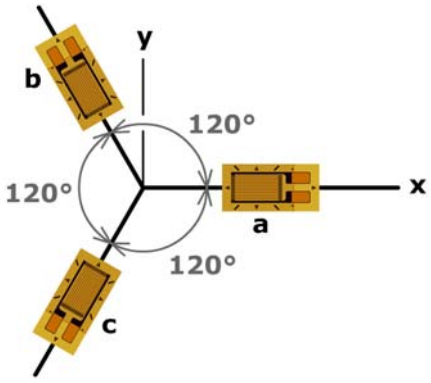
IDE 110 – Mechanics of Materials **Student** _____
Dec 12, 2005

1. The following strains were measured from the strain gage rosette shown:



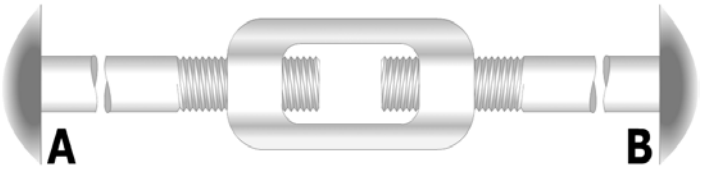
ε_a = -555 $\mu\varepsilon$ ε_b = +925 $\mu\varepsilon$ ε_c = +740 $\mu\varepsilon$

If Poisson's ratio is ν = 0.3,
(a) Determine the principal strains
(b) Determine the maximum shearing strain
(c) Determine the angle from the x axis to the largest tensile principal strain.

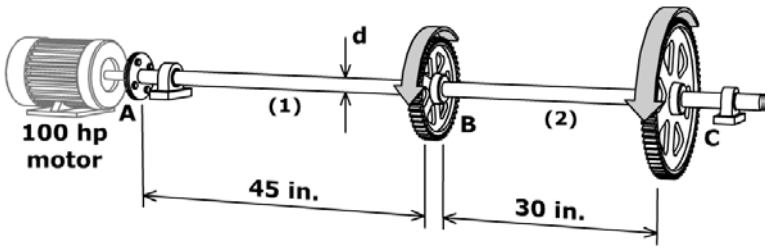
PRINT CLEARLY
Include proper units
Box-in your answers

2. A steel tie rod [E = 200 GPa; $\alpha = 11.9\times10^{-6}$/°C] containing a rigid turnbuckle is attached to rigid walls. During the summer when the temperature was 30°C, the turnbuckle was tightened to produce a tension stress in the tie rod of 15 MPa. The elastic strength for the steel is 250 MPa and the ultimate strength is 450 MPa. A factor of safety of 2 is required with respect to the elastic strength, and a factor of safety of 4 is required with respect to the ultimate strength.

   Is the tie rod overstressed in the winter when the temperature is –10°C? Show justification for your answer.



3. A motor delivers 100 hp at 600 rpm to the end of a shaft. The gears at B and C take out 40 hp and 60 hp, respectively. Determine the minimum diameter **d** required for the shaft if the allowable shear stress is 7,000 psi and the angle of twist between the motor and gear C is limited to 2°. Assume $G = 12 \times 10^6$ psi. [Note: 1 hp = 550 lb-ft/s]



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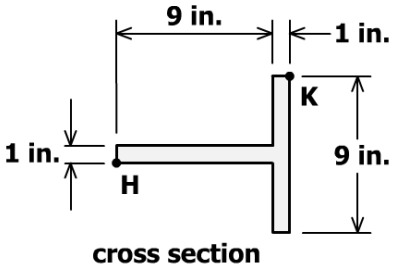
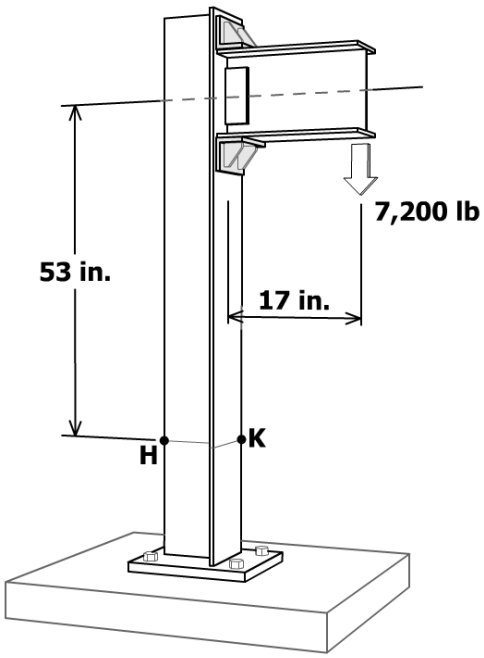
4. The tee-shaped column supports the loading shown. Determine the normal stresses at points H and K.





