MEC-E1030 - Random Loads and Processes L

Exam, 18.10.2022, On-line / Otakaari 4, 213, 09:00-12:00 Mashrura Musharraf

Question 1. Deterministic vs. Stochastic Loads

A. Explain the deterministic and stochastic loads for your application case (group work). What is the primary difference between how you measure deterministic vs. stochastic loads? **2p**
B. How are the continuous probability distributions connected (e.g. Weibull, Rayleigh, Gaussian) mathematically? **2p**
C. How can you measure the randomness of a given time history? Explain mathematically and/or graphically. **2p**

Question 2. Mathematics of Random Process

A. In the assignments we mostly focused on analyzing one sample function of a random process. What assumptions allow us to use only one sample function for analyzing a random process? How would you validate these assumptions? **2p**
B. Among the time-frequency-probability domains, which one is more helpful in assessing whether a process is narrow or broad-banded and why? How do you make a broad-banded process narrow banded? **2p**
C. Describe the process to calculate the average and standard deviation for the position/displacement of ergodic random signal. In addition to these statistical quantities, what else do you need to derive the best fit probability distributions? **2p**

Question 3. Environmental Loads and Responses

A. Describe how the random load in your application case forms (physical process). What is the idea of the scatter diagram? **2p**
B. Explain the roles of Fourier transformation and its inverse in the context of random processes and design? **2p**
C. What assumptions need to be valid for you to have a direct link between spectrum and probability? Explain why having a direct link is deemed useful? Was it indeed useful for your application case? **2p**

Question 4. Assessment of design values

A. Explain the roles of short- and long-term assessment of random loads? How are these related? **2p**
B. The wave spectrum [m^2/s] and response amplitude operator [ton^2/m^2] of the bending moment of the ship is given as:

$$w_{RAO} = \left\{ \begin{array}{ccccc} 0.3 & 0.4 & 0.5 & 0.6 & 0.7 \end{array} \right\},$$

$$S_{wave} = \left\{ \begin{array}{ccccc} 2\times10^{1} & 4\times10^{1} & 3\times10^{1} & 3\times10^{1} & 0 \end{array} \right\}$$

$$RAO = \left\{ \begin{array}{ccccc} 0 & 2\times10^{9} & 4\times10^{9} & 3\times10^{9} & 0 \end{array} \right\}$$

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

C. Calculate the mth moment of load spectrum given in previous point. Select m based on last number of you student ID (0-3, 4th moment; 4-6, 6th moment; 7-9, 8th moment). **2p**