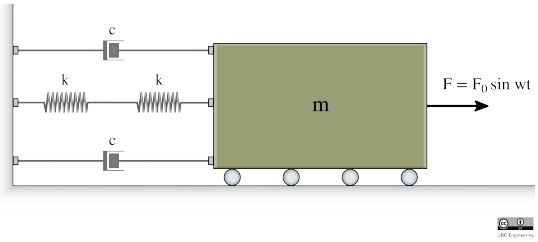
22-R-VIB-JL-47



A mass of $m = 27$ kg is supported by rollers and has a periodic force of $F = 4\sin 5t$ applied to it. Two springs in series, each with stiffness $k = 32$ N/m and two dampers in parallel, each with a damping constant $c = 0.6$ N·s/m attached to the wall keep the block in steady-state vibration.

Find the inductance L, resistance R, and capacitance C of the equivalent electrical analog system.

Select the circuit diagram that represents the damped forced system's electrical equivalent.

Solution

Calculating the spring equivalent and damping equivalent we have:

$k_{eq} = \left(\frac{1}{k} + \frac{1}{k}\right)^{-1} = \frac{k}{2} = 16$ [N/m]

$c_{eq} = c + c = 2c = 1.2$ [N·s/m]

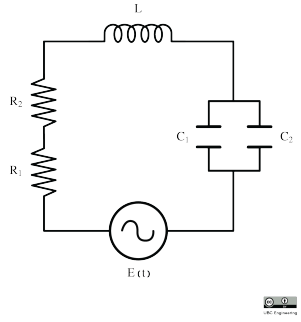
Putting the equation of motion into the standard form $F_0 \sin\omega_0 t = m\ddot{x} + c_{eq}\dot{x} + k_{eq}x$:

$4\sin 5t = 27\,\ddot{x} + 1.2\,\dot{x} + 16\,x$

Then inductance L, resistance R, and capacitance C of the equivalent electrical analog system is given by:

$L = m = 27$ [H]
$R = c_{eq} = 1.2$ [Ω]
$C = \frac{1}{k_{eq}} = 0.0625$ [F]

Lastly creating the equivalent circuit, the equivalent inductance is a single inductor with inductance $L = m$. The equivalent resistance is 2 resistors in series each with resistance $R = c$ for an equivalent resistance of $R_{eq} = 2R = 2c$. And the equivalent capacitance is 2 capacitors in parallel each with capacitance $C = \frac{1}{k}$ for an equivalent capacitance $C_{eq} = 2C = \frac{2}{k}$ (shown below).



Device	Equivalent Series Connection	Equivalent Parallel Connection
Resistors	$R_{eq} = R_1 + R_2 + \cdots + R_N$	$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \cdots + \frac{1}{R_N}$
Capacitors	$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} + \cdots + \frac{1}{C_N}$	$C_{eq} = C_1 + C_2 + \cdots + C_N$
Inductors	$L_{eq} = L_1 + L_2 + \cdots + L_N$	$\frac{1}{L_{eq}} = \frac{1}{L_1} + \frac{1}{L_2} + \cdots + \frac{1}{L_N}$