College of Maritime Engineering, and Biological, Oceanical and Natural Resource Sciences

Ship Structures I

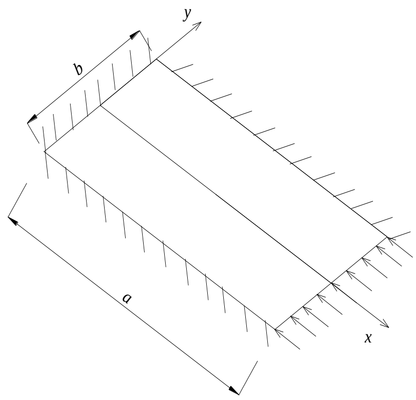
2nd Evaluation February/09/2018

Student: ……………………………………………………………………………

1.- To obtain the equilibrium of an arbitrary element of a plate in Plane stress you are asked to deduce its differential equation. In the present case there is an **external body force** (a force that acts throughout the volume of a body) in the *x*-direction. The force per unit volume in the mentioned direction is *X*, $\left[F / L^3\right]$. (5)

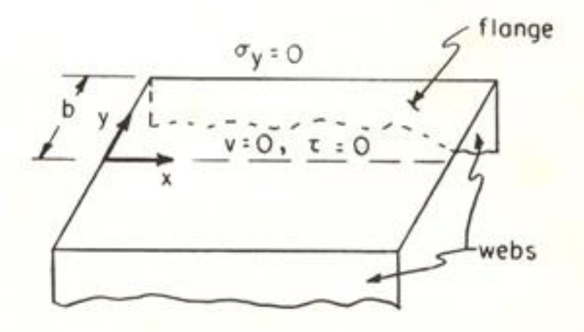
a.	b.	c.	d.
$\frac{\partial \sigma_x}{\partial x} + \frac{\partial \tau_{yx}}{\partial y} + X = 0$	$\frac{\partial \sigma_x}{\partial x} + \frac{\partial \tau_{yx}}{\partial x} + X = 0$	$\frac{\partial \sigma_x}{\partial x} + \frac{\partial \tau_{yx}}{\partial y} + t\,X = 0$	$\frac{\partial \sigma_x}{\partial x} + \frac{\partial \tau_{yx}}{\partial y} = 0$

2.- Consider a 6 mm in thickness rectangular plate, clamped in three edges and a uniformly distributed force of 600 kg_f/cm, in the fourth as shown in the figure. Calculate the strain in *x*-direction. Plate dimensions are a: 1.4 m and b: 0.6 m, and material mechanical properties correspond to steel. (10)



a. ε_x=+0.000431	b. $\mu\varepsilon_x$ = -331	c. $\mu\varepsilon_x$ = -431	d. ε_x =+331

3.- Determine the effectiveness of the deck plate in a simple steel barge, with the following main characteristics: *L*: 40 m, *B*: 6 m, *D*: 2.5 m, & *Δ*: 360 tons. Thicknesses are bottom & deck: 8 mm, and side 7 mm. When the ship travels in 1.0 m amplitude waves, microstrain is registered reporting the following values: (10)



y	$\mu\varepsilon_x$
0.0	-25
B/6	-27
B/3	-30
B/2	-38

a. 67%	b. 77%	c. 87%	d. 97%

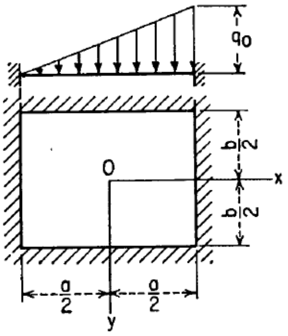
4.- Which one of the following expressions correspond to the Kinematic hypothesis employed in plate theory? (5)

a. $\varepsilon_y = -x\frac{\partial^2 w}{\partial y^2}$	b. $\varepsilon_x = -z\frac{\partial^2 w}{\partial y^2}$	c. $\gamma_{xy} = -z\left(\frac{\partial^2 w}{\partial x \partial y}\right)$	d. $\gamma_{xy} = -z\left(\frac{\partial^2 w}{\partial x \partial y} + \frac{\partial^2 w}{\partial y \partial x}\right)$

