ENG2200
Electric Circuits

Chapter 3

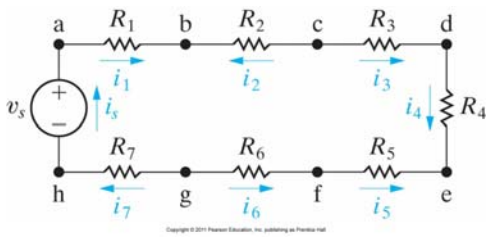
Simple Resistive Circuits

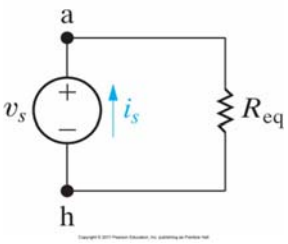
Chapter 3

- Resistance in series and parallel
- Voltage and current dividers
- Measuring voltage, current, and resistance
- Delta-to-Wye (Δ to Y)

Resistance in Series

- Two or more resistors are connected *in series* if they carry the same current
- $R_{eq} = R_1 + R_2 + \cdots + R_7$



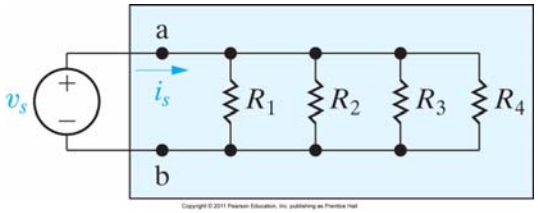


Resistors in parallel.

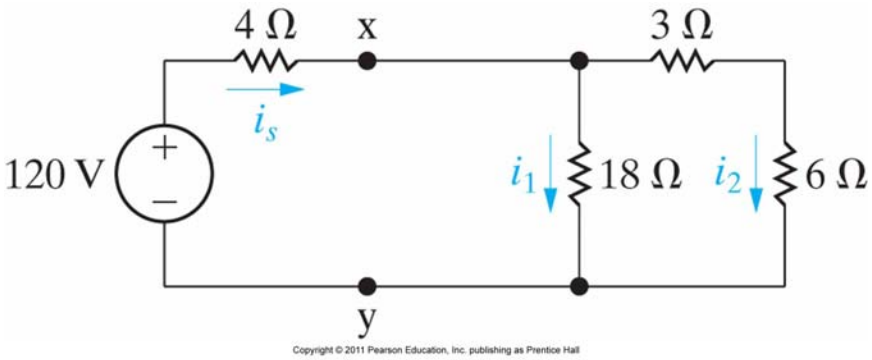
- Two, or more, resistors are connected in parallel if they have the same voltage.

$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \frac{1}{R_4}$$

(use conductance)

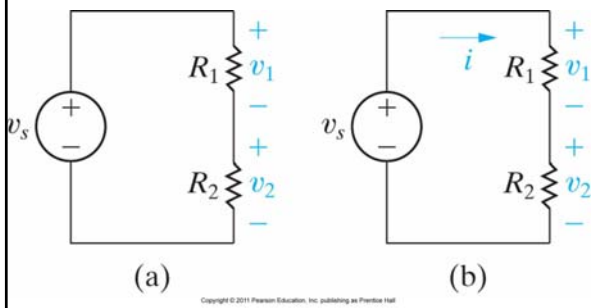


Find i_s, i_1, and i_2

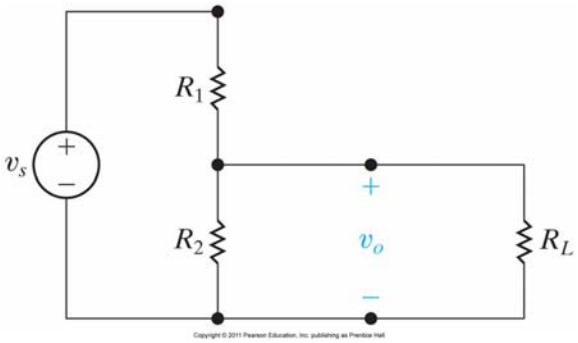


Voltage Divider

What is v_1 and v_2 relative to v_s?



