Module I: DC Circuits 6 Hrs

Basic circuit elements and sources; Ohms law, Kirchhoff's laws; Series and parallel connection of circuit elements; Source transformation; Node voltage analysis; Mesh current analysis; Maximum power transfer theorem

CO1:

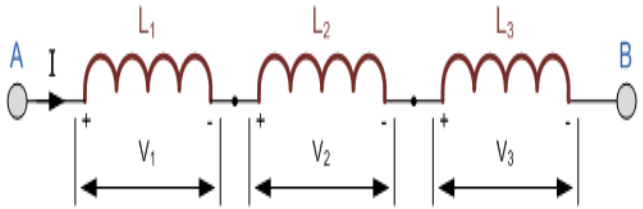
Evaluate DC and AC circuit parameters using various laws and theorems

Module 1

Evaluate DC circuit parameters using various laws and theorems

Inductances in series

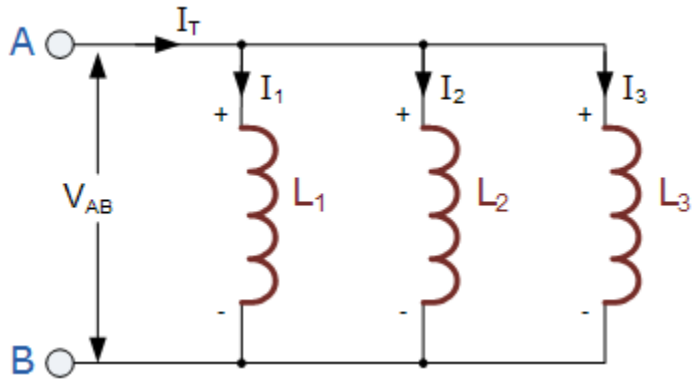
- Voltage across the inductor
  $V = L di/dt$
- In a series circuit, $V = V_1+V_2+V_3$



- In a series circuit, Current remains same (I)
- $V = L_1 di/dt + L_2 di/dt + L_3 di/dt$
- $V = di/dt\ (L_1+L_2+L_3)$
- $V = L_{eq} di/dt$
- $L_{eq} = L_1+L_2+L_3$

Inductances in parallel

- Voltage across the inductor
  $V = L di/dt$
- In a parallel circuit,
  $I = I_1 + I_2 + I_3$



- In a parallel circuit, voltage remains same (V)
- $V = L_1 di_1/dt = L_2 di_2/dt = L_3 di_3/dt$
- $di_1/dt = V/L_1$; $I_1 = 1/L_1 \int V dt$
- $di_2/dt = V/L_2$; $I_2 = 1/L_2 \int V dt$
- $di_3/dt = V/L_3$; $I_3 = 1/L_3 \int V dt$

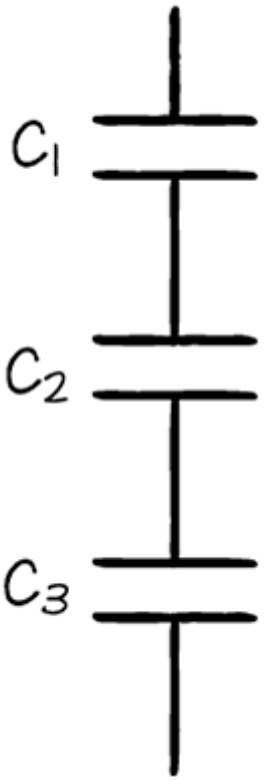
Inductances in parallel

- $I = I_1+I_2+I_3$
- $I = 1/L_1\int Vdt+1/L_2\int Vdt+ 1/L_3\int Vdt$
- $1/L_{eq}\int Vdt = 1/L_1\int Vdt+1/L_2\int Vdt+ 1/L_3\int Vdt$
- $1/L_{eq} = 1/L_1+I/L_2+1/L_3$

$$\frac{1}{L_T} = \frac{1}{L_1} + \frac{1}{L_2} + \frac{1}{L_3} \ldots\ldots + \frac{1}{L_N}$$

