Faculty of Maritime Engineering and Marine Sciences

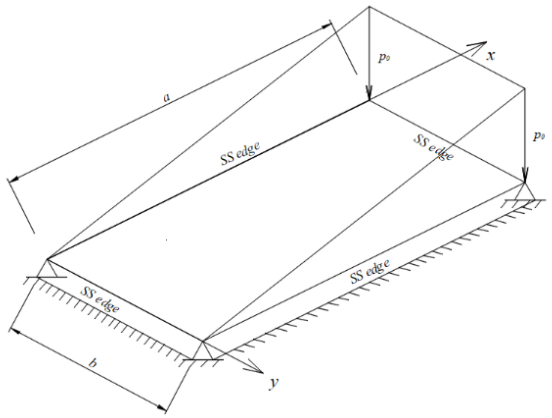
Ship's Structure

Exam #2 – Plate bending & Hull structure analysis **August, 26th, 2025**

Student: …… **ID:** …… **Completion time**: ……

Part 1. Closed books

1.- A rectangular simply supported steel plate *a*: 2 m, *b*: 0.6 m, and *t*: 8 mm, is supporting a hydrostatic loading from 2 meters height sea water column. A two-term sine series expansion is developed to represent this loading, kN/m^2. Select which one is the correct combination? (10)



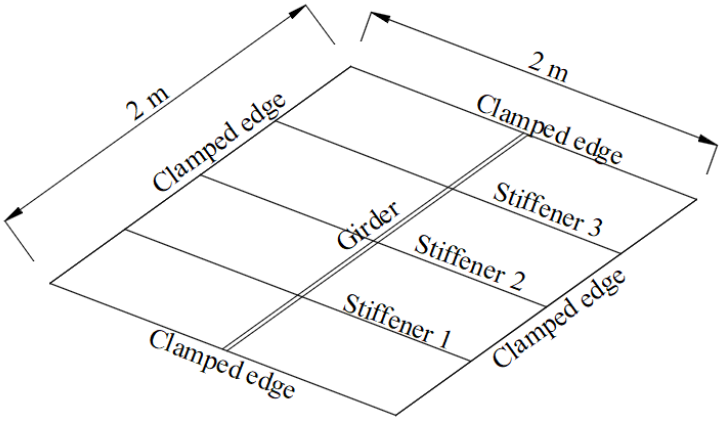
$$p(x,y) = \sum_{m=1}^{\infty}\sum_{n=1}^{\infty} p_{mn} sin\frac{m\pi x}{x} sin\frac{n\pi y}{b}$$

Amplitudes m n pmn 1 1 -.1621E+02 1 2 0.0000E+00 2 1 0.8106E+01 2 2 0.0000E+00	Amplitudes m n pmn 1 1 0.1621E+02 1 2 0.0000E+00 2 1 -.8106E+01 2 2 0.0000E+00	Amplitudes m n pmn 1 1 0.1621E+02 1 2 -.8106E+01 2 1 0.20560+01 2 2 0.0000E+00	Amplitudes m n pmn 1 1 0.1621E+02 1 2 0.0000E+00 2 1 0.8106E+01 2 2 0.0000E+00

2.- In a steel ship section (*B*: 20, *D*:10 m) with one longitudinal bulkhead and a double-bottom (h_{db}: 2 m), the shear flow is null on the deck at 3.98 m from center line. Thickness is uniform in the section, 10 mm, sectional inertia is 13.9 m^4 and neutral axis is 4.33 m from base line. Calculate maximum shear stress on the section's side when a shear force of 20 MN acts on the section. (10)

235 MPa	55 MPa	72 MPa	110 MPa

3. A reinforced steel plate panel is formed by one girder and three stiffeners, as can be seen in the figure. The effective inertia of stiffeners is 70 cm^4 and the girders are 5 times stiffer. Loading is uniform on the panel 20 kN/m^2. Considering the flexibility of the girder, the contact force between girder and stiffener 1 is calculated as 8271 N, while the one between stiffener 2 and girder is 6954 N. What is the reaction on each of the girder ends? (10)



16540 N	11748 N	15000 N	20000 N

4.- In a point around the side of a ship hull plating stresses are estimated as σ_y: 150 MPa and τ_{xy}: 30 MPa. Considering maximum distortion theory, what is the extreme value of σ_x that may be applied in that point, to avoid yielding? (10)

