MEC-E1030 - Random Loads and Processes L

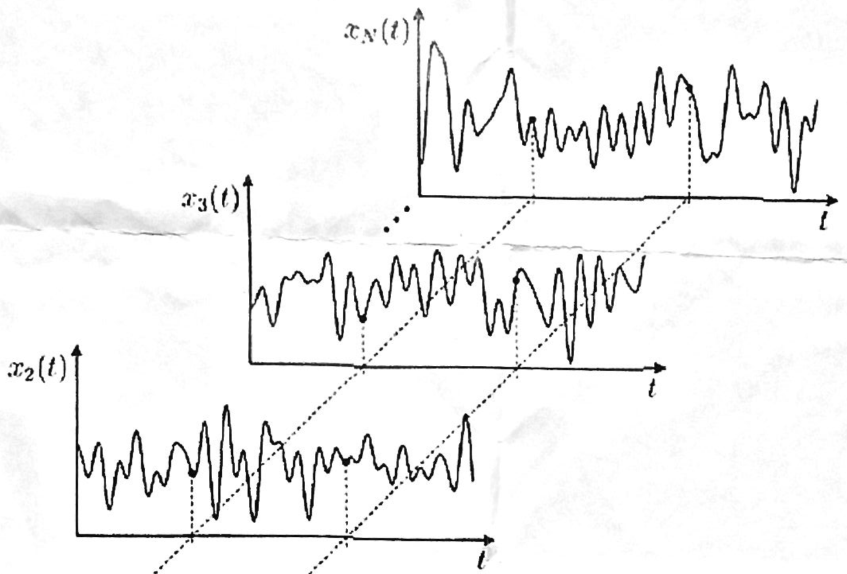
Exam, 24.10.2017, Otakaari 3, 213, 09:00-12:00 Jani Romanoff

Question 1. Deterministic vs. Stochastic Loads

A. Explain the difference between deterministic and stochastic loads. Explain the transition between these when time spans are considered. **2p**
B. What is needed to define the response of random load and the probability of exceeding certain reference value (e.g. stress)? **2p**
C. How are the continuous probability distributions connected (e.g. Weibull, Rayleigh, Gaussian)? **2p**

Question 2. Mathematics of Random Process

A. What does stationary, ergodic process mean? Use attached figure to explain this. **2p**



B. What measures you could use to make broad-banded process to narrow-banded and Gaussian? What mathematical criteria you would use to assess the success? **2p**
C. Describe the to process to calculate the time average and standard deviation for random signal and resulting probability distributions? What affects the results? **2p** discrete

Question 3. Environmental Loads

A. Describe how the random load in your application case [1](project work) forms (physical process). What are the random and stationary parts of the load in your application case and associated time spans? **2p**

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[1] If you do not have one, describe ocean waves.

B. What is the scatter diagram? How is it associated with the load spectra? **2p**

C. What is the link between spectrum and probability? What assumptions need to be valid that the link can be derived based on mathematics? **2p**

Question 4. Deterministic vs. Stochastic Loads

A. What does dynamic response mean in terms of natural frequency of the system? What is the benefit we obtain for design with this assumption? **2p**

B. How can you obtain Rayleigh distribution for peak values of a Gaussian process? Explain the steps and assumptions made? **2p**

C. The wave spectrum [m²/s] and response amplitude operator [ton²/m²] of the bending moment of the ship is given as:

$$\omega_{RAO} = \{\ 0.3\quad 0.4\quad 0.5\quad 0.6\quad 0.7\ \},$$

$$S_{wave} = \{\ 2\cdot 10^1\quad 4\cdot 10^1\quad 3\cdot 10^1\quad 3\cdot 10^1\quad 0\ \}$$

$$RAO = \{\ 0\quad 2\cdot 10^9\quad 4\cdot 10^9\quad 3\cdot 10^9\quad 0\ \}$$

Calculate maximum bending moment during 3 hour time. **2p**

Bonus Question. Big Picture

Draw and explain the big picture of assessing the response of a structure to random excitation due to environment. **2p**

Equations

$$n = \frac{T}{2\pi}\sqrt{\frac{m_2}{m_0}} \qquad S_{yy}(\omega) = |H(\omega)|^2 S_{xx}(\omega) \qquad R = k\int_0^\infty S(\omega)d\omega, k = 2 \text{ or } 8$$

$$\bar{\omega}_1 = \frac{m_1}{m_0} = \frac{\int_0^\infty \omega S(\omega)d\omega}{\int_0^\infty S(\omega)d\omega} \qquad \hat{z} = \sqrt{\ln\frac{n}{\alpha}}\sqrt{R} \qquad m_k = \int_0^\infty \omega^k S(\omega)d\omega$$

F=ma

m/s²

kg m / s²

m²/s

ton / m

$m^2/s \cdot \sqrt{\frac{kg^2}{m^2}}$