Modelo del Motor D.C

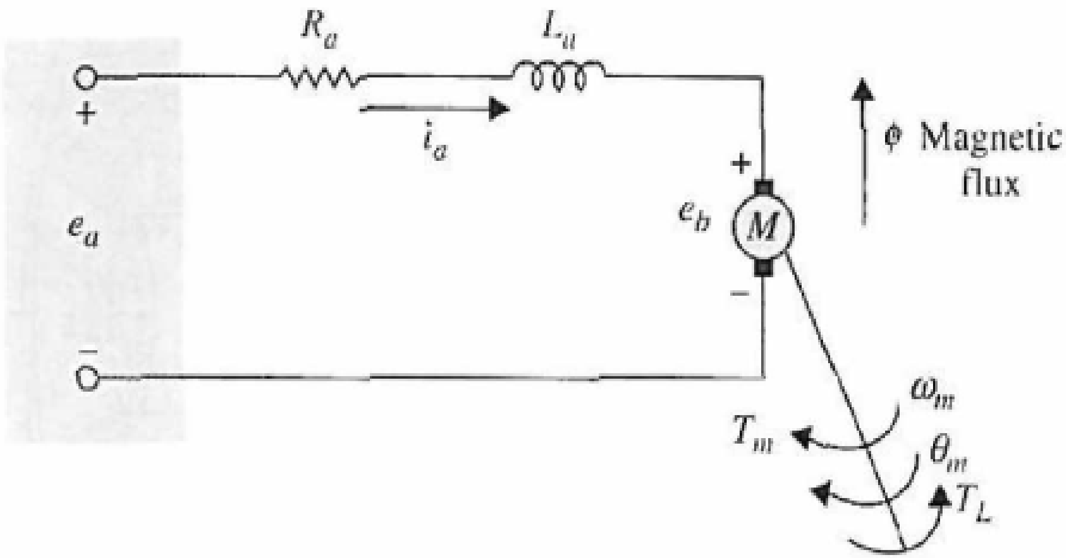


Figure 4-70 Model of a separately excited dc motor.

$i_a(t)$ = armature current	L_a = armature inductance
R_a = armature resistance	$e_a(t)$ = applied voltage
$e_b(t)$ = back emf	K_b = back-emf constant
$T_L(t)$ = load torque	ϕ = magnetic flux in the air gap
$T_m(t)$ = motor torque	$\omega_m(t)$ = rotor angular velocity
$\theta_m(t)$ = rotor displacement	J_m = rotor inertia
K_i = torque constant	B_m = viscous-friction coefficient

Modelo del Motor D.C

$$\frac{di_a(t)}{dt} = \frac{1}{L_a}e_a(t) - \frac{R_a}{L_a}i_a(t) - \frac{1}{L_a}e_b(t) \qquad (4\text{-}204)$$

$$T_m(t) = K_i i_a(t) \qquad (4\text{-}205)$$

$$e_b(t) = K_b \frac{d\theta_m(t)}{dt} = K_b \omega_m(t) \qquad (4\text{-}206)$$

$$\frac{d^2\theta_m(t)}{dt^2} = \frac{1}{J_m}T_m(t) - \frac{1}{J_m}T_L(t) - \frac{B_m}{J_m}\frac{d\theta_m(t)}{dt} \qquad (4\text{-}207)$$

where K_i is the **torque constant** in N-m/A, lb-ft/A, or oz-in/A.

