

> restart

> Sistema := diff(x<sub>1</sub>(t), t) = x<sub>3</sub>(t), diff(x<sub>2</sub>(t), t) = x<sub>4</sub>(t), diff(x<sub>3</sub>(t), t) = - $\frac{(H_1 + H_2)}{M_1} \cdot x_1(t)$   
+  $\frac{H_2}{M_1} \cdot x_2(t)$ , diff(x<sub>4</sub>(t), t) =  $\frac{H_2}{M_2} \cdot x_1(t) - \frac{H_2}{M_2} \cdot x_2(t)$  : Sistema<sub>1</sub>; Sistema<sub>2</sub>; Sistema<sub>3</sub>;  
Sistema<sub>4</sub>

$$\frac{d}{dt} x_1(t) = x_3(t)$$

$$\frac{d}{dt} x_2(t) = x_4(t)$$

$$\frac{d}{dt} x_3(t) = -\frac{(H_1 + H_2) x_1(t)}{M_1} + \frac{H_2 x_2(t)}{M_1}$$

$$\frac{d}{dt} x_4(t) = \frac{H_2 x_1(t)}{M_2} - \frac{H_2 x_2(t)}{M_2} \quad (1)$$

> H<sub>1</sub> := 2; H<sub>2</sub> := 1; M<sub>1</sub> := 1; M<sub>2</sub> := 2; a :=  $\frac{20}{100}$

$$H_1 := 2$$

$$H_2 := 1$$

$$M_1 := 1$$

$$M_2 := 2$$

$$a := \frac{1}{5} \quad (2)$$

> Condiciones := x<sub>2</sub>(0) = a, x<sub>1</sub>(0) =  $\frac{H_2}{H_1} \cdot a$ , x<sub>3</sub>(0) = 0, x<sub>4</sub>(0) = 0

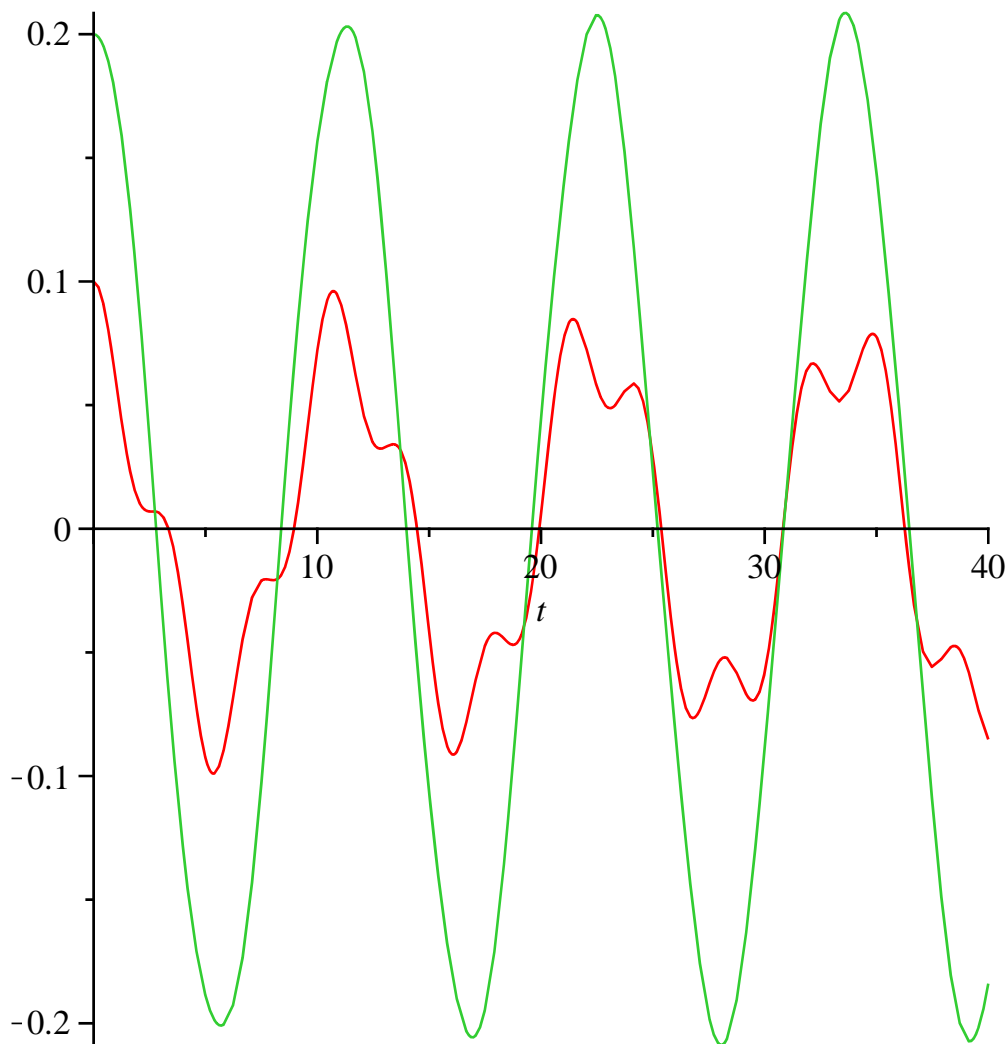
$$\text{Condiciones} := x_2(0) = \frac{1}{5}, x_1(0) = \frac{1}{10}, x_3(0) = 0, x_4(0) = 0 \quad (3)$$

