1. (3 points). Which shape is more efficient (e.g., can sustain a greater moment) for a strong-axis bending application if it is known that buckling modes cannot occur? Assume the cross-sectional areas are the same.

(A) (B)

\[ \text{MAXIMIZE DEPTH} \]
\[ \text{(I}_y\text{ DOES NOT MATTER)} \]

2. (10 points) True or False. An A36 S15x42.9 shape that is subjected to strong-axis bending with constant bending moment will fail in fully-plastic bending, rather than lateral torsional buckling if its unbraced length is 4.5 feet.

\[ L_b = 4.5 \text{ FT} \]
\[ L_p = 1.76 \sqrt{\frac{E}{F_y}} = 1.76 (1106) \sqrt{\frac{29,000}{36}} = 52.95 \approx 4.41 \]

\[ L_b > L_p \quad \text{M}_Y \neq \text{M}_P \]

3. (3 points) True or False. A compact section is one whose flanges and webs are sufficiently thick so that the shape is able to reach \( M_y \) (when LTB is prevented by continuous bracing).

\[ \text{TRUE IF M}_P, \text{ NOT M}_Y \]

4. (3 points) True or False. If the slenderness of the flange exceeds the cutoff of \( \lambda_n \), then the section will fail by local buckling at a moment that is less than \( M_y \), assuming that the web is compact and that LTB is prevented by continuous bracing.

\[ \text{ELASTIC LB} \quad \text{M}_P \neq \text{M}_Y \]

5. (15 points). Evaluate the compactness of the flanges for the rolled I-shape if \( F_y = 50 \text{ ksi} \): compact, non-compact, or slender?

\[ \lambda = \frac{6}{14} = 2.4 \]
\[ \chi_p = 0.38 \sqrt{\frac{29000}{50}} = 9.15 \]
\[ \lambda = 1.0 \sqrt{\frac{29000}{50}} = 24.08 \]

\[ \lambda_p < \lambda < \lambda_r \quad \text{NON-COMPACT} \]
6. (16 points) An A36 C12x30 shape is bent about its weak axis by a uniformly distributed load over a simple span of 5 feet. It is laterally-braced at its ends, only. Using ASD, determine the maximum uniformly-distributed load that may be safely applied (units: kips/ft).

\[ M_p = F_y Z_y = (36)(4.32) = 155.5 \text{k}\cdot\text{in} \]

\[ M_p = 155.5 \text{k}\cdot\text{in} = 12.96 \text{k}\cdot\text{ft} \]

\[ \Rightarrow \frac{M_p}{L^2} = 7.776 \text{k}\cdot\text{ft}^3 = \frac{wL^2}{8} \Rightarrow w = 2.49 \text{k}\cdot\text{ft}^{-1} \]
7. (50 points). Using AISC ASD, determine the maximum constant end-moment $M$ that can be safely applied for the shape shown and clearly state whether it is controlled by fully plastic bending or LTB.

Assume:
- That the beam self-weight is negligible
- That the residual stress is equal to $0.3F_y$, (per AISC Standard)

Given:
- Braced at the end-points, only. $F_y = 50$ ksi. The section is compact.
- Flanges are 10"x5/8". Web is 12"x3/8".
- $L_o = 27.0$ feet
- $I_1 = 553$ in$^4$, $I_2 = 104$ in$^4$, $A = 19.5$ in$^2$

Plastic Moment:
- $M_p = (3/2.5)(12^{3/8}) + (6)(112.5) = 4620$ k-in

LTB:
- $w/ L_o = 16', L_p = 7'$
- $L_p = 1.76 \sqrt{\frac{E}{F_y}} = 1.76 \left(\frac{104}{19.5}\right)^{1/2} \frac{29000}{50} = 97.88 = 8.16'$
- $L_p < L_o < L_r$ — Inelastic LTB (Linear Fact)
- $M_r = 0.7F_yS_y = 0.7(50)(553/638) = 2922$ kip-in

$\text{Slope} = \frac{4620 - 2922}{27.0 - 8.15} = -90.08$

$M_n = 4620 - 90.08(16 - 8.15) = 3913$ kip-in

$\Rightarrow \frac{M_n}{R} = \frac{(3913)(3/8)}{2348} = 19.6$ k-ft.

OR $2350 \text{ kip-in} @ 3 \text{ digits}$