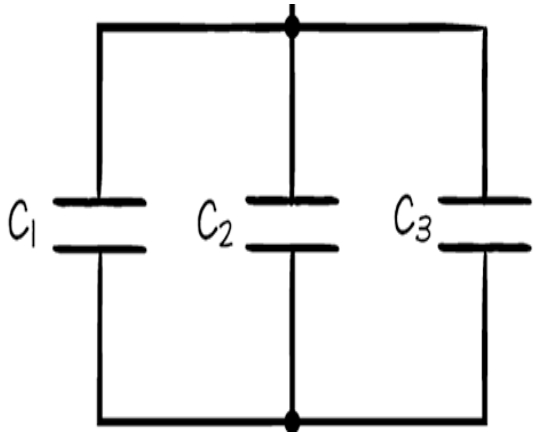
Capacitances in series

- $V_1 = 1/C_1 \int i dt$
- $V_2 = 1/C_2 \int i dt$
- $V_3 = 1/C_3 \int i dt$
- In a series circuit, $V = V_1+V_2+V_3$
- $V = 1/C_1 \int i dt + 1/C_2 \int i dt + 1/C_3 \int i dt$
- $V = (1/C_1+1/C_2+1/C_3) \int i dt$
- $V = 1/C_{eq} \int i dt$
- $1/C_{eq} = 1/C_1+1/C_2+1/C_3$



Capacitances in parallel

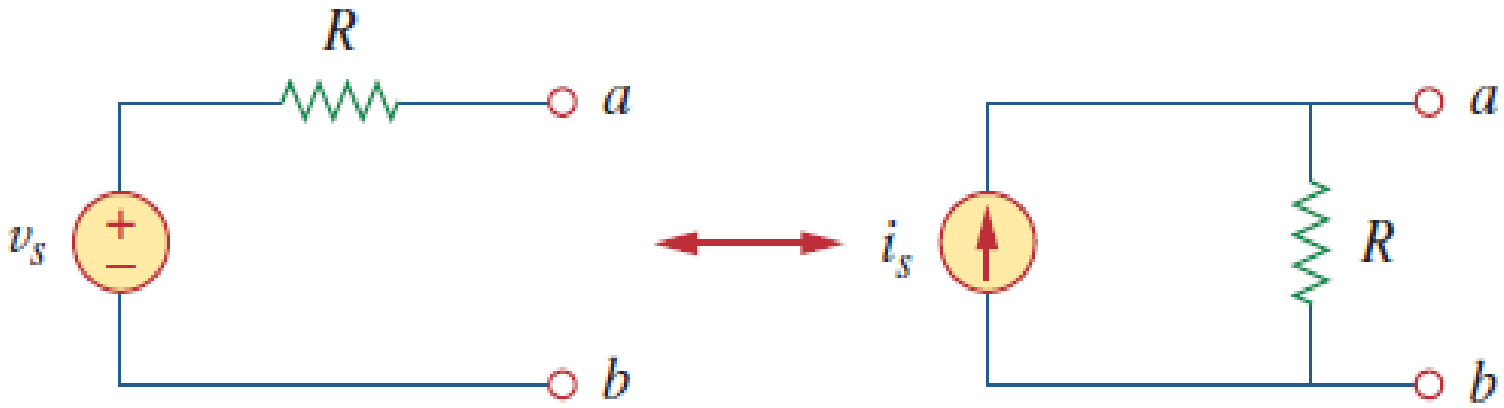
- Current through the capacitor
  $I = CdV/dt$
- In a parallel circuit,
  $I = I_1+I_2+I_3$
- $I_1 = C_1dV/dt$
- $I_2 = C_2dV/dt$
- $I_3 = C_3dV/dt$
- $I = C_1dV/dt+C_2dV/dt+C_3dV/dt$
- $I = (C_1+C_2+C_3)dV/dt$
- $C_{eq} = C_1+C_2+C_3$



Series and parallel connection of circuit elements

Elements Symbol	RESISTOR 	CAPACITOR 	INDUCTOR 
Denoted by	R	C	L
Equation	$R = \frac{V}{I}$	$C = \frac{Q}{V}$	$L = \frac{V_L}{(di/dt)}$
Series	$R_T = R_1 + R_2$	$\frac{1}{C_T} = \frac{1}{C_1} + \frac{1}{C_2}$	$L_T = L_1 + L_2$
Parallel	$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}$	$C_T = C_1 + C_2$	$\frac{1}{L_T} = \frac{1}{L_1} + \frac{1}{L_2}$