Von Mises stress is defined as:

$$\sigma_{VM} = \sqrt{\sigma_x{}^2 + \sigma_y{}^2 - \sigma_x\sigma_y + 3\tau^2}$$

$$\sigma_{VM} = \sqrt{\sigma_1{}^2 + \sigma_2{}^2 - \sigma_1\sigma_2}$$

σ_x =235 MPa	σ_x =264 MPa	σ_x = -193 MPa	σ_x = -114 MPa

Faculty of Maritime Engineering and Marine Sciences

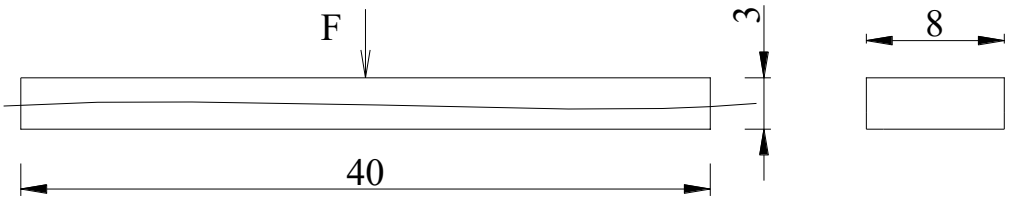
Ship's Structure

Exam #2 – Plate bending & Hull structure analysis **August, 26th, 2025**

Student: …… **ID:** …… **Completion time**: ……

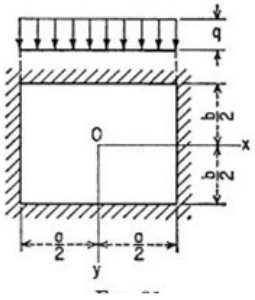
Part 2. Closed books

1.- Consider a steel box barge with main dimensions: Length 40 m, Breadth: 8 m and Depth: 3.0 m, transporting cargo on its deck; the ship's hull is built with steel plates 8 mm in thickness in sides and deck and 9 in the bottom. Lightweight is 100 tons and assumed uniformly distributed over the whole length. To complete a quick analysis of the primary behavior of the hull structure, the cargo is represented as a concentrated force of 200 tons at midships. When ship navigates in Sagging condition, calculate the safety factor for maximum normal stress, applying for the wave height the common empirical formulation $1.1\sqrt{L}$ in English system of units. (30).



2.- The deck structure of a fishing vessel (L: 58 m, B: 12 m, D: 6 m) with transverse framing system is to be analyzed. The ship has two longitudinal bulkheads forming a central passage 2.5 m wide, and the transverse bulkheads are separated 4.8 m. There is one longitudinal girder on each side of the deck, and transverse deck frames are separated by 60 cm. Deck plating is 7 mm thick. Loading on the deck has been estimated as 17 kN/m^2 uniformly distributed on the surface. Prepare a sketch of the deck structure and check if the deck thickness is adequate for an allowable stress of 120 MPa. Finally, select adequate dimensions for the girders considering that their stiffness is much larger than those of the transverse deck stiffeners and the allowable stress is 160 MPa. You may assume that deck plate effectiveness is 60%. (30)

TABLE 35. DEFLECTIONS AND BENDING MOMENTS IN A UNIFORMLY LOADED RECTANGULAR PLATE WITH BUILT-IN EDGES (FIG. 91)
$\nu = 0.3$



b/a	$(w)_{x=0,y=0}$	$(M_x)_{x=a/2,y=0}$	$(M_y)_{x=0,y=b/2}$	$(M_x)_{x=0,y=0}$	$(M_y)_{x=0,y=0}$
1.0	$0.00126qa^4/D$	$-0.0513qa^2$	$-0.0513qa^2$	$0.0231qa^2$	$0.0231qa^2$
1.1	$0.00150qa^4/D$	$-0.0581qa^2$	$-0.0538qa^2$	$0.0264qa^2$	$0.0231qa^2$
1.2	$0.00172qa^4/D$	$-0.0639qa^2$	$-0.0554qa^2$	$0.0299qa^2$	$0.0228qa^2$
1.3	$0.00191qa^4/D$	$-0.0687qa^2$	$-0.0563qa^2$	$0.0327qa^2$	$0.0222qa^2$
1.4	$0.00207qa^4/D$	$-0.0726qa^2$	$-0.0568qa^2$	$0.0349qa^2$	$0.0212qa^2$
1.5	$0.00220qa^4/D$	$-0.0757qa^2$	$-0.0570qa^2$	$0.0368qa^2$	$0.0203qa^2$
1.6	$0.00230qa^4/D$	$-0.0780qa^2$	$-0.0571qa^2$	$0.0381qa^2$	$0.0193qa^2$
1.7	$0.00238qa^4/D$	$-0.0799qa^2$	$-0.0571qa^2$	$0.0392qa^2$	$0.0182qa^2$
1.8	$0.00245qa^4/D$	$-0.0812qa^2$	$-0.0571qa^2$	$0.0401qa^2$	$0.0174qa^2$
1.9	$0.00249qa^4/D$	$-0.0822qa^2$	$-0.0571qa^2$	$0.0407qa^2$	$0.0165qa^2$
2.0	$0.00254qa^4/D$	$-0.0829qa^2$	$-0.0571qa^2$	$0.0412qa^2$	$0.0158qa^2$
∞	$0.00260qa^4/D$	$-0.0833qa^2$	$-0.0571qa^2$	$0.0417qa^2$	$0.0125qa^2$

Von Mises equivalent stress: $\sigma_{eq} = \sqrt{\sigma_x{}^2 + \sigma_y{}^2 - \sigma_x\sigma_y + 3\tau_{xy}{}^2}$

jrml/2025