Faculty of Maritime Engineering and Marine Sciences

Ship Dynamics

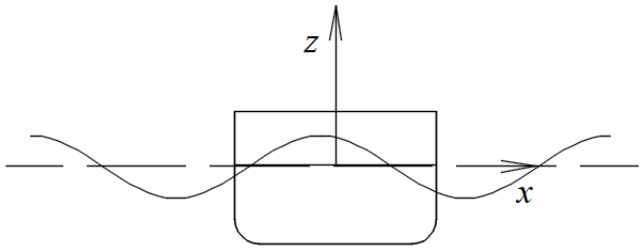
Exam 1 **June 29th, 2026**

Student: ..... Student ID: .....

Closed books

1.- Calculate the hydrodynamic force exerted by a wave train on the sides of a box-barge (*L*: 50 m, *B*: 10, *D*: 4 and *T*: 3 m), when they move perpendicular to the vessel longitudinal length in the +*x*-direction. Assume that the pressure may be estimated with the wave velocity potential. Characteristics of the regular waves are: 30 m long and 0.75 m in amplitude.

$$\phi = \frac{i\zeta_o g}{\omega} e^{kz} e^{i(\omega t - kx)}$$



where ζ_0 is the wave amplitude, k is wave number, ω is wave frequency and g is the acceleration of gravity.
(30)

2. A simplified ship has constant semicircular section; it floats with a draft equal to the radius and with no trim and is to be analyzed when she receives waves from the bow. Let's consider that the mass distribution is uniform. Length of the ship is 35 meters, beam is 6 meters, and the vessel operates in fresh water.

i. In a very simple way, let's assume that the added mass per unit length is equal to the dry mass per unit length, and calculate natural frequencies of oscillation in the vertical plane. (25)

ii. Calculate the Froude-Krylov component of the force exerted by the waves on the ship hull. (25)

$$F_3^{FK} = \left[\rho g \zeta_o \int_{-L/2}^{L/2} dx B(x) e^{-kT(x)} e^{ikx}\right] e^{i\omega t}$$

iii. If the ship advances with a 12-knot velocity and receives waves with length equal to twice the length of the ship, determine the total added mass and damping coefficient of the ship, A_{33} and B_{33}. To estimate the sectional properties, use: $a_{33} = C\frac{\rho\pi B_n^2}{8}$, $b_{33} = \frac{\rho g^2 \overline{A}^2}{\omega_e^3}$, and the attached figures. (20)

EXTRA CREDIT. Calculate the heave response of the ship to the incoming wave system.

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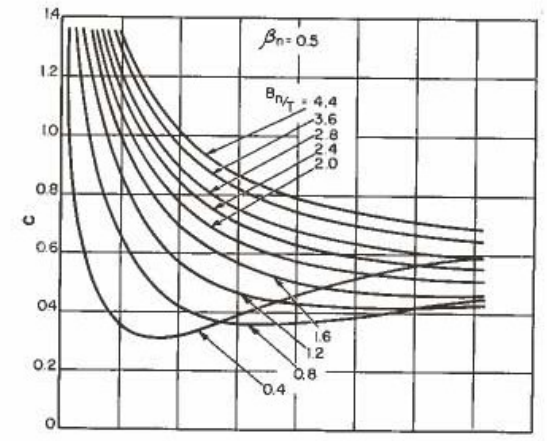

