2nd Problem

Suspension for a wheel on a bumpy road is shown.

Let vehicle mass → m_1

wheel mass → m_2

Spring in suspension has a spring const k_1

Tire also has a spring const k_2

Damping constant → b

wkt Transfn func $\frac{X_1(s)}{X(s)}$ ⇒ which is required answer

wkt

> Inertia + restoring force + Damping force = Exciting Force — I

First

Forces on m_1:

$$\text{inertia} = m_1 \frac{d^2y_1}{dt^2}$$

$$\text{Restoring } f = k_1(y_1 - y_2)$$

$$\text{Damping } f = b\frac{d(y_1 - y_2)}{dt}$$

exciting = 0

Forces on m_2:

$$\text{inertia} = m_2 \frac{d^2y_2}{dt^2}$$

$$\text{Restoring } F = k_1(y_1 - y_2)$$

$$\text{Damping } F = b\frac{d(y_2 - y_1)}{dt}$$

$$\text{Exciting force} = k_2 x$$

now with help of eq (I)

$$m_1 \frac{d^2y}{dt^2} + b\frac{d(y_1-y_2)}{dt} + k_1(y_1-y_2) = 0 \quad \text{(for } m_1\text{)}$$

$$m_2 \frac{d^2y}{dt^2} + b\frac{d(y_2-y_1)}{dt} + k_1(y_2-y_1) + k_2 y_2 = k_2 x \quad \text{(for } m_2\text{)}$$

now apply Laplace Transformation ; zero initial conditions

$$m_1 s^2 Y_1(s) + bs(Y_1(s) - Y_2(s)) + k_1(Y_1(s) - Y_2(s)) = 0 \longrightarrow (1)$$

$$m_2 s^2 Y_2(s) + bs(Y_2(s) - Y_1(s)) + k_1(Y_2(s) - Y_1(s)) + k_2 Y_2(s) = k_2 X(s) \longrightarrow (2)$$

after rearranging ; $Y_2(s) = \dfrac{(m_1 s^2 + bs + k_1)}{(bs + k_1)} Y_1(s)$

$$\therefore \frac{Y_1(s)}{X(s)} = \frac{k_2(bs+k_1)}{\left[-(bs+k_1)^2 + (m_2 s^2 + bs + k_1 + k_2)(m_1 s^2 + bs + k_1)\right]}$$

↓

Transfer func