National Exams December 2012

98-Nav-A4, Ship Structure and Strength of Ships

3 hours duration

Notes

1) Attempt all questions. The exam is marked out of 100, with marks indicated [n] per question.

2) The exam is closed book. No notes or written material of any form is permitted. Casio or Sharp calculator models are allowed. Simple drawing equipment, such as a ruler or straightedge, pencil or pen, eraser are permitted.

3) Even in the case of numerical problems, written explanations of the solution are necessary, and should be neat, legible, clear and concise. Sketches, neatly labeled, should be used as appropriate to illustrate the method of solution. If there is any uncertainty, the candidate should explain the assumptions used in preparing the answer. The clarity of the answer will influence the grade.

Q1. General Aspects of Ship Structures

1 a) [6] Describe the general steps involved in ship design and discuss where structural design fits into the overall design process.

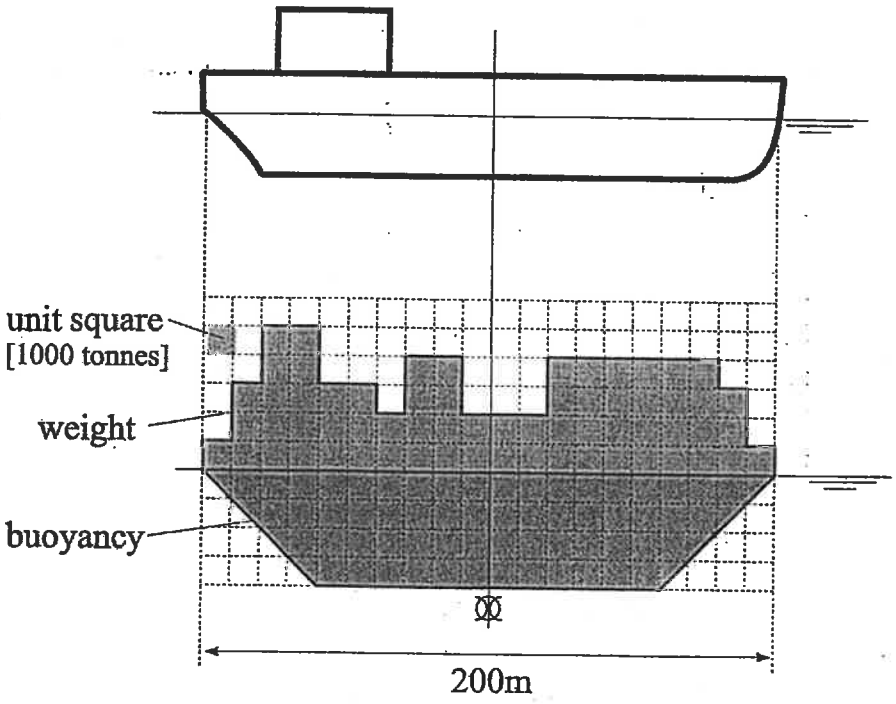
1 b) [6] Sketch a cross section of a commercial steel ship, of a type of your choosing, and label the structural components/items drawn. State what type of ship you have drawn. There is no need to label more than 30 items.

1 c) [6] Give one example each of primary, secondary and tertiary structure in a ship.

Q2. Loads

2 a) [10] The following diagram shows a simplified version of the still water weight and buoyancy curves for a 200m vessel. The total weight is 64000 tonnes. Each unit square in each of the weight and buoyancy diagrams represents 1000 tonnes (there are 64 squares in each plot). The area of both the weight and buoyancy are the same, and their centroids are at midships.

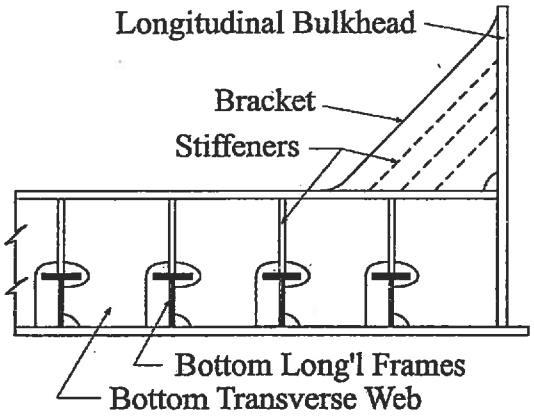
Based on this data, plot the bending moment and shear force diagrams for the ship, (from the stern to midships only). What is moment at midships?



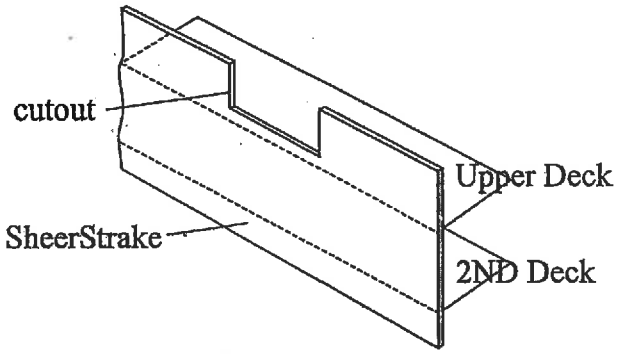
2 b) [8] Describe and illustrate with sketches, how you would calculate the bending moment caused by an L/20 wave, assuming that you had the hull lines, and bonjean curves for every station.

Q3. Structural Details

3 a) [8] The figure below shows bottom structural details. Indicate the role of all structural members. Indicate which members may fail by instability (buckling) mechanisms.



3 b) [6] The figure below shows side shell at the deck edge. Indicate where and why fatigue cracks are likely to form.



3 c) [6] Explain how a riveted crack arrestor seam works.

3 d) [5] What is a doubler plate?.

Q4 Materials

4 a) [6] Discuss the meaning and significance of the "grade" of steel? For instance, how do grades of steel differ? Why are different grades selected?

4 b) [5] Describe some ways of joining a steel hull and Aluminum superstructure. What types of problems are encountered in such a situation?

Q5 Structural behaviour

5 a) [6] For the half section of a simple steel hull shown below, find the moment of inertia and section modulus and location of the neutral axis.

5b) [12] For this type of cross section, show how to derive the shear flow formula:

$$q = \tau \cdot t = \frac{Q \cdot m(s)}{I}$$

where:

q : shear flow
τ : shear stress
t : shell thickness
Q: shear force
I : section modulus
m(s): 1st moment of area up to the point, about the neutral axis

$$m(s) = \int_0^s t\, z\, ds$$

5c) [10] Assuming a nominal yield strength of 250 MPa, what would be the shear force capacity (in MN) of the section shown? (you will need to estimate the max. allowable shear stress)