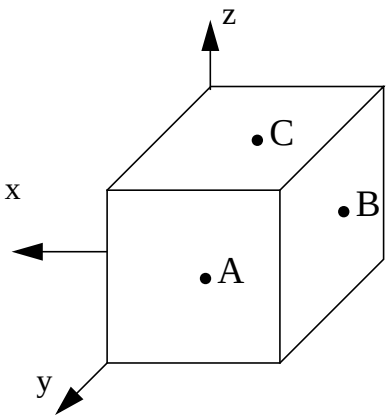
EXAM 1 MEEM2150 Feb. 19th, 2004

To get Full credit you must draw free body diagram any time you use equilibrium equations to determine forces or moments.

---

1. (a) Show the non-zero stress components on the A,B, and C faces of the cube. Use the coordinate system that is given only.

$$\begin{bmatrix} \sigma_{xx} = 100\text{MPa(C)} & \tau_{xy} = -60\text{MPa} & \tau_{xz} = 40\text{MPa} \\ \tau_{yx} = -60\text{MPa} & \sigma_{yy} = 0 & \tau_{yz} = 0 \\ \tau_{zx} = 40\text{MPa} & \tau_{zy} = 0 & \sigma_{zz} = 50\text{MPa(T)} \end{bmatrix}$$



(b & c) The stresses at a point were found to be σ_{xx} = 100 MPa (T), σ_{yy} = 200 MPa (T) and τ_{xy} = 140 MPa . The material has a *shear* modulus of elasticity of 70 GPa and Poisson's ratio of 0.25.

(b) Determine ε_{zz} assuming *Plane Stress* ε_{zz} = ----------

(c) Determine γ_{xy} assuming *Plane Strain*: γ_{xy} = ----------

(d) What is the difference between displacement and deformation?

(e) What is the difference between Lagrangian strain and Eulerian strain.

(f) How many stress components are needed to specify stress at a point in three dimension? How many are independent components?

Total Number of Components=-------- Independent Number of Components=--------

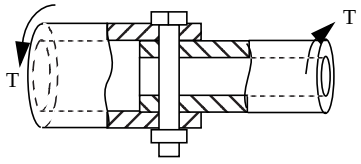
(g) The axial strain in a rod is given by $\varepsilon_{xx} = K(L - x)$, where K is a constant for a given material and L is the length of the rod. Determine the elongation of the rod in terms of K and L.

Elongation = ----------

2. In the following problems draw free body diagram. **Arrows and labels** on forces and moments must be clearly indicated.

(a & b) The two pipes have an outer diameters of 70 mm and 50 mm and a wall thickness of 10 mm. The pipes overlap on a length of 200 mm. The bolt diameter is 15 mm. Use this information to solve parts a and b.

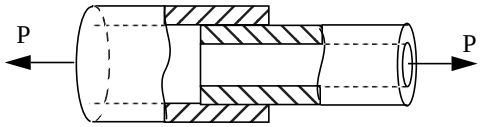
(a) A pipe is held by a bolt and subjected to a torque as shown. Draw the free body diagram for calculating shear stress in the bolt. What is the area of the imaginary cut?



A=----------

(b) A pipe is adhesively bonded and subjected to an axial force as shown. Draw the free body diagram for calcu-

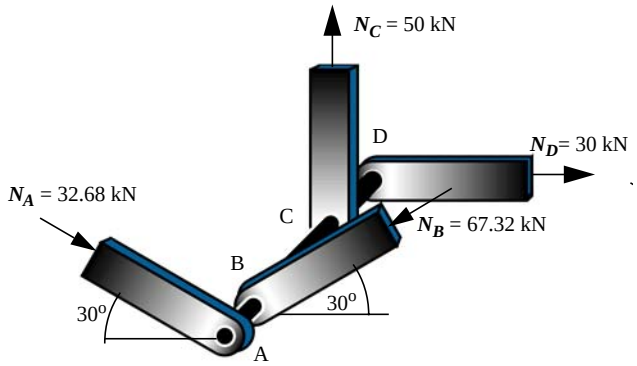
lating shear stress in the adhesive. What is the area of the imaginary cut?



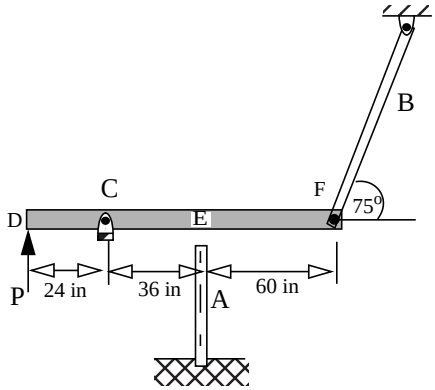
A=----------

(c) Draw the three free body diagrams necessary to calculate the maximum shear stress in the pin in the joint shown below. What is the maximum shear force in the pin?

V_{max}= ----------



3. A gap of 0.004 of an inch exists between the rigid bar and bar A before the load P is applied. The rigid bar is hinged at point C. The lengths of bars A and B are 30 in and 50 in, respectively. Both bars have an area of cross-sections of 1.25 in^2, modulus of elasticity of 30,000 ksi and a yield stress of 40 ksi. Due to force P, point D was observed to move upwards by 0.014 in. (a) Determine the applied force P. (b) The factor of safety for the system if yielding is to be avoided.



P= ----------

K_{safety} = ----------

ANSWERS

1(b) ε_{zz} = - 428.6μ (c) γ_{xy} = 2000 μ

(f) Total Number of Components= 9 Independent Number of Components= 6

(g) Elongation = $KL^2/2$

2 (a) A=176.7 mm^2 (b) A= 0.0314 m^2 (c) V_{max}= 58.3 kN

3. P= 188.6 kips K_{safety} = 1.23