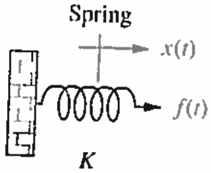
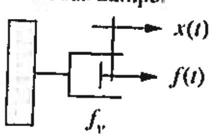
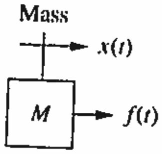
COMPARE ELECTRICAL + MECHANICAL SYSTEMS

Table 2.3 Voltage-current, voltage-charge, and impedance relationships for capacitors, resistors, and inductors

Component	A₁ Voltage-current	A₂ Current-voltage	B Voltage-charge	Impedance $Z(s) = V(s)/I(s)$	Admittance $Y(s) = I(s)/V(s)$
Capacitor	$v(t) = \frac{1}{C}\int_0^t i(\tau)\,d\tau$	$i(t) = C\frac{dv(t)}{dt}$	$v(t) = \frac{1}{C}q(t)$	$\frac{1}{Cs}$	Cs
Resistor	$v(t) = Ri(t)$	$i(t) = \frac{1}{R}v(t)$	$v(t) = R\frac{dq(t)}{dt}$	R	$\frac{1}{R} = G$
Inductor	$v(t) = L\frac{di(t)}{dt}$	$i(t) = \frac{1}{L}\int_0^t v(\tau)\,d\tau$	$v(t) = L\frac{d^2q(t)}{dt^2}$	Ls	$\frac{1}{Ls}$

Note: The following set of symbols and units is used throughout this book: $v(t)$ = V (volts), $i(t)$ = A (amps), $q(t)$ = Q (coulombs), C = F (farads), R = Ω (ohms), G = ℧ (mhos), L = H (henries).

Table 2.4 Force-velocity, force-displacement, and impedance translational relationships for springs, viscous dampers, and mass

Component	A Force-velocity	B Force-displacement	Impedance $Z_M(s) = F(s)/X(s)$
Spring  $x(t)$, $f(t)$, K	$f(t) = K\int_0^t v(\tau)\,d\tau$	$f(t) = Kx(t)$	K
Viscous damper  $x(t)$, $f(t)$, f_v	$f(t) = f_v v(t)$	$f(t) = f_v\frac{dx(t)}{dt}$	$f_v s$
Mass  $x(t)$, M, $f(t)$	$f(t) = M\frac{dv(t)}{dt}$	$f(t) = M\frac{d^2x(t)}{dt^2}$	Ms^2

Note: The following set of symbols and units is used throughout this book: $f(t)$ = N (newtons), $x(t)$ = m (meters), $v(t)$ = m/s (meters/second), K = N/m (newtons/meter), f_v = N-s/m (newton-seconds/meter), M = kg (kilograms = newton-seconds²/meter).

ENERGY STORAGE

DISSAPATE ENERGY

MECH' MASS SPRING DAMPER

↕ ↕ ↕

ELE' - INDUCTOR CAPACITOR RESISTOR

FORCE ≈ VOLTAGE

VELOCITY ≈ CURRENT

ΣF (VELOCITY) ≈ KVL (LOOP)