As a student at Union College, I am part of a community that values intellectual effort, curiosity and discovery. I understand that in order to truly claim my educational and academic achievements, I am obligated to act with academic integrity. Therefore, I affirm that I carried out the work on this exam with full academic honesty, and I rely on my fellow students to do the same.

For this Exam, I understand that:

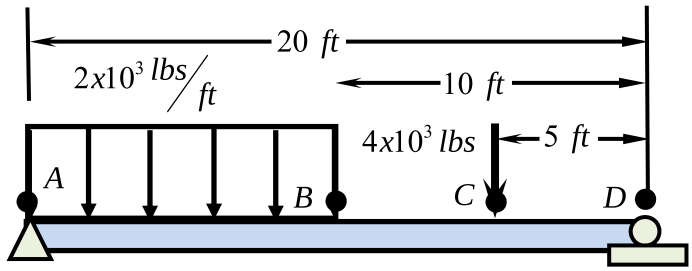
1. I **must** work alone in writing out the solutions to the problems in this exam.
2. I **cannot** copy solutions, in part or whole, to the problem on this exam from any person or resource.
3. I **cannot** use any electronic resources to assist me in the solution to the questions on this exam except for my calculator to only performing appropriate calculations on the exam.
4. I **can** use one page - single sided - of notes during the exam. This one page of notes **cannot** contain any solutions to problems. **I must staple this page to the back of my exam at the end of the exam**.

Signature: ______________________________

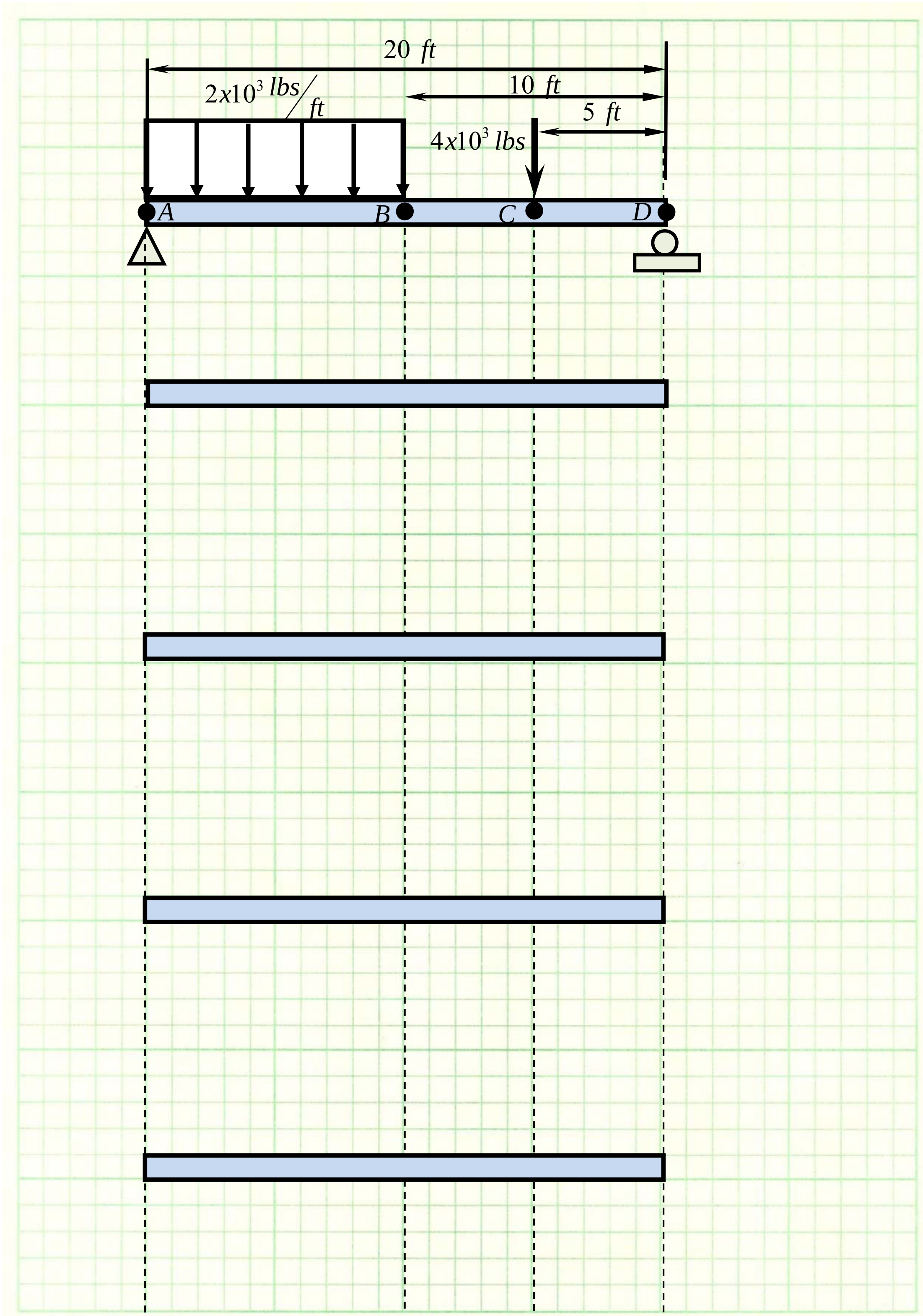
Print Name: ______________________________

