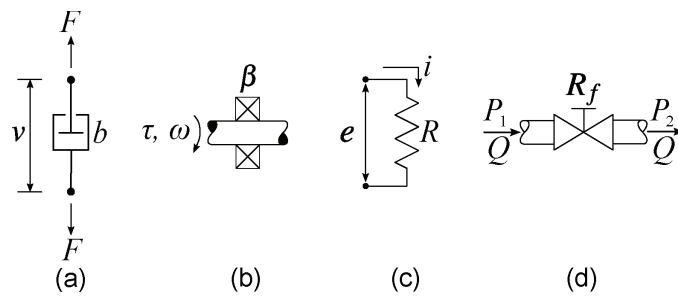


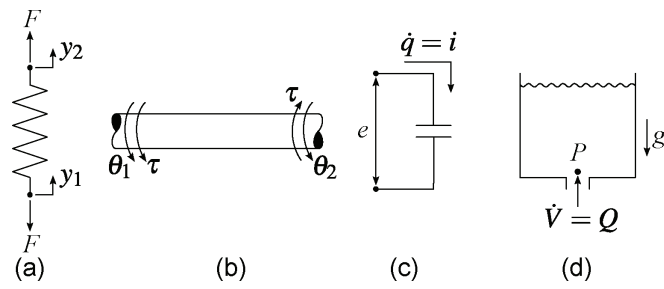
**FIGURE 2.1**

*One-port, R-element examples including (a) a mechanical damper, (b) a roller bearing, (c) an electric resistor, and (d) a hydraulic valve.*



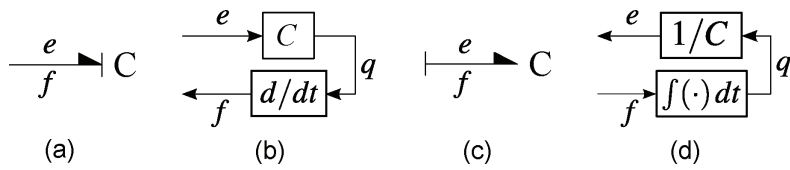
**FIGURE 2.3**

*One-port, C-element examples including (a) a spring, (b) a torsion shaft, (c) an electric capacitor, and (d) a hydraulic accumulator.*



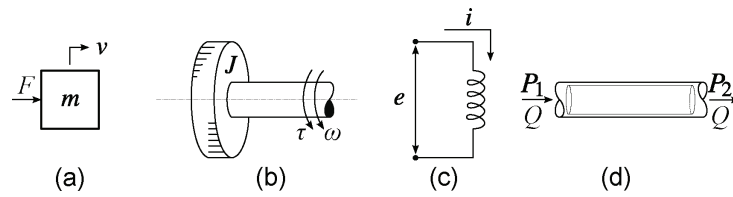
**FIGURE 2.4**

*Linear, 1-port, C-element representations including (a) a derivative causality bond graph, (b) a derivative causality block diagram, (c) an integral causality bond graph, and (d) an integral causality block diagram.*



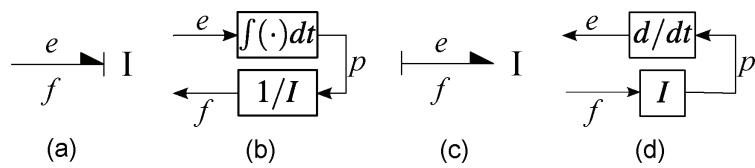
**FIGURE 2.5**

*One-port I-element examples including (a) a mass, (b) a rotational inertia, (c) an inductor, and (d) a slug of fluid.*



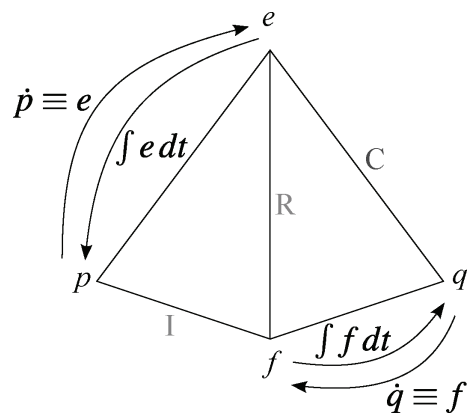
**FIGURE 2.6**

*Linear, 1-port, I-element representations including (a) an integral causality bond graph, (b) an integral causality block diagram, (c) a derivative causality bond graph, and (d) a derivative causality block diagram.*