Potenciómetro

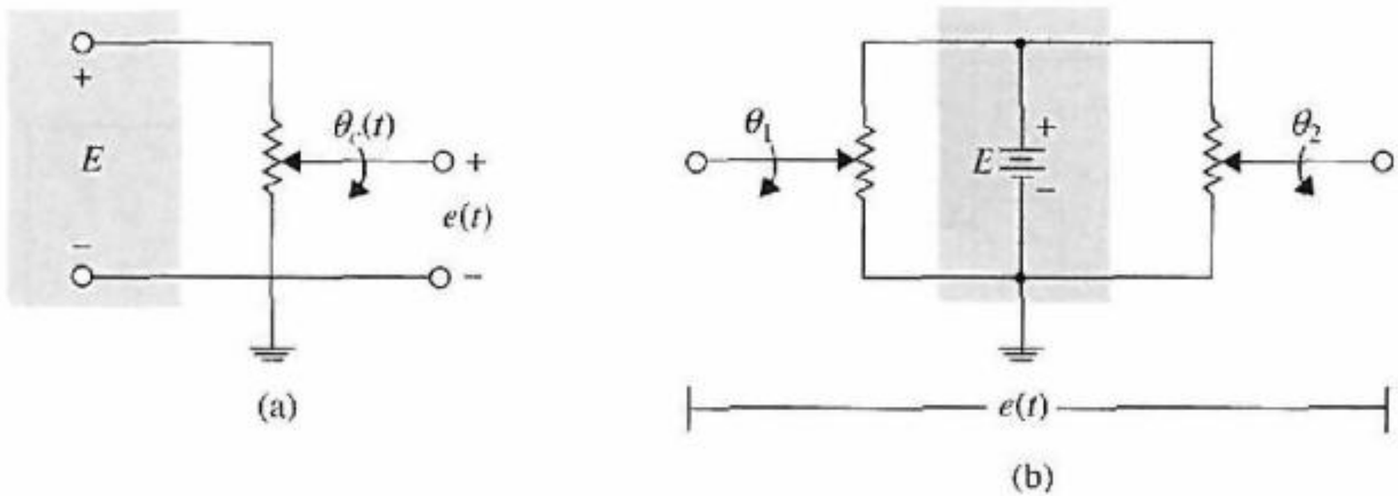
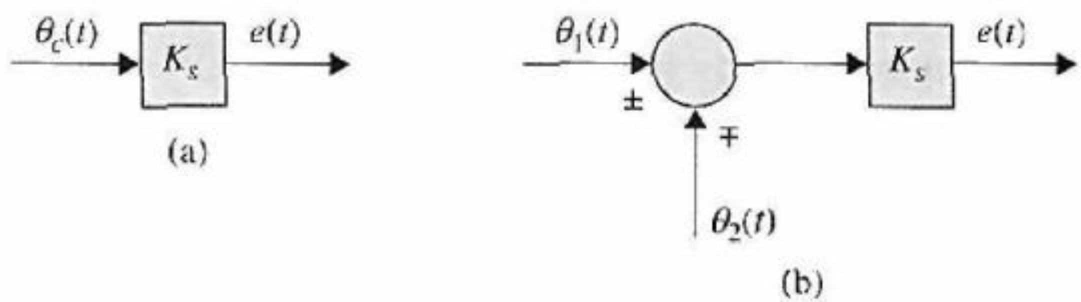


Figure 4-52 Potentiometer used as a position indicator. (b) Two potentiometers used to sense the positions of two shafts.