> Sol := dsolve({Sistema, Condiciones}, {x<sub>1</sub>(t), x<sub>2</sub>(t), x<sub>3</sub>(t), x<sub>4</sub>(t)}) : Sol<sub>1</sub>; Sol<sub>2</sub>

$$x_1(t) = \frac{1}{20} \cos\left(-\frac{1}{4} t \sqrt{22} + \frac{1}{4} t \sqrt{6}\right) + \frac{1}{440} \sqrt{22} \cos\left(-\frac{1}{4} t \sqrt{22} + \frac{1}{4} t \sqrt{6}\right) \sqrt{6}$$
$$+ \frac{1}{20} \cos\left(\frac{1}{4} t \sqrt{22} + \frac{1}{4} t \sqrt{6}\right) - \frac{1}{440} \sqrt{22} \cos\left(\frac{1}{4} t \sqrt{22} + \frac{1}{4} t \sqrt{6}\right) \sqrt{6}$$

$$x_2(t) = \frac{1}{10} \cos\left(-\frac{1}{4} t \sqrt{22} + \frac{1}{4} t \sqrt{6}\right) + \frac{1}{110} \sqrt{22} \cos\left(-\frac{1}{4} t \sqrt{22} + \frac{1}{4} t \sqrt{6}\right) \sqrt{6}$$
$$+ \frac{1}{10} \cos\left(\frac{1}{4} t \sqrt{22} + \frac{1}{4} t \sqrt{6}\right) - \frac{1}{110} \sqrt{22} \cos\left(\frac{1}{4} t \sqrt{22} + \frac{1}{4} t \sqrt{6}\right) \sqrt{6} \quad (4)$$

> plot([rhs(Sol<sub>1</sub>), rhs(Sol<sub>2</sub>)], t = 0..40)



> restart

> Sistema := diff(x1(t), t) = x3(t), diff(x2(t), t) = x4(t), diff(x3(t), t) = - $\frac{(H_1 + H_2)}{M_1} \cdot x_1(t)$   
 $+ \frac{H_2}{M_1} \cdot x_2(t)$ , diff(x4(t), t) =  $\frac{H_2}{M_2} \cdot x_1(t) - \frac{H_2}{M_2} \cdot x_2(t)$  : Sistema1; Sistema2; Sistema3;  
 Sistema4

$$\frac{d}{dt} x_1(t) = x_3(t)$$

$$\frac{d}{dt} x_2(t) = x_4(t)$$

$$\frac{d}{dt} x_3(t) = -\frac{(H_1 + H_2) x_1(t)}{M_1} + \frac{H_2 x_2(t)}{M_1}$$

$$\frac{d}{dt} x_4(t) = \frac{H_2 x_1(t)}{M_2} - \frac{H_2 x_2(t)}{M_2}$$

(5)