The effect of loading

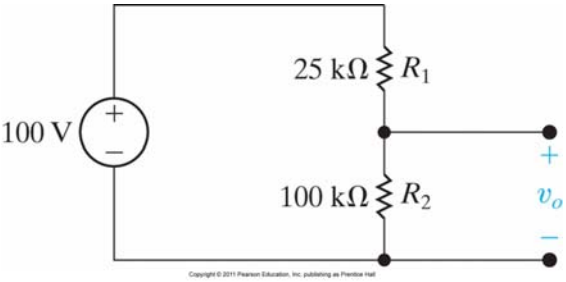


The effect of loading

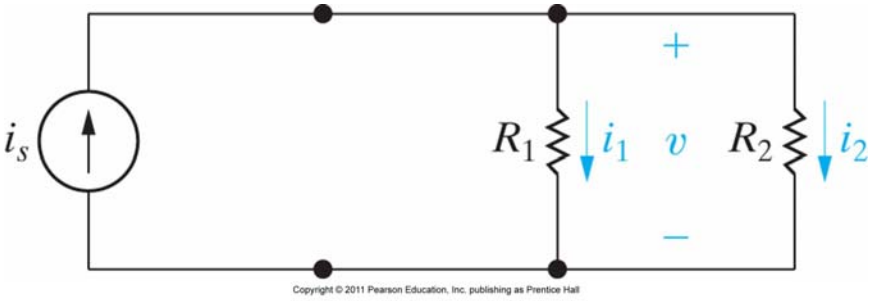
Find v_0

What if the load is 10Ω

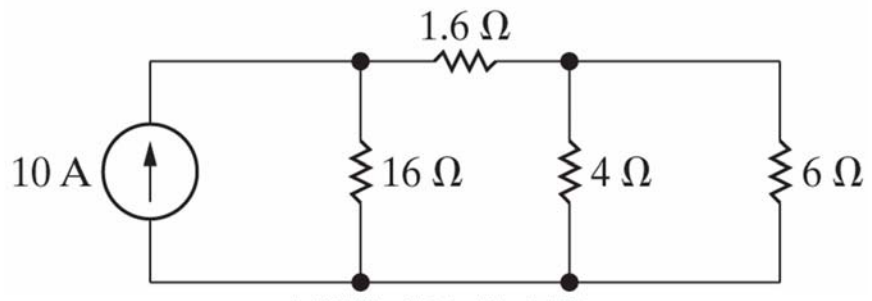
What is the load id 10 M Ω



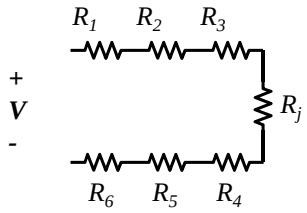
Find i_1 and i_2 in terms of i_s



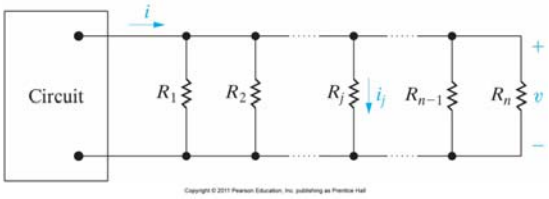
Find the power dissipated in the 6 Ω resistir



Voltage and current dividers



$$v_j = iR_j = \frac{R_j}{R_{eq}} v$$

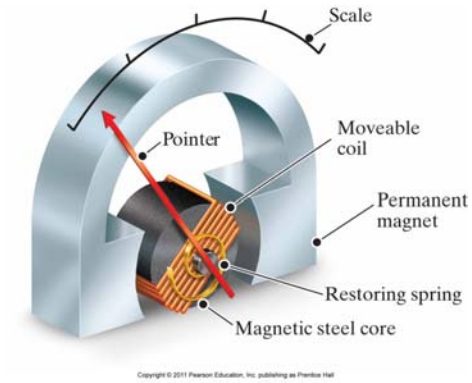


$$i_j = \frac{v}{R_j} = \frac{R_{eq}}{Rj} i$$

Measuring Voltage and Current

- Voltmeter is an instrument to measure voltage across a load
  - In parallel with the load
  - Ideal resistance of ∞
- Ammeter is an instrument to measure current is a load
  - In series with the load
  - Ideal resistance of 0

D'Arsonval meter movement.