$$e(t) = K_s\theta_c(t) \qquad e(t) = K_s[\theta_1(t) - \theta_2(t)]$$



Tacómetro

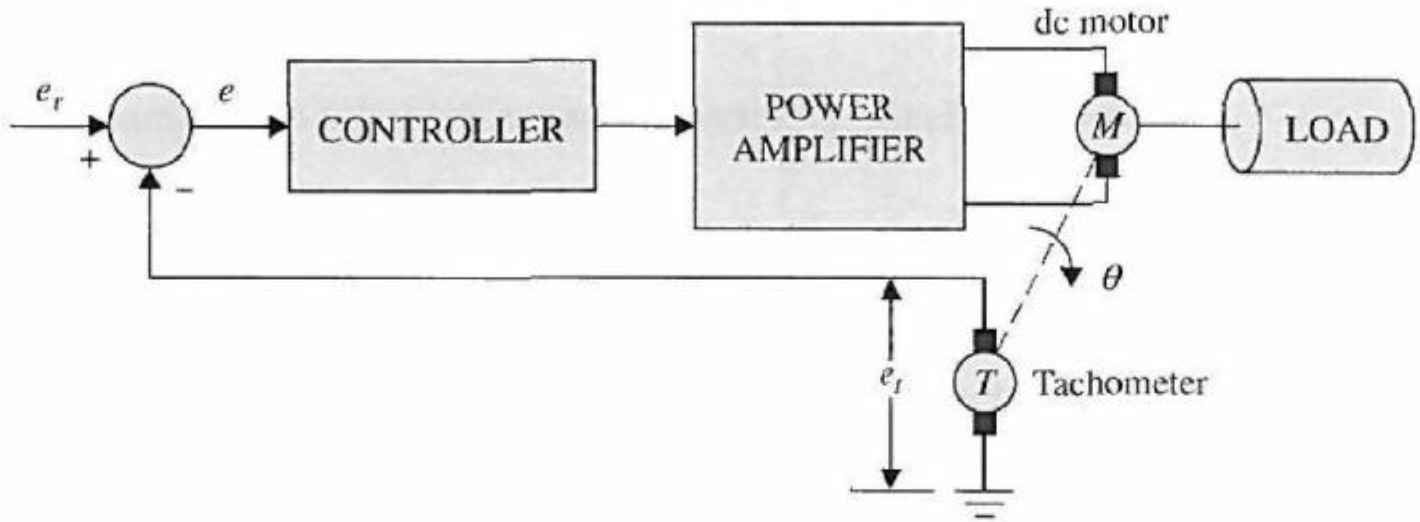
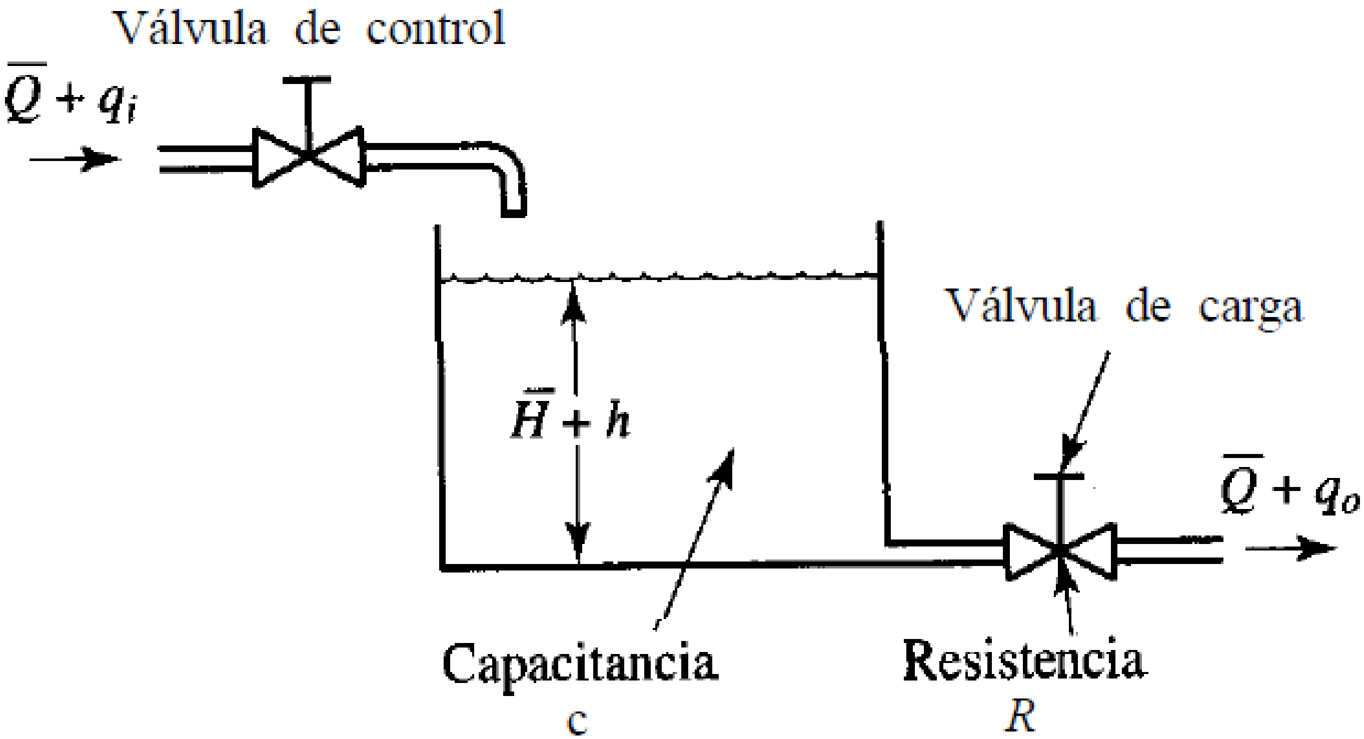


Figure 4-56 Velocity-control system with tachometer feedback.

$$e_t(t) = K_t \frac{d\theta(t)}{dt} = K_t \omega(t)$$

Sistemas de Nivel de Líquido



Sistemas de Nivel de Líquido

Sistemas del nivel de líquido. Considere el sistema que aparece en la figura 3–22(a). Las variables se definen del modo siguiente:

$\bar{Q}$ = velocidad de flujo en estado estable (antes de que haya ocurrido cualquier cambio), m^3/seg

q_i = desviación pequeña de la velocidad de entrada de su valor en estado estable, m^3/seg

q_o = desviación pequeña de la velocidad de salida de su valor en estado estable, m^3/seg

$\bar{H}$ = altura en estado estable (antes de que haya ocurrido un cambio), m

h = desviación pequeña de la altura a partir de su valor en estado estable, m

$$R = \frac{\text{cambio en la diferencia de nivel, m}}{\text{cambio en la velocidad de flujo, } m^3/seg}$$

$$C = \frac{\text{cambio en el líquido almacenado, } m^3}{\text{cambio en la altura, m}}$$

