Faculty of Maritime Engineering and Sea Sciences

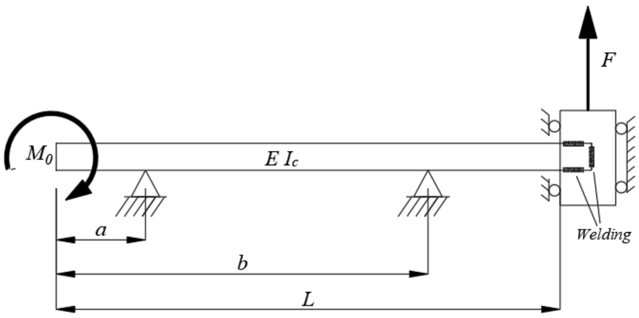
Ship's Structure

First exam: Shear stress in bending & Energy methods **July 5th, 2025**

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

Part 1: Multiple choice questions. Closed books, 40'

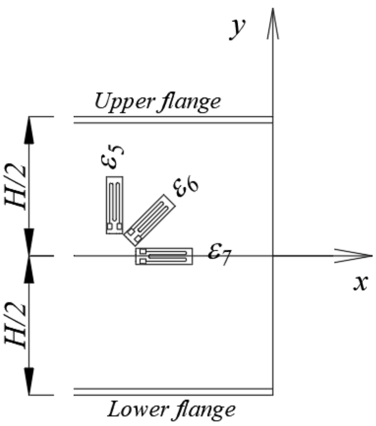
1. The following beam supported in two intermediate points and loaded as it is shown in the figure, is to be analyzed. What are the boundary conditions that you must apply to solve the problem?



a. $V(0) = 0, \quad E\,I_c v_{,xx}(0) = -M_0,$ $E\,I_c v_{,xxx}(L) = F, \quad v_{,x}(L) = 0$	b. $E\,I_c v_{,xxx}(0) = 0, \quad E\,I_c v_{,xx}(0) = M_0,$ $E\,I_c v_{,xx}(L) = 0, \quad v_{,x}(L) = 0$
c. $V(0) = 0, \quad E\,I_c v_{,xx}(0) = M_0,$ $E\,I_c v_{,xxx}(L) = -F, \quad v_{,x}(L) = 0$	d. $E\,I_c v_{,xxx}(0) = 0, \quad E\,I_c v_{,xx}(0) = M_0,$ $E\,I_c v_{,xx}(L) = 0, \quad v(L) = 0$

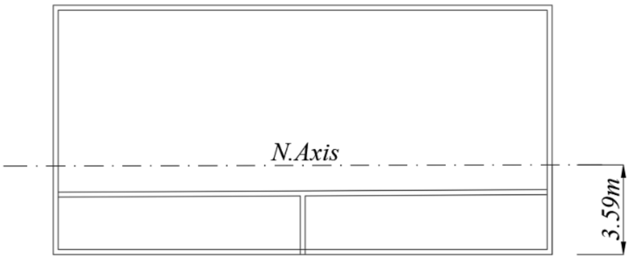
3. In the SiMar Naval engineering lab of FIMCM a simply supported I-section aluminum beam is tested under a concentrated force applied in a downward direction at the midpoint of the beam. The following values of normal strain are obtained in a rosette installed at a vertical position corresponding to mid height: ε_5: 19E-6 , ε_6: -32E-6 & ε_7: -6E-6. What is the shear strain at the point of measurement?

$$\boldsymbol{\varepsilon_{x'} = \varepsilon_x cos^2\theta + \varepsilon_y\, sin^2\theta + \gamma_{xy} sin\theta\, cos\theta}$$



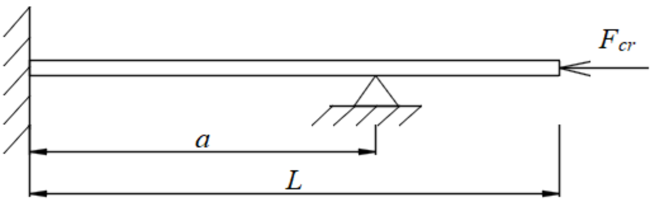
a. $\mu\gamma_{xy}$= -125	b. $\mu\gamma_{xy}$= 125	c. $\mu\gamma_{xy}$= -77	d. $\mu\gamma_{xy}$= -37

