EEE1024: Fundamentals of Electrical and Electronics Engineering

Dr. Sanchit Khatavkar

Course Outline

- DC Circuits – Basics
- AC Circuits - Basics
- Digital Systems
- Semiconductor Devices
- μ processor & μ controller
- Sensors
- Comm. Systems

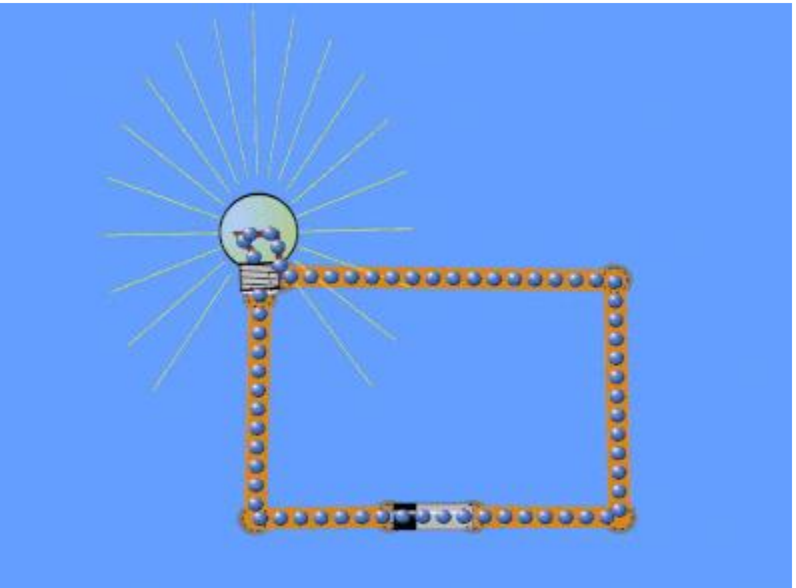
Direct Current Vs Alternating Current

Thomas Elva Edison

Current remains constant with time

Unidirectional

DC: Constant flow of electrons from an area of high electron density to an area of low electron density.

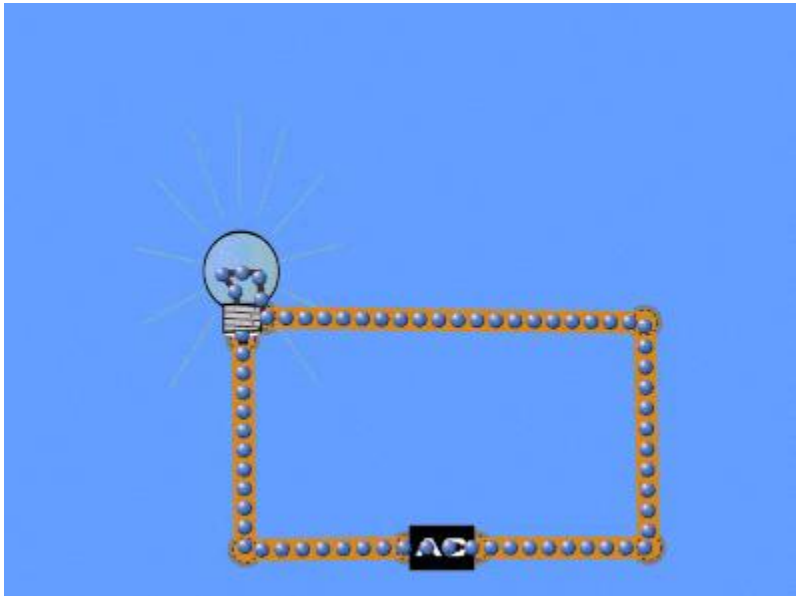


Nikola Tesla

Current varies sinusoidally with time

Bi-directional

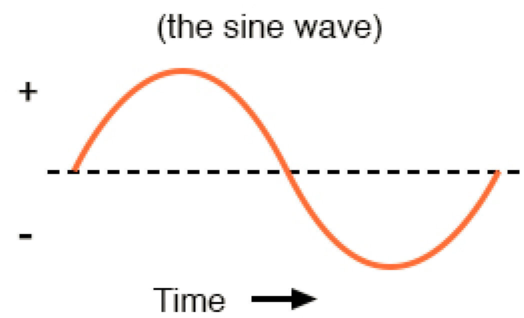
AC: Current will flip the direction of charge flow (60 times a second in USA (60 Hz) and 50 times a second in Europe (50 Hz) and also in ?