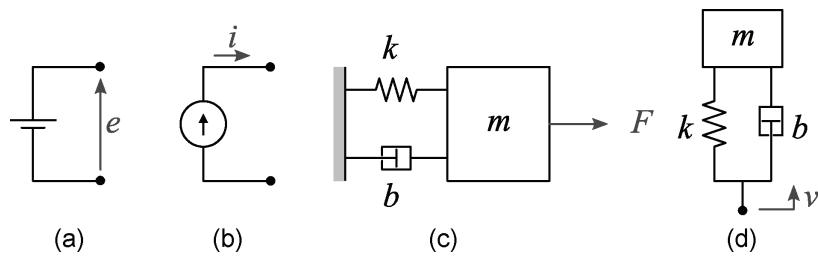
**FIGURE 2.7**

*Tetrahedron of state and the 1-port elements (redrawn from Paynter (1961) and Karnopp, Margolis, and Rosenberg (2000)).*



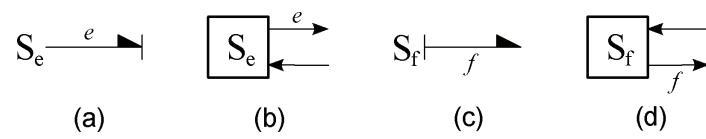
**FIGURE 2.8**

*Effort and flow source examples including (a) a voltage source, (b) a current source, (c) an external force input, and (d) an external velocity input.*



**FIGURE 2.9**

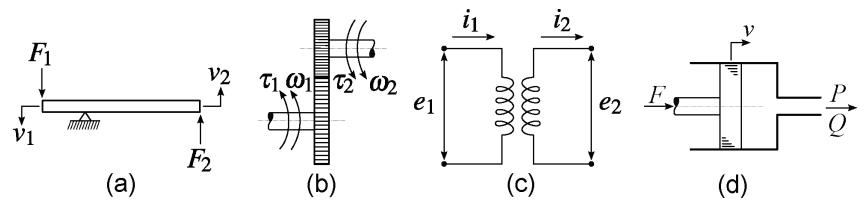
*Effort and flow source element representations including (a) an effort source bond graph, (b) an effort source block diagram, (c) a flow source bond graph, and (d) a flow source block diagram.*





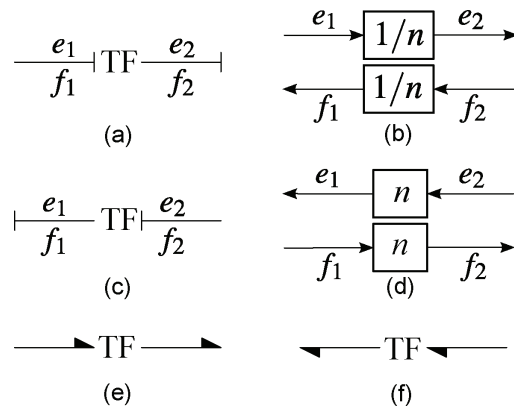
**FIGURE 2.10**

*TF-element examples including (a) a rigid lever, (b) a gear pair, (c) an electrical transformer, and (d) a hydraulic ram.*



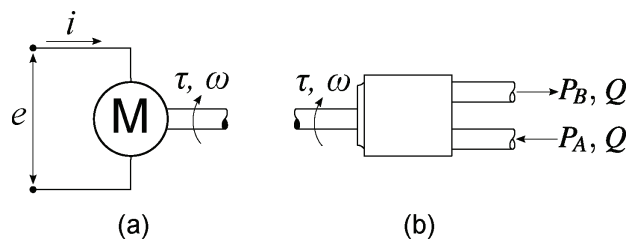
**FIGURE 2.11**

*TF-element representation including (a) an effort-in-effort-out bond graph, (b) an effort-in-effort-out block diagram, (c) a flow-in-flow-out bond graph, (d) a flow-in-flow-out block diagram, (e) a power-in-power-out bond graph, and (f) a power-out-power-in bond graph.*