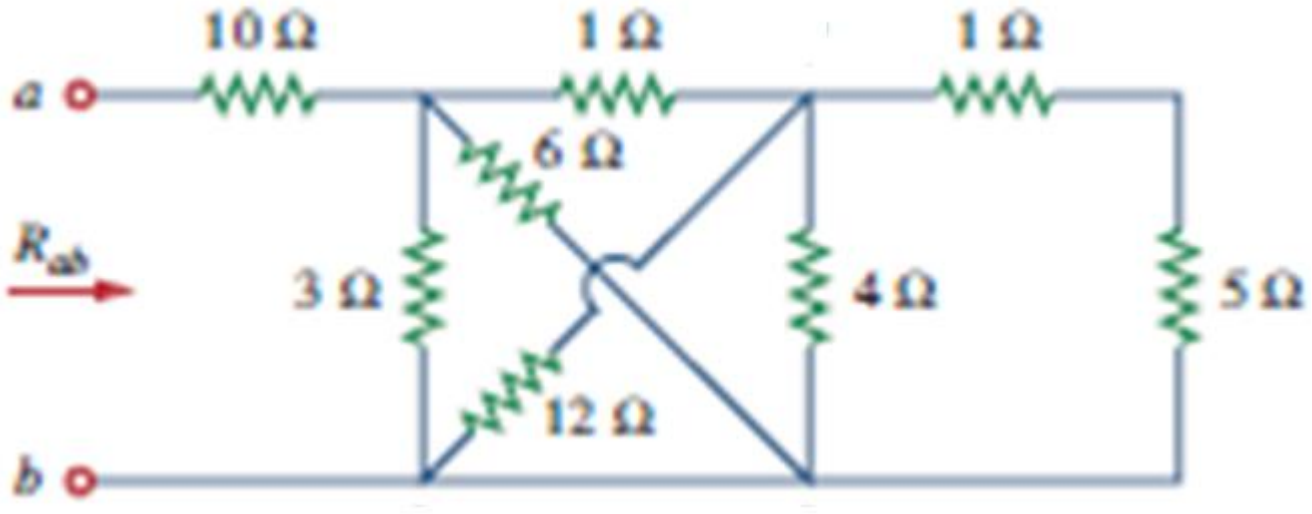
Source Transformation

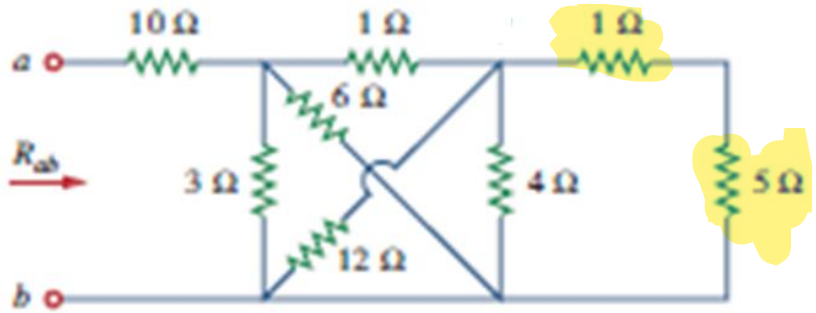


- Source transformation is the process of replacing a voltage source V_s in series with the resistor R by a current source I_s in parallel with a resistor R or vice versa
- Tool for simplifying circuits

