Problem 1

The seismic analysis of a “critical structure”, part of an industrial complex must be undertaken. As a first approximation, the structure is idealized as a two degrees-of-freedom system as shown in Fig. 1. The stiffness matrix and the concentrated masses related to these degrees-of-freedom are also indicated on the figure.

The structure is to be located in a seismic zone defined by the design response spectrum given below. Assuming that the structure must remain elastic under the design earthquake determine:

a) The maximum probable inter-story drift between the roof and the first floor.

b) The maximum probable overturning moment that must be transmitted at the base of the structure.

Figure 1- Critical structure idealized as a 2 DOF system.
Problem 2

A two-story building is modeled as a simple two-degrees-of-freedom system, as illustrated in Fig. 3. The equations of motion of this system in free vibrations (ignoring damping) are written as:

\[
\begin{bmatrix}
0.0385 & 0 \\
0 & 0.0245
\end{bmatrix}
\begin{bmatrix}
x_1 \\
x_2
\end{bmatrix}
\begin{bmatrix}
kN-m-s^2/m \text{mm} \\
6.30 & -4.38
\end{bmatrix}
\begin{bmatrix}
\text{mm} \\
-4.38 & 6.30
\end{bmatrix}
\begin{bmatrix}
x_1 \\
x_2
\end{bmatrix}
= 0
\]

The structure, located on a Site Class B in downtown Los Angeles (Lat: 33° 56' N, Long: 118° 24' W), must remain elastic and must be designed per ASCE 7-05.

a) Construct the ASCE 7-05 design response spectrum for the site.

b) Using the SRSS statistical combination, estimate the maximum inter-story shear and the maximum inter-story displacements for each floor.
**Problem 3**

The two-story frame, shown in Fig. 4, has rigid floors and lumped masses at the floor levels. The lateral load resisting system is made of a single diagonal bracing member in the first story with fixed ended columns in both stories. Assuming only one DOF per floor:

a) Find the mass matrix of the system.

b) Find the stiffness matrix of the system.

c) Find the frequency matrix.

d) Find the modal matrix.

e) Calculate the generalized mass matrix for each mode of vibration.

f) Calculate the modal participation factor for each mode of vibration.

Initially at rest, the structure is subjected to the S00E component of the 1940 El Centro earthquake having the response spectrum shown in Fig. 5. Assuming that the structure remains elastic during the earthquake and 5% critical damping for each mode:

g) Calculate the maximum possible base shear.

h) Using the SRSS combination, calculate the maximum probable base shear.

![Two-story frame diagram](image.png)

Column $EI = 60000 \text{ kN-m}^2$
Bracing $EA = 600000 \text{ kN}$
Weight of each floor = 3200 kN

Figure 4 - Two-story frame.
Figure 5 - El Centro earthquake response spectrum (1940-05-18, comp. S00E).