> H1 := 2; H2 := 1; M1 := 2; M2 := 1; a :=  $\frac{20}{100}$

$$H_1 := 2$$

$$H_2 := 1$$

$$M_1 := 2$$

$$M_2 := 1$$

$$a := \frac{1}{5} \quad (6)$$

$$> \text{Condiciones} := x_2(0) = a, x_1(0) = \frac{H_2}{H_1} \cdot a, x_3(0) = 0, x_4(0) = 0$$

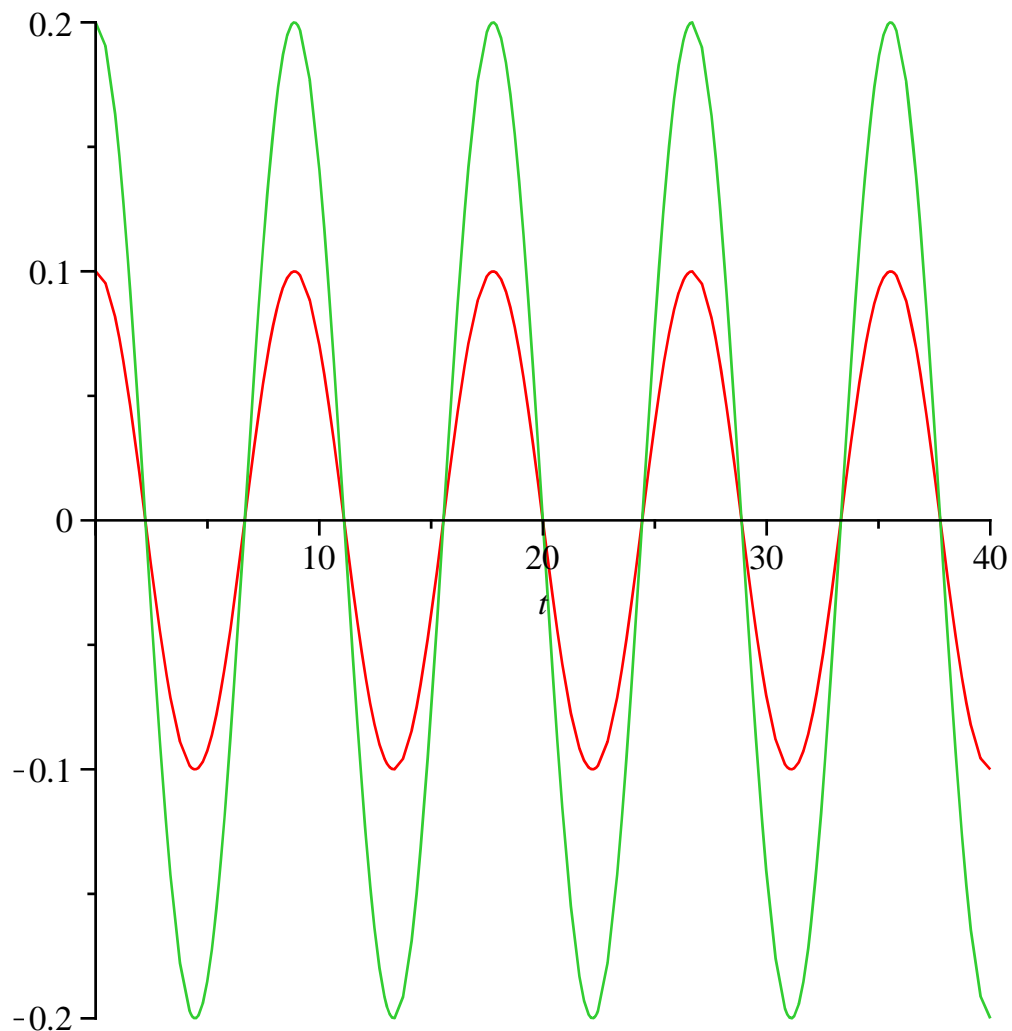
$$\text{Condiciones} := x_2(0) = \frac{1}{5}, x_1(0) = \frac{1}{10}, x_3(0) = 0, x_4(0) = 0 \quad (7)$$

