Faculty of Maritime Engineering and Sea Sciences

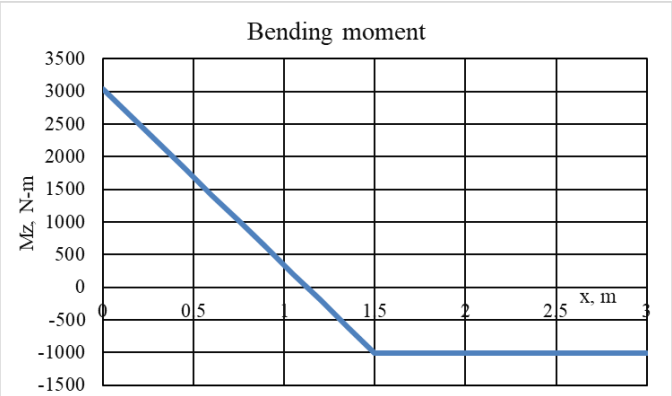
Ship's Structure

First exam: Shear stress in bending & Energy methods **July 2nd, 2024**

Student: ..... Student ID: .....

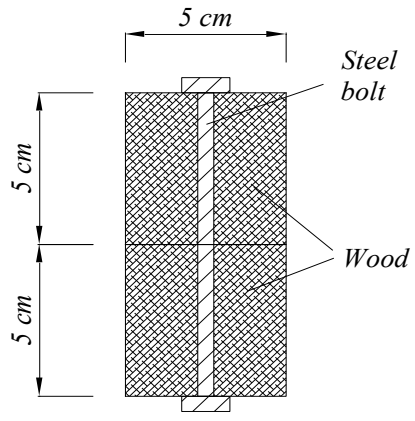
Part 1: Multiple choice questions. Closed books, 25'

1. A prismatic beam is clamped on its left end and with an unknown support in the other; its length is *3 m* and bending rigidity EI_c. The beam supports a concentrated force F at $x=a$, and the following distribution of bending moment is obtained. Calculate the value of the applied force on the beam. (10)



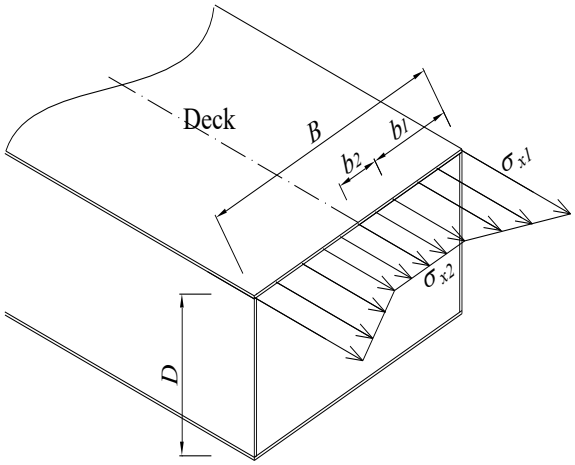
2670 N	3000 N	1000 N	4000 N

2. You have two boards of wood, 5x5 cm each (E_{wood}: 121 MPa, ν: 0.36) joined with steel bolts, separated longitudinally a distance of 15 cm. What is the shearing force that each bolt will develop if the shear force acting on the beam section is 1000 N? (10)



7000 N	235000 N	110 kN	90 kN

3. The simplified hull structure of a box-barge is analyzed in waves, L: 60 m, B: 12 m, D: 4 m & T: 2.5 m. With the value of the bending moment at midships, the following normal stress distribution with trapezoidal shape is obtained. Calculate the effectiveness of the deck plate considering that the material is steel (t= 8 mm, b_1=4 m, b_2=2 m, and σ_{x1}=160, and σ_{x2}=110 N/mm^2). (10)



68%	60%	79%	90%

4. In a 1 m-long beam with one end clamped and the other free with a concentrated force, with rectangular section (B: 1 cm x H: 12 cm) the total strain energy (bending+shear effect) is:

$$U = \frac{F^2 L^3}{3 E I}\left[1 + \frac{3}{5}(1+\nu)\left(\frac{H}{L}\right)^2\right]$$

The material has the following characteristics: E: 6.86E4 MPa & G: 2.541E4 MPa. Applying the principle of Conservation of energy, calculate the deflection of the end, when a force of 1 kN is applied. (10)

3.45mm	6.83mm	8.35mm	10.25mm

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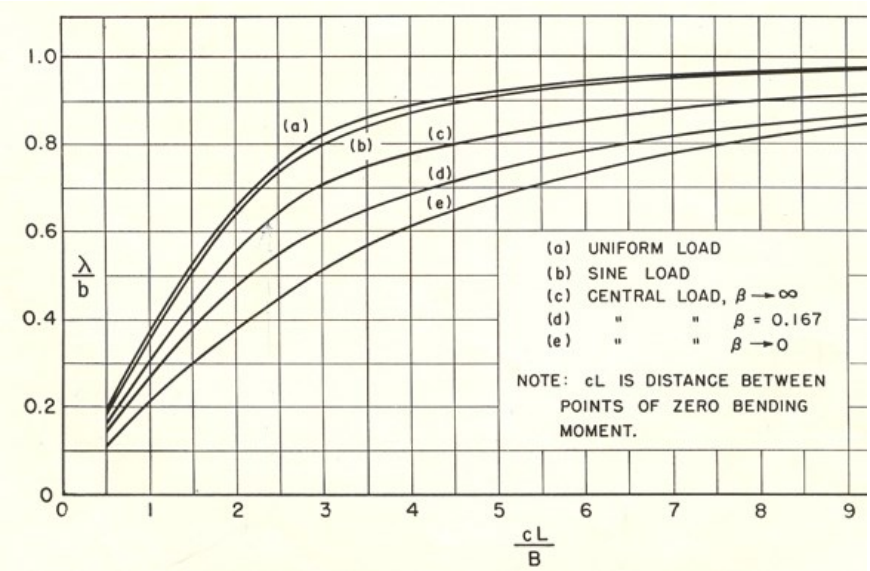
Part 2: Problems. Closed books, 90'

1. You are asked to analyze a longitudinal strong structural element in the bottom of a steel ship (L: 80 m, B: 13 m, D: 6.5 m, T: 4.0 m, and C_B: 0.68). Pressure on the bottom of the hull can be estimated as 1.20 times hydrostatic pressure on the bottom. This element is assumed as clamped on the transverse bulkheads of the ship, which are separated 6 meters. If the longitudinal elements which are analyzed, are transversely separated 2.0 meters between them, calculate the maximum normal stress in the center of the span. The structural element is I-type, 50 cm height with a 8 cm wide flat bar on its top, and it is welded to the bottom plating of the ship; all elements are 8 mm thick. (35)



Bending moment for a clamped-clamped beam with uniform load p_o is:

$$M_z(x) = \frac{p_o}{2}x^2 - \frac{p_o L x}{2} + \frac{p_o L^2}{12}$$

2.- Using Rayleigh-Ritz method, approximate and plot the distribution of bending moment in a 2.0-meter long beam which is clamped on one end, and supported by a spring on the other, K: 1.0E7 N/m. Loading is composed of a 2500 N/m uniformly distributed, and a concentrated force of 2000 N at 1.2 meters from the clamped end. Beam is made of a steel tube, 10 cmx8.5 cm in outside and inside diameters. To approximate the deflection function, you must use at least a *third order polynomial*, and in case you do not remember, the sectional inertia of a circular section is $\pi D^4/64$. (25)