College of Maritime Engineering and Sea Sciences

Ship Structures I

2nd Evaluation January, 31st/2019

Student: ....

Short questions (each one values 6 points)

1.- Prof. Schade's work on effective breadth is summarized in three graphs which present that parameter as function of a parameter which depends on the applied load function and boundary conditions. If in a certain case the effective breadth of the flange plate of a beam is calculated very small, that is probably due to:

a. Very small distance between points of null moment.	b. Presence of a concentrated force.	c. The ends of the beam are clamped.	d. Flange width of the beam is very small.

2.- What is the correct expression to evaluate the effective breadth of a plate which is the flange of a single web. In the expression, *b* is half width of the flange, *L* is span of the beam, and, *F* is the Airy stress function.

a. $\lambda = \dfrac{\dfrac{\partial^2 F}{\partial y^2}}{\dfrac{\partial^2 F}{\partial y^2}(y=0)}$	b. $\lambda = \dfrac{\int_0^b \dfrac{\partial^2 F}{\partial y^2}\, dy}{\dfrac{\partial F}{\partial y}(y=0)}$	c. $\lambda = \dfrac{\int_0^b \dfrac{\partial^2 F}{\partial y^2}\, dy}{\dfrac{\partial^2 F}{\partial y^2}(y=0)}$	d. $\lambda = \dfrac{\dfrac{\partial F}{\partial y}}{F(y=0)}$

3.- In a rectangular steel plate you apply uniformly distributed loads along the edges: σ_x and σ_y. Dimensions of the plate are *a* in the *x*-direction, *b* in the *y*-direction, and uniform thickness *t*. What is the change in thickness due to the applied load condition?

a. $\Delta t = -t\left(\dfrac{-\sigma_x - \sigma_y}{E}\right)$	b. $\Delta t = -\dfrac{t}{E(1-\nu^2)}\left(\sigma_x + \sigma_y\right)$	c. $\Delta t = -\dfrac{t\nu}{E}\left(\sigma_x^2 + 2\sigma_x\sigma_y + \sigma_y^2\right)$	d. $\Delta t = -\dfrac{t\nu}{E}\left(\sigma_x + \sigma_y\right)$

4.- If you want to analyze an aluminum alloy rectangular plate (*a* x *b*) in bending, with the edge $x=a$ considered as free. The load is a concentrated force at the center of the plate. What would be the boundary conditions in the free edge?

a. $M_y=Q_y=M_{yx}=0$	b. $M_x=Q_x=M_{xy}=0$	c. $M_x=Q_x=M_{yx}=0$	d. $M_y=Q_y=0$

5.- After applying Timoshenko's method to analyze bending of a clamped rectangular plate (*a* x *b*) supporting a group of concentrated forces: -100 N at (x: $a/4$, $y=b/4$), -100 N at (x: $a/4$, $y=3/4b$). Solution using two terms for the expansion of each moment distribution on the edges is: M_1: 100, M_3: 22, N_1,: 34 and, N_3:10, N m/m. Maximum bending moment on the plate is:

a. $M_{y\,max}= 122\ N$	b. $M_{x\,max}= 78\ N$	c. $M_{y\,max}= 78\ N$	d. $M_{x\,max}= 134\ N$

6.- To estimate the buckling critical stress conservation of energy is going to be applied. For a rectangular plate which is simply supported in two edges (in the *x*-direction), and, clamped in the other two (in the *y*-direction), what is an adequate function to proceed with the calculation? The compressive load is applied in the *x*-direction, and, you may assume that material is isotropic and plate has constant thickness.

a. $w(x,y)=W\sin\frac{n2\pi y}{b}\left(1-\cos\frac{m\pi x}{a}\right)$	b. $w(x,y)=W\sin\frac{n\pi y}{b}\left(1-\cos\frac{m\pi x}{a}\right)$
c. $w(x,y)=W\sin\frac{n\pi y}{b}\left(1-\cos\frac{m2\pi x}{a}\right)$	d. $w(x,y)=W\sin\frac{n\pi y}{b}\sin\frac{m2\pi x}{a}$

7.- To evaluate the external work developed by a uniformly distributed stress applied in the x-direction that produces a plate to buckle, the following expression is to be used. Plate is fixed on all its edges, with isotropic material and dimensions *a*x*b*x*t*.

