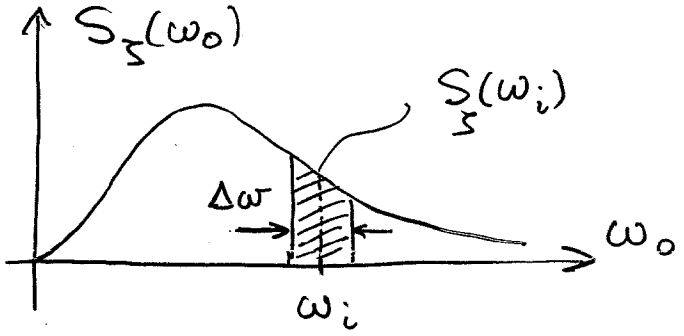
SEAKEEPING IN RANDOM WAVES

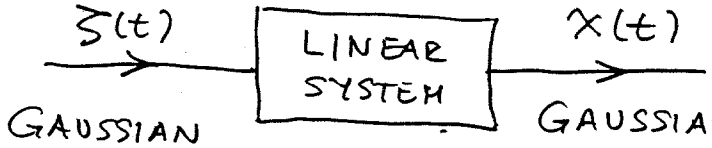
- ASSUME KNOWN THE AMBIENT WAVE SPECTRAL DENSITY $S_\zeta(\omega_0)$ ASSUMED UNIDIRECTIONAL FOR SIMPLICITY



- $\frac{1}{2} A_i^2 = S(\omega_i)\,\Delta\omega$

- $\int_0^\infty S_\zeta(\omega)\,d\omega = \sigma_\zeta^2 \equiv$ VARIANCE OF THE WAVE ELEVATION OF AMBIENT RANDOM SEASTATE, ASSUMED GAUSSIAN WITH ZERO MEAN

- ASSUMING THAT THE RAO(ω) OF A SEAKEEPING QUANTITY $x(t)$ HAS BEEN DETERMINED FROM A FREQUENCY DOMAIN ANALYSIS;



GAUSSIAN
$\bar{\zeta}=0,\ \sigma_\zeta^2$

GAUSSIAN
$\bar{x}=0,\ \sigma_x^2 = \int_0^\infty S_\zeta(\omega)\,|RAO|^2\,d\omega$

WIENER-KHINCHINE

SPECTRAL ANALYSIS WITH FORWARD-SPEED

$$\omega = \left| \omega_0 - U \frac{\omega_0^2}{g} \cos\beta \right|$$

- AMBIENT WAVE SPECTRAL DENSITY $S_\zeta(\omega_0)$ IS DEFINED RELATIVE TO THE ABSOLUTE WAVE FREQUENCY ω_0.
- THE $RAO_x(\omega)$ IS USUALLY DEFINED RELATIVE TO THE ENCOUNTER FREQUENCY ω.
- THE RELATION OF $\omega \leftrightarrow \omega_0$ IS NOT SINGLE VALUED. THE QUESTION THUS ARISES OF WHAT IS THE σ_x^2 VALUE?

ANSWER

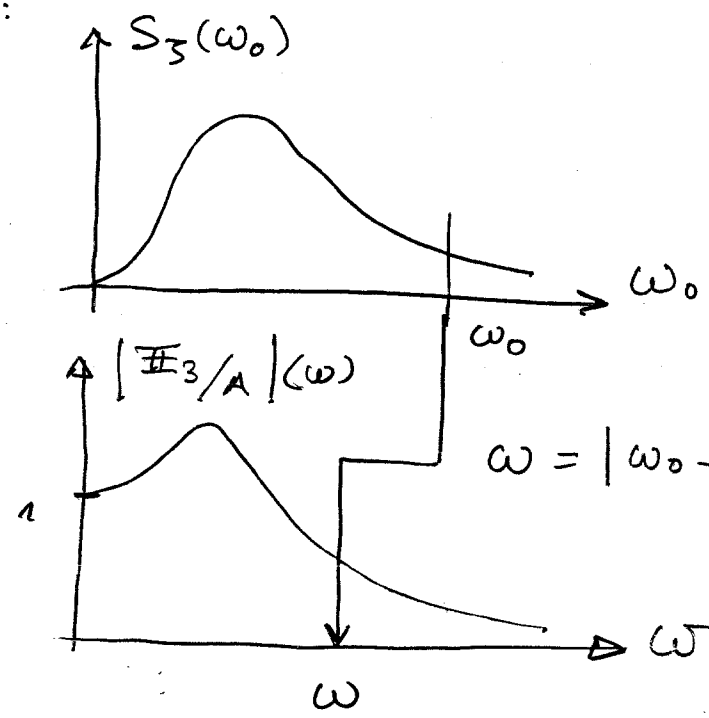
→ GIVEN ω_0, A SINGLE VALUE OF ω ALWAYS FOLLOWS

→ THE OPPOSITE IS NOT ALWAYS TRUE. GIVEN ω THERE MAY EXIST MULTIPLE ω_0's SATISFYING THE ENCOUNTER FREQUENCY RELATION.

→ THEREFORE IT IS MUCH SIMPLER TO PARAMETRIZE WITH RESPECT TO ω_0, EVEN WHEN THE $RAO(\omega)$ IS EVALUATED AS A FUNCTION OF ω.

PROCEED AS FOLLOWS:

INTRODUCE:



CONSIDER THE HEAVE MOTION OF A SHIP WITH FORWARD SPEED

$$\omega = \left| \omega_0 - U\frac{\omega_0^2}{g}\cos\beta \right|$$

SIMPLY REDEFINE THE RAO (ω) AS FOLLOWS

$$|RAO_3|(\omega) = |RAO_3|\left(\omega_0 - U\frac{\omega_0^2}{g}\cos\beta\right)$$

$$\equiv |RAO_3|^*(\omega_0)$$, NEW FUNCTION OF ω_0 BY VIRTUE OF THE $\omega \leftrightarrow \omega_0$ RELATION

THE STANDARD DEVIATION OF HEAVE FOLLOWS BY SIMPLE INTEGRATION OVER ω_0:

$$\sigma_3^2 = \int_0^\infty d\omega_0\, S_3(\omega_0)\, |RAO_3^*(\omega_0)|^2 .$$

- THE OPPOSITE CHOICE OF PARAMETRIZING THE ABOVE INTEGRAL WRT ω ENDS UP WITH A LOT OF UNNECESSARY ALGEBRA.