Faculty of Maritime Engineering and Marine Sciences

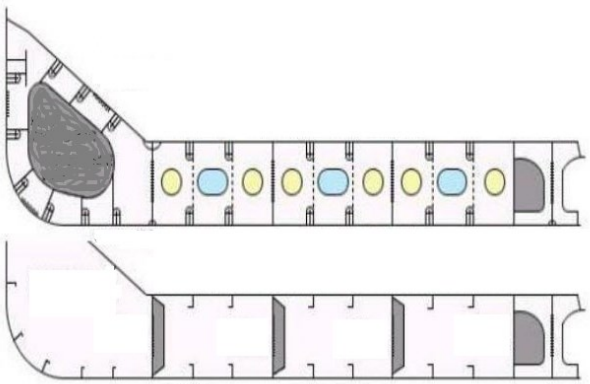
Ship's Structure

Quiz 4 – Ship hull stress analysis **August 31st, 2021**

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

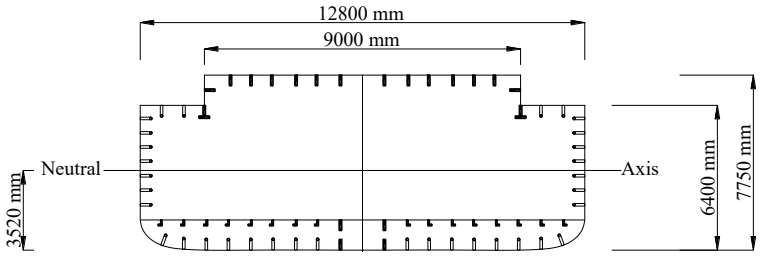
Part 1. Closed books

1. In the attached figure, a midship section of a ore-carrier ship with longitudinal framing system is presented. Main dimensions are: L: 108 m, B: 21.0 m, D; 10.80 m, T_{loaded}: 9.2 m, and height of double bottom is 1.20 m. Spacings are: between transverse bulkheads, 12.0 m, between longitudinal stiffeners, 0.77 m and between bottom floors, 2.40 m. A side girder forms the limit of a ballast tank in the double bottom of the ship. What is the plate aspect ratio that you would use to analyze the bending of a side girder? (10)



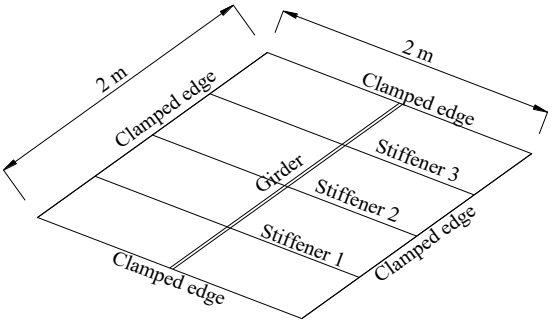
2.50 : 1	2.08 : 1	2.0 : 1	3.12 : 1

2. A tanker ship with dimensions: L: 78.76 m, B: 12.80 m, D: 6.40 m, T: 5.66 m, has a longitudinal framing system with double bottom. According to RINA, an IACS ship classification society, the allowable normal stress for the standard steel in a primary analysis is 17.5 kN/cm^2. If according to those rules, the maximum bending moment in hogging condition is 72441 kN-m, what is the maximum bending moment that can be developed in still water? (15)



168 MN-m	208000 kN-m	187368 kN-m	224 MN-m

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 ratio between inertia of girder and stiffeners is 5:1. Pressure on the panel is uniform and has a value of 20 kN/m^2. If the reaction on the first stiffener is 5864.7 N, what is the contact force between this stiffener and the girder? (10)



8271 N	10 kN	5.25 kN	9.33 kN

4. For the analysis of a reinforced plate panel of problem 3 of this exam, the redistribution of bending moment because of the rotation of the stiffeners is considered. Using Timoshenko's solution for a steel clamped rectangular plate under uniform load the required thickness of a plate is to be calculated. Uniform pressure on the panel is 30 kN/m^2, and stiffener and girder inertias are 70 and 350 cm^4, respectively. Apply a 1.5 mm for corrosion allowance. (15)

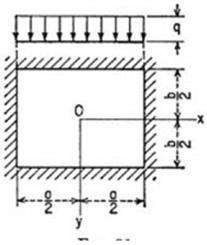


TABLE 35. DEFLECTIONS AND BENDING MOMENTS IN A UNIFORMLY LOADED RECTANGULAR PLATE WITH BUILT-IN EDGES (FIG. 91)
$\nu = 0.3$

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	$0.00254qa^4/D$	$-0.0829qa^2$	$-0.0571qa^2$	$0.0412qa^2$	$0.0158qa^2$
∞	$0.00260qa^4/D$	$-0.0833qa^2$	$-0.0571qa^2$	$0.0417qa^2$	$0.0125qa^2$

6.23 mm	7.00 mm	7.85 mm	5.43 mm

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Part 2. Closed books

Useful relations

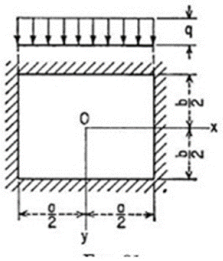
Shear stress in bending:

$$\tau_{xy} = \frac{V(x)\, Q(y,z)}{I_c\, b}$$

Normal stress in plate bending:

$$\sigma_x = \frac{12\, M_x}{t^2}$$

Bending moment in rectangular plate under uniform load:



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Equivalent von Misses stress:

$$\sigma_{eq} = \sqrt{\sigma_x^{\,2} + \sigma_y^{\,2} - \sigma_x \sigma_y + 3\tau^2}\ .$$

I declare that during this exam I have fulfilled the Code of Ethics of our university.

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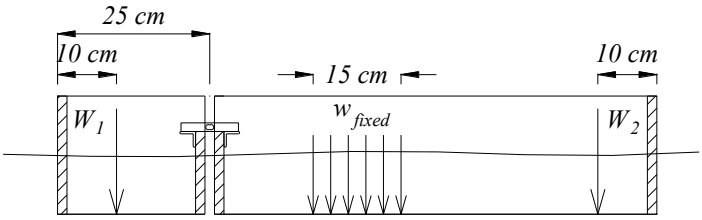
1. In SiMar laboratory a simplified hull bending test is completed. A PVC plastic tube is employed (*L*: 100 cm, *diameter*: 20 cm, *thickness*: 0.4 cm, and specific weight of PVC is 14210 N/m^3). In the central part of the model a distributed weight w_{fixed} of 5.27 N/cm is placed, and two concentrated forces each one of 19.6 N are placed at 10 cm from each end.



Calculate the shear force at the point where the load cell is located (25 cm from left end). (25)

2. A stiffened panel built with standard steel, with external dimensions 2x2.5 m, has four stiffeners in the vertical direction. The steel plate is 6 mm in thickness, the stiffeners are 100x5 mm flat bars and following DNV recommendation the plate as 100% effective. The load is uniformly distributed of 24000 kN/m^2, acting on the whole panel. Determine the Safety factor of the panel, applying the Maximum Distortion energy theory, considering all edges of the reinforced panel as simply supported. (25)