# APPENDIX FOR ANALOGOUS SYSTEMS

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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.

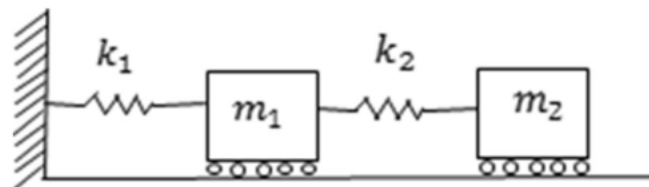| Translational Mechanical System | Electrical System |
|---|---|
| Force(F) | Voltage(V) |
| Mass(M) | Inductance (L) |
| Frictional coefficient(B) | Resistance(R) |
| Spring constant(K) | Reciprocal of Capacitance(1/C) |
| Displacement(x) | Charge(q) |
| Velocity(v) | Current(i) |

TABLE 2

INPUT PARAMETERS

Example:



Fig. 2.

Equations of translational mechanical system:
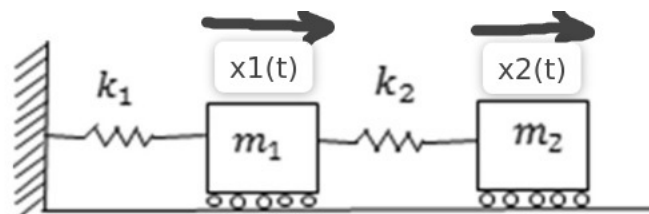


Fig. 2.

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

$$m_2 \ddot{x}_2(t) + k_2 (x_2(t) - x_1(t)) = 0 \tag{2}$$
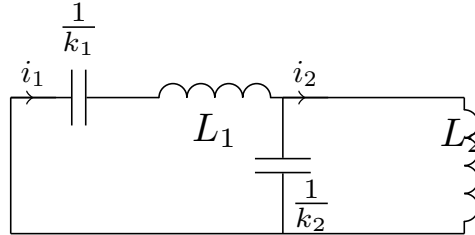
Mesh equations of electrical system:



Fig. 2.

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

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

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

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

$$\implies L_2 \ddot{q}_2 + k_2 (q_2 - q_1) \, dt = 0 \tag{6}$$

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($\psi$) |
| Velocity(v) | Voltage(V) |

TABLE 2

INPUT PARAMETERS