CE311 Fall 2016  Exam 1  9/14/16

"Some countries use the Metric System. Others have been to the Moon." - Pierce Harger

Name: _____________________________

CE 311 Exam 1
100 points
September 14, 2016

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**

\[ M/EI = 1/\rho \]

\[ \varepsilon = -y/\rho \]

\[ \sigma = My/I \]

\[ M = El_k \]

\[ I = (\pi/4)r^4 \text{ for a solid circular cross-section} \]

**Beam Shear Stress**

\[ \tau = VQ/It \]

\[ q = VQ/I \]

\[ q = F/s \]

\[ I = (\pi/4)r^4 \text{ for a solid, circular shape of radius } r \]

**ABBREVIATIONS**

psf – pounds per square foot

plf – pounds per linear foot

k – kip (kilo-pound)

**Bonus Questions (0.1 points each)**

Give the city that corresponds with the following Division I colleges/mascots:

1. Oregon Ducks: **EUGENE**
2. Stanford Cardinal: **Palo Alto**
3. Kansas State Wildcats: **Manhattan**
4. Baylor Bears: **Waco, TX**
5. Tennessee Volunteers: **Knoxville**
6. Alabama Crimson Tide: **Tuscaloosa**
7. Texas A&M Aggies: **College Station**
8. Wisconsin Badgers: **Madison**
9. Iowa Hawkeyes: **Iowa City**
10. Iowa State Cyclones: **Ames**
1. (5 points). Determine the Degree of Indeterminacy (DOI) of the structure shown.

![Structure Diagram]

\[ \text{DOI} = 4(3) - 5 - 2 = 5 \]

2. (5 points). Determine the DOI for the Truss if all of the member-to-member connections are RIGID.

![Truss Diagram]

\[ \text{DOI} = 5(3) - 1 - 2 - 2 = 10 \]

3. (2 points). TRUE or FALSE. If the loads \( P \) were increased until failure occurred, the structure below would fail even though none of the members would experience material failure.

![Structure Diagram]

\[ \text{DOI} = -1. \text{ UNSTABLE, WILL COLLAPSE W/O MATERIAL FAILURE} \]

4. (3 points). List and describe the two types of Limit States that a structural engineer must design for.

**Strength Limit States**: Structure must support all loads \( \text{w/o failure, either by material failure (e.g., concrete crushing)} \text{ or by instability (e.g., prob:3).} \)

**Serviceability Limit States**: Structure must provide sufficient stiffness so that occupants are not frightened, unsettled, etc. (e.g., excessive wind sway, vibrations, etc.)
5. (50 points) Determine the maximum dead load moment $M_D$ on the W21x57 member BEH for the floor plan below if the members shown support a 4"-thick concrete slab ($f_{concrete} = 150$ lb/ft). The area bounded by ABDE is a floor opening (no slab or beams). All connections are pins.

### Floor Plan

- **W21x57**: 13497 lbs
- **W16x26 (Typ)**: 168,912 ft-lbs
- **W18x35 (EF)**: 169 kip-ft (3 digits)

**Final Answer:**

$M_D = 169$ kip-ft
6. (35 points) Determine the normal stress at position E, due to the 4.8 kip applied force, and indicate whether it is tension or compression. ABC is a continuous bar with a pin support at B. CED is a continuous bent bar that is pin-connected at C and has a pinned support at D. E is located on the top surface of the member. All members are square 4" x 4" cross-sections.

\[ A = 16 \text{ in}^2 \]
\[ \frac{A}{4} = 4 \text{ in}^2 = 21.33 \text{ in}^4 \]

\[ F = 4 \text{ ft} \]
\[ 4 \text{ ft} = 21.33 \text{ in}^4 \]

CED is 2FM

\[ 4 \text{ kips} \]

\[ 10 \text{ ft} \]

\[ 6 \text{ ft} \]

\[ 10' \]

\[ 8' \]

\[ \sigma_E = \frac{P}{A} + \frac{Mc}{I} \]
\[ \sigma_E = -\frac{8k}{16 \text{ in}^2} + \frac{(288)(2\text{ in})}{21.33 \text{ in}^4} = -0.5 + 27.0 \]
\[ = 26.5 \text{ ksi} \]

Final Answer:
\[ \sigma_E = 26.5 \text{ ksi} \]

\[ T \text{ or } C \]