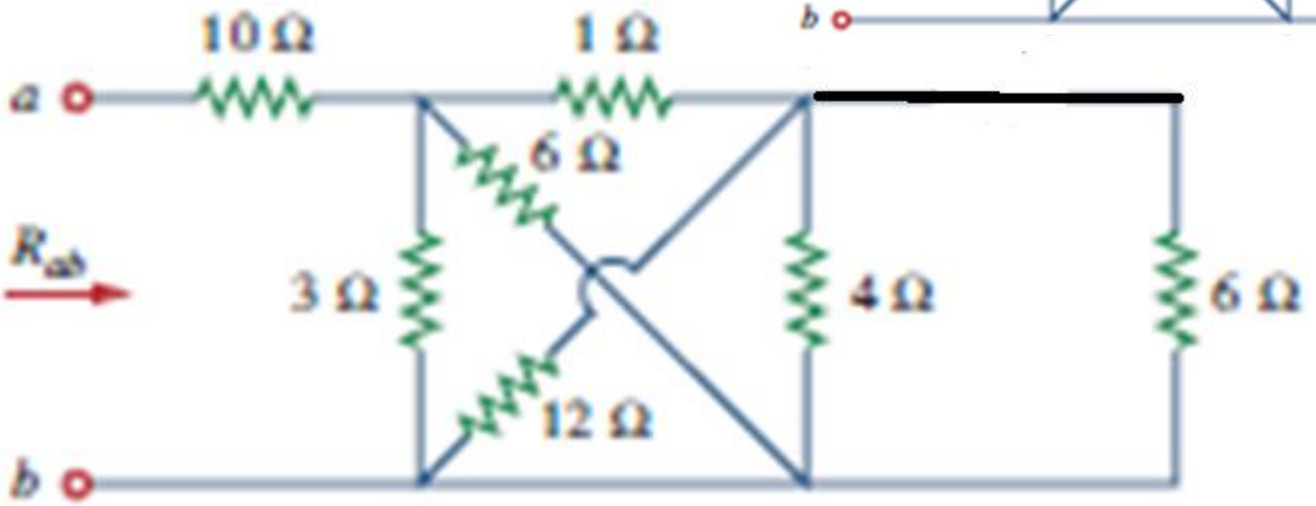
Simple problems

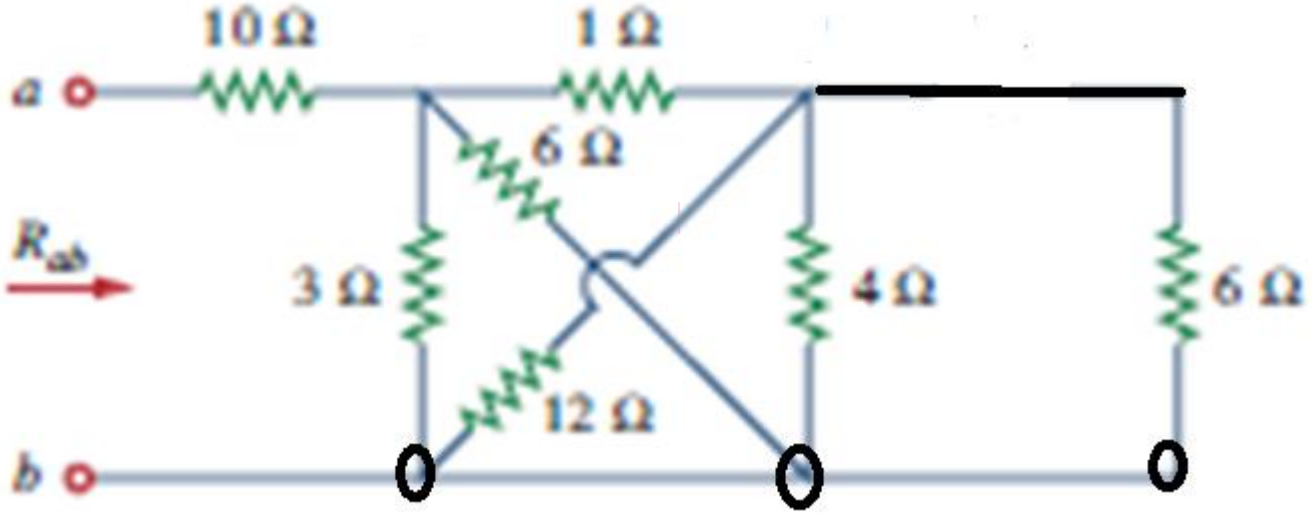
Find the equivalent resistance



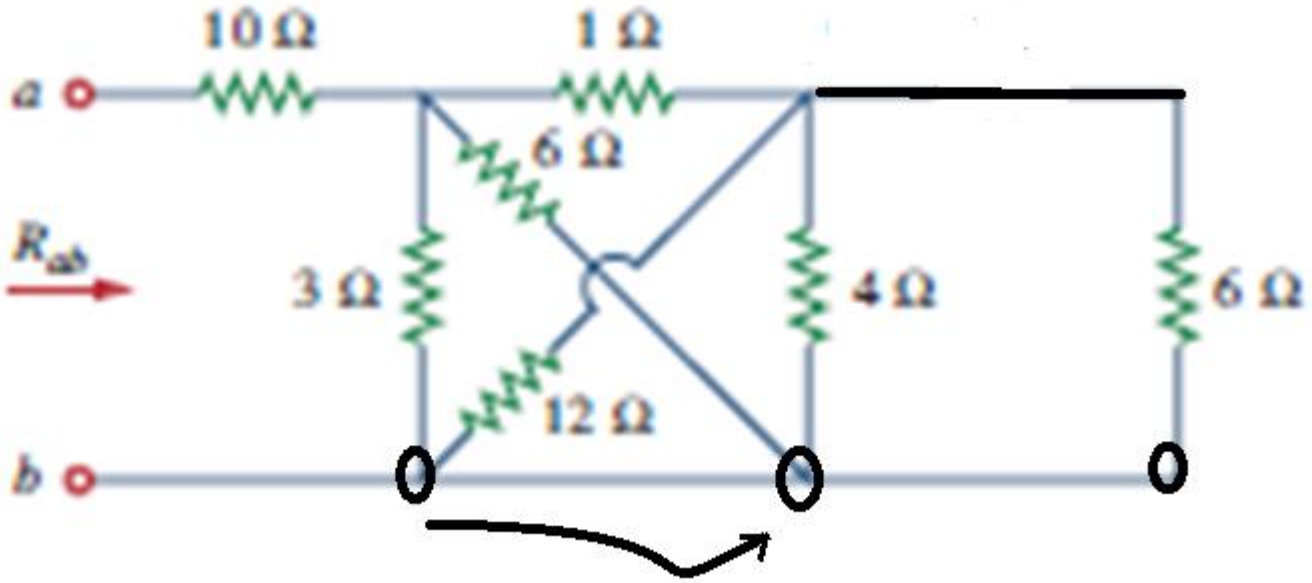


1 Ω and 5 Ω are in series





