Step-1

Consider the equation:

$$Ax = \lambda Mx$$

$$\begin{bmatrix} 2 & -1 \\ -1 & 2 \end{bmatrix} x = \lambda \begin{bmatrix} m_1 & 0 \\ 0 & m_2 \end{bmatrix} x$$

$$\left\{ \begin{bmatrix} 2 & -1 \\ -1 & 2 \end{bmatrix} - \begin{bmatrix} \lambda m_1 & 0 \\ 0 & \lambda m_2 \end{bmatrix} \right\} x = 0$$

$$\begin{bmatrix} 2-\lambda m_1 & -1 \\ -1 & 2-\lambda m_2 \end{bmatrix} x = 0$$

By substituting $m_1 = 1$ and $m_2 = 2$, we get,

$$\begin{bmatrix} 2-\lambda & -1 \\ -1 & 2-2\lambda \end{bmatrix} x = 0$$

$$\begin{bmatrix} 2-\lambda & -1 \\ -1 & 2-2\lambda \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} = 0$$

$$(2-\lambda)x_1 - x_2 = 0$$

$$-x_1 + x_2(2-2\lambda) = 0$$

Therefore, the normal modes are M-orthogonal.