

Assignment 2: Stiffened Structures

Individual assignment: One per student. Multiple attempts allowed, but only last submission graded.

Ensure you review your file after submission and avoid leaving submission until the last minute.

Marks awarded for ANSWERS only.

Use solutions template to enter in results and follow instructions provided in template file.

Question 0: Your student number is used to assign parameters, according to the table below.

Digit	3rd	4th	5th		6th		7th	
Parameter	<i>a</i>	<i>b</i>	<i>A</i>	<i>B</i>	<i>C</i>	<i>D</i>	<i>E</i>	<i>F</i>
Value								
0	0.90	0.90	12	150	5	20	2	10
1	0.91	0.91	12.1	151	5.1	21	2.1	11
2	0.92	0.92	12.2	152	5.2	22	2.2	12
3	0.93	0.93	12.3	153	5.3	23	2.3	13
4	0.94	0.94	12.4	154	5.4	24	2.4	14
5	0.95	0.95	12.5	155	5.5	25	2.5	15
6	0.96	0.96	12.6	156	5.6	26	2.6	16
7	0.97	0.97	12.7	157	5.7	27	2.7	17
8	0.98	0.98	12.8	158	5.8	28	2.8	18
9	0.99	0.99	12.9	159	5.9	29	2.9	19

e.g.: Student number 3308705, produces the following table of values

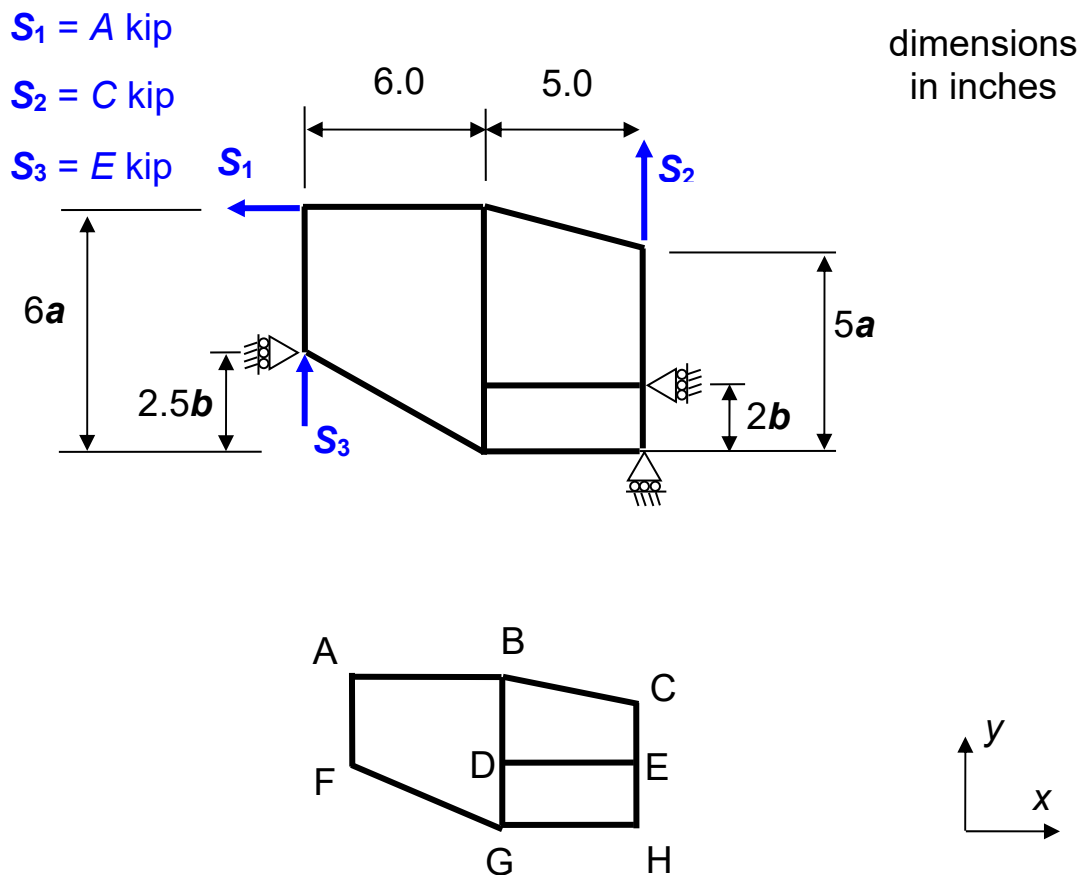
Digit	3rd	4th	5th		6th		7th	
Parameter	<i>a</i>	<i>b</i>	<i>A</i>	<i>B</i>	<i>C</i>	<i>D</i>	<i>E</i>	<i>F</i>
Value	0	8	7		0		5	
0	0.9	0.98	12.7	157	5	20	2.5	15

