13.022

SURFACE WAVES AND THEIR INTERACTION WITH FLOATING BODIES

Quiz 3
Monday, December 11, 2000
1:30 Hours - Open Book

1. (35%) You are conducting a seakeeping experiment in a towing tank on a ship model of length L_M advancing with constant velocity in head regular waves of amplitude A_M and wavelength λ_M. The Ship/Model length ratio is r=50.

   a) What full scale conditions is your seakeeping experiment relevant for? Namely, what are the ship scale values for L_S, U_S, A_S and λ_S?

   b) During the above experiment you measured the amplitude of the vertical velocity and acceleration at the bow of the model and you found them to be equal to V_M and W_M, respectively. What are the corresponding values at the bow of the ship?

   c) Next you conducted a head seas experiment in the towing tank with the model advancing with velocity U_M in a wave spectrum defined by the spectral density function $S_M(\omega_0)$, defined relative to the wave maker. What is the definition of the corresponding spectral density function at the ship scale?

   d) The RMS values of the vertical velocity and acceleration measured at the bow have been found to be v_M and w_M. What are the corresponding RMS values for the ship?

2. (35%) During the sea trials of a high-speed vessel you have been tasked to measure the seakeeping performance of the vessel by installing two accelerometers one at the bow, x=L/2 and one at midships x=0, where L is the ship length. The ship speed is known and equal to U.

   During a run of the vessel in head regular waves the bow instrument measured a vertical acceleration amplitude w_B and the midships instrument measured a vertical acceleration amplitude w_M. After some signal processing you determined that the period of both acceleration signals was the same and equal to T and their phase difference was φ.

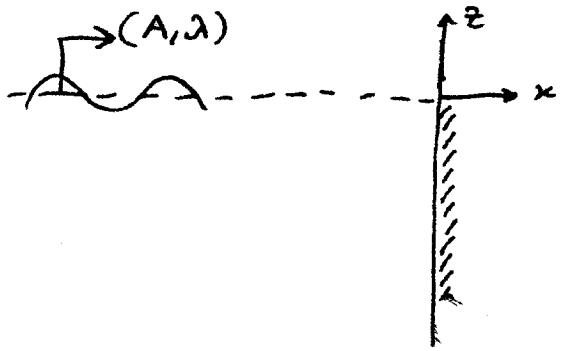
   a) Determine the length of the ambient waves during the experiment.

   b) Determine the amplitude of the heave and pitch motions of the vessel relative to a coordinate system with its origin at midships.

   c) Determine the point on the vessel where the vertical acceleration is zero.

   d) How does the location of the point in c) depend on the vessel speed U?

3. (30%) Plane progressive waves of length λ and amplitude A are incident upon a breakwater assumed of infinite depth.



a) Determine the mean horizontal drift force acting on the breakwater.

b) Determine the center of effort of the force in b).

c) Consider the breakwater shown in the figure below, with its top being submerged under the free surface at a draft H. Regular waves of amplitude A and length λ are incident upon it. Laboratory experiments have determined that the amplitude of the transmitted waves is reduced by a factor of 4. Determine the horizontal drift force acting on the breakwater.