$$> \text{Sol} := \text{dsolve}(\{\text{Sistema}, \text{Condiciones}\}, \{x_1(t), x_2(t), x_3(t), x_4(t)\}) : \text{Sol}_1; \text{Sol}_2$$

$$x_1(t) = \frac{1}{10} \cos\left(\frac{1}{2} \sqrt{2} t\right)$$

$$x_2(t) = \frac{1}{5} \cos\left(\frac{1}{2} \sqrt{2} t\right) \quad (8)$$

$$> \text{plot}([ \text{rhs}(\text{Sol}_1), \text{rhs}(\text{Sol}_2) ], t = 0..40)$$



> restart

> Sistema := diff(x<sub>1</sub>(t), t) = x<sub>3</sub>(t), diff(x<sub>2</sub>(t), t) = x<sub>4</sub>(t), diff(x<sub>3</sub>(t), t) = - $\frac{(H_1 + H_2)}{M_1} \cdot x_1(t)$

+  $\frac{H_2}{M_1} \cdot x_2(t)$ , diff(x<sub>4</sub>(t), t) =  $\frac{H_2}{M_2} \cdot x_1(t) - \frac{H_2}{M_2} \cdot x_2(t)$  : Sistema<sub>1</sub>; Sistema<sub>2</sub>; Sistema<sub>3</sub>;

Sistema<sub>4</sub>

$$\frac{d}{dt} x_1(t) = x_3(t)$$

$$\frac{d}{dt} x_2(t) = x_4(t)$$

$$\frac{d}{dt} x_3(t) = -\frac{(H_1 + H_2) x_1(t)}{M_1} + \frac{H_2 x_2(t)}{M_1}$$

$$\frac{d}{dt} x_4(t) = \frac{H_2 x_1(t)}{M_2} - \frac{H_2 x_2(t)}{M_2}$$

(9)

> H<sub>1</sub> := 1; H<sub>2</sub> := 2; M<sub>1</sub> := 1; M<sub>2</sub> := 2; a :=  $\frac{20}{100}$

$$H_1 := 1$$

$$H_2 := 2$$

$$M_1 := 1$$

$$M_2 := 2$$

$$a := \frac{1}{5}$$

(10)

> Condiciones := x<sub>2</sub>(0) = a, x<sub>1</sub>(0) =  $\frac{H_2}{H_1} \cdot a$ , x<sub>3</sub>(0) = 0, x<sub>4</sub>(0) = 0

$$\text{Condiciones} := x_2(0) = \frac{1}{5}, x_1(0) = \frac{2}{5}, x_3(0) = 0, x_4(0) = 0$$

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> Sol := dsolve({Sistema, Condiciones}, {x<sub>1</sub>(t), x<sub>2</sub>(t), x<sub>3</sub>(t), x<sub>4</sub>(t)}) : Sol<sub>1</sub>; Sol<sub>2</sub>

