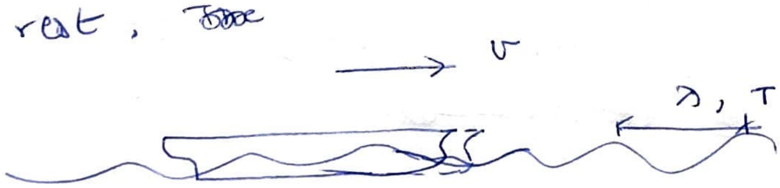
This type of relationship is ~~very~~ quite analogous to a single degree of freedom spring mass damper system. However, the difficulty here lies in the fact that a_{33}, b_{33} these are functions of frequency ω, and therefore ~~so~~ it is not straightforward to solve for ~~this~~ the motion response η_3 even for the case when the motion is presumed to be uncoupled.

All the other members of the other matrices depend ~~on~~ upon ~~body~~ geometry of the vessel, location of center of gravity, center of buoyancy and center of flotation.

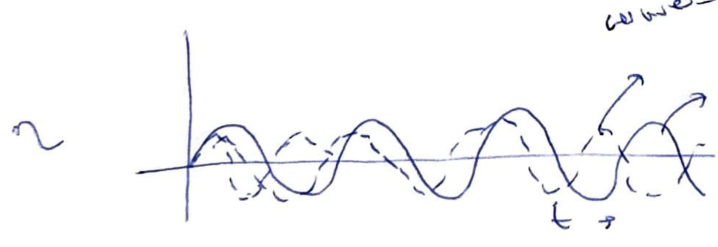
2

Wave encountering frequency for a ship with a forward speed

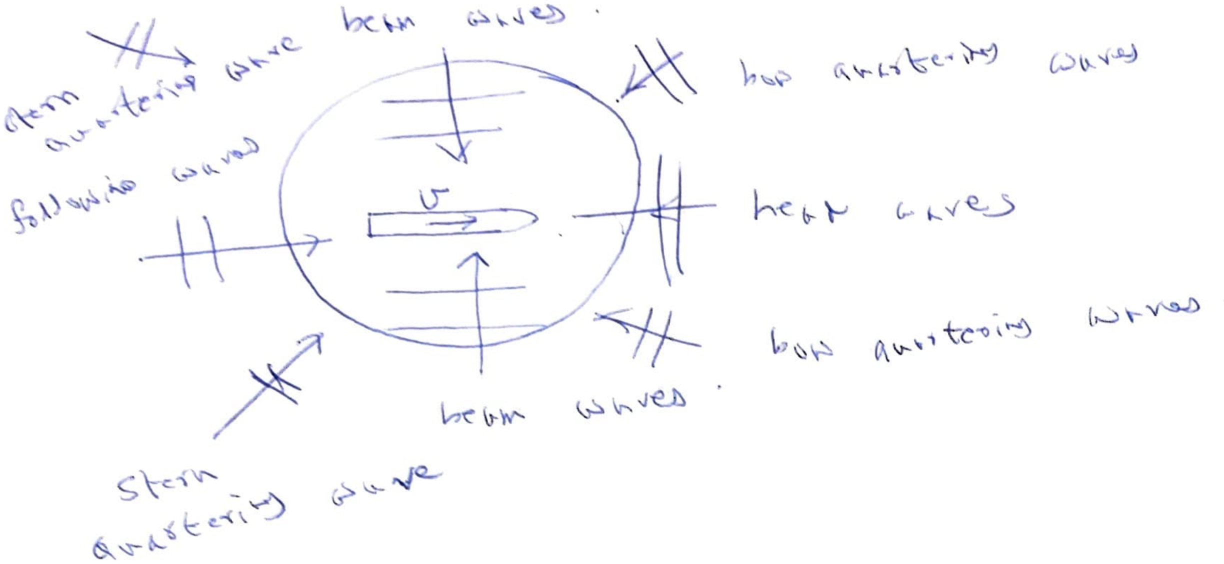
For a ship moving with a forward speed U, the frequency of the incident waves will be different from what the ship experiences when it is at ~~as~~ rest. ~~There~~

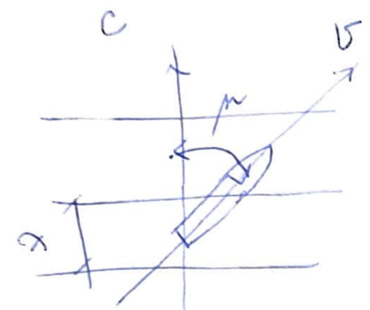


waves measured in a moving frame of reference.



