.5	6450	269	10.9	210	17.4	65.8	42.9	211	81.3	13.5	128	45.7
WT265×46	5890	267	10.2	209	15.6	65.5	39.0	195	81.5	11.9	114	45.0
WT265×37	4750	264	9.65	166	13.6	74.4	33.4	175	83.8	5.20	62.6	33.0
WT265×33	4190	262	8.89	165	11.4	75.7	29.6	159	84.1	4.29	52.1	32.0
WT230×41	5230	230	9.91	191	16.0	54.9	24.8	141	68.8	9.37	97.8	42.4
WT230×37	4730	229	9.02	191	14.5	53.8	22.3	128	68.6	8.32	87.7	41.9
WT230×30	3790	227	8.00	153	13.3	58.2	18.6	110	70.1	3.98	51.9	32.3
WT230×26	3320	225	7.62	152	10.8	60.7	16.7	102	70.9	3.19	42.0	31.0
WT205×42.5	5410	209	10.9	181	18.2	49.3	20.3	127	61.2	8.99	99.3	40.6
WT205×37.5	4750	207	9.65	180	16.0	48.0	17.6	111	61.0	7.74	86.2	40.4
WT205×30	3800	203	7.75	178	12.8	46.0	13.8	87.7	60.2	5.99	67.5	39.6
WT205×23.05	2940	202	6.99	140	11.2	51.3	11.4	76.0	62.2	2.58	36.7	29.7