Sistemas de Nivel de Líquido

$$C\,dh = (q_i - q_o)\,dt$$

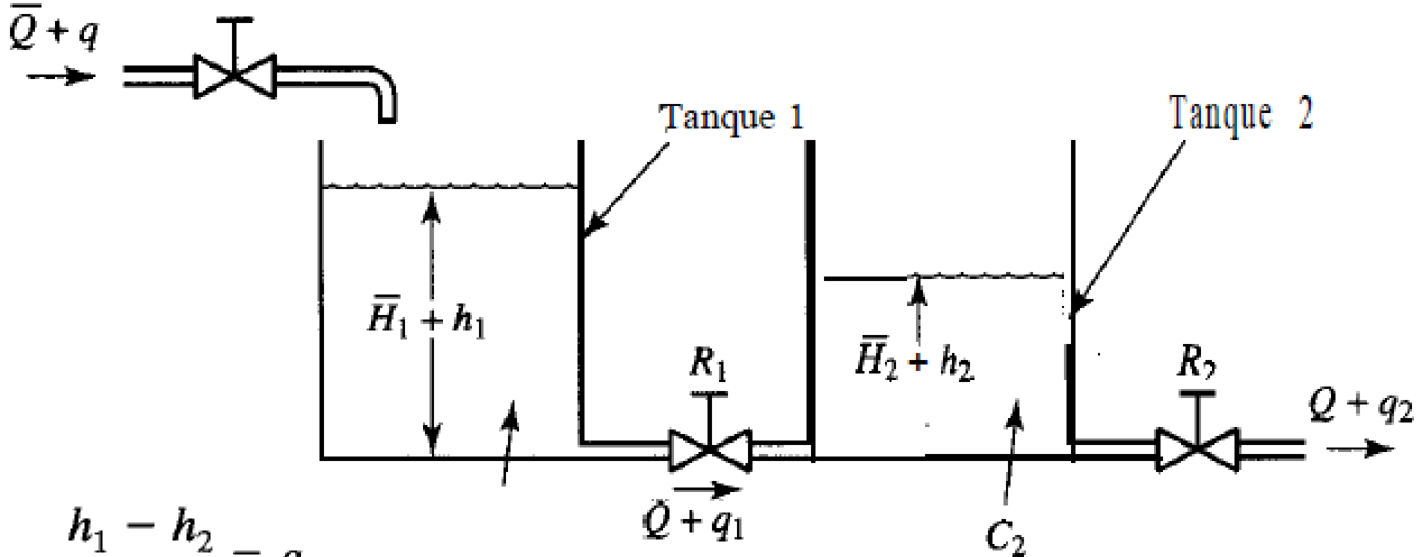
A partir de la definición de resistencia, la relación entre q_o y h se obtiene mediante

$$q_o = \frac{h}{R}$$

La ecuación diferencial para este sistema para un valor constante de R se convierte en

$$RC\frac{dh}{dt} + h = Rq_i \qquad (3\text{–}69)$$

Sistemas de Nivel de Líquido



$$\frac{h_1 - h_2}{R_1} = q_1$$

$$C_1 \frac{dh_1}{dt} = q - q_1$$

$$\frac{h_2}{R_2} = q_2$$

$$C_2 \frac{dh_2}{dt} = q_1 - q_2$$

Linealización

$$\frac{d\mathbf{x}(t)}{dt} = \mathbf{f}[\mathbf{x}(t), \mathbf{r}(t)]$$

$$\Delta \dot{x}_i = \sum_{j=1}^{n} \frac{\partial f_i(\mathbf{x}, \mathbf{r})}{\partial x_j}\bigg|_{x_0, r_0} \Delta x_j + \sum_{j=1}^{p} \frac{\partial f_i(\mathbf{x}, \mathbf{r})}{\partial r_j}\bigg|_{x_0, r_0} \Delta r_j \qquad (4\text{-}237)$$

Eq. (4-237) may be written in vector-matrix form:

$$\Delta \dot{\mathbf{x}} = \mathbf{A}^* \Delta \mathbf{x} + \mathbf{B}^* \Delta r \qquad (4\text{-}238)$$

Linealización

$$\mathbf{A}^* = \begin{bmatrix} \frac{\partial f_1}{\partial x_1} & \frac{\partial f_1}{\partial x_2} & \cdots & \frac{\partial f_1}{\partial x_n} \\ \frac{\partial f_2}{\partial x_1} & \frac{\partial f_2}{\partial x_2} & \cdots & \frac{\partial f_2}{\partial x_n} \\ \cdot & \cdot & \cdots & \cdot \\ \frac{\partial f_n}{\partial x_1} & \frac{\partial f_n}{\partial x_2} & \cdots & \frac{\partial f_n}{\partial x_n} \end{bmatrix}$$

$$\mathbf{B}^* = \begin{bmatrix} \frac{\partial f_1}{\partial r_1} & \frac{\partial f_1}{\partial r_2} & \cdots & \frac{\partial f_1}{\partial r_p} \\ \frac{\partial f_2}{\partial r_1} & \frac{\partial f_2}{\partial r_2} & \cdots & \frac{\partial f_2}{\partial r_p} \\ \cdot & \cdot & \cdots & \cdot \\ \frac{\partial f_n}{\partial r_1} & \frac{\partial f_n}{\partial r_2} & \cdots & \frac{\partial f_n}{\partial r_p} \end{bmatrix}$$

