Faculty of Maritime Engineering and Sea Sciences

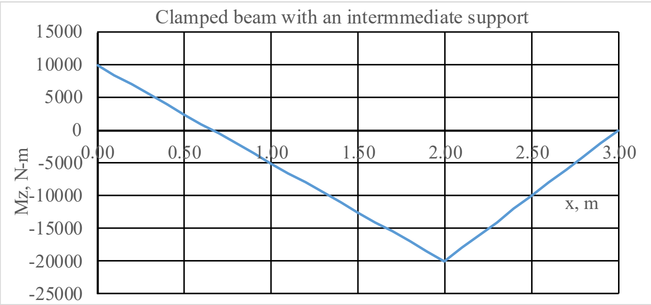
Ship's Structure

First exam: Shear stress in bending & Energy methods **June 29th, 2026**

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

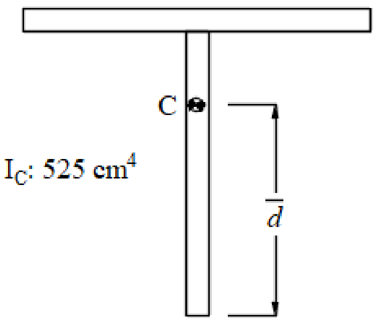
Part 1: Multiple choice questions. Closed books, 40'. 10 points per question.

1. The bending moment distribution of a clamped beam with an intermediate support, and a concentrated force on its end is shown in the figure. What is the reaction force in the clamped end? Length of the aluminum beam is 3 m (E: 6.86E10 N/m^2, ν: 0.33).



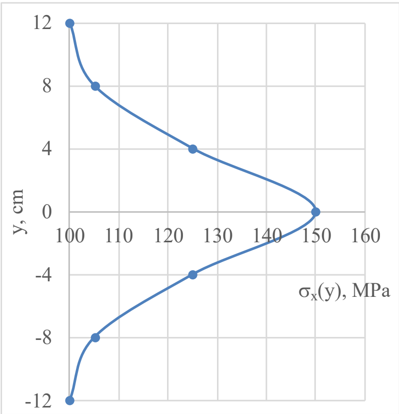
a. R_A= +18000 *N*	*b.* R_A= −20000 *N*	*c.* R_A= 30000 N	*d.* R_A= -15000 N

2. In a laboratory experiment a strain gage is installed in the flange of Te-section (h: 15, w: 10, t: 0.8 cm); properties of the steel beam are: sectional inertia: 525 cm^4 and its centroid is 11 cm from the lower end. If under a lateral load, the *micro*-strain is +200, what is the bending moment in this section?



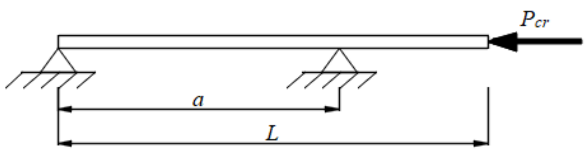
a. M_z= +2187 N-m	*b.* M_z= -5402 N-m	c. M_z= +3184 N-m	*d.* M_z= -2187 N-m

3. In a steel beam bending experiment the normal stress in the 24 cm flange width of a Te-section is measured in 4 equally spaced positions; web height is 30 cm and thickness is 0.8 cm. Calculate the efficiency of the flange of the beam section.



a. *Eff.: 69%*	b. *Eff.: 78%*	c. *Eff.: 72%*	d. *Eff.: 83%*

4. Conservation of energy is going to be applied to estimate the critical load of a prismatic steel column with a simply supported end and another intermediate support. Select an adequate function to develop this calculation. *($\zeta \equiv x/L$, $\bar{a} \equiv a/L$).*



a. $\tilde{v}(x) = a_1[\zeta^3 + \zeta\,\bar{a}^3 - 2\,\zeta^2\bar{a}]$	*b.* $\tilde{v}(x) = a_1\,[\zeta\,\bar{a}^2 + \zeta^3 - 2\,\zeta^2\,\bar{a}]$
c. $\tilde{v}(x) = a_1\left[\zeta^4 - 2\,\zeta^3 + 2\,\bar{a}^3\right]$	*d.* $\tilde{v}(x) = a_1\left[\zeta^3 - 2\,\zeta^2 + \zeta + \bar{a}^2\right]$

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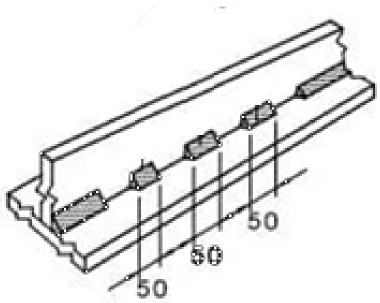
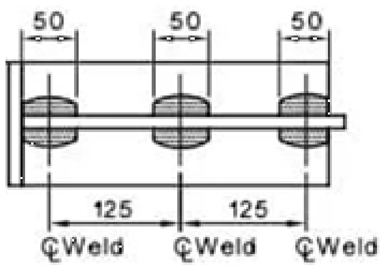
Part 2: Problems. Closed books, 1h15'

1.- In some cases an I-beam may be built from the three plate elements and joined them together, with intermittent welding. We are going to analyze a case of a steel section with web of 60 cm in height and 7 mm in thickness, and flanges of 60 cm in width and 8 mm in thickness. It has been estimated that *each piece of welding* can support a force of 12000 N. In the attached figure the intermittent welding connection details between the web and lower flange is shown in mm.





i. Prepare a clear diagram showing the shear stress acting on the welding joining the upper flange and the web, and calculate the maximum shear force that may be applied on the beam so that the welding does not fail?

ii. Considering the whole I-section, what is the maximum shear force that may be applied on the beam, considering an allowable stress of 80 MPa?

iii. So, what is the maximum shear force that may be applied on the beam section?

(35)

2.- The Rayleigh-Ritz (R-R) method is to be applied to analyze a cantilever prismatic beam ($E{*}I_C$) to which two springs (K_1 and K_2) are added to reduce the end deflection under a concentrated force F as shown in the attached figure. Applying the R-R method, obtain an expression for the deflection of the end point, check its sign and compare it with the original situation, that is the cantilever beam with no springs. (25)