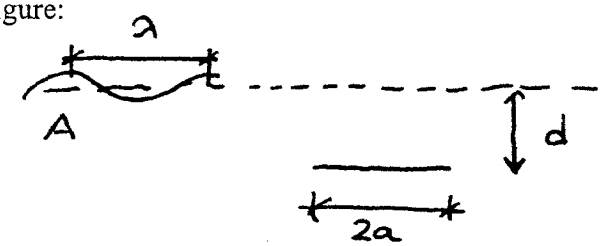
13.022

SURFACE WAVES AND THEIR INTERACTION WITH FLOATING BODIES

Quiz 2
Wednesday, November 8, 2000
1:30 Hours - Open Book

1. (35%) A two dimensional flat plate of width 2a is kept fixed at a distance d below an ambient regular plane progressive wave of amplitude A and wavelength λ, as shown in the figure:

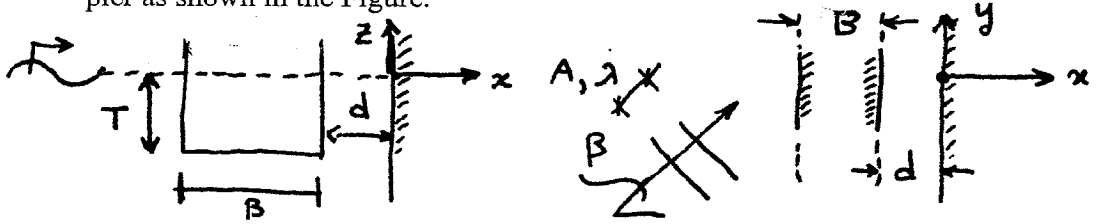


a) Assuming that $\lambda >> 2a$, estimate the surge and heave exciting force on the plate, assuming potential flow.

b) Use your result in a) to estimate the surge and heave damping coefficients.

c) Assuming that $\lambda >> 2a$, estimate the roll exciting moment on the plate, using the result that in an infinite fluid the plate roll added mass is equal to $\pi\rho a^4/8$.

2. (30%) A ship with a long uniform rectangular midship section is moored next to a pier as shown in the Figure.



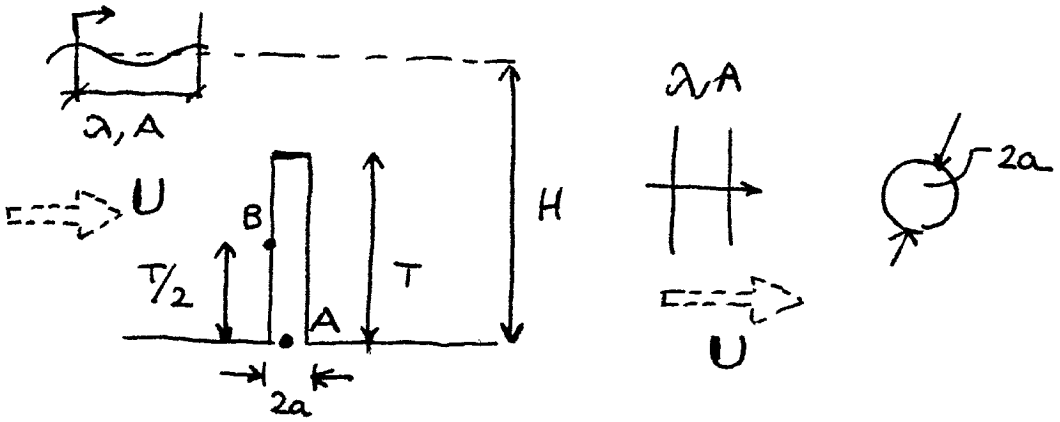
Plane progressive waves of amplitude A and wavelength λ are incident upon the ship at an angle β.

a) Derive the surge and heave Froude-Krylov exciting force for beam waves β=90 deg.

b) Use your results in a) to estimate the frequencies where the heave damping coefficient is zero.

c) Repeat question a) for an arbitrary angle of incidence β.

3. (35%) An underwater offshore storage tank shaped like a vertical circular cylinder with radius a and height T is sitting on the ocean floor with depth H, as shown in the figure. Plane progressive waves of amplitude A and wavelength λ are incident upon the cylinder.



a) Derive an expression for the overturning pitch moment amplitude and phase exerted by the ambient waves upon the storage tank. Derive the moment about an origin located at point A.

b) In order to carry out the tank structural design we need estimates of the linear hydrodynamic pressure over its surface. Derive an expression of the total linear pressure amplitude and phase at the point B located on the weather side of the tank.

c) How do your answers in a) and b) change when a uniform current with velocity U flows in the same direction as the incident wave?.