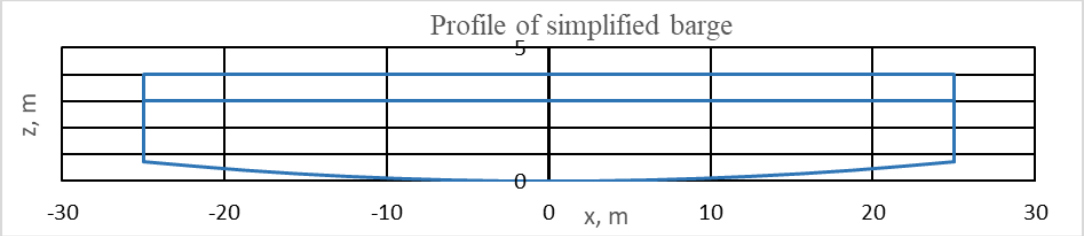
Faculty of Maritime Engineering and Marine Sciences

Ship Dynamics

Quiz 2 – Ship response in the vertical plane **July 17th, 2020**

Open books (you may use spreadsheets)

You are asked to analyze the response in regular waves, of a 50 m long barge with constant beam *B* of 10 m, vertical sides and quadratic profile ($z = 0.0012x^2$), as shown in the following figure. Depth and mean draft are 4 and 3 m, respectively, and advances with constant velocity of 12 knots in waves of 60 m in length coming from the bow.



Calculate the following coefficients of the motion equations in the vertical plane. For the numerical integrations use a $\Delta x = L/4$. (50)

i.- Virtual mass, in Mkg

ii.- A_{35}

iii.- A_{53}

iv.- B_{55}

v.- B_{35}

vi.- Virtual radius of gyration as a percentage of *L* (see the system of motion equations).

Considering that the regular waves have amplitude of 0.75m, calculate (50):

vii.- $\bar{F}_5^{FK}$ (only the Froude-Krylov component),

viii.- Considering only the Froude-Krylov component, the amplitude and phase of the heave motion. Use the following system of equations, where some of the values are already calculated.

$$\begin{bmatrix} (M + A_{33}) & A_{35} \\ A_{53} & 690 Mkg\, m^2 \end{bmatrix} \begin{Bmatrix} \ddot{\bar{\varsigma}}_3 \\ \ddot{\bar{\varsigma}}_5 \end{Bmatrix} + \begin{bmatrix} 730\, kNs/m & B_{35} \\ B_{53} & B_{55} \end{bmatrix} \begin{Bmatrix} \dot{\bar{\varsigma}}_3 \\ \dot{\bar{\varsigma}}_5 \end{Bmatrix} \begin{bmatrix} 5.02\, MN/m & C_{35} \\ C_{53} & 1050\, MNm \end{bmatrix} \begin{Bmatrix} \bar{\varsigma}_3 \\ \bar{\varsigma}_5 \end{Bmatrix} = \begin{Bmatrix} 684 + i2740, N \\ \bar{F}_5^{FK} \end{Bmatrix}$$

Notation: 1 Mkg=10^6 kg, 1 MN=10^6N, 1 kN=10^3N

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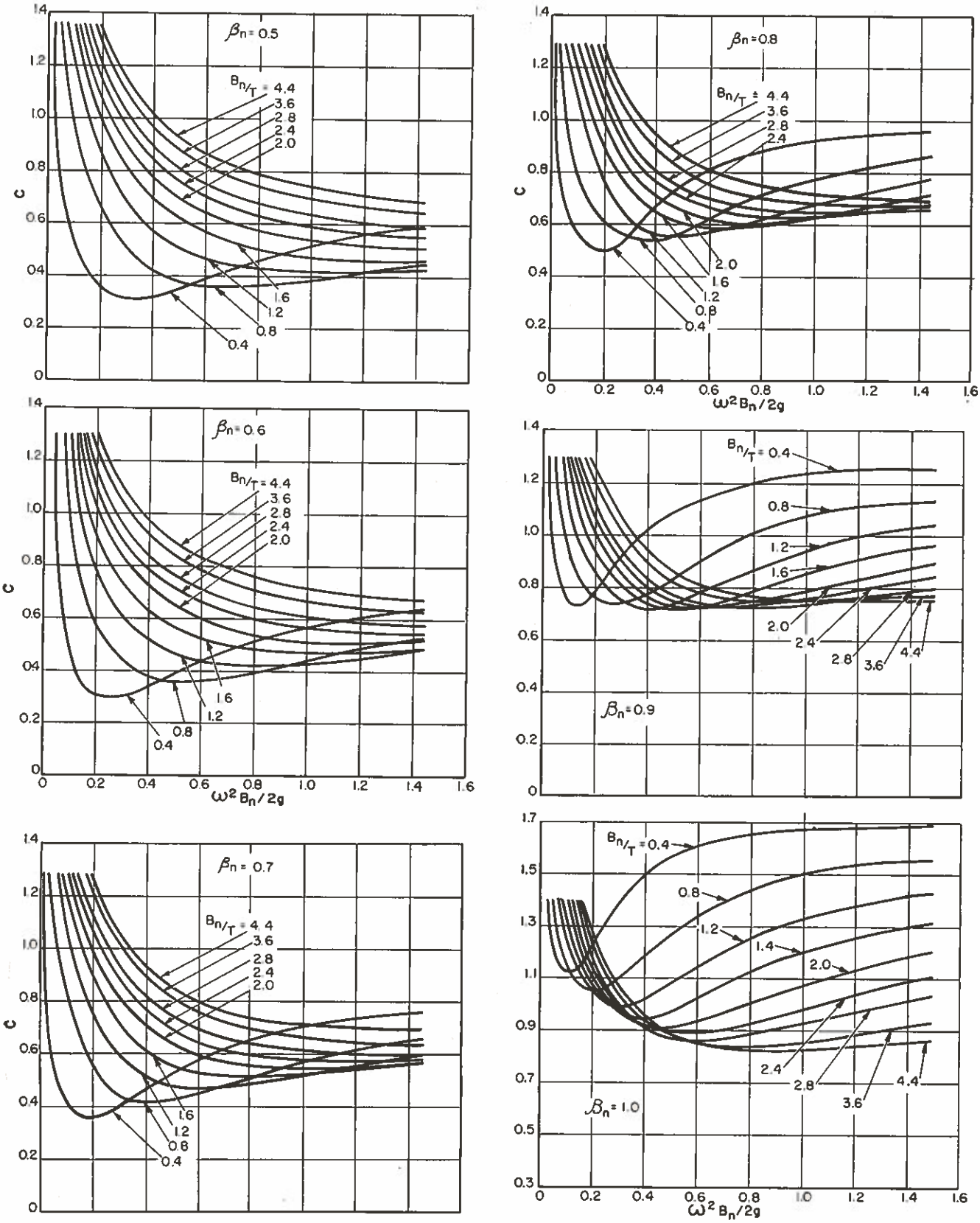