6 Ω, 4 Ω and 12 Ω are in parallel



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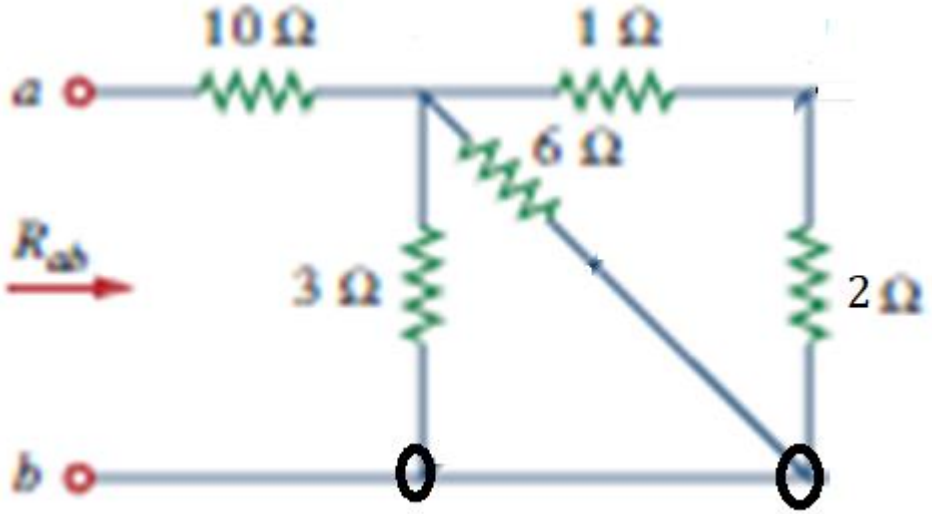
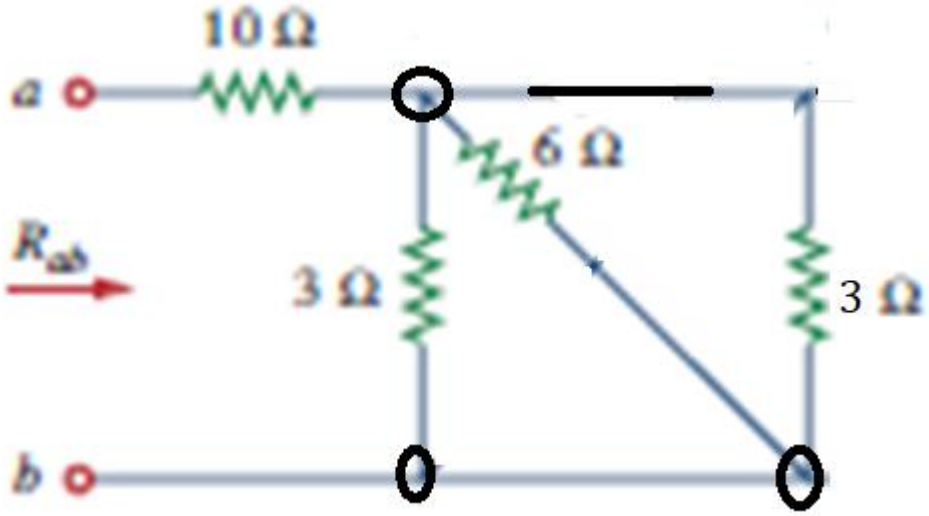
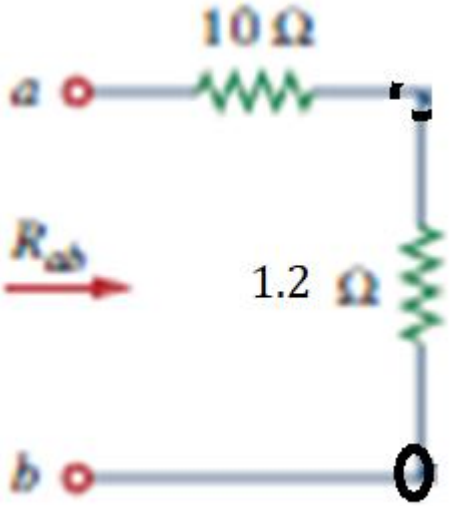