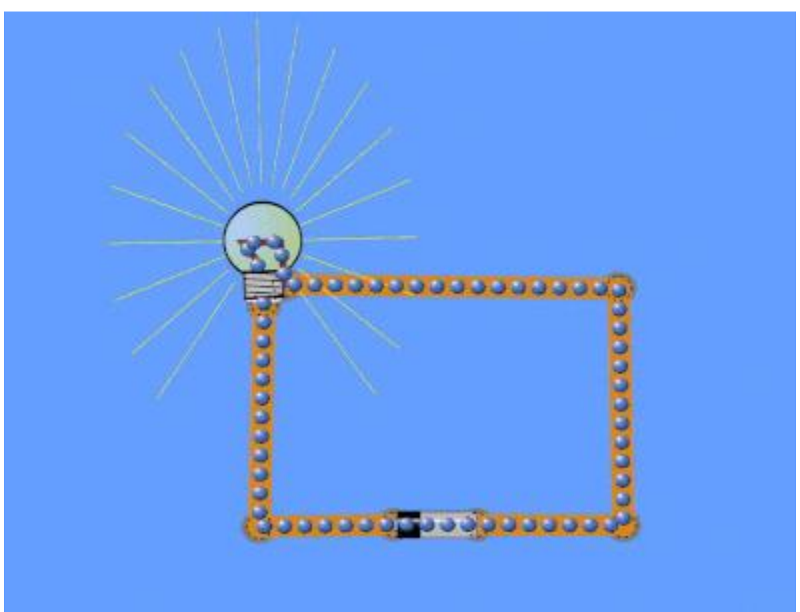


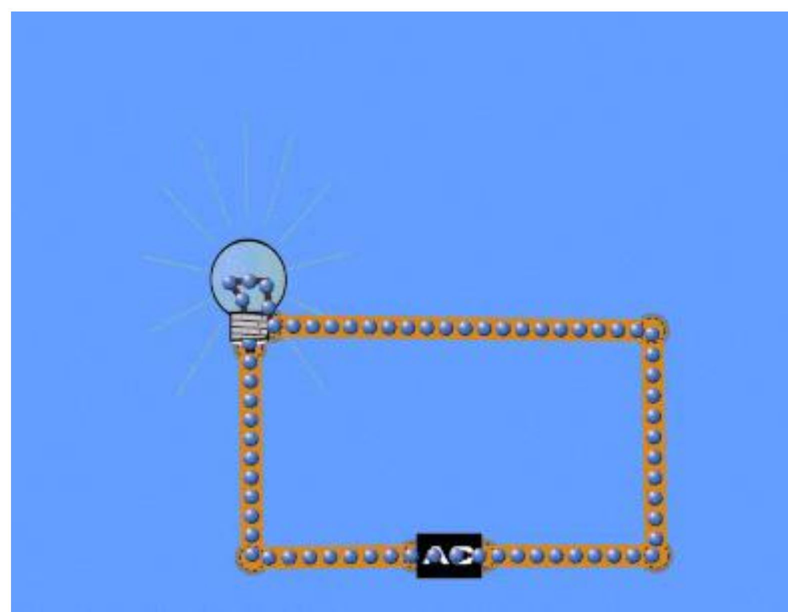
Direct Current Vs Alternating Current

DC voltage

AC voltage

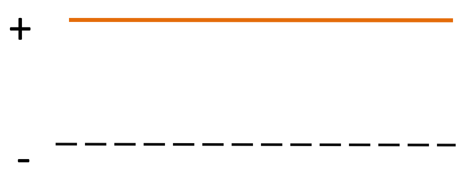




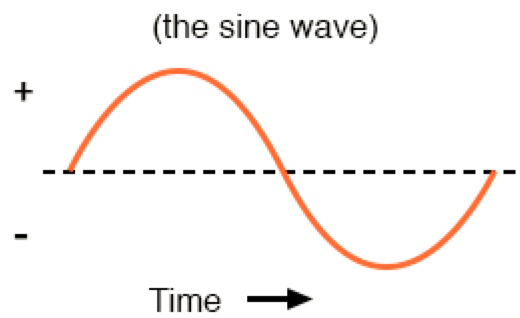


Direct Current Vs Alternating Current

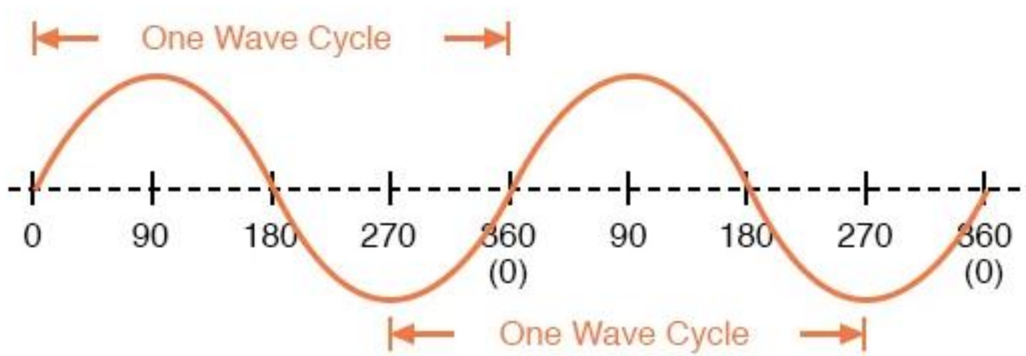