- When current flows in the coil, it creates a torque that rotates the pointer.
- A meter is rated at 50mV and 1mA means when the coil is carrying 1mA there is a voltage drop of 50mV and the pointer full scale
- To use it as an ammeter, a parallel resistor is used
- To use it as voltmeter, a serial resistor is used

Example

- A 50 mV, 1 mA d'Arsonval movement is used as ammeter with a full scale of 10mA
- What is R_A?
- What measurement will result to if used to measure current in a 100Ω R with 1V across

Example

- A 50 mV, 1 mA d'Arsonval movement is used as Voltmeter with a full scale of 150 V
- What is R_v?
- What measurement will result if used to measure voltage across 75 kΩ R in series with 15 KΩ with v = 60V

Figure 3.26 The Wheatstone bridge circuit.

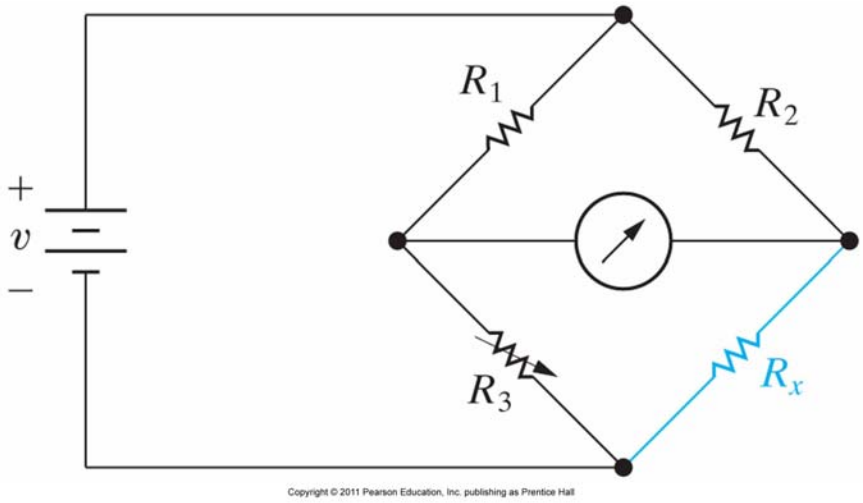


Figure 3.27 A balanced Wheatstone bridge ($i_g = 0$).

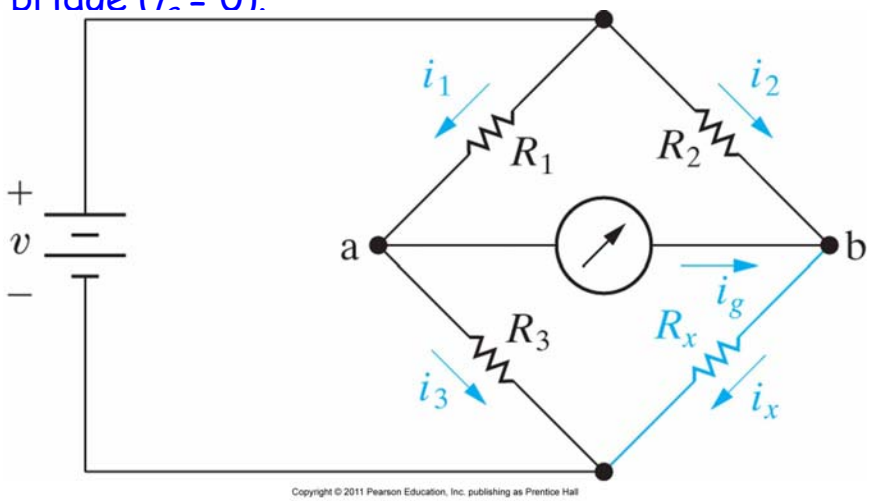


Figure 3.29 A Δ configuration viewed as a π configuration.

