ELECTRICAL ANALOGOUS OF MECHANICAL SYSTEMS

Systems remain analogous as long as the differential equations governing the systems or transfer functions are in ideal form.
Since the electrical systems are two types of inputs either voltage or current source, there are two types of analogies -force voltage analogy/ torque voltage analogy and force current analogy/ torque current analogy.

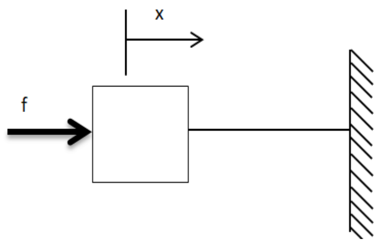
Force / torque voltage analogy -Each junction in the mechanical system response to a closed loop which consists of electrical excitation sources and passive elements analogous to the mechanical driving source and passive elements connected to the junction
Force / torque current analogy -Each junction in the mechanical system corresponds to a node which joins electrical excitation sources and passive elements analogous to the mechanical driving sources and passive elements connected to the junction

Force Voltage Analogy

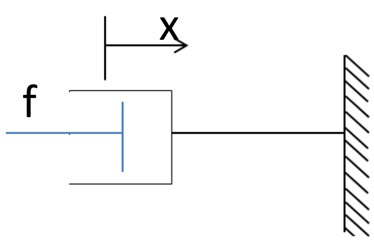
Mechanical system

I/P : Force

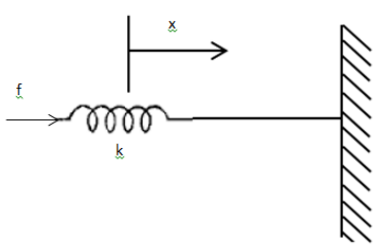
O/P : Velocity



$$f = M \frac{dx^2}{dt} = M\frac{dv}{dt}$$



$$f = B\,\frac{dx}{dt} = Bv$$

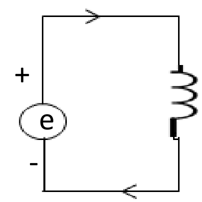


$$f = kx = k \int v\,dt$$

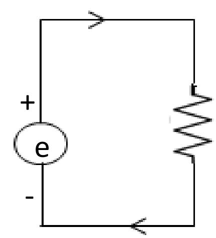
Electrical system

I/P : Voltage Source

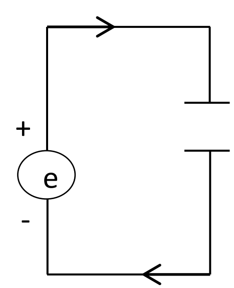
O/P : Current through element



$$e = L\,\frac{di}{dt}$$



$$f = i\,R$$



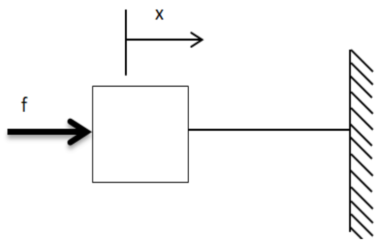
$$f = \frac{1}{C}\int idt$$

Force Current Analogy

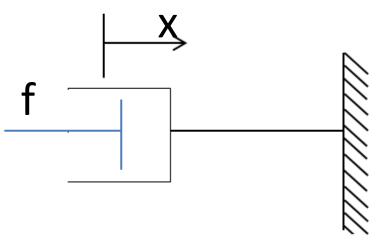
Mechanical system

I/P : Force

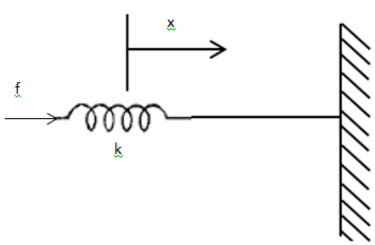