DC voltage



AC voltage



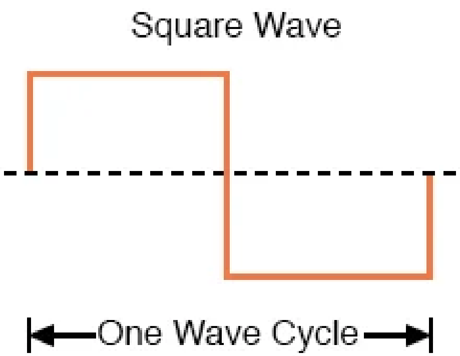
Periodic Motion

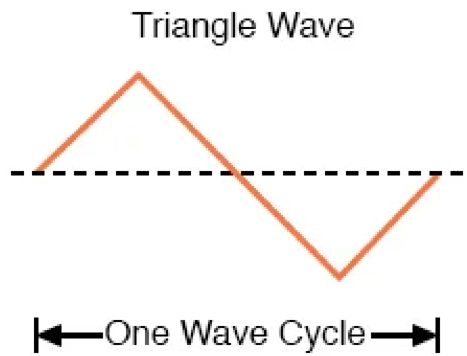


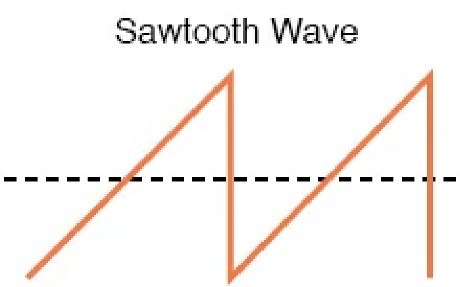
$$Frequency(Hz) = \frac{1}{Period(s)}$$

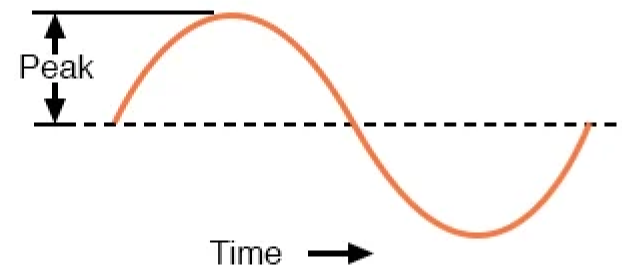
Direct Current Vs Alternating Current

Types of waves