5.- In order to make an estimation of the Shear force in an steel simply supported plate, which one of the following expressions is correct? (5)

a. $Q_y = \frac{\partial M_y}{\partial y} + \frac{\partial M_{xy}}{\partial x}$	b. $Q_y = -\frac{\partial M_y}{\partial y} + \frac{\partial M_{xy}}{\partial x}$	c. $Q_y = \frac{\partial M_y}{\partial y} + \frac{\partial M_{yx}}{\partial y}$	d. $Q_y = \frac{\partial M_y}{\partial y} - \frac{\partial M_{xy}}{\partial x}$

6.- In a watertight bulkhead of a tanker ship, a clamped rectangular steel plate (a=1.2, b=1.2, t=0.008 m) supports hydrostatic load as shown in the figure. Using Timoshenko`s book, maximum bending moment is estimated as M_x is 0.58 kN m/m, when maximum pressure q_o is 12054 N/m^2. Determine plate curvature in that position. (10)



a. K_y=0.06 1/m	b. K_x=0.06 m^{-1}	c. K_y=0.006 1/m	d. K_x=0.6 1/m

7.- Consider a Simply Supported rectangular steel plate with dimensions 2x0.75 m, and 1.2 cm in thickness is used as an emergency connector between two lengths of a bridge under maintenance. When one tire of a cargo truck stands in the center of the plate, a 1500 kg of force is exerted on the plate. What is the maximum deflection that suffers the plate? (10)

a. 1.0 mm	b. 2.0 mm	c. 3.0 mm	d. 4.0 mm

8.- A rectangular clamped plate (*a*: 0.55, *b*: 1.20, & *t*: 0.008 m) supporting pressure of 40.5 kN/m^2 is analyzed with Timoshenko's method, with two-term sine series in both moment expansions. Results of calculations are shown in the following table. (10)

M_1 = -0.490 kN	N_1 = -0.714 kN
M_3 = 0.210 kN	N_3 = 0.306 kN

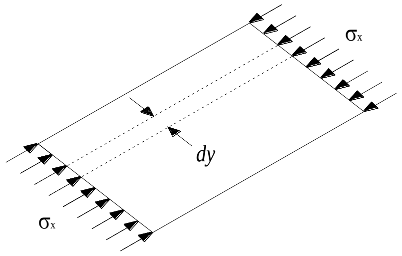
Calculate the maximum normal stress on the plate.

a. σ_{max}= = 96 N/mm^2	b. σ_{max}= = 96 N/mm^2	c. σ_{max} = 120 N/mm^2	d. σ_{max}= 96 N/mm^2

9.- To evaluate the Elastic strain energy in a plate that undergoes deflection, two effects can be identified: bending and torsion. To calculate the component due to bending the following expression can be applied: (5)

a.	$\frac{dU}{dA}=\frac{D}{2}\left\{\frac{\partial^2 w}{\partial x^2}\left(\frac{\partial^2 w}{\partial x^2}+\nu\frac{\partial^2 w}{\partial y^2}\right)+\frac{\partial^2 w}{\partial y^2}\left(\frac{\partial^2 w}{\partial y^2}+\nu\frac{\partial^2 w}{\partial x^2}\right)\right\}$
b.	$\frac{dU}{dA}=D(1-\nu)\left(\frac{\partial^2 w}{\partial x\partial y}\right)^2$
c.	$\frac{dU}{dA}=\frac{D}{2}\left\{\frac{\partial^2 w}{\partial x^2}\left(\frac{\partial^2 w}{\partial y^2}+\nu\frac{\partial^2 w}{\partial x^2}\right)+\frac{\partial^2 w}{\partial y^2}\left(\frac{\partial^2 w}{\partial x^2}+\nu\frac{\partial^2 w}{\partial y^2}\right)\right\}$
d.	$\frac{dU}{dA}=\frac{D}{2}\left\{\frac{\partial^2 w}{\partial x^2}\left(\frac{\partial^2 w}{\partial x^2}+\nu\frac{\partial^2 w}{\partial y^2}\right)+\frac{\partial^2 w}{\partial y^2}\left(\frac{\partial^2 w}{\partial y^2}+\nu\frac{\partial^2 w}{\partial x^2}\right)\right\}+D(1-\nu)\left(\frac{\partial^2 w}{\partial x\partial y}\right)^2$

10.- When the External force in *x*-direction acting on a simply supported rectangular plate (*a* in *x*-direction, *b* in *y*-direction, and thickness *t*) reaches the critical value, takes it to buckle, and advances a distance *du* in *x*-direction.



