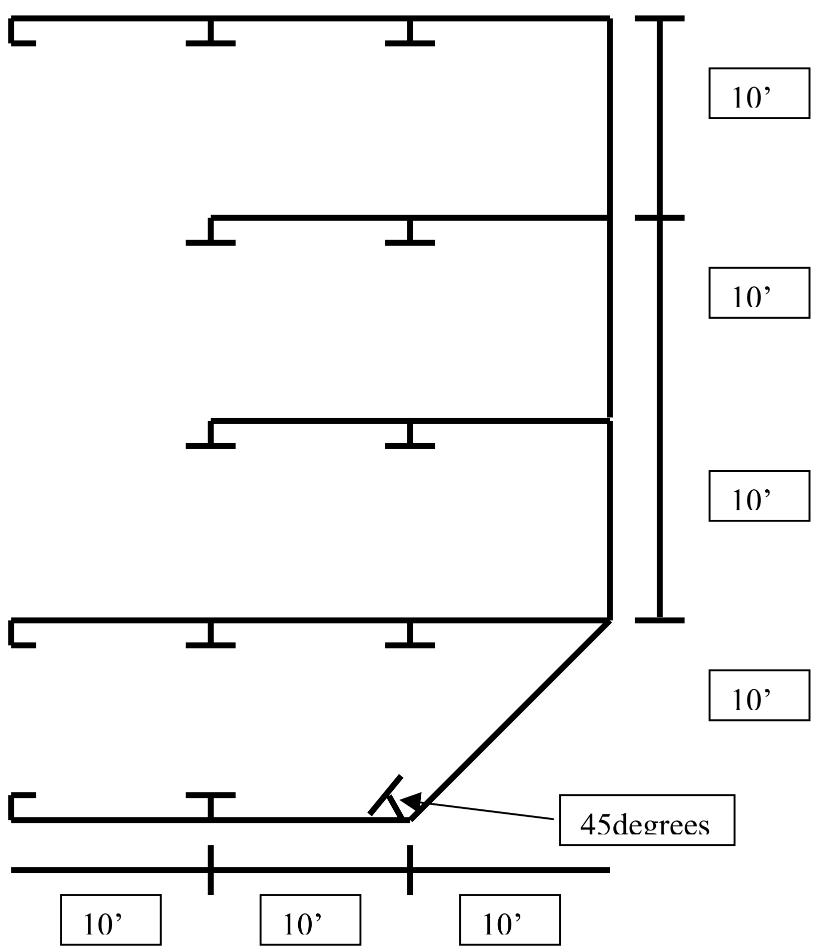
13.122 Ship Structural Design and Analysis

Problem Set 3-2003

Part A:

1. Shames (13.10 Text) Problem 11.10.
2. Shames (13.10 Text) Problem 11.53.

Part B: Shear Flow for a Lateral Load along the Y axis.



a) Calculate the shear flow around the half-breadth midship section shown above using the shear force for the midship section calculated in PS2. **DO NOT ignore the effects of the stiffeners and girders**. Given the yield stresses for medium or ordinary strength steel, determine whether or not the deck members fail due to shear stress. If a deck member does fail, determine what thickness is necessary to prevent failure. $I_{yy} = 7670$ ft^4. Hint: Rather than treating each stiffener and girder as an open section, "lump" the stiffener and girder areas. See PNA Vol. 1, Ch. IV, Section 3 for details.

Part C:

In the lecture on bending without twist, we derived the location of shear center:

$$y_D := \frac{I_{zy} \cdot \int Q_z \cdot h_c \, ds + I_z \cdot \int Q_y \cdot h_c \, ds}{\left(-I_{zy}^2 + I_y \cdot I_z\right)} \qquad z_D := \frac{-I_y \cdot \int Q_z \cdot h_c \, ds + I_{zy} \cdot \int Q_y \cdot h_c \, ds}{\left(-I_{zy}^2 + I_y \cdot I_z\right)}$$

in the lecture on pure twist, we derived the location of the center of twist:

$$y_D := \frac{\left(I_{y\omega c} \cdot I_z - I_{yz} \cdot I_{z\omega c}\right)}{\left(I_y \cdot I_z - I_{yz}^2\right)} \qquad z_D := \frac{\left(-I_{z\omega c} \cdot I_y + I_{yz} \cdot I_{y\omega c}\right)}{\left(I_y \cdot I_z - I_{yz}^2\right)}$$

Show that these are identical.

Hint: integration by parts can be applied to the second moments of inertia, establishing equivalence with an integral of the first moment of area; e.g.

$$I_z = \int_0^b y \cdot y \, dA = -\int_0^b Q_z \, dy$$