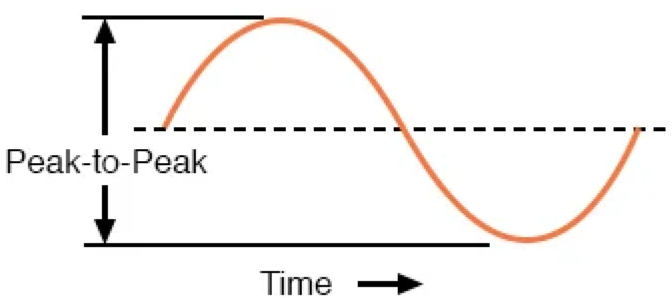




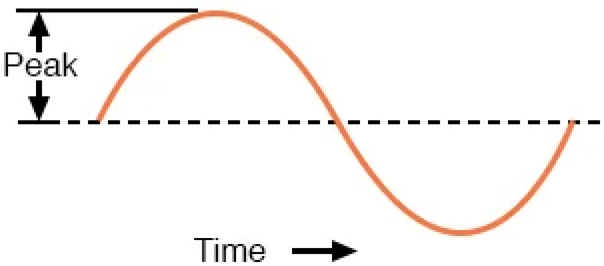




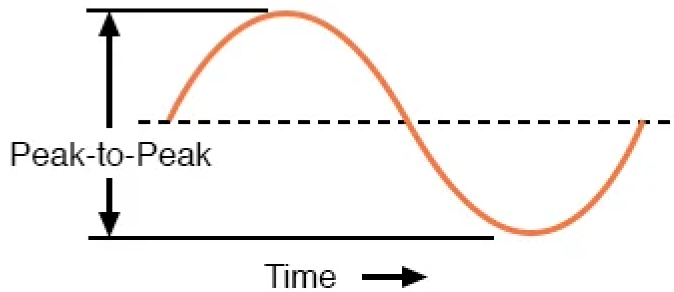
Peak voltage of a waveform.

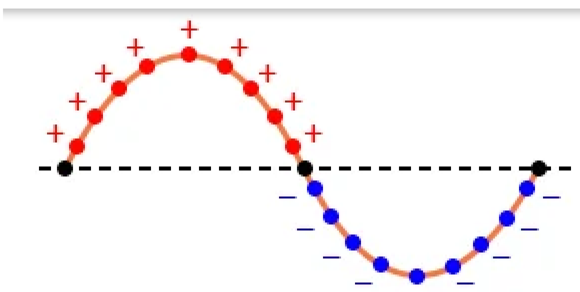


Direct Current Vs Alternating Current

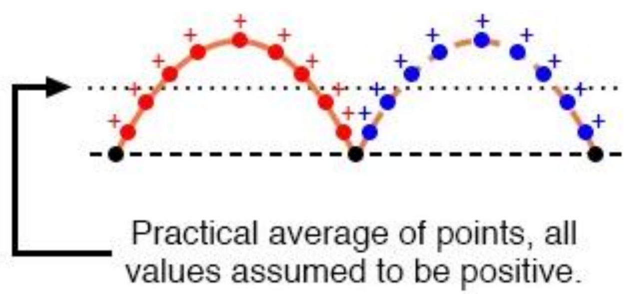


Peak voltage of a waveform.