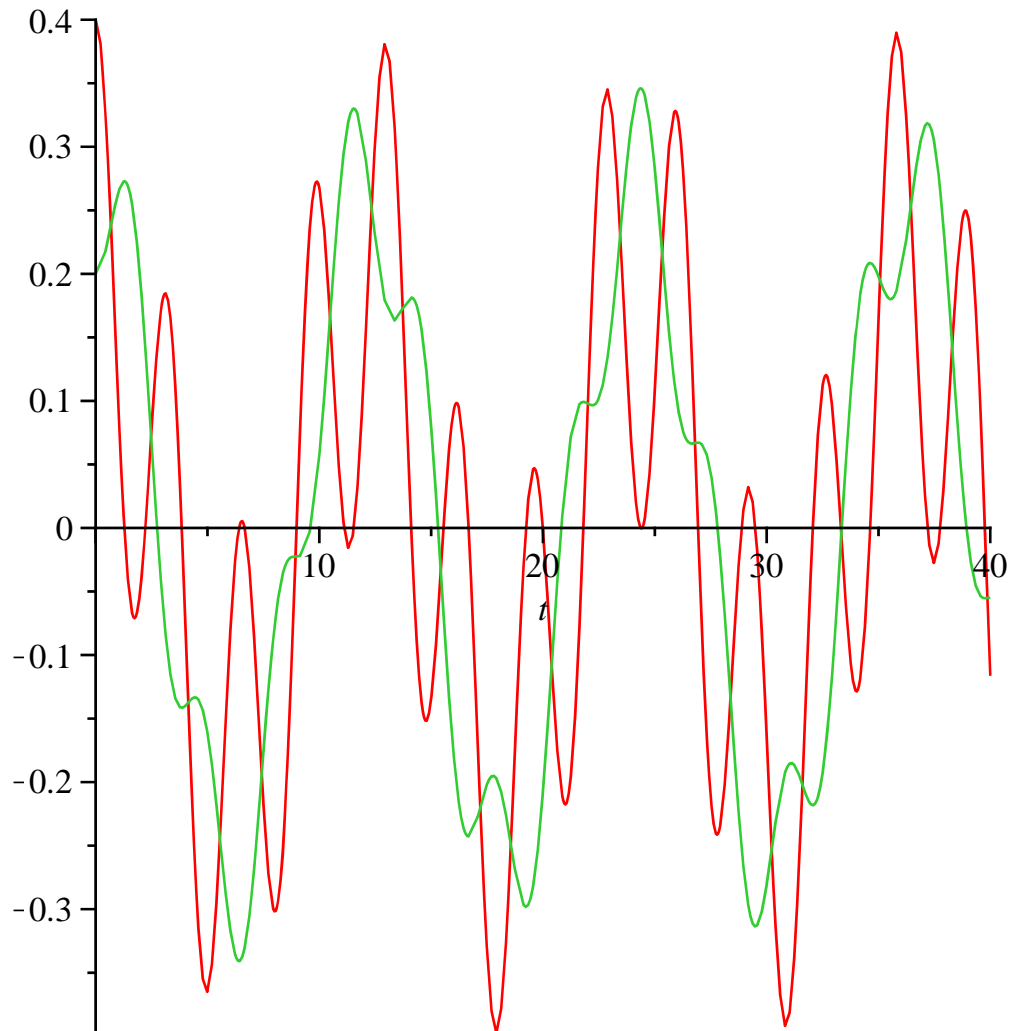
$$x_1(t) = -\frac{1}{2} \left( \frac{1}{10} \sqrt{2} - \frac{1}{10} \sqrt{6} \right) \cos\left(-\frac{1}{2} t \sqrt{6} + \frac{1}{2} t \sqrt{2}\right) \sqrt{6} - \frac{1}{2} \left( \frac{1}{10} \sqrt{2} - \frac{1}{10} \sqrt{6} \right) \cos\left(-\frac{1}{2} t \sqrt{6} + \frac{1}{2} t \sqrt{2}\right) \sqrt{2} - \frac{1}{2} \left( -\frac{1}{10} \sqrt{2} - \frac{1}{10} \sqrt{6} \right) \cos\left(\frac{1}{2} t \sqrt{6} + \frac{1}{2} t \sqrt{2}\right) \sqrt{6} + \frac{1}{2} \left( -\frac{1}{10} \sqrt{2} - \frac{1}{10} \sqrt{6} \right) \cos\left(\frac{1}{2} t \sqrt{6} + \frac{1}{2} t \sqrt{2}\right) \sqrt{2} + \frac{1}{2} t \sqrt{2} \sqrt{2}$$