Fig. 37 Grim's (1959) computations of hydrodynamic mass coefficients C for two-dimensional floating bodies in heaving motion (Ref. [26])

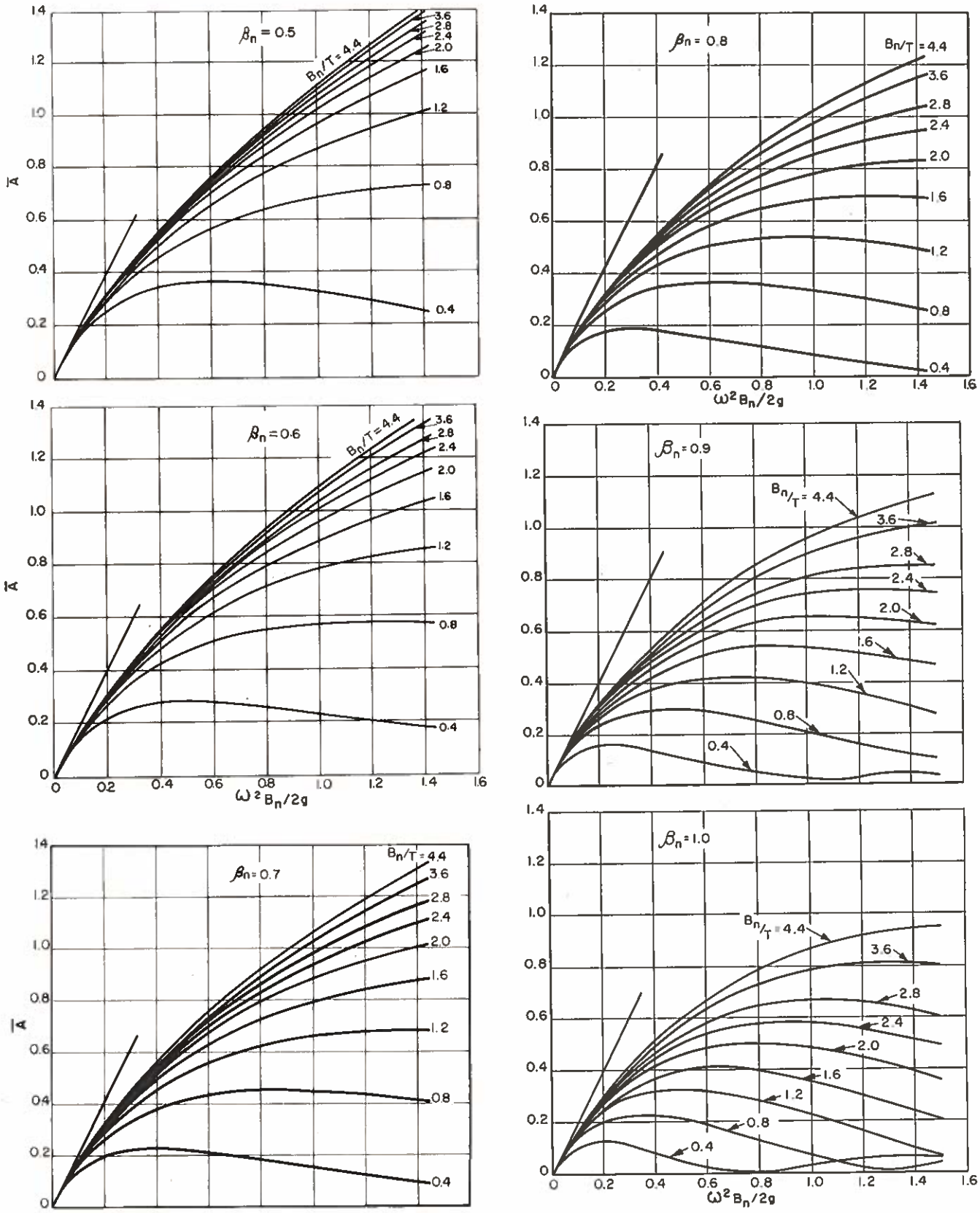

Fig. 40 Grim's (1959) computations of amplitude ratios $\bar{A}$ for two-dimensional floating bodies in heaving motion (Ref. [26])