3. To classify a steel tanker ship (L: 120 m, B: 20m, D: 10m, T: 7.9m), with 1.0 m-height double bottom, the maximum shear force that may be applied on a section must be calculated. Plate thicknesses in mm are 8 on deck, 9 on sides, 10 on double bottom, 10 in bottom and 10 in vertical keel. The sectional inertia has been estimated as 12.38 m^4. Maximum stress on the structure according to the classification society are σ_{allow}: 140 MPa and τ_{allow}: 80 MPa. (10)



a. V_{max}= 2.07E11 N	b. V_{max}= 20.2 MN	c. V_{max}= 35.4 MN	d. V_{max}= 2.35 MN

4. A column supported in the way it is shown in the attached figure has a constant transverse section and L meters long. The critical buckling load is to be approximated using the principle of Conservation of Energy. Which one of the proposed functions is adequate to complete the proposed calculation? (10)



a. $\tilde{v}(x) = a_1 \frac{x}{L} (x-a)(x-L)^2$	b. $\tilde{v}(x) = a_1 \ x (x-a)^2 (x-L)^2$
c. $\tilde{v}(x) = a_1 \left(\frac{x}{L}\right)^3 \left(\frac{x}{L} - \frac{a}{L}\right)^2$	d. $\tilde{v}(x) = a_1 \left(\frac{x}{L}\right)^3 (x-L)^2$

Faculty of Maritime Engineering and Sea Sciences

Ship's Structure

First exam: Shear stress in bending & Energy methods **July 5th, 2025**

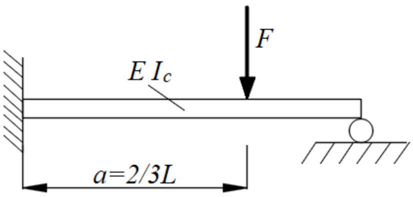
Student: .... Student ID: ....

Part 2: Problems. Closed books, 80'

1. Considering the normal stress developed on the flange, determine the maximum force that may be applied on the I-beam (*H*: 20 cm, B: 15 cm, *t*: 6 mm) clamped-simply supported with a concentrated force as shown in the figure. Material of the beam has the following mechanical properties *E*: 6.9E10 Pa, ν: 0.33, σ_{yield}: 200 MPa. Consider a safety factor of 2.0. The length of the beam is 2.0 m. (35)

Bending moment for a clamped-SS beam with a concentrated force:

$$M_z(x) = -F\left(x - \frac{2}{3}L\right) S\left[x - \frac{2}{3}L\right] + 0.481\,F\,x - 0.1481\,F\,L$$



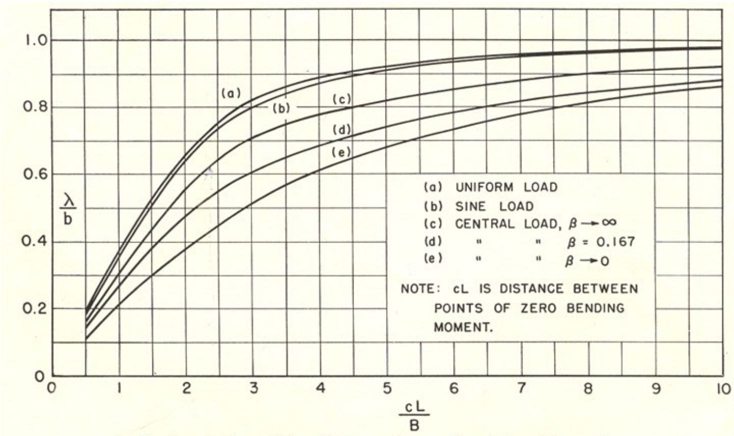
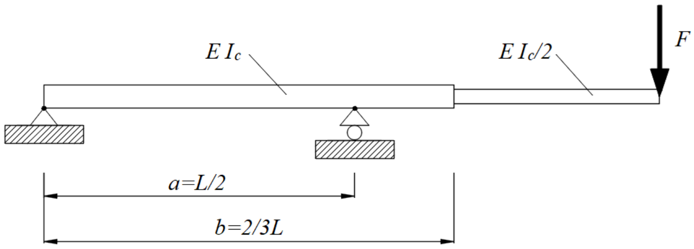


FIG. 9.—CASE I. SINGLE WEB. EFFECTIVE BREADTH RATIO λ/b FOR TYPICAL LOADS

2.- To reduce the weight of a simple structure, a reduction of the transverse section on the end of the beam is proposed as shown in the figure. It is desired to calculate the deflection on the point of application of force *F*. Apply the Rayleigh-Ritz method to approximate the end point deflection, considering that the reduction in section produces that the sectional inertia decreases by 2. Why do you think your result is correct? (25)



jrml/ 2025