Question 1 (40%)

The tapered stiffened beam below is loaded by forces as shown. The beam is assumed to consist of stiffeners carrying only direct stress and shear panels carrying only shear stress. The material used has $E = 10500$ ksi, $G = 3900$ ksi, $\sigma_{ty} = 48$ ksi, $\sigma_{cy} = 38$ ksi, $\sigma_{sy} = 37$ ksi. The values of a , b , A , C , E are taken from Question 0.

- Calculate the stiffener axial loads (lbf) at the end of each beam segment and the shear flows (lbf/in) along each panel edge. (30%)
- Size the beam by determining stiffener areas (in²) and shear panel thicknesses (in). (10%)

For stiffeners, size to yield stress (in tension or compression), considering the maximum load in each segment (i.e. each segment can have a different area). For the shear panels, size to yield stress (in shear, maximum in each panel) or shear buckling, whichever is critical. For the buckling calculation, assume that the shear panels are simply supported on all edges, and for the tapered panels use the smaller edge dimensions (i.e. assume a rectangular panel with the smaller of the width and height edge dimensions). When sizing, use a minimum possible area of 0.30 in² and a minimum possible thickness of 0.0052 in.



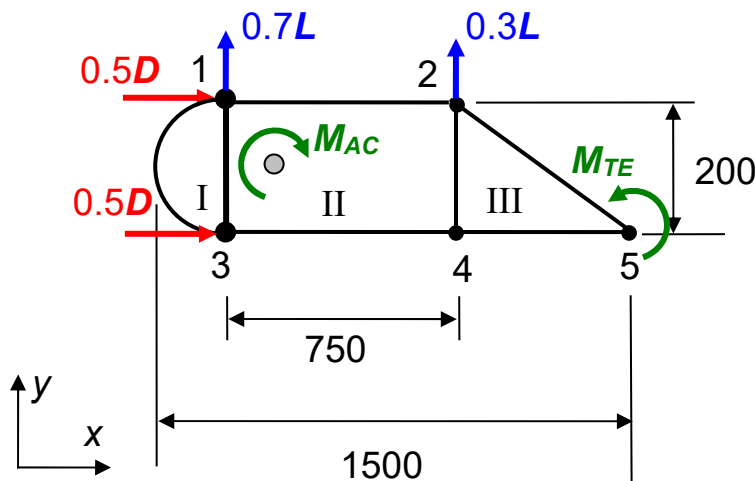
Question 2 (60%)

The three-cell structure shown below uses stiffeners connected with shear panels. Note that the curved panel between stiffeners 1 and 3 is semi-circular. The structure is under the action of forces and moments as shown. Assume the shear panels do not carry any direct stress. The material properties are: $E = 72 \text{ GPa}$, $G = 28 \text{ GPa}$, $\sigma_{ty} = 270 \text{ MPa}$, $\sigma_{cy} = 240 \text{ MPa}$, $\tau_y = 170 \text{ MPa}$. The values of a , b , B , D , F are taken from Question 0.

- Calculate the shear flow (N/mm) in each panel and determine the critical margin of safety in shear (not buckling or any other mode). (50%)
- Re-size the thickness (mm) of the shear panels to reduce the cross-sectional area to achieve the following design requirements (10%):
 - area fraction A/A_0 less than 0.30
 - all margins of safety greater than or equal to 0.0
 - no panel thickness less than 0.2015 mm

The area fraction is calculated as A/A_0 , where A is the cross-sectional area of all panels combined, and A_0 is the cross-sectional area of all panels using thicknesses as shown in the figure below.

In re-sizing the panels, you should consider that the beam cross-section dimensions and stiffener areas are fixed, and that only the panel thicknesses can be varied. You should only consider failure due to shear (not buckling or any other mode).



dimensions in mm

areas in mm^2

Booms 1, 3: area = $700a$

Booms 2, 4, 5: area = $50b$

panel thickness (t)

$t = 1.5 \text{ mm}$ for all panels except

$t_{1-3} = 5 \text{ mm}$

$$L = B \text{ kN}$$

$$D = D \text{ kN}$$

$$M_{AC} = F \text{ kN m}$$

$$M_{TE} = 0.2F \text{ kN m}$$