wave measured in a static frame of reference





$$T_e = \frac{\lambda}{c - V\cos\mu}.$$

$$c = \frac{\lambda}{T} \quad \text{or,} \quad \lambda = c.T$$

$$\therefore T_e = \frac{c.T}{c - V\cos\mu} = \frac{T}{1 - \frac{V}{c}\cos\mu},$$

$$\omega_e = \frac{2\pi}{T_e} = \frac{2\pi}{T}\left(1 - \frac{V}{c}\cos\mu\right) = \omega\left(1 - \frac{V}{c}\cos\mu\right)$$

for deep water, $\omega^2 = gK$, $\therefore$ $\frac{\omega}{K} = \frac{g}{\omega} = c$

or, $\frac{1}{c} = \frac{\omega}{g}$

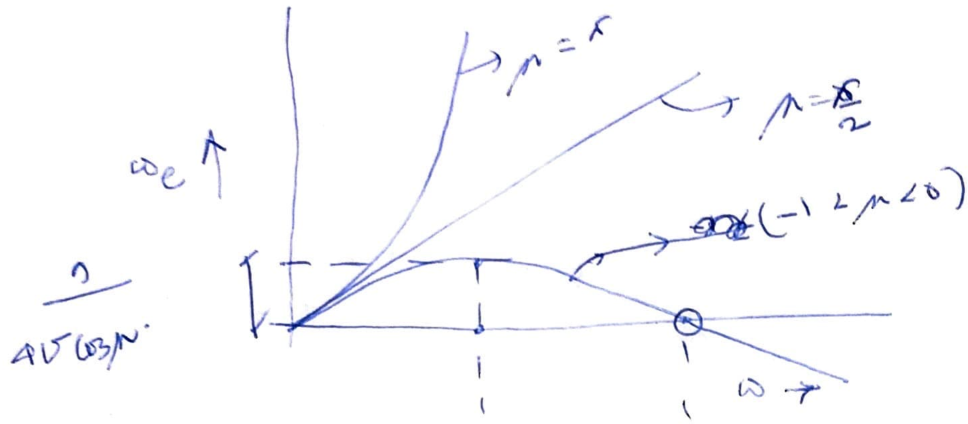
$$\therefore \omega_e = \omega\left(1 - \frac{\omega V}{g}\cos\mu\right) \quad \text{——— (1)}$$

Equation (1) is the expression for wave encountering ~~with a~~ frequency for a ship moving with a ~~velocity~~ velocity V with an angle μ with respect to the phase velocity of the incident regular wave.

now, let us examine the behaviour of wave encountering frequency in the range of μ as

$\frac{\pi}{2} \le \mu \le \pi$, where ~~μ = π refers~~.

μ = π refers to head waves.



ω_e max;

$$\omega = \frac{g}{2U\cos\mu}$$

$$\omega_e = 0 \rightarrow \omega = \frac{g}{U\cos\mu}$$

$\Delta S > \Delta\omega$,

since, $U > C$

if $\omega_e < 0$

if $1 - \frac{U}{C}\cos\mu < 0$

or, $U > C$ if $\mu = 0$.

as in the case with following sea.

In this case the waves will tend to move backward from the forwarding ship.

This leads to the impression that the wave encountering frequency is negative.

<u>Example</u>

A 5 m ship model makes an angle of 40° with the crest line. Bow of the ship meets successive crests at 15 s. The wave crests take 10 s to cover the length of the ship while ~~measuring~~ measured by the observer at the ship. What is the speed of the ship?

$\mu = 50°$

$\mu = 50° =$

$$10 = \frac{5\cos\mu}{c - v\cos\mu}$$

$$\therefore \quad c - v \times 0.64 = 3.1$$

$$15 = \quad T_e = \frac{\lambda}{c - v\cos\mu} = 15$$

$$\therefore \quad \lambda = 15 \times 3.1 = 46.5 \text{ m.}$$

$$\lambda = \frac{2\pi v^2}{g}$$

or, $$v = \left(\frac{g\lambda}{2\pi}\right)^{\frac{1}{2}}$$

$$= 6.82 \text{ m/s.}$$

$$\therefore \quad v = \frac{6.82 - 3.1}{0.64} = 4.57 \text{ m/s.}$$