Session 2: MDOF systems

Consider the following three degrees-of-freedom model:

\[ \begin{align*}
    &m_1 \quad k_1 \quad c_1 \\
    &| \quad \downarrow \quad \downarrow \\
    &m_2 \quad k \quad c \\
    &| \quad \downarrow \quad \downarrow \\
    &m_3 \quad k \quad c
\end{align*} \]

A) Write the equations of motion in the time domain in a matrix form.

B) For the numerical values \( m = 1 \text{ kg}, k = k_1 = 16 \text{ N/m}, c = c_1 = 0.1 \text{ Ns/m} \), compute the eigenfrequencies and the mode shapes of the conservative system. Represent the mode shapes, and check the orthogonality conditions.

C) Compute the mode shapes and the eigenfrequencies when \( k_1 = 0 \). Represent the mode shapes. Comment

D) For the value of \( k_1 = k \), compute the impulse response for \( x_3 \) by projecting the equations of motion in the modal basis. Represent the Bode diagram for the same coordinate \( x_3/f \) and for the acceleration \( \ddot{x}_3/f \). Is the modal damping hypothesis valid? Multiply by a factor 5 the damping coefficient of mode 2 and plot the Bode diagram for \( x_3 \) on the same graph as with the initial value of the damping. Comment.

E) Consider the case when \( c_1 = 0 \). Is the modal damping hypothesis still verified? Draw the Bode diagram for \( x_3/f \) using the full system of equations (solve frequency by frequency). Compare with the modal approach in which the coupling is neglected. Comment

Note: Use the `eig` function to compute the eigenfrequencies and mode shapes.