CE 311 Exam 3
October 14, 2016

You are allowed to have the AISC manual, drawing equipment, and a calculator, only. The AISC manual may contain handwritten notes but may not contain attached sheets nor may any photocopied materials be added to the AISC manual.

**Bonus Questions (0.1 points): Beer Slogans – Past and Present**
Identify the beer brand by its slogan (some are old, some are new)

1. Head for the mountains. **BUSCH**
2. The beer that made Milwaukee famous. **SCHUTZ**
3. The Coldest Tasting Beer In The World **COORS LIGHT**
4. Tastes great, less filling **MILLER LITE**
5. The One and Only. **NEWCASTLE BROWN**
6. It’s BEER. Hooray beer! **RED STRIPE**
7. Reassuringly expensive **STELLA ARTOIS**
8. Out of the darkness comes light. **GUINNESS**
9. The one beer to have when you’re having more than one **SCHAEFFER**
10. When you’re out of **SCHUTZ**, you’re out of beer.

11. (0.1 points) How many gallons of beer are contained in a standard US beer barrel? **31**
1. (5 points) The structure below is an arch. The axial force in member AB is:
   a. 3.00 kips
   b. 7.00 kips
   c. 7.62 kips
   d. None of the above

   Given: Reactions, as shown.

   $\sqrt{3^2 + 7^2} = \sqrt{9 + 49} = \sqrt{58}$

   B/C not funicular

2. (10 points) Circle the correct $P_{u}/\Omega$ for A992 W12x210 column

   A. 1790 kips  FOR $KL = 6'$
   B. 1350 kips  FOR $KL = 18'$
   C. 1680 kips  FOR $KL = 10'$  \(\text{(`For } KL = 18'\)}/3\)
   D. 450 kips

   $KL_{eq} = \frac{18}{18} = 10'$

   Contrast (vs. $KL = 6'$)
3. (30 points). Select the lightest A992 W16, per ASD, for an applied load \( P = 200 \) kips.

Given:

Hint: A W16 should not be expected to be very efficient for this application, as there are no intermediate braces for the weak axis.

\[
\text{Guess } \frac{F_{ec}}{A} = 15 \text{ ksi} \implies A = 13.3 \text{ in}^2
\]

\[
\implies \text{W16x45} \quad \left( A=13.3 \text{ in}^2, \frac{F_{y}}{F_{y}} = 1.57 \right)
\]

\[
\frac{kL}{A} = \frac{144}{1.57} = 91.7 \implies \frac{F_{ec}}{A} = 16.16 \text{ ksi} \quad \text{ (TABLE 4-22)}
\]

\[
\implies \frac{P_{o}}{A} = (13.3 \text{ in}^2)(16.16 \text{ ksi}) = 215 \text{k}
\]

\[
\frac{P_{o}}{A} > P \quad \text{OK}
\]

Go lighter?

W16x40? \( (11.8 \text{ in}^2)(16.16 \text{ ksi}) = 190 \text{k} \quad \text{No}

\text{Lightest} \quad \text{W16x45}
4. (35 points) Select the lightest A992 W8 shape for column grid location B2, between the foundation and the 2nd floor. Two-story building, shown.

   Story Heights: 20'
   All connections are simple pins. The floors act as rigid diaphragms.
   The column is subjected to axial forces, only.
   - Roof Dead Load Pressure = 25 psf. This includes every dead load on the roof (framing, decking, roofing material, etc.).
   - 2nd Floor Dead Loads: W16x26 Fill Beams and W18x35 Girders, as shown, supporting a 4-inch-thick concrete (γ = 150 lb/ft³) slab.
   - Live Load, AFTER Applying the Live Load Reduction Factor: 80 psf. (it has already been applied. Do not apply it again).
   - Snow Load: 100 psf (location: Arctic Circle)

**Dead Pressures - 2nd Fler**

   Slab: \( \frac{1}{2} \times (150) = 50 \text{psf} \)
   Fills: \( \frac{26 \text{psf}}{6.5'} = 4 \text{psf} \)
   Girders: \( \frac{35 \text{psf}}{26'} = 1.35 \text{psf} \)
   \( KL = 20' \)

\( \Rightarrow W8 \times 48 \)

\( \frac{P_n}{A} = 159 \text{k} @ KL = 20' \)

\( D = 0.75(L+S) = 145.6 \text{k} \)

\( C_{ow} \times S.W = (40') \times (48 \text{psf}) = 1.9 \text{k} \)

\( \Rightarrow [P = 148 \text{k}] < [\frac{P_n}{A} = 159 \text{k}] \)
5. (20 points). Determine the maximum normal stress in the parabolic arch.

Given: Parabolic arch with fixed supports, a uniformly-distributed load of \( w = 1 \text{ kip/ft} \), and a maximum arch height of 5'. The cross-section is 10" x 10" stone.

\[ w = 1 \text{ kip/ft} \]

\[ \text{Parabolic Arch} \]

\[ 8 \text{ feet} \]

\[ 5 \text{ feet} \]

\[ \text{Cross Section} \]

\[ 10" \times 10" \]

\[ \text{Cut @ B} \]

\[ F_h \]

\[ F_v = 4k \]

\[ P = \sqrt{4^2 + 1.6^2} = 4.308 \text{ k}\]

\[ \frac{wA}{t} = 10^{3}\text{psi} \]

\[ \sigma_{\text{max}} = 0.0431 \text{ksi} = 43.1 \text{psi} \]