$$x_2(t) = -\frac{1}{2} \left( \frac{1}{10} \sqrt{2} - \frac{1}{10} \sqrt{6} \right) \cos\left(-\frac{1}{2} t \sqrt{6} + \frac{1}{2} t \sqrt{2}\right) \sqrt{6} - \left( \frac{1}{10} \sqrt{2} - \frac{1}{10} \sqrt{6} \right) \cos\left(-\frac{1}{2} t \sqrt{6} + \frac{1}{2} t \sqrt{2}\right) \sqrt{2} - \frac{1}{2} \left( -\frac{1}{10} \sqrt{2} - \frac{1}{10} \sqrt{6} \right) \cos\left(\frac{1}{2} t \sqrt{6} + \frac{1}{2} t \sqrt{2}\right) \sqrt{6} - \frac{1}{2} \left( -\frac{1}{10} \sqrt{2} - \frac{1}{10} \sqrt{6} \right) \cos\left(\frac{1}{2} t \sqrt{6} + \frac{1}{2} t \sqrt{2}\right) \sqrt{2}$$

(12)

$$-\frac{1}{10} \sqrt{6} \cos\left(\frac{1}{2} t \sqrt{6} + \frac{1}{2} t \sqrt{2}\right) \sqrt{6} + \left(-\frac{1}{10} \sqrt{2} - \frac{1}{10} \sqrt{6}\right) \cos\left(\frac{1}{2} t \sqrt{6} + \frac{1}{2} t \sqrt{2}\right) \sqrt{2}$$

> plot([rhs(Sol<sub>1</sub>), rhs(Sol<sub>2</sub>)], t=0..40)



> restart

> Sistema := diff(x<sub>1</sub>(t), t) = x<sub>3</sub>(t), diff(x<sub>2</sub>(t), t) = x<sub>4</sub>(t), diff(x<sub>3</sub>(t), t) = - $\frac{(H_1 + H_2)}{M_1} \cdot x_1(t)$

+  $\frac{H_2}{M_1} \cdot x_2(t)$ , diff(x<sub>4</sub>(t), t) =  $\frac{H_2}{M_2} \cdot x_1(t) - \frac{H_2}{M_2} \cdot x_2(t)$  : Sistema<sub>1</sub>; Sistema<sub>2</sub>; Sistema<sub>3</sub>;  
Sistema<sub>4</sub>

$$\frac{d}{dt} x_1(t) = x_3(t)$$

$$\frac{d}{dt} x_2(t) = x_4(t)$$

$$\begin{aligned}\frac{d}{dt} x_3(t) &= -\frac{(H_1 + H_2) x_1(t)}{M_1} + \frac{H_2 x_2(t)}{M_1} \\ \frac{d}{dt} x_4(t) &= \frac{H_2 x_1(t)}{M_2} - \frac{H_2 x_2(t)}{M_2}\end{aligned}\tag{13}$$

$$\begin{aligned}> H_1 := 2; H_2 := 1; M_1 := 2; M_2 := 1; a := \frac{20}{100} \\ & \quad H_1 := 2 \\ & \quad H_2 := 1 \\ & \quad M_1 := 2 \\ & \quad M_2 := 1 \\ & \quad a := \frac{1}{5}\end{aligned}\tag{14}$$

$$\begin{aligned}> \text{Condiciones} := x_2(0) = a, x_1(0) = \frac{H_2}{H_1} \cdot a, x_3(0) = 0, x_4(0) = 0 \\ & \quad \text{Condiciones} := x_2(0) = \frac{1}{5}, x_1(0) = \frac{1}{10}, x_3(0) = 0, x_4(0) = 0\end{aligned}\tag{15}$$

$$\begin{aligned}> \text{Sol} := \text{dsolve}(\{\text{Sistema}, \text{Condiciones}\}, \{x_1(t), x_2(t), x_3(t), x_4(t)\}) : \text{Sol}_1; \text{Sol}_2 \\ & \quad x_1(t) = \frac{1}{10} \cos\left(\frac{1}{2} \sqrt{2} t\right) \\ & \quad x_2(t) = \frac{1}{5} \cos\left(\frac{1}{2} \sqrt{2} t\right)\end{aligned}\tag{16}$$

$$> \text{plot}([ \text{rhs}(\text{Sol}_1), \text{rhs}(\text{Sol}_2) ], t = 0 .. 40)$$