Exam Date: ______________________________

PROBLEM 1: Answer the following questions for the beam shown below.



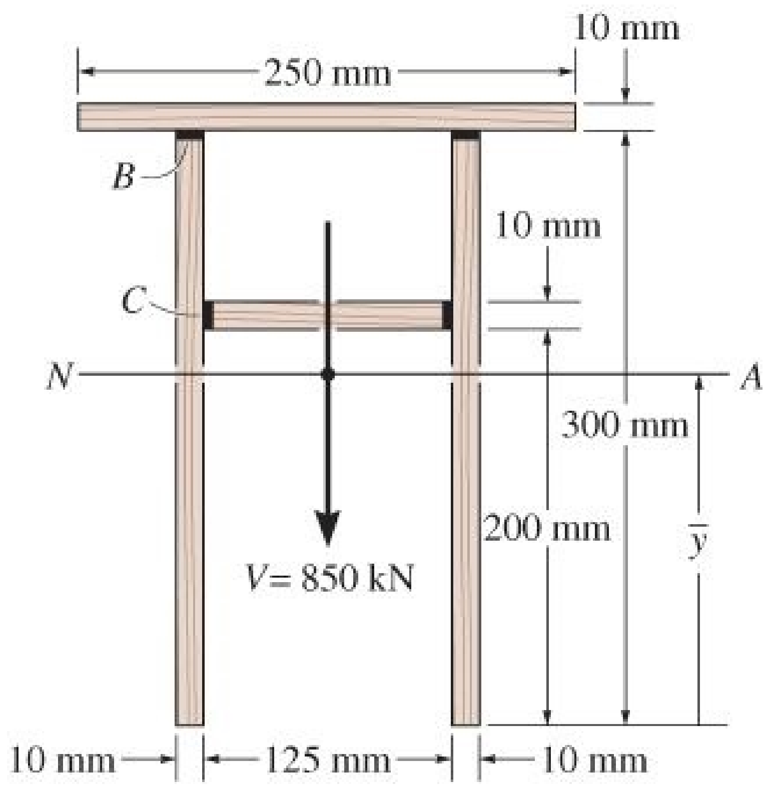
1a. Determine the reactions at A and D, and using the provided beam bending tables determine the deflections at B andC. Identify and Illustrate the beams used in the solution on the figure provided below.


20 ft
10 ft
5 ft
2x10^3 lbs/ft
4x10^3 lbs
A
B
C
D

1b. Write a general expression for the load, shear, bending moment, curvature, and deflection of the beam using singularity functions. Make sure to calculate all constants.