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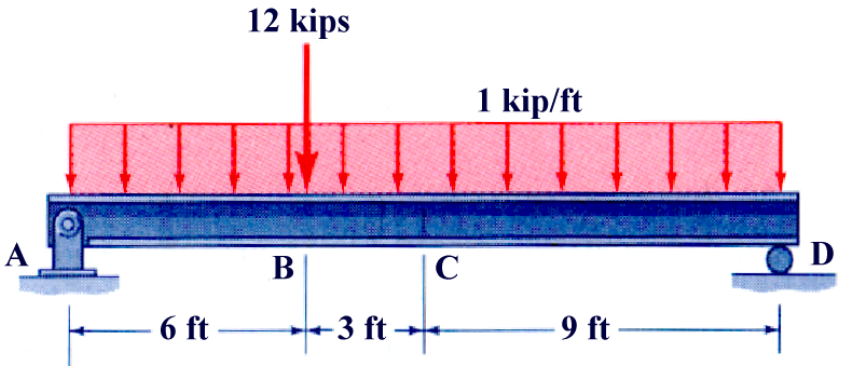
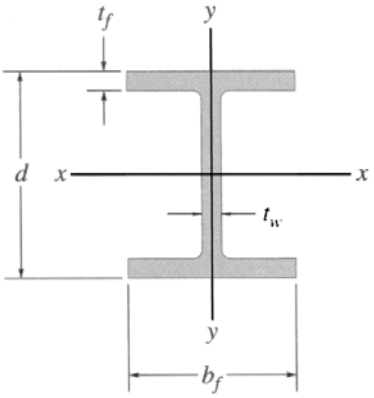
5. A W14×53 wide-flange beam supports the distributed load and concentrated load shown. Consider location B on the beam, which is located **just to the left** of the 12 kip concentrated load. At the junction between the top flange and the beam web, determine:
   (a) The bending stress σ
   (b) The shear stress τ.



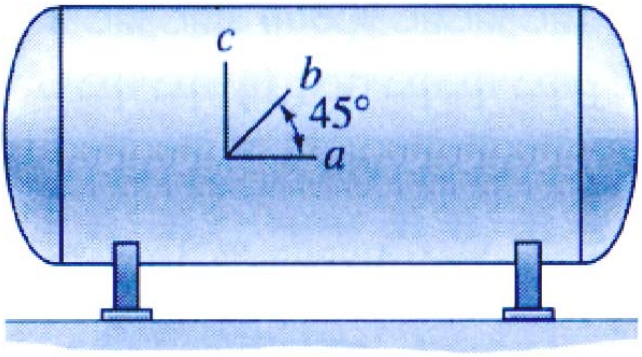
Wide-Flange Sections or W Shapes

Designation	Area A	Depth d	Web thickness t_w	Flange width b_f	Flange thickness t_f	x–x axis I	x–x axis S	x–x axis r	y–y axis I	y–y axis S	y–y axis r
in. × lb/ft	in^2	in.	in.	in.	in.	in^4	in^3	in.	in^4	in^3	in.
W14 × 53	15.6	13.92	0.370	8.060	0.660	541	77.8	5.89	57.7	14.3	1.92
W14 × 43	12.6	13.66	0.305	7.995	0.530	428	62.7	5.82	45.2	11.3	1.89
W14 × 38	11.2	14.10	0.310	6.770	0.515	385	54.6	5.87	26.7	7.88	1.55
W14 × 34	10.0	13.98	0.285	6.745	0.455	340	48.6	5.83	23.3	6.91	1.53
W14 × 30	8.85	13.84	0.270	6.730	0.385	291	42.0	5.73	19.6	5.82	1.49
W14 × 26	7.69	13.91	0.255	5.025	0.420	245	35.3	5.65	8.91	3.54	1.08
W14 × 22	6.49	13.74	0.230	5.000	0.335	199	29.0	5.54	7.00	2.80	1.04



Include proper units
Box-in your answers

6. A 45° strain gage rosette is attached to a compressed air tank with gage "a" oriented parallel to the long axis of the tank. The tank is made of steel that has a modulus of elasticity of E = 29×10^6 psi and Poisson's ratio of $\nu = 0.3$. The inside diameter of the tank is 40 inches, the wall thickness is 0.375 inches, and the internal pressure is 180 psi. Determine the strain measured by each strain gage: ε_a, ε_b, and ε_c.



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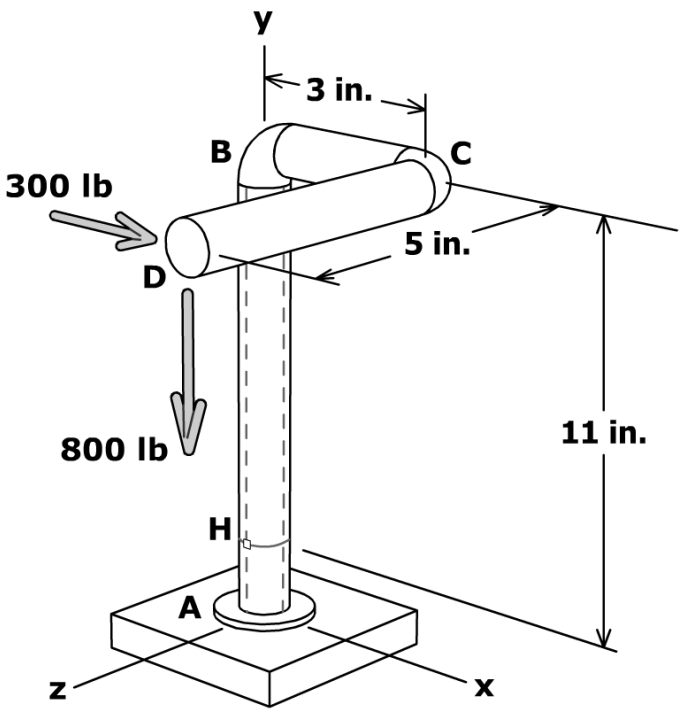
7. For the structure shown, determine the normal and shear stresses acting at point H. Show the results on a stress element.



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Box-in your answers

8. A W305×97 structural steel beam supports the loadings shown. The moment of inertia for the beam is $I = 222 \times 10^6\ mm^4$, and the modulus of elasticity is $E = 200$ GPa. Determine the deflection at the right end of the beam.