Student ID Number: _____

Solid Mechanics Qualifying Exam
Department of Mechanical Engineering

January, 2005

Students are allowed one sheet of notes not greater than 8.5" x 11.0". Both sides of the sheet may be used.

Answer all questions.
All questions are weighted equally.

Examiners: R. Averill and G. Cloud

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1. A T-rosette was mounted on a 100 inch diameter thin walled pressure vessel, but mistakenly was placed at an arbitrary angle with respect to the axes of the vessel. At an internal pressure of 100 psi, the strains in the two legs of the rosette are 840 $\mu\varepsilon$ and 640 $\mu\varepsilon$. Knowing that the Young's modulus of the vessel material is 10×10^6 psi and that Poisson's ratio is 0.3, calculate the thickness of the pressure vessel. (Note: The vessel has end caps, and the gage is mounted well away from these end caps. Ignore transverse sensitivity of the strain gages.)

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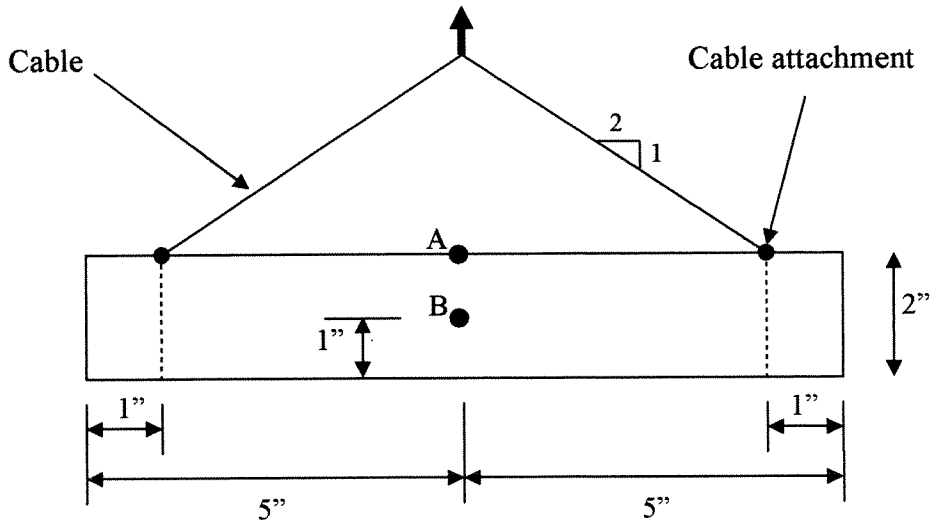
2. The thin-walled pressure vessel shown is 10 ft. long, 2 ft. in diameter, and has a wall thickness of 0.25 inches. The pressure in the tank is 50 psi. The tank and its contents weigh 65 lbs per lineal foot. Determine the principal stresses and maximum shearing stresses at points A and B.



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3. A mass of 10 kg is suspended from the ceiling on a steel wire of 1 mm diameter and 2 m length. The mass is now rotated through an angle θ causing the wire to twist. If the steel has a yield stress of 300 MPa and a shear stiffness G = 80 GPa, estimate the maximum value of θ if there is to be no plastic deformation. Use the Von Mises (distortional strain energy) theory of yielding.

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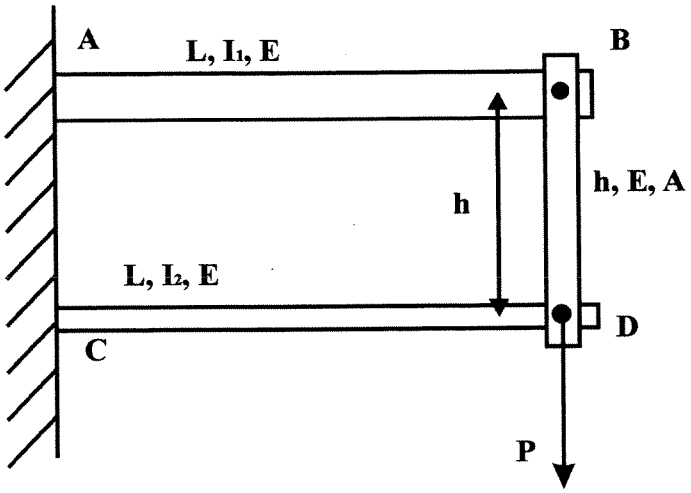
4. Two cantilever beams having different cross sections have their free ends coupled by an extensible link, as shown. The joints are simple pins. The system carries a load P that is applied directly to pin D. Set up all equations needed to determine the force in the link BD.



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5. A rectangular column with cross sectional dimensions b and h has ball-and-socket support joints at its ends, as shown. At mid-height, the column is restrained in the plane of the figure, but it is not restrained in the other direction. Determine the ratio h/b such that the critical load is the same for buckling in the two principal planes of the column. You must show all calculations for full credit.