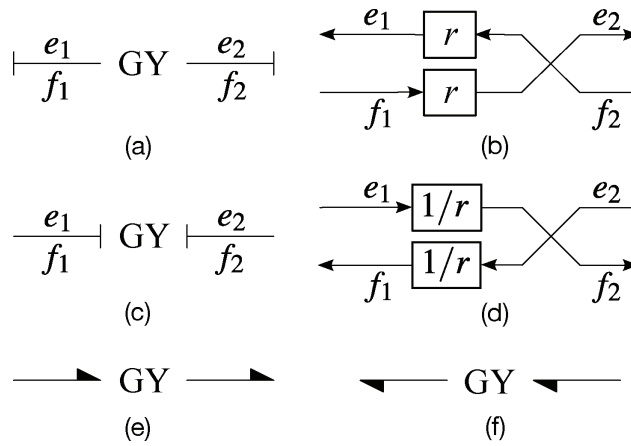
**FIGURE 2.12**

*GY-element examples including (a) an ideal electric motor and (b) an ideal centrifugal pump.*



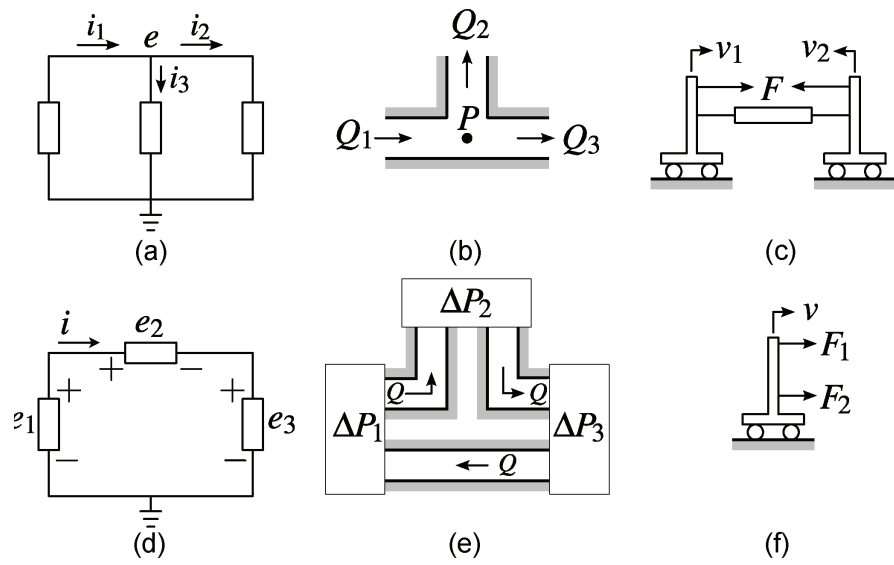
**FIGURE 2.13**

*GY-element representations including (a) a flow-in-effort-out bond graph, (b) a flow-in-effort-out block diagram, (c) an effort-in-flow-out bond graph, (d) an effort-in-flow-out block diagram, (e) a power-in-power-out bond graph, and (f) a power-out-power-in bond graph.*