True Average



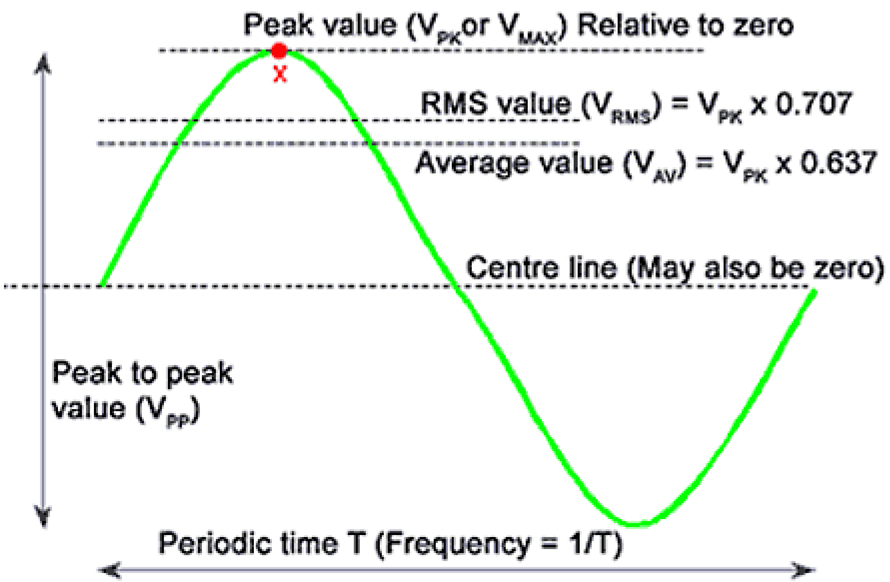
Practical Average –
Measured by meter

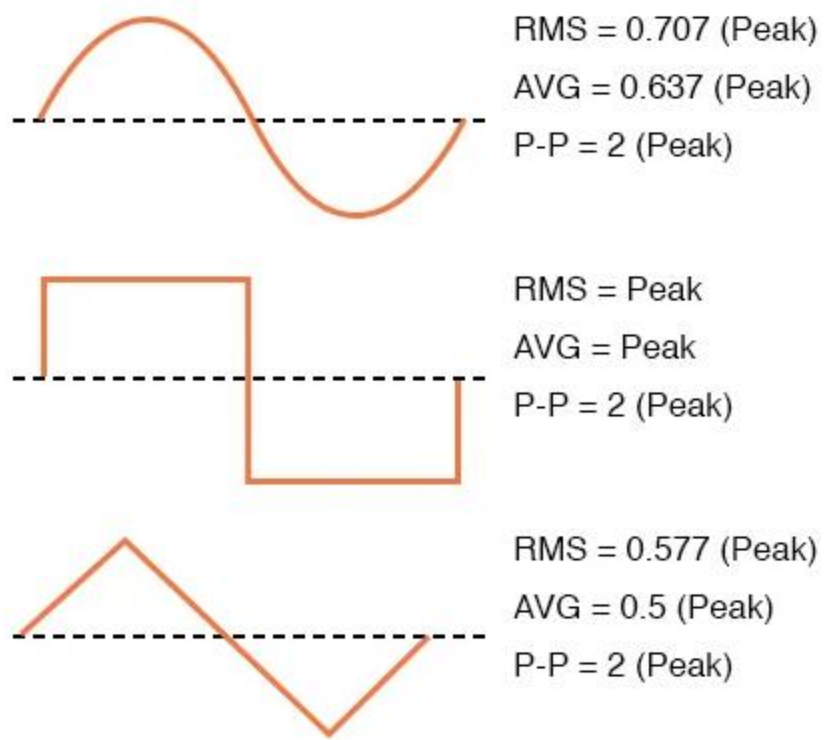
AC

RMS –
Root Mean Square

DC

Direct Current Vs Alternating Current





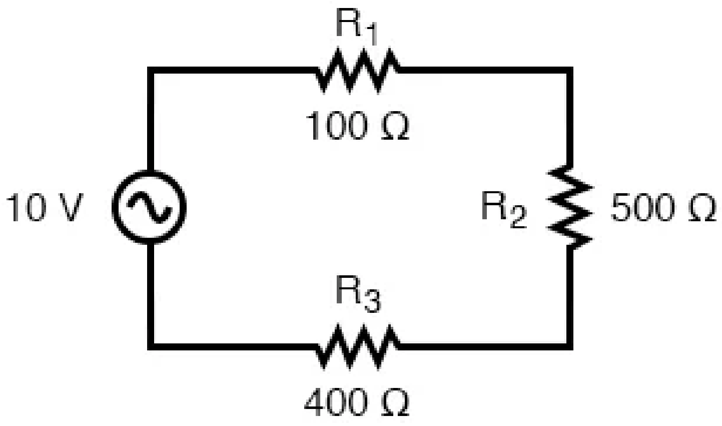
$$V_{AV} = V_{PK} \times 0.637$$

$$V_{RMS} = V_{PK} \times 0.707$$

$$V_{PP} = V_{PK} \times 2$$

Direct Current Vs Alternating Current

Resistive Circuit



$$I = \frac{V}{R_{eq}}$$

$$R_{eq} = 100 + 500 + 400 = 1000\Omega (1k\Omega)$$

Series circuit – current same

