# GATE NM-54 2022

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Q: A system with two degrees of freedom, as shown in the figure, has masses $m_1 = 200kg$ and $m_2 = 100kg$ and stiffness coefficients $k_1 = k_2 = 200N/m$. Then the lowest natural frequency of the system is _____ rad/s (rounded off to one decimal place).
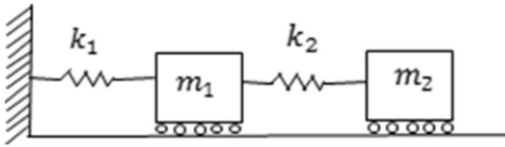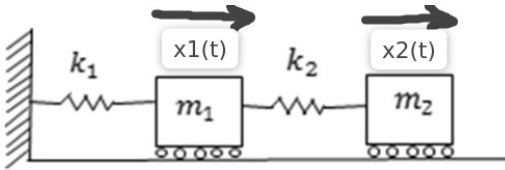


Fig. 0.

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**Solution:**



Fig. 0.

$$m_2\ddot{x}_2(t) + k_2\,(\ddot{x}_2(t) - \ddot{x}_1(t)) = 0 \quad (1)$$
$$m_1\ddot{x}_1(t) + k_2\,(\ddot{x}_2(t) - \ddot{x}_1(t)) + k_1\ddot{x}_1(t) = 0 \quad (2)$$

$$\ddot{x}_1(t) + x_2(t) = 0 \quad (3)$$
$$\ddot{x}_2(t) + 2\,(x_2(t) - x_1(t)) = 0 \quad (4)$$

Substituting (3) in (4)

$$\dddot{x}_1(t) + 2\ddot{x}_1(t) + x_1(t) = 0 \quad (5)$$