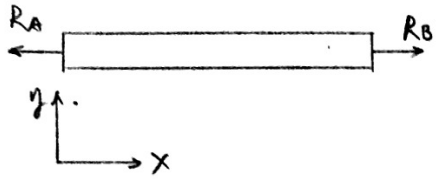
# Midterm 1 Solution

## Problem 1




$\Sigma F_x = 0$ ; $R_A = R_B = F_x$

$\varepsilon_y = \frac{1}{E}[\sigma_y - \nu(\sigma_x + \sigma_z)] + \alpha\Delta T$ ($\sigma_y \to 0$, $\sigma_z \to 0$)

$= \frac{-\nu\sigma_x}{E} + \alpha\Delta T \quad (1)$

$\sigma_x = \frac{F_x}{A}$

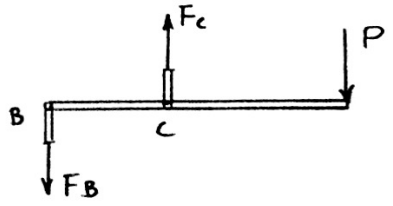
$e_x = 0$ , $\frac{F_x L}{AE} + \alpha\Delta T L = 0$

$\frac{\sigma_x}{E} + \alpha\Delta T = 0 \quad (2)$

solve $\Delta T$ from (1) and (2)

$\Delta T = \frac{\varepsilon_y}{(1+\nu)\alpha} = -11.26^\circ C$

## Problem 2




$\Sigma M_B = 0$ $\quad F_C \cdot 12in - P \cdot 30in = 0$ $\quad F_C = \frac{5}{2}P$

$\Sigma F_y = 0$ $\quad -F_B + F_C - P = 0$ $\quad F_B = \frac{3}{2}P$

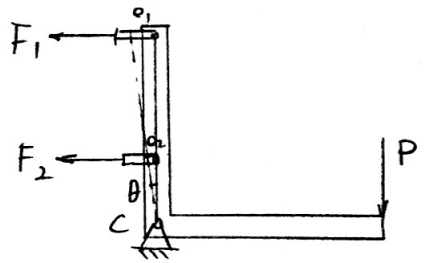
$F_C > F_B$, pin/link will yield first at link CD

$\frac{F_{cmax}}{A_{bar}} = \frac{\frac{5}{2}P_{max}}{1\ in^2} = 70ksi \Rightarrow P_{max} = 28\ kips$

$\frac{F_{cmax}}{A_{pin}} = \frac{\frac{5}{2}P_{max}}{\frac{\pi}{4}\ in^2} = 30ksi \Rightarrow P_{max} = 9.425\ kips$

$P_{allow} = \frac{P_{max}}{F.S.} = 3.142kips$ ( pin on CD tend to yield first)

Problem 3




$\Sigma M_C = 0$

$F_1 \cdot 0.9m + F_2 \cdot 0.3m - 40kN \cdot 0.9m = 0.$ (1)

$\frac{e_1}{0.9m} = \frac{e_2}{0.3m} = \tan\theta$

$e_1 = 3e_2$

$\frac{F_1 L}{AE} + \alpha \Delta T L = \frac{3F_2 L}{AE} + 3\alpha\Delta T L$ (2)

solve $F_1$ $F_2$ from (1) and (2)

$F_1 = 39.84\,kN$

$F_2 = 0.48\,kN$

$\sigma_1 = \frac{F_1}{A} = 99.6MPa$

$\sigma_2 = \frac{F_2}{A} = 1.2MPa$