If you use a function $w(x,y)=W\ sen(\pi x/a)\ sen(\pi y/b)$ to calculate Critical stress, the *x*-displacement of the loaded edge is: (10)

a.	$\Delta u(y)=\frac{1}{2}\frac{(\pi W)^2}{a}\left(sin\left(\frac{\pi y}{b}\right)\right)^2$	b.	$\Delta u=\frac{1}{2}\frac{(\pi W)^2}{ab}$
c.	$\Delta u(y)=\frac{1}{4}\frac{(\pi W)^2}{a}\left(cos\left(\frac{\pi y}{b}\right)\right)^2$	d.	$\Delta u(y)=\frac{1}{4}\frac{(\pi W)^2}{a}\left(sin\left(\frac{\pi y}{b}\right)\right)^2$

11.- When plate buckling is analyzed for the simply supported case, the following function is considered: $w(x,y) = W\ sen\frac{m\pi x}{a}\ sen\frac{n\pi y}{b}$, where *m* and *n* are integer numbers. How do you select values for *m* & *n*? (5)

a.	They depend on the support conditions of borders of the plate.
b.	Those that produce the maximum value of the critical stress.
c.	Those that produce the minimum value of the critical stress.
d.	Depend on the lateral load (symmetrical/unsymmetrical) applied on the plate.

12.- According to DNV ship classification rules, critical stress σ_c of a plate under uniform compression load can be calculated:

$$\sigma_c = \sigma_{el} \quad when \quad \sigma_{el} < \frac{\sigma_f}{2}$$

$$= \sigma_f\left(1 - \frac{\sigma_f}{4\sigma_{el}}\right) \quad when \quad \sigma_{el} > \frac{\sigma_f}{2}$$

where σ_f is the minimum upper yield stress of material in .

The ideal elastic buckling stress may be taken as:

$$\sigma_{el} = 0.9\,k\,E\left(\frac{t - t_k}{1000s}\right)^2, \text{ in N/mm}^2,$$

where:
s & *l* are shortest & longest sides of plate panel in m,
t & t_k are thickness and corrosion allowance in mm, and,
E is the modulus of elasticity of the material in N/mm^2.

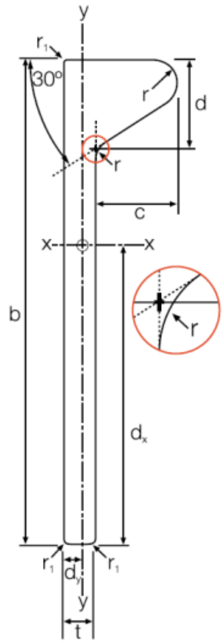
For plating with transverse stiffeners (perpendicular to compression stress):

$$k = 1.1\left[1 + \left(\frac{s}{l}\right)^2\right]^2.$$

Hull bending in waves produces stresses in *x*-direction (forward-aft). In a steel ship (*L*: 70, *B*: 11, *D*: 6 m) with spacing between deck transverse stiffeners and longitudinal girders of 0.60 and 1.60 m respectively, calculate the critical buckling stress of a deck plate panel. Thickness is 9 mm in deck, and rules recommend to take 1.25 mm as allowance for corrosion. (5)

a. 235 N/mm^2	b. 2450 Kg/cm^2	c. 443 N/mm^2	d. 44.3 N/mm^2

13.- In a longitudinally framed steel ship thickness of deck plate is 9 mm, transverse girders are spaced 1.6 m, and bulb-type longitudinal stiffeners, are separated 55 cm. From the catalogue of the steelworks, the sectional properties of the stiffeners are: *b*: 160 mm, *t*: 9 mm, *A*: 17.8 cm^2, d_x: 93.6 mm, d_y: 7.1 mm, I_{yy}: 7.32 cm^4, and I_{xx}: 448 cm^4, see attached figure. Taking a 75% of effectiveness for the deck plating which is welded to the stiffeners, calculate the elastic critical stress of the stiffeners. (10)



a.	235 N/mm^2	b.	100 N/mm^2
c.	335 N/mm^2	d.	1100 Kg/cm^2

Jrml/2018

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

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