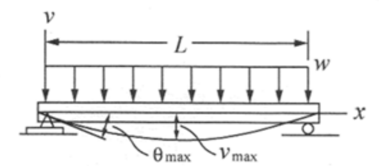
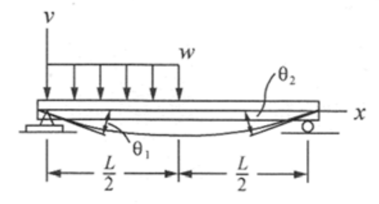
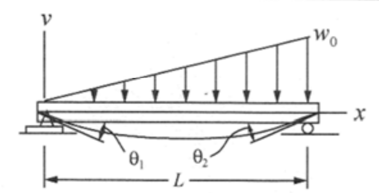
PROBLEM 2: The beam below is constructed from four boards nailed together at B and C. This board is subjected to a shear of V=850 kN as shown.

$$\bar{y} = 0.1968\ m$$
$$I = 87.52(10^{-6})\ m^4$$



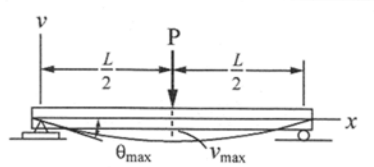
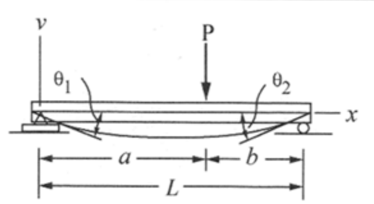
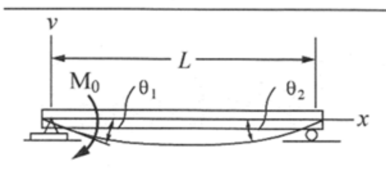
2b: Calculate the shear flow through B and C.

2c: If each nail can carry 5 kN, what nail spacing is needed at B and C.

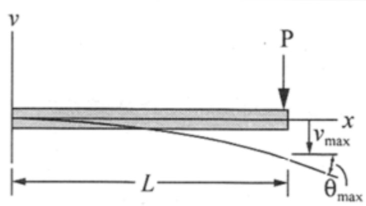
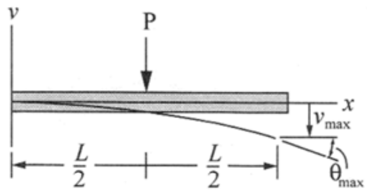
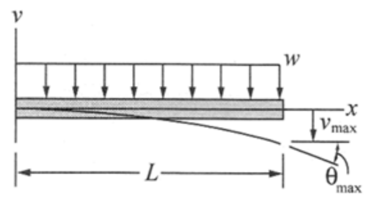
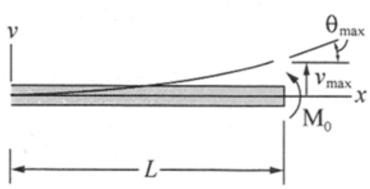
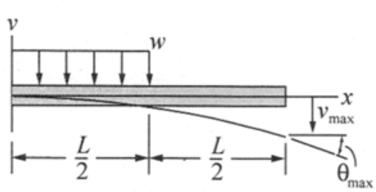
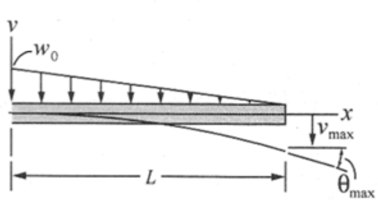
	$\theta_{max} = \frac{-wL^3}{24EI}$	$v_{max} = \frac{-5wL^4}{384EI}$	$v = \frac{-wx}{24EI}(x^3 - 3Lx^2 + L^3)$
	$\theta_1 = \frac{-3wL^3}{128EI}$ $\theta_2 = \frac{7wL^3}{384EI}$	$v\Big\rvert_{x=L/2} = \frac{-5wL^4}{768EI}$ $v_{max} = -0.006563\frac{wL^4}{EI}$ at $x = 0.4598L$	$v = \frac{-wx}{384EI}(16x^3 - 24Lx^2 + 9L^3)$ $0 \le x \le L/2$ $v = \frac{-wL}{384EI}(8x^3 - 24Lx^2 + 17L^2x - L^3)$ $L/2 \le x < L$
	$\theta_1 = \frac{-7w_0L^3}{360EI}$ $\theta_2 = \frac{w_0L^3}{45EI}$	$v_{max} = -0.00652\frac{w_0L^4}{EI}$ at $x = 0.5193$	$v = \frac{-w_0x}{360EIL}(3x^4 - 10L^2x^2 + 7L^4)$

