

## 13.022

### SURFACE WAVES AND THEIR INTERACTION WITH FLOATING BODIES

#### Problem Set # 7

Due Friday, December 3rd, 1999

1. A tension-leg platform (TLP) consists of four legs of radius  $a$  centered on the corners of a square with sides of length  $d$ . Plane progressive waves of length  $\lambda$  and heading  $\beta$  are incident upon the TLP.
  - a) Assuming that there exists no hydrodynamic interaction between the legs, derive an expression of the yaw exciting moment acting on the TLP about the center of the square defined by the centers of the four legs.
  - b) Approximate the yaw exciting moment in the case when the wavelength is large compared to the leg diameter.
  - c) Derive expressions for values of the wave heading for which the yaw exciting moment vanishes.
  
2. Anti-rolling tanks is a popular device for the reduction of the rolling motion of ships. The purpose of this problem is to derive the underlying physics and design the optimum anti-rolling tank for maximum reduction of the rolling motion of a two dimensional section in beam waves.
  - a) Consider the U-shaped tank shown in Figure 1. Denoting by  $d$  the tank width and by  $L$  its length, derive an equation of motion of the enclosed column of water and determine its natural frequency. Assume that the tank is slender, or that its width  $d$  is small compared to its length  $L$ .
  - b) Consider the anti-rolling tank of the previous question to be fitted inside a ship section as shown in Figure 2. Denoting by  $\xi_4(t)$  the roll displacement and by  $\zeta(t)$  the elevation differential of the water column inside the tank, derive the coupled set of FREE (un-excited) differential equations governing  $\xi_4(t)$  and  $\zeta(t)$ .
  - c) Determine the optimal width of the anti-rolling tank for the maximum possible reduction of the section rolling motion at resonance.