CE 311 Celebration of Knowledge 3  
October 9, 2013

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

**Bonus Questions**

1. (0.1 points) Who was President of the United States when the Pittsburgh Pirates last won the World Series?
   JIMMY CARTER

2. (0.1 points) According to the 2014 National Students Steel Bridge Competition Rules, what is the length of the river, the minimum distance that the bridge must span?
   17’ 0”

3. (0.1 points) The Seal of the United States contains the expression, “e pluribus unum.” What does this mean?
   “FROM MANY, ONE” OR “OUT OF MANY, ONE”

4. (0.1 points) The motto of Lafayette College is “Veritas liberabit.” What does this mean?
   “THE TRUTH SHALL SET YOU FREE”

5. (0.1 points) Which U.S. president threw out the most Opening Day baseballs?
   FRANKLIN DELANO ROOSEVELT (the only president to serve for more than 8 Opening Days)

6. (0.1 points) Which university won the first college football game ever played?
   RUTGERS (defeated Princeton. Then Rutgers lost the next 69 consecutive years against Princeton)

7. (0.1 points) How many gallons of beer are contained in a standard US beer barrel?
   31 US GALLONS (or 330.66 beers, using beer-math)

8. (2 points) What is the ASD $r_d/\sigma$ for a $\frac{3}{4}”$ A325-N bolt in single shear?
   11.9 kips per Table 7-1
1. (3 points) TRUE OR FALSE: The maximum axial force in the arch below occurs at Point B. This is why traditional masonry arches have larger "Keystones" that are placed at the top of the arch.

Given: the arch has a uniformly-distributed load. The arch has a parabolic shape and fixed supports at A and C.

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

\[ F_H = \text{Constant} \]
\[ F_V = \text{Max @ Support} \]
\[ P = \sqrt{F_H^2 + F_V^2} \text{ occurs @ Support} \]

2. (5 points) For the structure below, circle the correct answer.

A). The structure is an arch, it has a Degree of Indeterminacy of 1, but can be solved by Statics because it is funicular.

B). The structure is not an arch, it has a Degree of Indeterminacy of 1, and cannot be solved by Statics because it is indeterminate.

C). The structure is an arch, it has a Degree of Indeterminacy of 3, but can be solved by Statics because it is funicular.

D). The structure is not an arch, it has a Degree of Indeterminacy of 0 and can be solved by Statics because it is determinate.

\[ 1 \text{ LOOP MINUS 2 PINS} \Rightarrow \text{DOF} = 1 \]

3. (10 points) What is the vertical component of force B_y at Point B?

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

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

\[ \text{Funicular Arch: Forces Are Always Axial} \]

\[ \therefore B_y = 0 \]
4. (30 points) Determine the heights of points B, C, and D in order for the arch to be funicular. Then, determine the maximum normal stress in segment AB.

Given: 32° gap, supporting 3 point loads, as shown. The maximum height of the arch is 6 feet. The cross-section of the arch is a 6" x 6" solid wooden shape.

\[
\begin{align*}
\int_0^{12} \frac{E}{A} \text{d}x &= 32E_y - 12(8) - \frac{1}{2}(4)(16) - (2)(24) \Rightarrow E_y = 6.5 \text{k}
\end{align*}
\]

\[
\begin{align*}
\int_0^{12} \frac{E}{A} \text{d}x &= 11.5 \text{k}
\end{align*}
\]

FBD AB:

\[
\begin{align*}
\frac{345 \text{ ft}}{10} &= \frac{19.16 \text{k}}{6} (11.5) = 19.16 \text{k}
\end{align*}
\]

\[
\begin{align*}
\sigma_{AB} &= \frac{19.16 \text{k}}{36 \text{ in}^2} = \frac{P}{A} = 0.532 \text{k} \text{sc}
\end{align*}
\]
5. (22 points). Select the lightest A992 W14 column that is adequate per ASD if it is subjected to an ASD applied load P=1100 kips (consisting of PD=700 kips and PL=400 kips), if it is braced, as shown:

\[ K_{Ly} = 12', \quad K_{Lx} = 24' \]

Table 4-1: W14 x 145 w/ \( \frac{P_a}{\alpha} = 1160 k \) @ KL=12'

\[ K_L = \frac{24'}{\frac{x}{K_y} = 1.59} = 15.09' \]

W/ KL = 15', \( \frac{P_a}{\alpha} = 1100 k \)

\[ \therefore \text{INADEQUATE } \because \frac{P_a}{\alpha} \text{ MUST BE LESS THAN 1100 } \]

\[ W14 x 159, \quad K_L = \frac{24'}{1.60} = 15' \Rightarrow \frac{P_a}{\alpha} = 1210 k \]

\[ \text{OK} \]

\[ \text{ALTERNATE: W14 x 145} \]

\[ \frac{P_a}{\alpha} = 1098 k \text{ BY INTERPOLATION} \]

\[ \text{But } 1098 k = 1100 k \text{ w/ 3 DIGIT STANDARD} \]

\[ \therefore \text{W14 x 145 OK} \]