1 Ω and 2 Ω are in series



6 Ω, 3 Ω and 3 Ω are in parallel

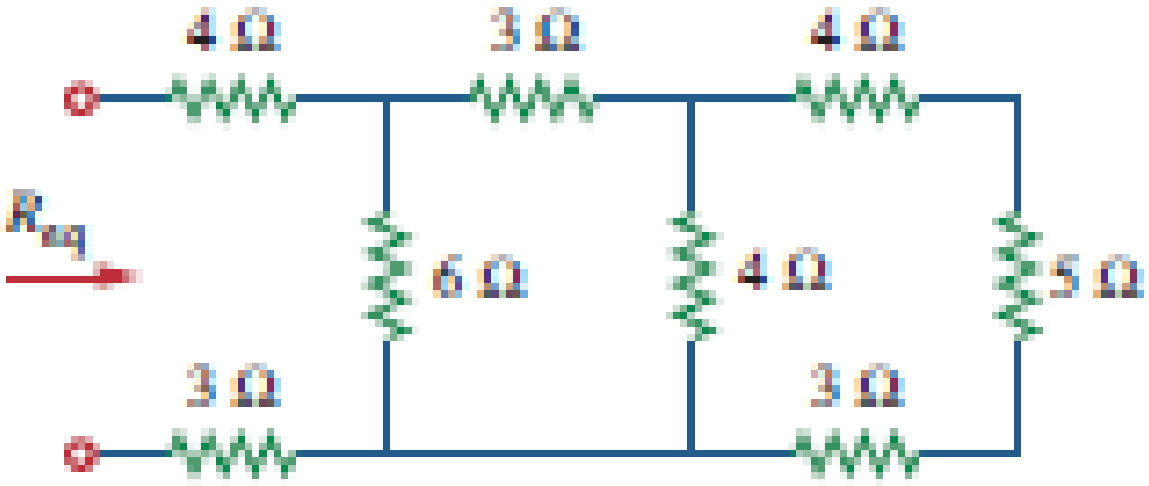


10 Ω and 1.2 Ω are in series

R_{ab} = 11.2 Ω

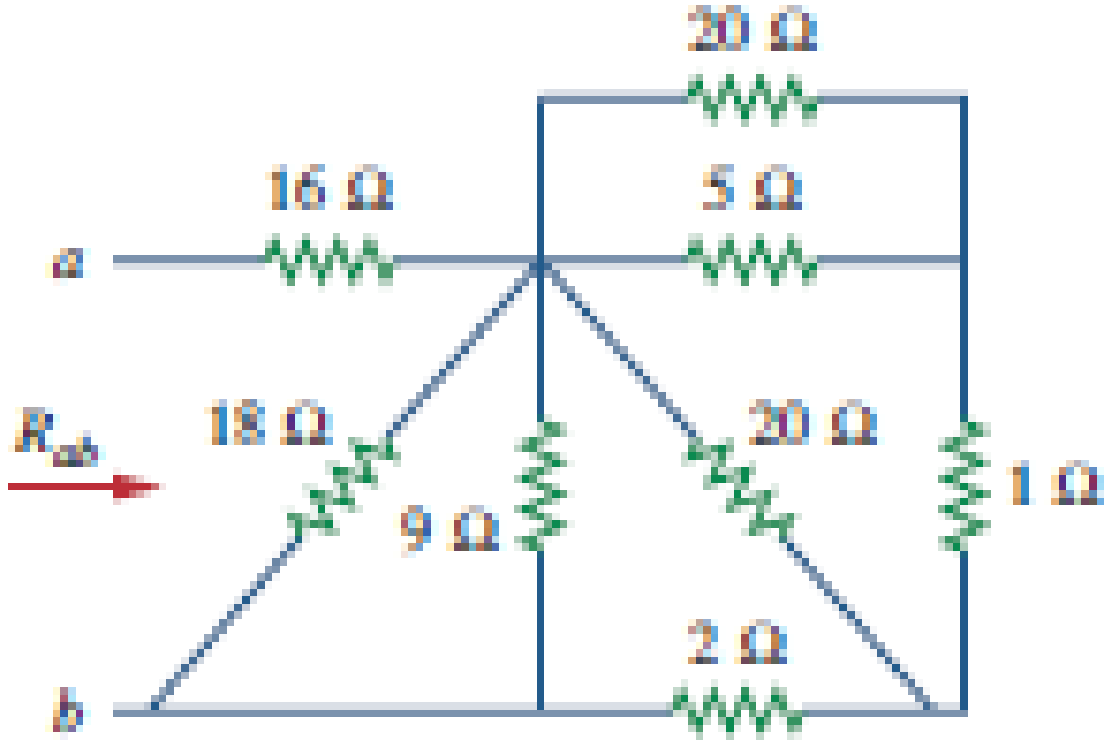
Simple problems

Find the equivalent resistance