Hibbeler, R.C., *Mechanics of Materials*, 4th ed., Prentice Hall, 2000.

Simply Supported Beam Slopes and Deflections

BEAM	SLOPE	DEFLECTION	ELASTIC CURVE
	$\theta_{max} = \frac{-PL^2}{16EI}$	$v_{max} = \frac{-PL^3}{48EI}$	$v = \frac{-Px}{48EI}(3L^2 - 4x^2)$ $0 \le x \le L/2$
	$\theta_1 = \frac{-Pab(L+b)}{6EIL}$ $\theta_2 = \frac{Pab(L+a)}{6EIL}$	$v\Big\rvert_{x=a} = \frac{-Pba}{6EIL}(L^2 - b^2 - a^2)$	$v = \frac{-Pbx}{6EIL}(L^2 - b^2 - x^2)$ $0 \le x \le a$
	$\theta_1 = \frac{-M_0L}{3EI}$ $\theta_2 = \frac{M_0L}{6EI}$	$v_{max} = \frac{-M_0L^2}{\sqrt{243}EI}$	$v = \frac{-M_0x}{6EIL}(x^2 - 3Lx + 2L^2)$

Cantilevered Beam Slopes and Deflections

BEAM	SLOPE	DEFLECTION	ELASTIC CURVE
	$\theta_{max} = \frac{-PL^2}{2EI}$	$v_{max} = \frac{-PL^3}{3EI}$	$v = \frac{-Px^2}{6EI}(3L - x)$
	$\theta_{max} = \frac{-PL^2}{8EI}$	$v_{max} = \frac{-5PL^3}{48EI}$	$v = \frac{-Px^2}{6EI}\left(\frac{3}{2}L - x\right) \quad 0 \le x \le L/2$ $v = \frac{-PL^2}{24EI}\left(3x - \frac{1}{2}L\right) \quad L/2 \le x \le L$
	$\theta_{max} = \frac{-wL^3}{6EI}$	$v_{max} = \frac{-wL^4}{8EI}$	$v = \frac{-wx^2}{24EI}(x^2 - 4Lx + 6L^2)$
	$\theta_{max} = \frac{M_0 L}{EI}$	$v_{max} = \frac{M_0 L^2}{2EI}$	$v = \frac{M_0 x^2}{2EI}$
	$\theta_{max} = \frac{-wL^3}{48EI}$	$v_{max} = \frac{-7wL^4}{384EI}$	$v = \frac{-wx^2}{24EI}\left(x^2 - 2Lx + \frac{3}{2}L^2\right)$ $0 \le x \le L/2$ $v = \frac{-wL^3}{192EI}(4x - L/2)$ $L/2 \le x \le L$
	$\theta_{max} = \frac{-w_0 L^3}{24EI}$	$v_{max} = \frac{-w_0 L^4}{30EI}$	$v = \frac{-w_0 x^2}{120EIL}(10L^3 - 10L^2 x + 5Lx^2 - x^3)$

Hibbeler, R.C., *Mechanics of Materials*, 4th ed., Prentice Hall, 2000.