# 13.022

## SURFACE WAVES AND THEIR INTERACTION WITH FLOATING BODIES

**Quiz 1**
**Wednesday, October 4, 2000**
**1:30 Hours - Open Book**

1. (40%) A pressure gauge is placed on the bottom of a channel of uniform depth H, in lieu of a "police radar", in order to detect the speed of ships cruising on the surface. Assume for the purpose of this problem that the flow is two-dimensional.

   When a ship passes over, the instrument detects a pressure signal which has the shape shown in the figure.
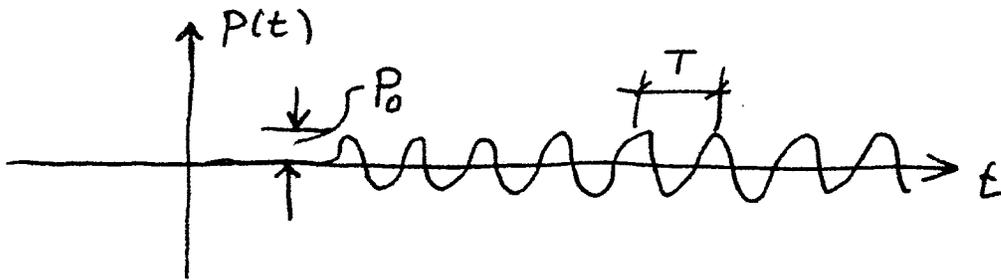


   a) Derive a relation between the ship speed U and the period T of the pressure signal.

   b) The amplitude of the pressure signal effectively disappears when the period T drops below a critical period $T^*$. Derive a relation between $T^*$ and the water depth H.

   c) Derive a new value for T when a current with velocity u flows against the ship?

2. (60%) A positively buoyant sphere is attached to the bottom of a wave tank with a wavemaker on one end and a vertical wall on the other. The sphere is submerged 3m below the free surface. At time t=0, the wavemaker starts a small amplitude time-harmonic oscillation at a constant frequency.

The record of the sphere motion over the first 30 seconds, indicates a substantial horizontal oscillation for 10<t<20 seconds and no motion for the rest of the time. Assuming that the horizontal displacement of the sphere is proportional to the horizontal acceleration of the fluid particles, determine:

a) The length of the tank
b) The distance of the sphere from the wavemaker
c) The length of the waves generated by the wavemaker