Theory exam in Structural Dynamics 2010-03-02 kl. 13-15

The test consists of 6 questions giving the maximum of 15 points. Each question should be answered on a separate paper. No helping aids are permitted on this test, except calculator. Do not forget to write your name on each submitted paper.

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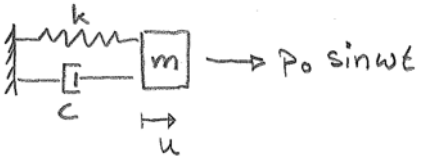
1) (2 p)

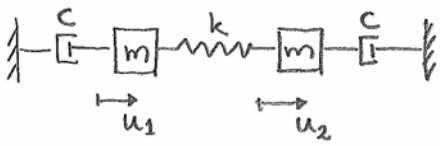
Write the standard form of the equation of motion for a damped single dof system according to the figure, using ω_n and $\zeta = c / (2m\omega_n)$.



Also derive the expression for the steady state displacement amplitude, if c=0.

2) (2 p)

Consider the two dof system below



Show, using free body diagrams, that the system can be defined by the following matrices

$$\mathbf{m} = \begin{bmatrix} m & 0 \\ 0 & m \end{bmatrix} \qquad \mathbf{c} = \begin{bmatrix} c & 0 \\ 0 & c \end{bmatrix} \qquad \mathbf{k} = \begin{bmatrix} k & -k \\ -k & k \end{bmatrix}$$

3) (3 p)

Write the complex form of the system in question 2) if mass number two is subjected to a steady state sinusoidal force with amplitude p_o and angular frequency ω. In deriving the complex system of equations consider the force to be a real variable.

Also use the complex system to write an equation for the elongation of the spring by expressing an equation in terms of $u^* = u_2^* - u_1^*$. Derive the amplitude of elongation from u^* and determine a resonance frequency from this derivation. What is the amplitude of the elongation at resonance?

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4) (3 p)

Determine eigen-values and eigen-vectors for the system in question 2) i.e. solve

$$\left(\mathbf{k} - \omega^2 \mathbf{m}\right)\mathbf{\Phi} = 0$$

What is the physical interpretation of the lowest eigen-value?

Show that the damping of the system in question 2) is of the Classical form.

5) (2 p)

Explain the main advantages of reducing a system of equations by using modal truncation when a numerical solution is sought.

Shortly explain the difference between modal truncation and the use of Ritz vectors.

6) (3 p)

Give a short description of the following terms in relation to earth-quake analysis:

- Response history
- Response spectrum
- Design spectrum

By response you can, if you want, use the displacement to be specific in the description.