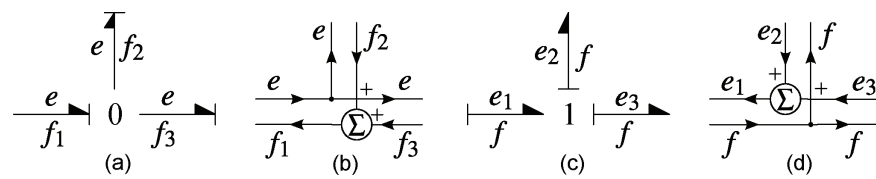
**FIGURE 2.14**

*(a)-(c) 0-junction examples and (d)-(f) 1-junction examples.*



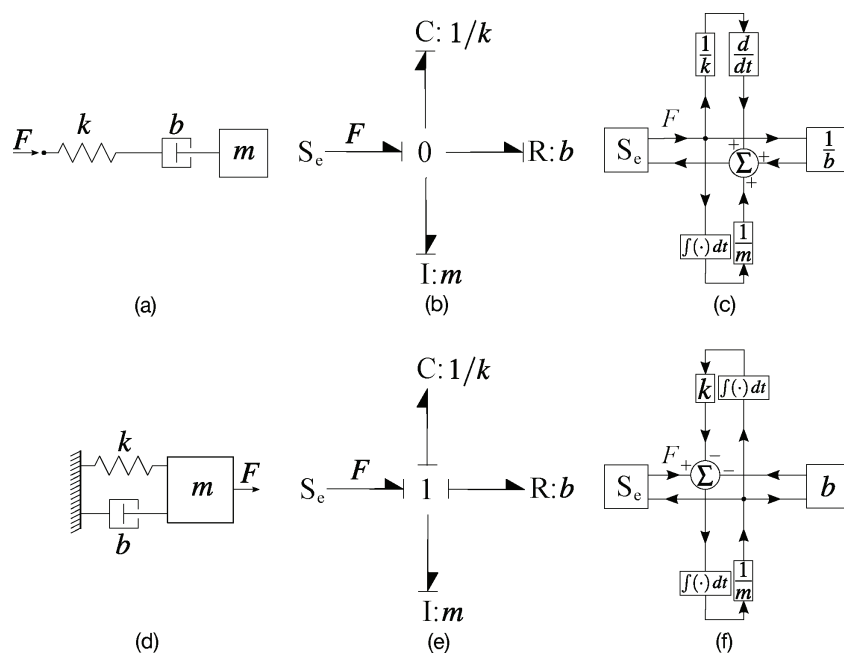
**FIGURE 2.15**

(a) 0-junction bond graph, (b) 0-junction block diagram, (c) 1-junction bond graph, and (d) 1-junction block diagram.



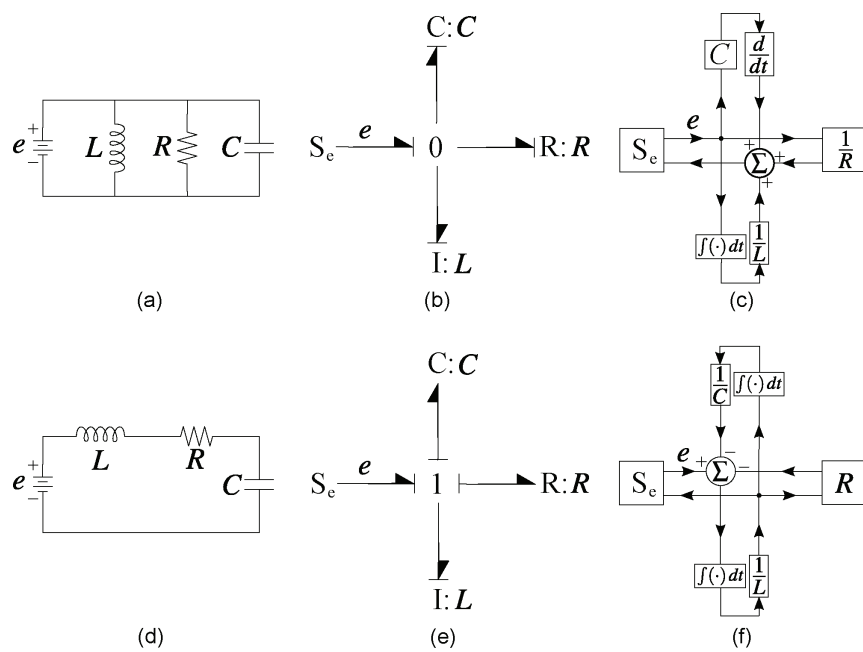
**FIGURE 2.16**

(a)-(b) Schematic, bond graph, and block diagram for common effort mass-spring-damper system; (d)-(f) schematic, bond graph, and block diagram for a common flow mass-spring-damper system.