Linealización

$$\Delta x_i = x_i - x_{0i} \tag{4-233}$$

and

$$\Delta r_j = r_j - r_{0j} \tag{4-234}$$

Then

$$\Delta \dot{x}_i = \dot{x}_i - \dot{x}_{0i} \tag{4-235}$$

Since

$$\dot{x}_{0i} = f_i(\mathbf{x}_0, \mathbf{r}_0) \tag{4-236}$$

Linealización

In Example 4-9-1, the linearized system turns out to be time-invariant. As mentioned earlier, linearization of a nonlinear system often results in a linear time-varying system. Consider the following nonlinear system:

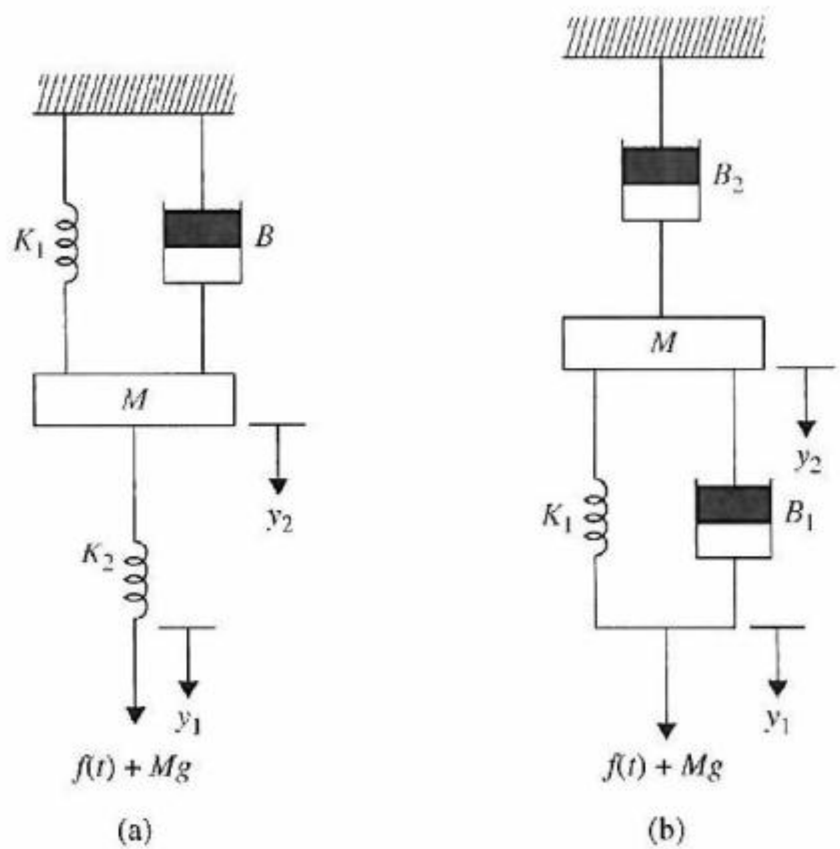
$$\dot{x}_1(t) = \frac{-1}{x_2^2(t)} \tag{4-266}$$

$$\dot{x}_2(t) = u(t)x_1(t) \tag{4-267}$$

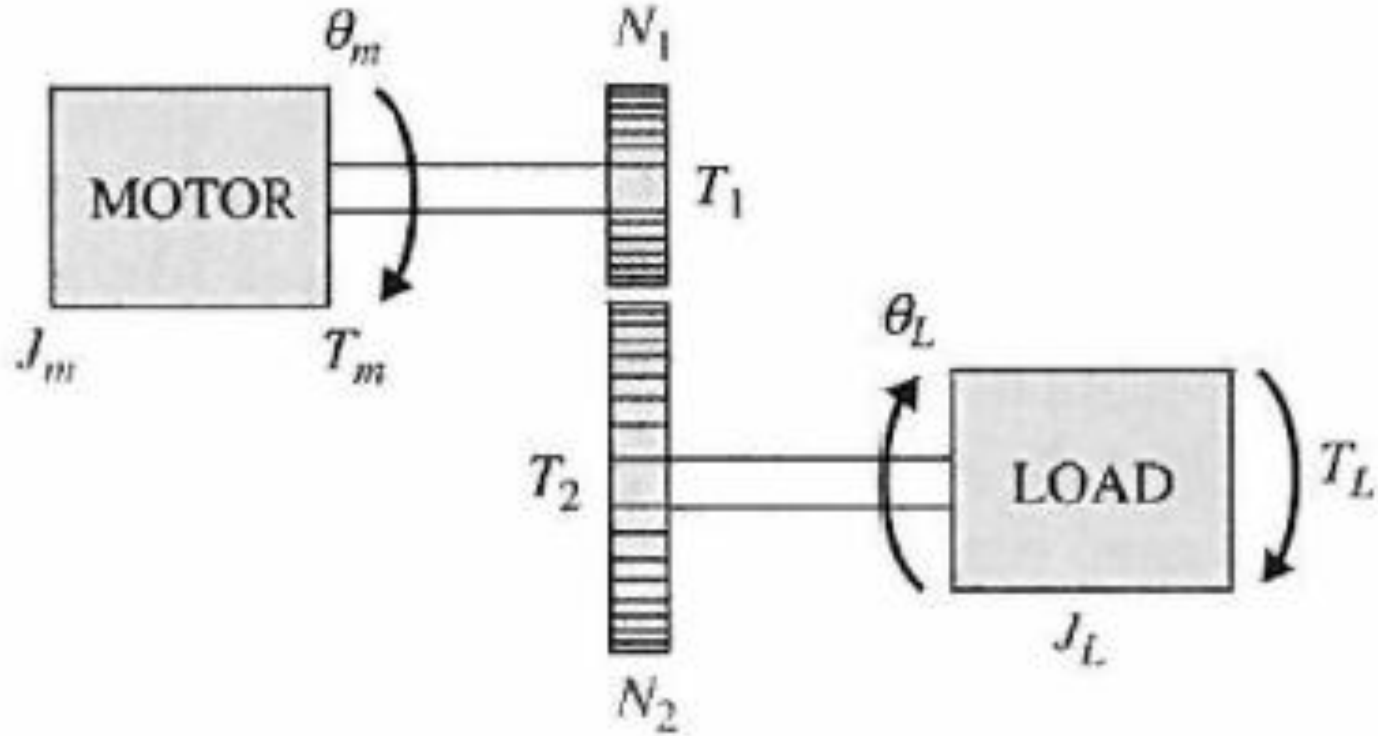
These equations are to be linearized about the nominal trajectory $[x_{01}(t), x_{02}(t)]$, which is the solution to the equations with initial conditions $x_1(0) = x_2(0) = 1$ and input $u(t) = 0$.

