

APPENDIX FOR ANALOGOUS SYSTEMS

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Analogous systems of electrical-mechanical systems are like a common language that bridges the gap between electrical and mechanical engineering. They allow us to understand and predict how different components interact, whether they're electrical circuits or mechanical machines. By recognizing similarities between electrical and mechanical elements, engineers can solve problems more efficiently and design better systems. This approach encourages collaboration between specialists from different fields and helps us develop innovative solutions that seamlessly integrate both electrical and mechanical aspects.

ELECTRICAL ANALOGIES OF MECHANICAL SYSTEMS:

Two systems are said to be analogous if :

- 1) The two systems are physically different.
- 2) Differential equation modelling of these two systems are same.

There are two types of electrical analogies of translational mechanical systems:

- 1) Force-Voltage analogy
- 2) Force-Current analogy

FORCE-VOLTAGE ANALOGY:

In this, the mathematical equations of translational mechanical system are compared with mesh equations of the electrical system.

Translational Mechanical System	Electrical System
Force(F)	Voltage(V)
Mass(M)	Inductance (L)
Frictional coefficient(B)	Resistance(R)
Spring constant(K)	Reciprocal of Capacitance(1/C)
Displacement(x)	Charge(q)
Velocity(v)	Current(i)

TABLE 2
INPUT PARAMETERS

Example:

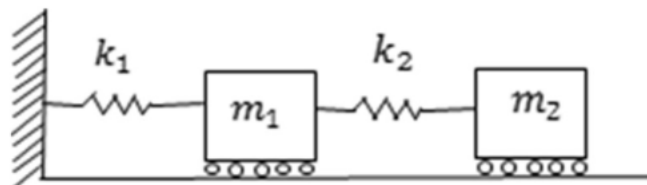


Fig. 2.

Equations of translational mechanical system:

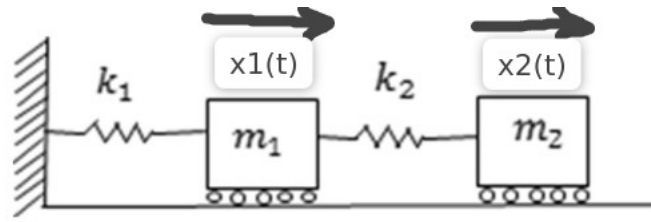


Fig. 2.

$$m_1 \ddot{x}_1(t) - k_2 (x_2(t) - x_1(t)) + k_1 x_1(t) = 0 \quad (1)$$

$$m_2 \ddot{x}_2(t) + k_2 (x_2(t) - x_1(t)) = 0 \quad (2)$$

Mesh equations of electrical system:

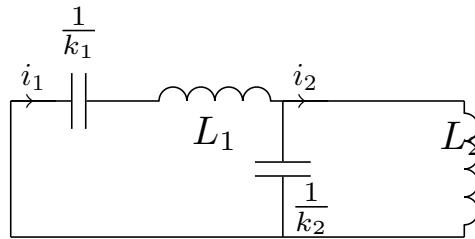


Fig. 2.

$$k_1 \int i_1 dt + L_1 \frac{di_1}{dt} + k_2 \int (i_1 - i_2) dt = 0 \quad (3)$$

$$L_2 \frac{di_2}{dt} - k_2 \int (i_1 - i_2) dt = 0 \quad (4)$$

but we know, $i = \frac{dq}{dt}$

$$\Rightarrow L_1 \ddot{q}_1 - k_2 (q_2 - q_1) + k_1 q_1 = 0 \quad (5)$$

$$\Rightarrow L_2 \ddot{q}_2 + k_2 (q_2 - q_1) dt = 0 \quad (6)$$

FORCE-CURRENT ANALOGY:

In this , the mathematical equations of the translational mechanical system are compared with the nodal equations of the electrical system.

Translational Mechanical System	Electrical System
Force(F)	Current(i)
Mass(M)	Capacitance(C)
Frictional coefficient(B)	Reciprocal of Resistance(1/R)
Spring constant(K)	Reciprocal of Inductance(1/L)
Displacement(x)	Magnetic Flux(ψ)
Velocity(v)	Voltage(V)

TABLE 2
INPUT PARAMETERS