O/P : Velocity



$$f = M\frac{d^2x}{dt^2} = M\frac{dv}{dt}$$



$$f = B\frac{dx}{dt} = Bv$$

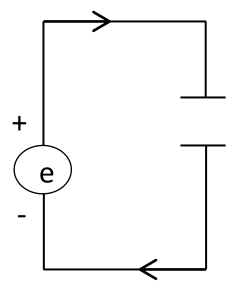


$$f = kx = k\int v\,dt$$

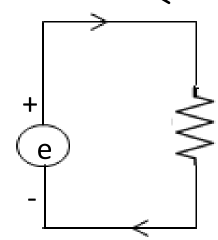
Electrical system

I/P : Current Source

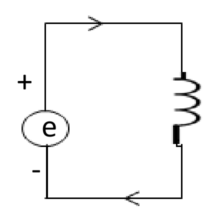
O/P : Current through element



$$i = C\frac{dv}{dt}$$



$$i = \frac{V}{R}$$



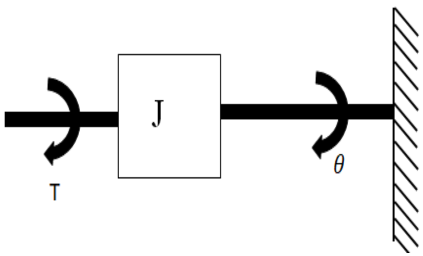
$$i = \frac{1}{L}\int V dt$$

Torque Voltage Analogy

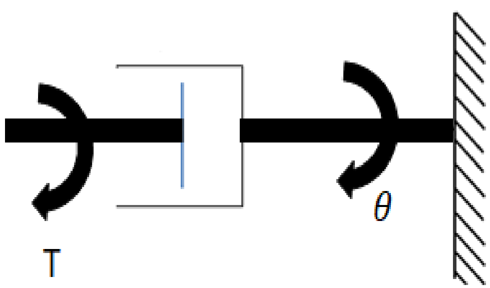
Mechanical system

I/P : Torque

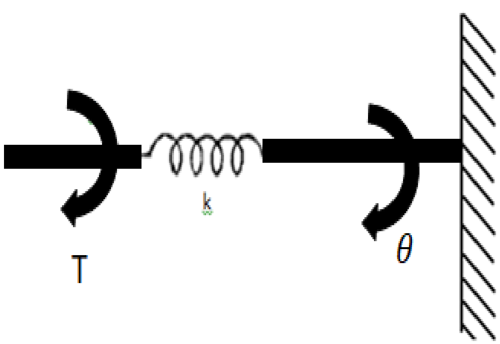
O/P : Angular Velocity



$$T = J\,\frac{d^2\theta}{dt^2} = J\frac{\omega}{dt}$$



$$T = B\,\frac{d\theta}{dt} = B\omega$$

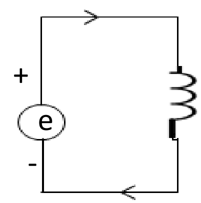


$$T = k\theta = k\int \omega\, dt$$

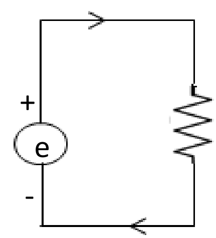
Electrical system

I/P : Voltage

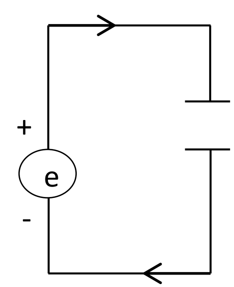
O/P : Current through element



$$e = L\,\frac{di}{dt}$$



$$e = iR$$



$$e = \frac{1}{C}\int i dt$$

Torque Current Analogy

Mechanical system

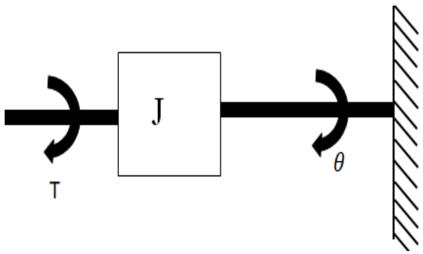
I/P : Torque

O/P : Angular Velocity

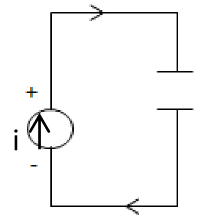
Electrical system

I/P : Current Source

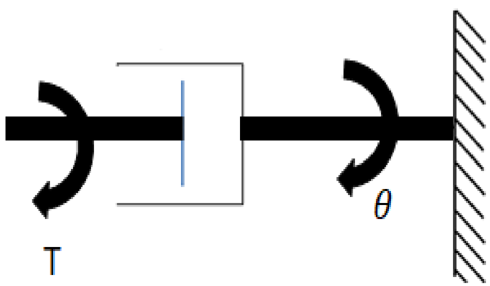
O/P : Voltage across the element



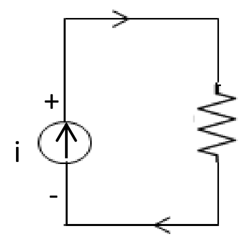
$$T = J\frac{d^2\theta}{dt^2} = J\frac{\omega}{dt}$$



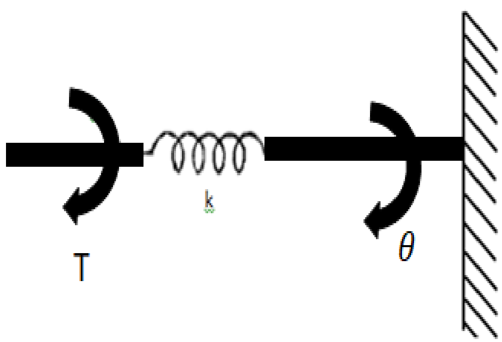
$$i = C\frac{dV}{dt}$$



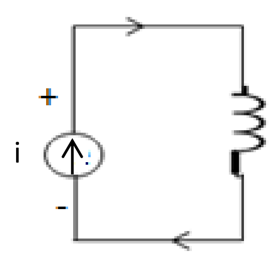
$$T = B\frac{d\theta}{dt} = B\omega$$



$$i = V R$$



$$T = k\theta = k\int \omega \, dt$$



$$i = \frac{1}{L}\int V dt$$