Linealizar para t = 0

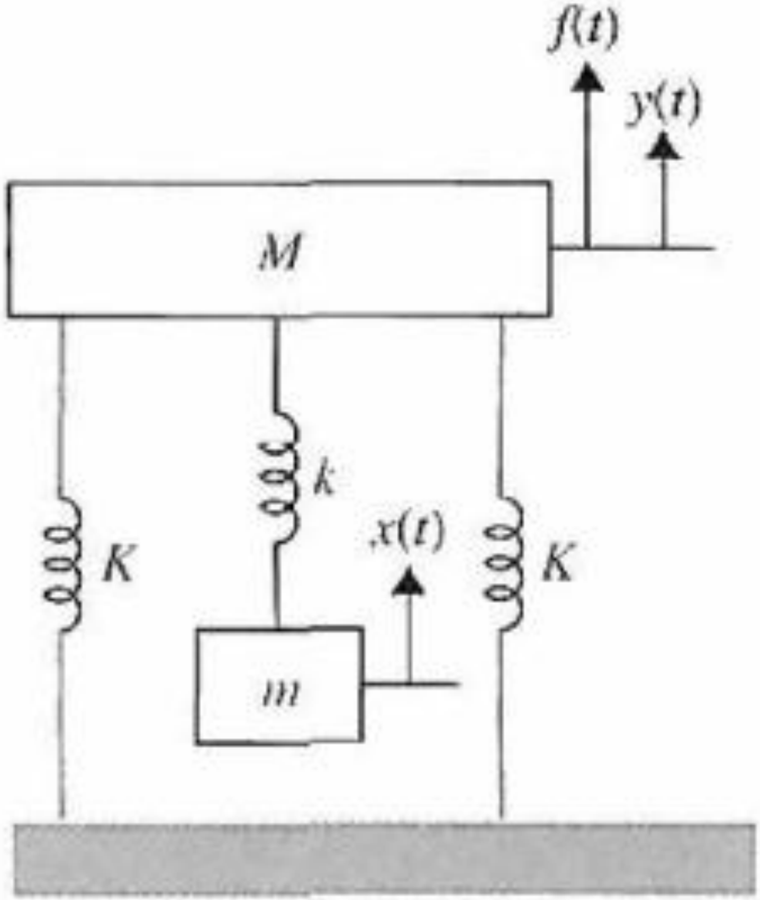
Ejercicios



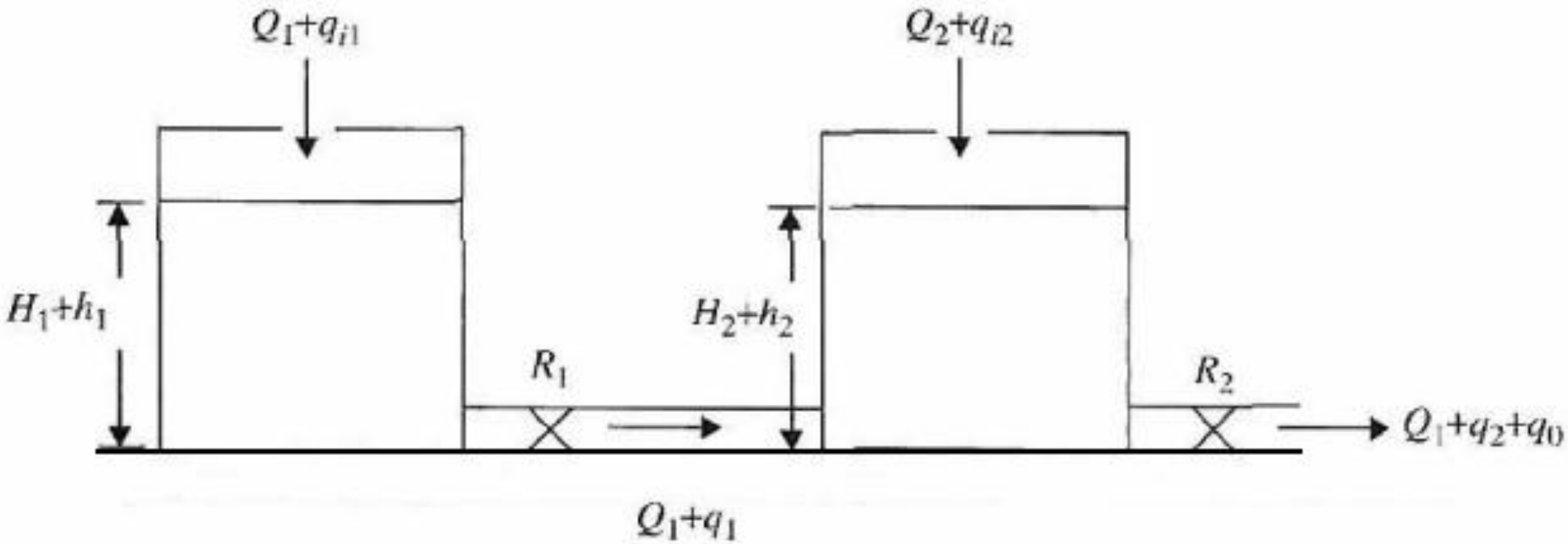
Ejercicios



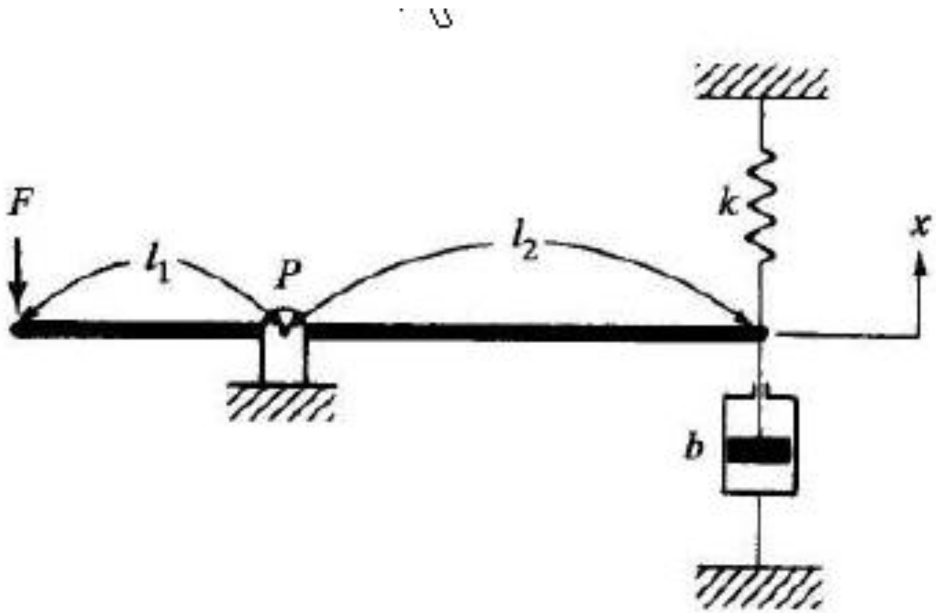
Ejercicios



Ejercicios



Ejercicios



In the mechanical system of Figure 3–28, one end of the lever is connected to a spring and a damper, and a force F is applied to the other end of the lever. Derive a mathematical model of the system. Assume that the displacement x is small and the lever is rigid and massless.