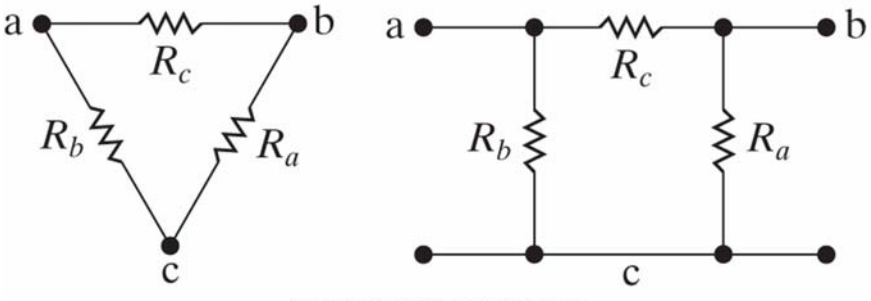


Figure 3.30 A Y structure viewed as a T structure.

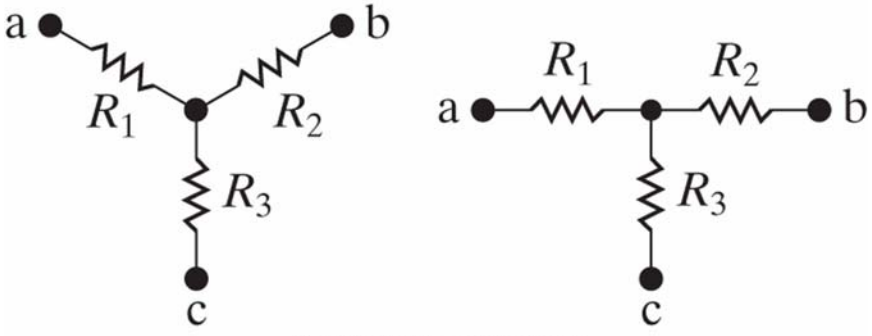
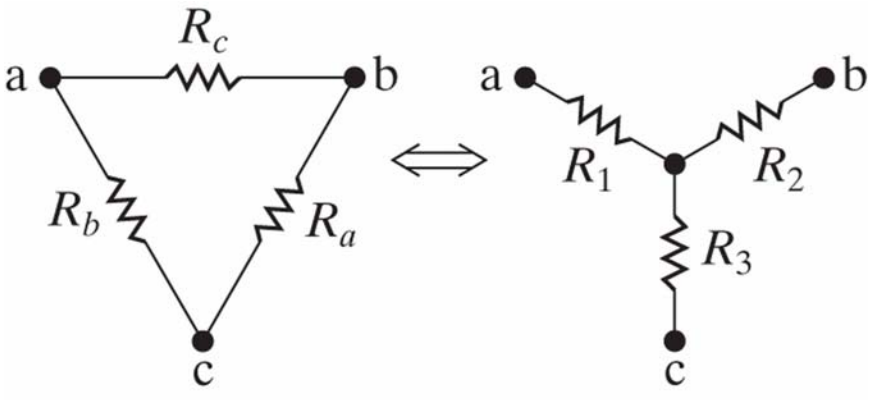


Figure 3.31 The Δ-to-Y transformation.



$$R_1 = \frac{R_b R_c}{R_a + R_b + R_c}$$

$$R_2 = \frac{R_c Ra}{R_a + R_b + R_c}$$

$$R_3 = \frac{R_a R_b}{R_a + R_b + R_c}$$

$$Ra = \frac{R_1 R_2 + R_2 R_3 + R_3 R_1}{R_1}$$

$$Rb = \frac{R_1 R_2 + R_2 R_3 + R_3 R_1}{R_2}$$

$$Rc = \frac{R_1 R_2 + R_2 R_3 + R_3 R_1}{R_3}$$

Figure 3.32 The circuit for Example 3.7.