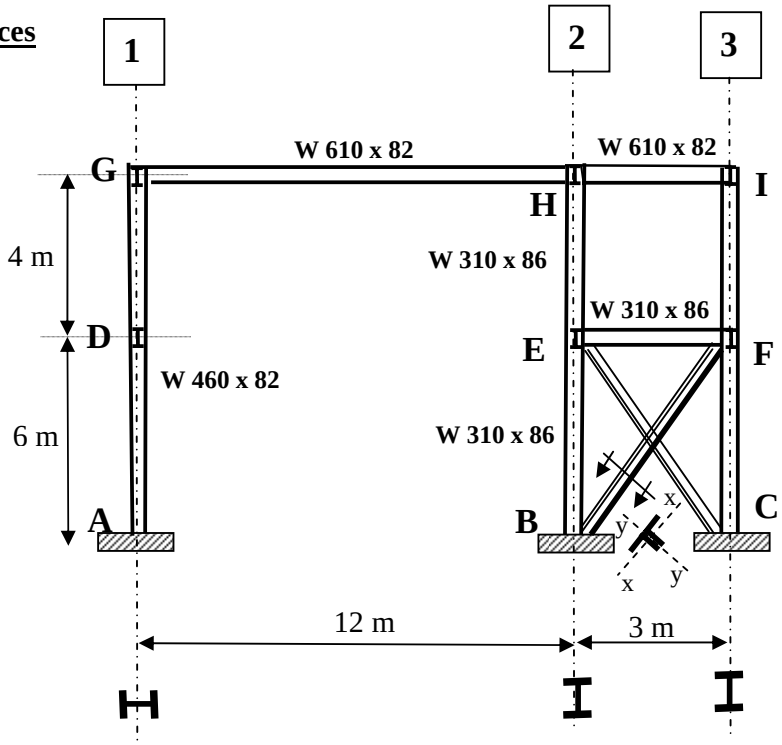
King Saud University College of Engineering,Department of Civil		Second Semester 1427 / 1428	
Student name		**Steel Structures** **CE 473**	**Time : 90 min**
Student number in class			

Second Mid Term Exam

Answer all problems in the provided spaces

The shown steel frame is laterally supported at points D, E, F, G, H, and I by longitudinal steel beams, all columns are fixed base. All steel members are made of A36. Braces BF and EC are made of double angles, back to back and they are assumed to be pinned at ends, while all other members are W-shapes as given in Figure.



Question 1: (3 points)

Choose the right answer:

1- For Column AG, buckling in plane is KLx ☐ , KLy ☐

Buckling outside plane is KLx ☐, KLy ☐

2- For Column BE, buckling in plane is KLx ☐ , KLy ☐

Buckling outside plane is KLx ☐, KLy ☐

3- For member BF (double angle back to back), buckling in plane is KLx ☐ , KLy ☐

Buckling outside plane is KLx ☐, KLy ☐

Question 2: (9 points)

For member BF, if KL_x = 3.5 m and KL_y = 6.5 m and its factored compression force is 300 kN, **use the LRFD tables** to find the lightest section of double angles for the following two cases and fill the given table;

	Lightest section	weight	Factored resistance
Double equal angles			
Double unequal angles with short leg back to back			

Which section will you select for design ?

Question 3: (8 points)

a) Determine the buckling length KL_x and KL_y for column AG (assume the column is fixed outside plane at A)

b) Determine the buckling length KL_x and KL_y for column BE, (assume the column is fixed outside plane at B)

Question 4: (10 points)

Member CE needs to be designed as a **bolted double angle, tension member**, using A325 bolts of 14 mm diameter, with a bearing connection at ends C and E. The ultimate tension force in member CE is 250 kN, it is required to;

1- Estimate the number of required bolts (assuming it is bearing connection) given; F_{vb} = 400 MPa,

2- Estimate the minimum thickness of angles

3- Estimate the size of angles,

a) Considering Yielding on gross area

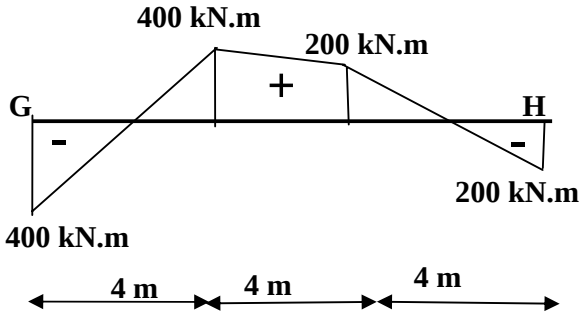
b) Considering Fracture at net area (take U =0.85)

Question 5: (10 points)

Determine the factored compression force of column AG (W 460x82), assuming that KL_x = 13m and KL_y =5m

Question 6: (10 points)

If the factored bending moment of beam GH is as shown in figure, and its section is W 610 x 82. The upper flange of the beam is continuously laterally supported by RC slab, while the lower flange is laterally fixed at ends only.



a) Determine the beam factored positive moment strength.

b) Determine the beam factored negative moment strength

c) Is the beam strength safe for both positive and negative moments?