**FIGURE 2.17**

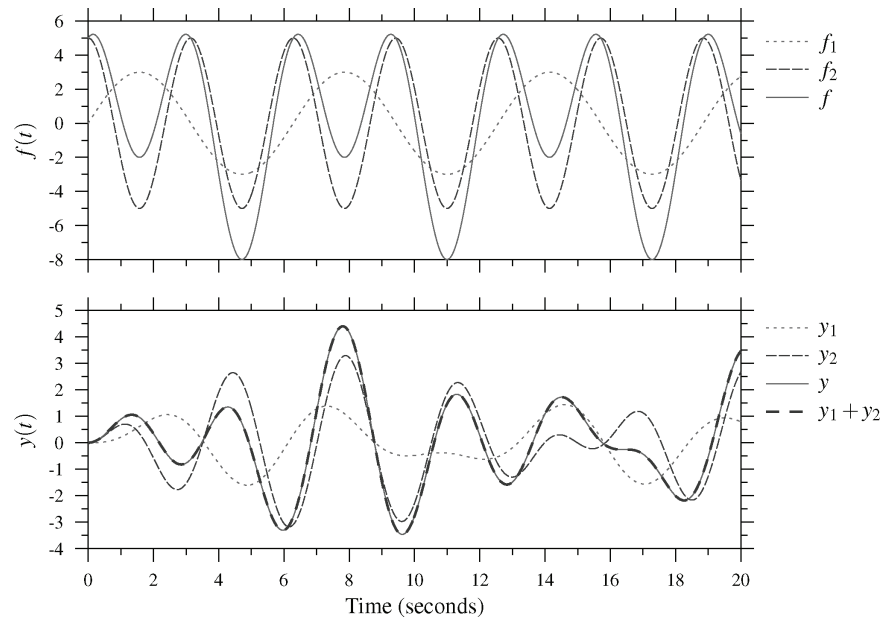
(a)-(b) Schematic, bond graph, and block diagram for common effort electrical circuit; (d)-(f) schematic, bond graph, and block diagram for a common flow electrical circuit.





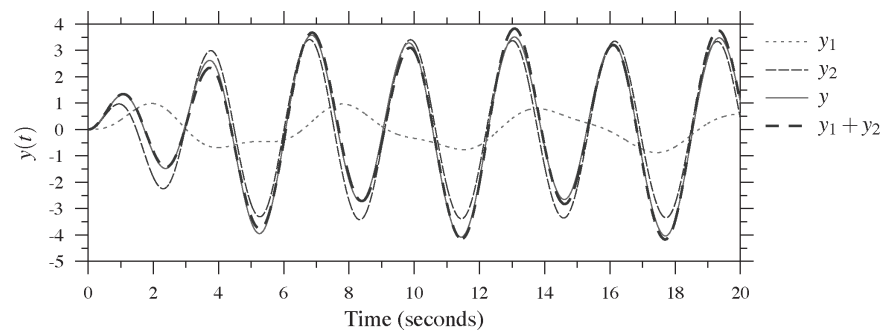
**FIGURE 2.18**

*An illustration of the additive and homogenous properties of linear systems.*



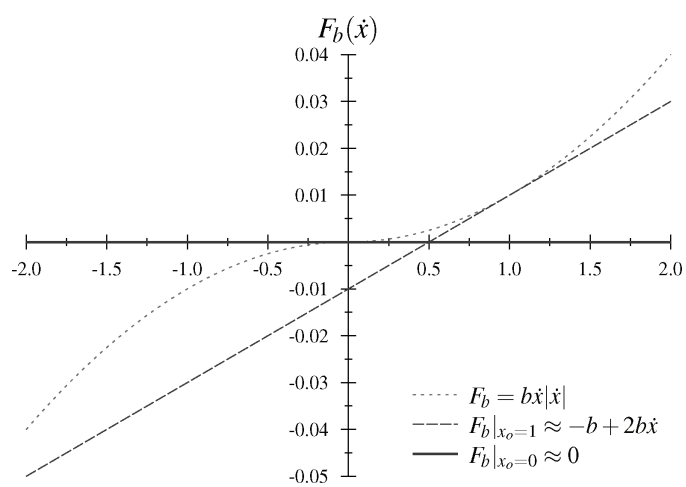
**FIGURE 2.19**

*An illustration of how nonlinear systems do not obey additive and homogenous properties.*



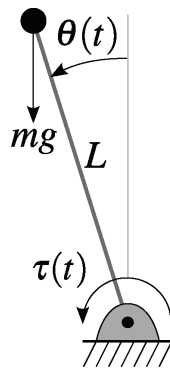
**FIGURE 2.20**

*The nonlinear damping force and its approximations at two operating points.*



**FIGURE 2.21**

*An inverted pendulum.*



**FIGURE 2.22**

*Nonlinear friction model.*

