CE 311 Exam 1
September 11, 2013

You are allowed to have the AISC manual, and a calculator.

Given Formulae:

Stress
\[ \sigma = E\varepsilon \]
\[ \tau = G\gamma \]
\[ G = \frac{E}{2(1 + \nu)} \]

Bending Flexural (normal) Stress
\[ \frac{M}{EI} = 1/\rho \]
\[ \varepsilon = -\gamma/\rho \]
\[ \sigma = My/I \]
\[ M = EIk \]
\[ I = (\pi/4)r^4 \text{ for a solid circular cross-section} \]

Beam Shear Stress
\[ \tau = VQ/It \]
\[ q = VQ/I \]
\[ q = F/s \]
\[ I = (\pi/4)r^4 \text{ for a solid, circular shape of radius } r \]

Bonus Questions (0.1 points, each)

1. How many commercial airplanes were hijacked during the 9/11/01 attacks in the US? 
   \text{1}

2. How many hijackers participated in the September 11\textsuperscript{th}, 2001 attacks on the US? 
   \text{19}

3. What day of the week was September 11, 2001? 
   \text{TUESDAY}

4. What was the Allies’ operation code name for the Normandy Invasion of France that took place on D-Day? 
   \text{OVERLORD}

5. On what date did D-Day take place? 
   \text{JUNE 6, 1944}

6. What was the name of the B-29 bomber that dropped the atomic bomb on Hiroshima, Japan? 
   \text{ENOLA GAY}

7. What was the name of the B-29 bomber that dropped the atomic bomb on Nagasaki, Japan? 
   \text{BOXCAR}

8. On which Pacific Island is Mount Suribachi? 
   \text{Iwo Jima}
1. (35 points)
   Part A. Draw the moment diagram for frame ABC, plotting the diagram on the compression side of the structure (the standard convention), labeling the maximum values for segments AB and AC. Plot diagram in the space provided.
   Part B. If column AB has a square, 6" x 6" cross-section, determine the normal stress on the left and right sides of the column, at a position immediately below point B.

   **EXTERNAL force**: 
   \[ 0 = \sum F_x \Rightarrow A_x = 10^k \]  
   \[ 0 = \sum M_A = -10(12) + 8C_y \Rightarrow C_y = 15^k \]  
   \[ 0 = \sum F_y \Rightarrow A_y = 15^k \]  

   **FBD AB**
   \[ FBD_{CB} \]
   \[ M_B = 8(12) = 120^k \cdot \text{ft} \]
   \[ M = \text{linear F\textsubscript{T}}, \text{comp side top} \]
   \[ M_a = 0 \ (\text{pin}) \]
   \[ M = \text{linear F\textsubscript{T}}, \text{comp side left} \]

   **NOTE**: \[ M_B = 120^k \cdot \text{ft} \]
   **This is used by STRESS, ELSE THE JOINT NOT IN EQUILIBRIUM**

   **PART A ANSWER**
   \[ M = 120^k \cdot \text{ft} \]
   \[ \text{AB} \]

   **PART B ANSWERS:**
   Left side \( \sigma = \frac{-39.6}{(\text{ksi})} \)  
   \[ \text{T or C?} \ (\text{circle one}) \]

   Right side \( \sigma = \frac{40.4}{(\text{ksi})} \)  
   \[ \text{T or C?} \ (\text{circle one}) \]
2. (28 points) Draw the line diagram for girder AB due to dead load and compute its maximum internal bending moment $M_0$ due to dead load, in units of kip-ft.

Given:
The floor plan below supports a 7.5" thick concrete slab (concrete unit weight = 150 lb/ft$^3$)
Fill beams are W16x26
Girders are W18x35

![Slab Pressure Diagram]

$w = (12')/93.75^2 + 26' = 1.151$ psf

Fills:

$w = (12')/93.75 + 26' = 1.151$ psf

Floor Plan

M = 221 + 2.52 = 224 k-ft
3. (3 points) At which location is the beam shear stress $\tau$ maximum (circle the answer)?

![Beam Diagram]

Given: $w = 1$ kip/ft

Location A
Location B
Location C
Location D
Location E
Location F

$\tau = 0$ @ D, E, F
$\tau = 0$ @ extreme fibers
$\tau = \max$ @ centroid
$\tau = \max$ @ B

4. (4 points) Determine the normal stress at point B if the normal stress at point A is 1 ksi (kip/in$^2$)

Given: The beam is subjected to equal end-moments $M$, as shown. A is a position at the extreme fiber. B is a position 2" below point A. The beam has a rectangular cross-section that is 10" deep, but the width is unknown.

![Beam Diagram]

$M$

$A$

$B$

Centroid

Cross-Section
9" x 10"

5. (4 points) Determine the degree of indeterminacy (DOI) of the structure below:

![Structure Diagram]

$3 \times 3 \times 3 = 3 \times (3 \times 2) = 3 \times 6 = 18$

$3 \times 3 \times 3 = 3 \times (3 \times 2) = 3 \times 6 = 18$

ANSWER: $G_B = \frac{3}{2} - 0.6 (\text{ksi})$

DOI = $6$
6. (4 points). Determine the degree of indeterminacy (DOI) of the truss below:

\[
\begin{align*}
0 &= 10 - 8 \quad \text{(b)} \\
8 &= 8 \\
\text{DOI} &= 10 + 8 - 2(8) = 2
\end{align*}
\]

7. (4 points). Determine the degree of indeterminacy (DOI) of the truss below:

\[
\begin{align*}
12 &= 12 - 5 \\
8 &= 8 \\
\text{DOI} &= 12 + 5 - 2(8) = 1
\end{align*}
\]

8. (2 points). TRUE or FALSE. The previous truss is stable. APPLY FORCE AS SHOWN. CONCEPTUAL TRUSS ANALYSIS OK.

9. (4 points). Determine the degree of indeterminacy (DOI) of the structure below:

\[
\begin{align*}
\text{DOI} &= (2 \text{ loops})(3 \text{ DOI}) - (3) - 2 \text{ pins} = 1
\end{align*}
\]

10. (4 points). Determine the degree of indeterminacy (DOI) of the structure below:

\[
\begin{align*}
\text{UNKNOWNS} &= 3 \\
\text{EQNS} &= 3 \text{ FBDs} \\
2 &= \text{DOI}
\end{align*}
\]

11. (4 points). Determine the degree of indeterminacy (DOI) of the structure below:

\[
\begin{align*}
3 &= 3 \\
4 &= 4 \\
\text{DOI} &= 3 + 4 - 2(4) = -1
\end{align*}
\]

12. (4 points). Determine the degree of indeterminacy (DOI) of the structure below:

\[
\begin{align*}
\text{ Alt. Scan.} \\
10 \text{ unknowns} \\
&= 2 \text{ FBDs} (3 \text{ eqns}) \\
\text{ DOI} &= 4
\end{align*}
\]