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a. $W_e=t\int_0^a\int_0^b\frac{\sigma_{cr}}{2}\sqrt{1+w_{,x}{}^2}\,dy\,dx$	b. $W_e=t\int_0^a\int_0^b t\,w_{,x}{}^2\,\sigma_{cr}\,dy\,dx$
c. $W_e=\frac{t}{2}\int_0^a\int_0^b\sigma_{cr}\,w_{,y}{}^2\,dy\,dx$	d. $W_e=t\int_0^a\int_0^b\sigma_{cr}\left[\sqrt{1+w_{,x}{}^2}-1\right]dy\,dx$

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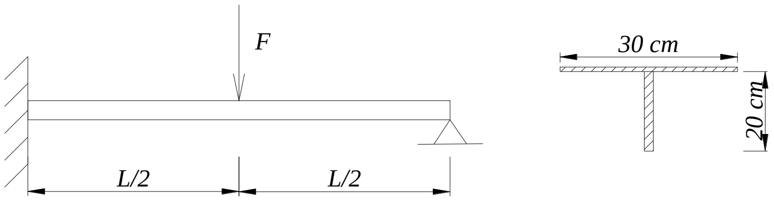
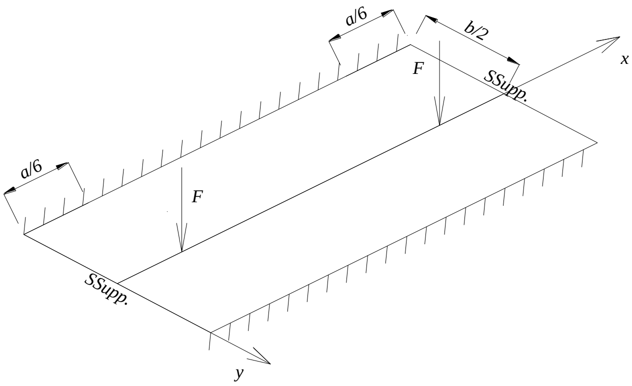
1.- You are asked to analyze a beam with a single web, clamped in one end and simply supported in the other, when a 2000 kg concentrated force is applied at mid-span as shown in the figure. Material is marine aluminum alloy 5863 (E: 7.24E5 kg/cm^2, ν : 0.33, G: 2.55E5 Kg/cm^2, γ : 2,670 Kg/m^3, σ_y : 2112 Kg/cm^2). (28 points)



Calculate the maximum normal stress developed on the flange plate, at longitudinal position where the force is applied. Beam length is 2 m, and thicknesses are: flange, 6 mm, and web, 9 mm.

2.- You have to design a rectangular aluminum alloy 5863 plate, with dimensions a: 1.50 & b: 0.75 m, which supports two concentrated forces acting downwards at the positions shown in the attached. Figure. Two of the edges are clamped, and the other two are SS. Each force is 10000 N. For the design process you have to consider a safety factor of 1.25 with respect to yield point (see problem 1), and for any series expansion use only one term.
(30 points)



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Useful relations:

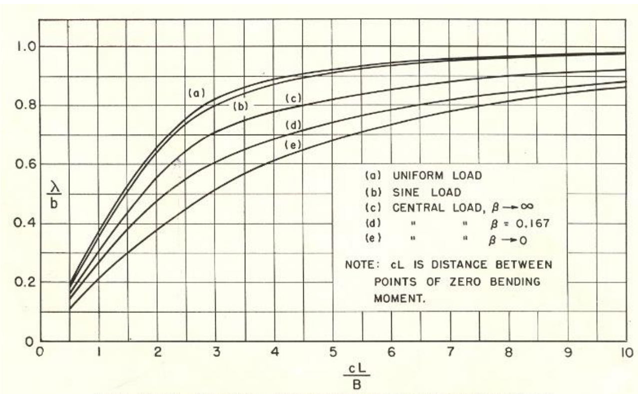

Fig. 9.—Case I. Single Web. Effective Breadth Ratio λ/b for Typical Loads

Simply supported plate with sinusoidal distribution of moment on x-edges, with: $\alpha_m = m\pi b/(2a)$:

$$w_1(x,y) = \sum_{m=1}^{\infty} \frac{a^2 M_m}{2\pi^2 m^2 D \cosh\alpha_m} sen\frac{m\pi x}{a}\left(\alpha_m \tanh\alpha_m \cosh\frac{m\pi y}{a} - \frac{m\pi y}{a} senh\frac{m\pi y}{a}\right)$$

I certify that during this examination I have complied with the *Code of Ethics of ESPOL*:

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