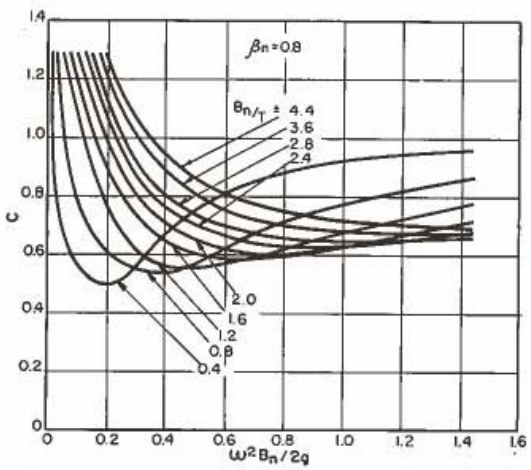

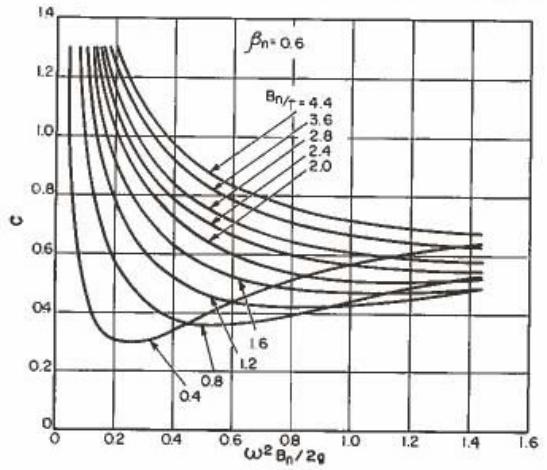

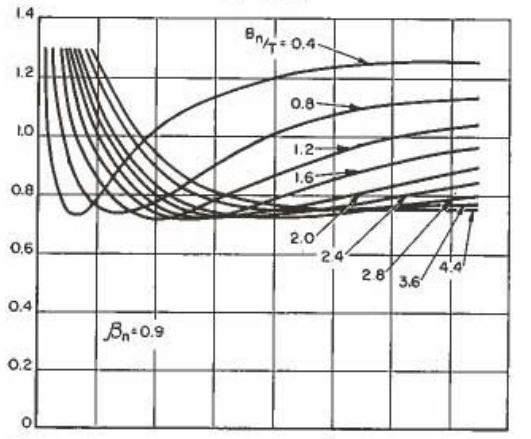

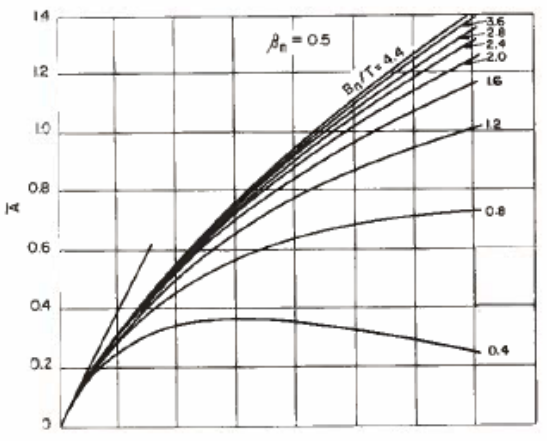

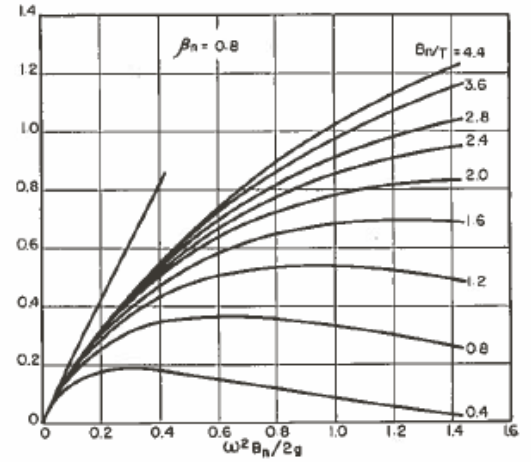

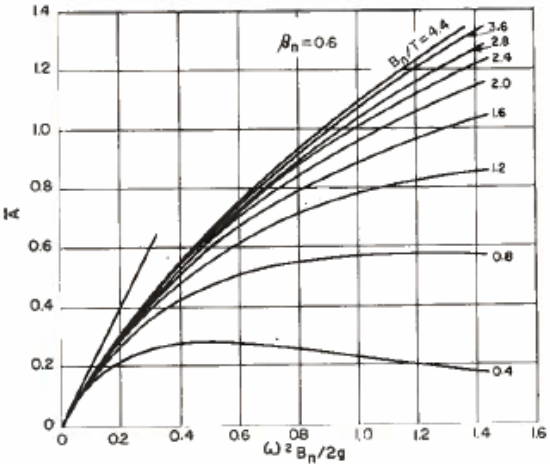

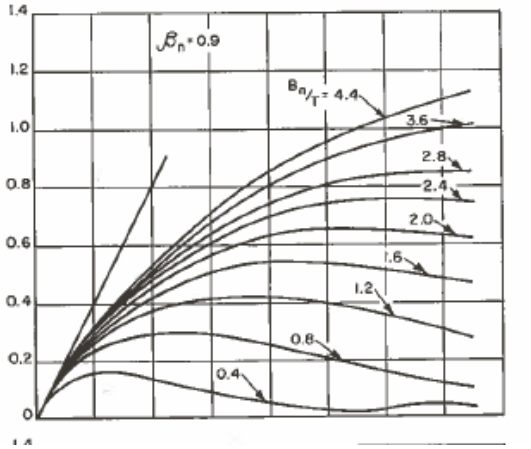

I certify that during this exam I have complied with the code of ethics of ESPOL:

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