Given:

Law of Cosines:

\[ c^2 = a^2 + b^2 - 2ab \cos(\gamma), \]
\[ b^2 = c^2 + a^2 - 2ca \cos(\beta), \]
\[ a^2 = b^2 + c^2 - 2bc \cos(\alpha), \]
\[ \cos(\gamma) = \frac{a^2 + b^2 - c^2}{2ab}. \]

Law of Sines:

\[ \frac{\sin A}{a} = \frac{\sin B}{b} = \frac{\sin C}{c}. \]

Formulae:

Normal stress \( \sigma = \frac{P}{A} \), where P is the normal force on the cut and A is the area of the cut.

Shear stress \( \tau_{\text{avg}} = \frac{V}{A} \), where V is the shear force on the cut and A is the area of the cut.

Normal strain \( \varepsilon = \frac{\Delta L}{L} \), where \( \Delta L \) is the change in length and L is the original length (AKA, gauge length).

Shear strain \( \gamma_{xy} = \text{the change in angle of } x-y, \text{ where } x-y \text{ are initially perpendicular or } \gamma_{xy} = \pi/2 - \theta', \) where \( \theta' \) is the deformed angle between x-y, measured in radians and \( \pi \) is obviously \( \pi \).

Hooke’s “Law” - \( \sigma = E \varepsilon \), where E = modulus of elasticity (AKA Elastic Modulus or Young’s Modulus).

Poisson’s Ratio \( \nu = - \frac{\varepsilon_{\text{lat}}}{\varepsilon_{\text{long}}} \), where the specimen is loaded in the long direction, resulting in long strain, as well as lat strain.

Hooke’s Law for Shear: \( \tau = G \gamma \), where G is the shear modulus of elasticity (AKA, the modulus of rigidity).

The elastic properties E, G, and \( \nu \) are related by:

\[ G = \frac{E}{2(1 + \nu)}. \]

Elastic Deformation of an Axially Loaded bar:

\[ \delta = \frac{FL}{AE}, \]
\[ \delta = \int_L \frac{F}{AE} \, dx. \]

Deformation due to thermal expansion:

\[ \delta = \alpha (\Delta T) L. \]

Bonus Questions (0.1 points each). Match the quote to the author.

_____A man only learns in two ways, one by reading, and the other by association with smarter people.
A. Will Rogers
B. Dan Gable
C. Plato
D. Steve Kurtz
E. Abraham Lincoln
F. Socrates
G. Charles Darwin
H. Vince Lombardi

_____While it is true that alcohol will not solve your problems, neither will milk or water.

_____It has long been recognized that the problems with alcohol relate not to the use of a bad thing, but to the abuse of a good thing.

_____I swear it upon Zeus an outstanding runner cannot be the equal of an average wrestler.

_____You may beat me, but you will not outwork me.

_____A mathematician is a blind man in a dark room looking for a black cat which isn't there.

_____Perfection is not attainable, but if we chase perfection we may catch excellence.

_____He was a wise man who invented beer.
1. (35 points). Determine the vertical displacement of point B.
   Given: Both members have area $A=1\text{in}^2$ and $E=500\text{ksi}$ (a plastic material). Connections are pins. Materials are elastic.

![Diagram of a truss with forces and dimensions]

FINAL ANSWER:
Vertical displacement at B, $\delta_B = \text{__________}\text{ inches}$
2. (40 points). Determine the maximum internal bending moment magnitude $|M|$ for span AB and for span BC, report the sign of each moment and indicate the location at which each of these maxima occurs.

Given: A is a fixed support. C is a roller support. B is a pinned connection.

| Span | Max. $|M|$ (kip-ft) | Location (x) | Indicate Sign |
|------|--------------------|--------------|---------------|
| AB   |                    |              |               |
| BC   |                    |              |               |
3. (25 points). A ½” diameter steel (E=30000 ksi) anchor bolt is embedded in concrete. When the upward load P is applied, the wedge-shaped base of the anchor resists a force of 1 kip, while the constant shear stress between the concrete and the 8-inch-long bolt is 0.500 ksi. Determine the extension of the bolt length AB. Materials are elastic.

**FINAL ANSWER:**
Extension, $\delta_{AB} =$ __________ inches