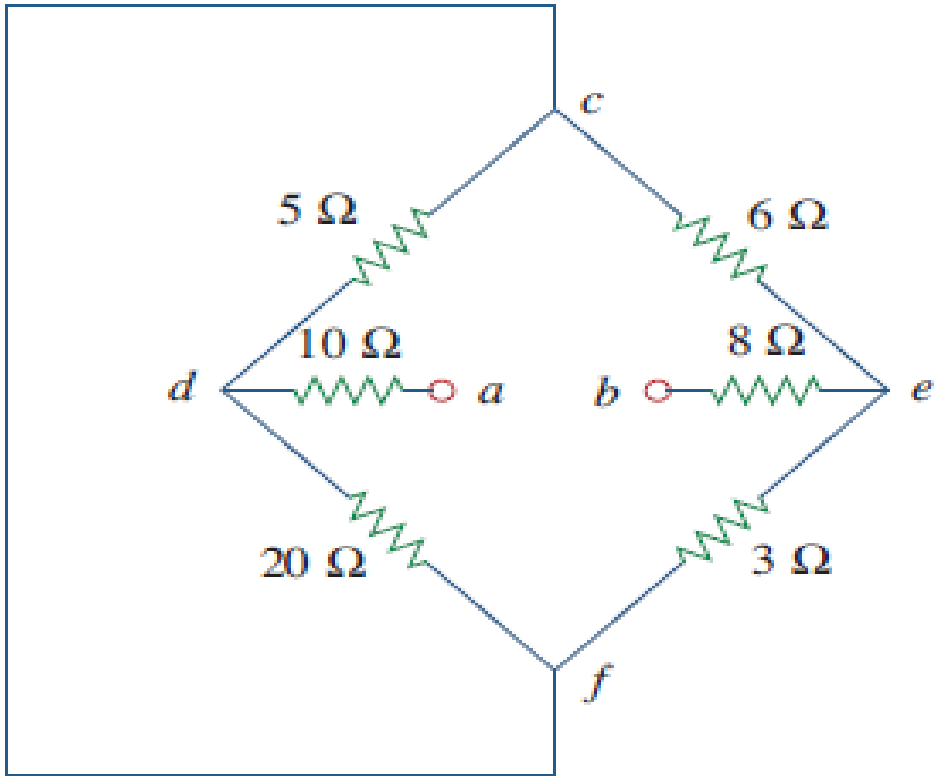
Simple problems

Find the equivalent resistance between terminal ab



Simple problems

Find the equivalent resistance between terminal ab



Simple problems

Find the current delivered by the source