Ejercicios

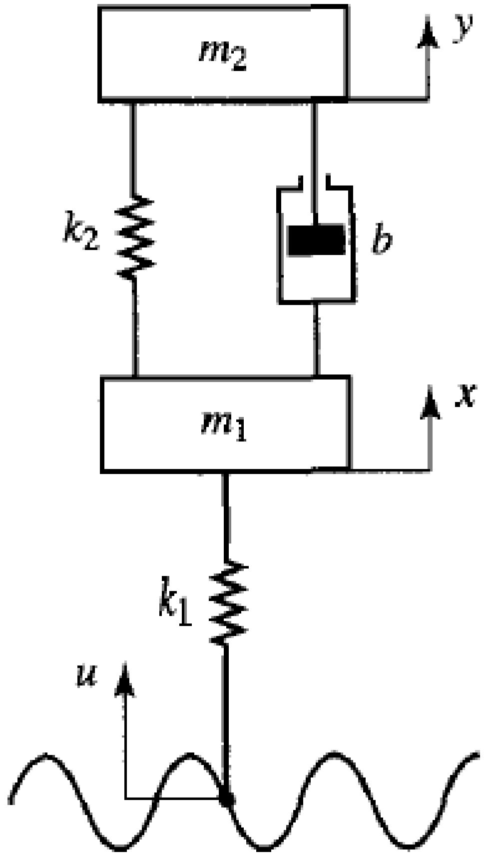
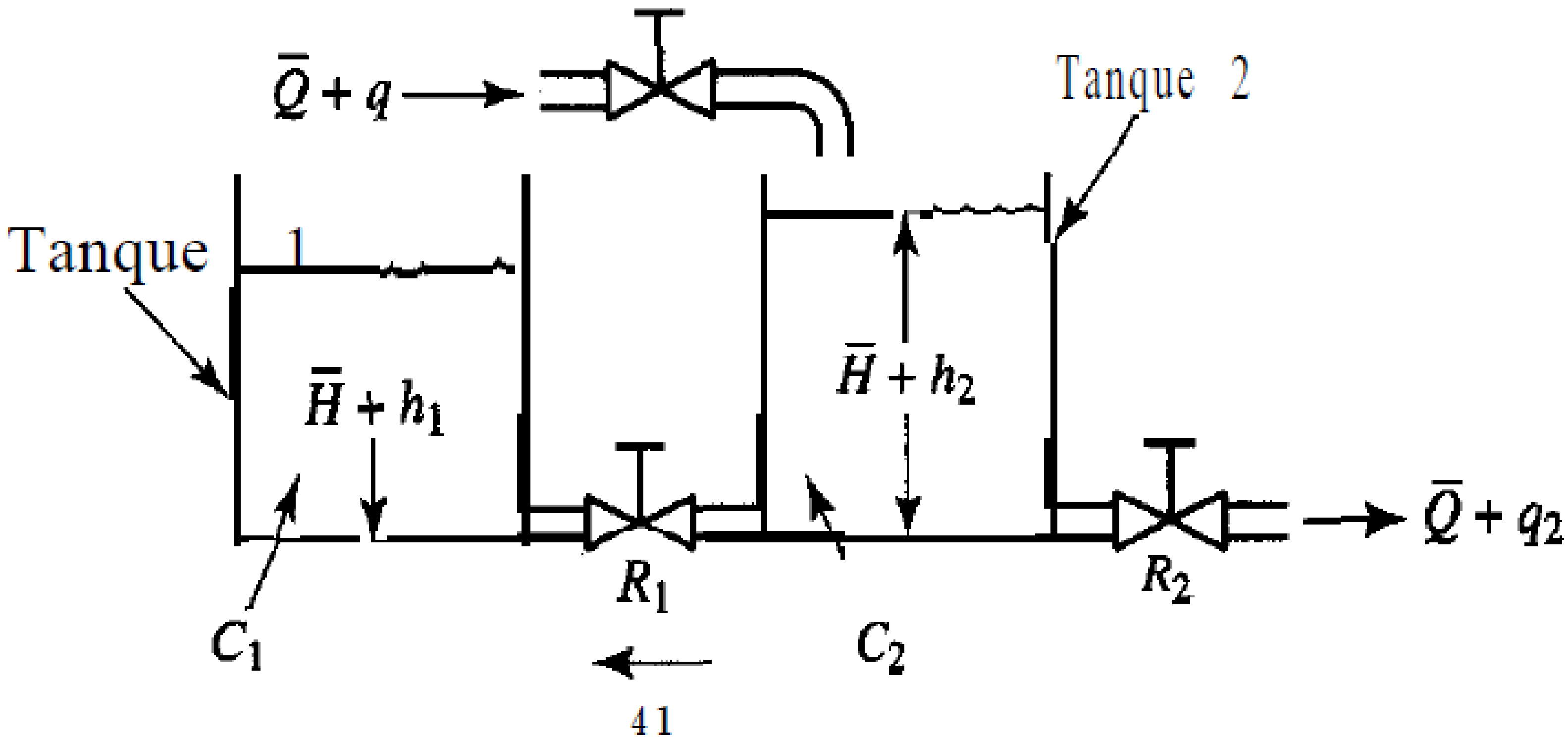


Figura 3–36
Sistema de suspensión.

Ejercicios



Ejercicios

Dado el sistema cuya ecuación diferencial es:

$$y = 3x^2 + 4x \cdot \dot{x} + \text{sen}(x) + 2$$

Linealizar en torno al punto de equilibrio dado por $x_0 = \pi/2$.