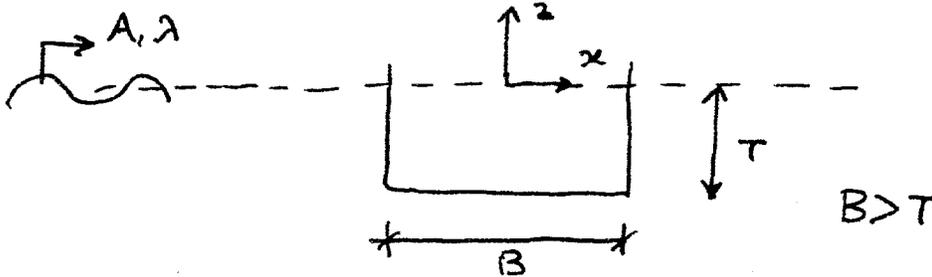# 13.022

SURFACE WAVES AND THEIR INTERACTION
WITH FLOATING BODIES

Quiz 2
**Wednesday, November 10, 1999**
1:30 Hours - Open Book

1. (35%) The midship section of a ship has the rectangular shape shown in the figure.

Ambient waves of amplitude A and length λ are incident on the section propagating in the positive x-direction.

a) Determine the surge and heave Froude-Krylov exciting forces. Obtain approximate values when $\lambda \gg B$.

b) Obtain estimates of the surge and heave diffraction exciting forces when $\lambda \gg B$.

c) What are the values of the heave and surge natural frequencies?

d) Estimate the section heave and surge responses at the heave natural frequencies. ⟨⟩ ⟨⟩ in your estimate.

2. (35%) An oceanographic buoy is tethered to the ocean floor with a cable of length L. Assume that the buoy is a circle with radius a and that its draft below the free surface is T.
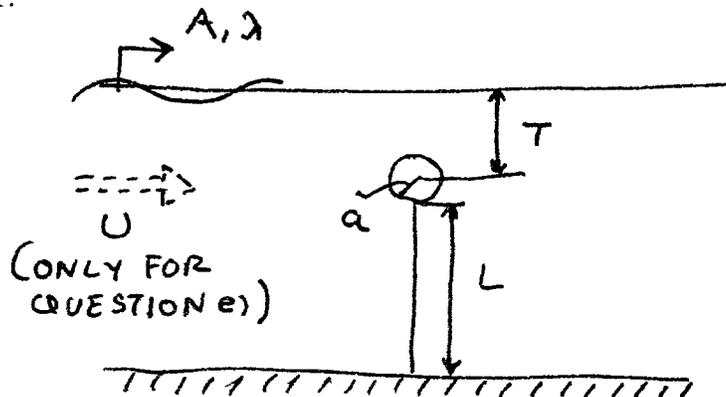
Waves of length λ and amplitude A are incident on the buoy as shown in the figure.

a) Determine the surge exciting force assuming that $\lambda \gg a$, the radius of the buoy.
b) Derive the linear surge equation of motion assuming that the fluid forces on the tether are small.
c) What is the surge natural frequency of the buoy?
d) Estimate the buoy response at resonance. What are various sources of damping. Comment on their relative magnitude.
e) A current with speed U is also incident on the buoy as shown in the figure. Comment on its impact on your answers in a)-d).

Assume water of infinite depth.

3. (30%) A ship is cruising at its service speed U in waves or frequency ω_0 and heading β. The ship heave natural frequency is known to be Ω, the pitch natural frequency is $3\Omega/4$ and the roll natural frequency is $\Omega/10$.

   Given the ship speed U, determine the pairs (ω_0, β) which excite resonance in heave, pitch and roll.