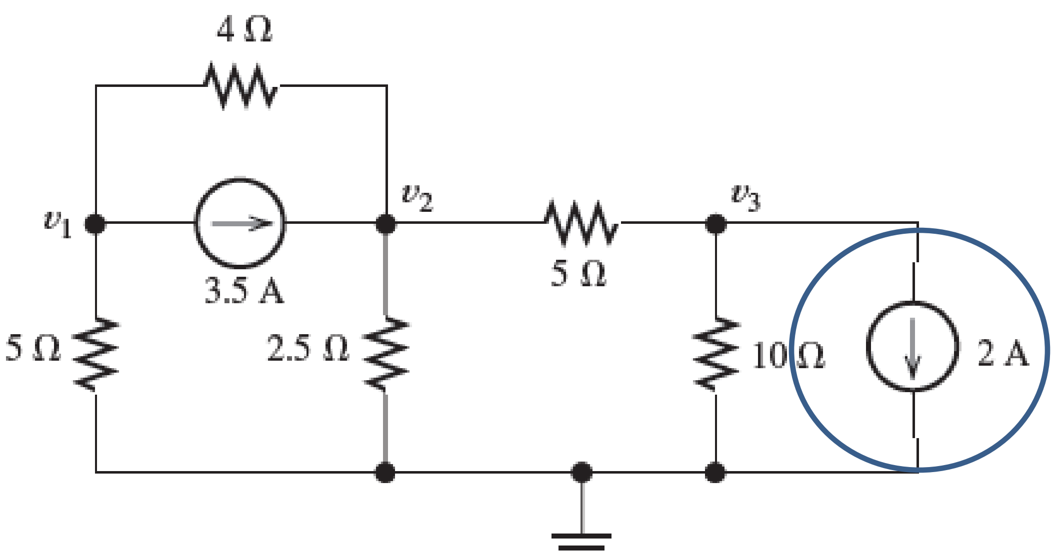
$$I = \frac{10}{1000} = 0.01A = 10mA$$

$$V_{R1} = I \times R_1 = 1V \qquad V_{R2} = I \times R_2 = 5V \qquad V_{R3} = I \times R_3 = 4V$$

AC circuit calculations for resistive circuits are the same as for DC!

Practice 1

Q1:



$$\frac{v_1}{5} + \frac{v_1 - v_2}{4} + 3.5 = 0$$

@1

$$0.45v_1 - 0.25v_2 = -3.5$$

$$\frac{v_2 - v_1}{4} + \frac{v_2}{2.5} + \frac{v_2 - v_3}{5} = 3.5$$

@2

$$-0.25v_1 + 0.85v_2 - 0.2v_3 = 3.5$$

$$\frac{v_3 - v_2}{5} + \frac{v_3}{10} = -2$$

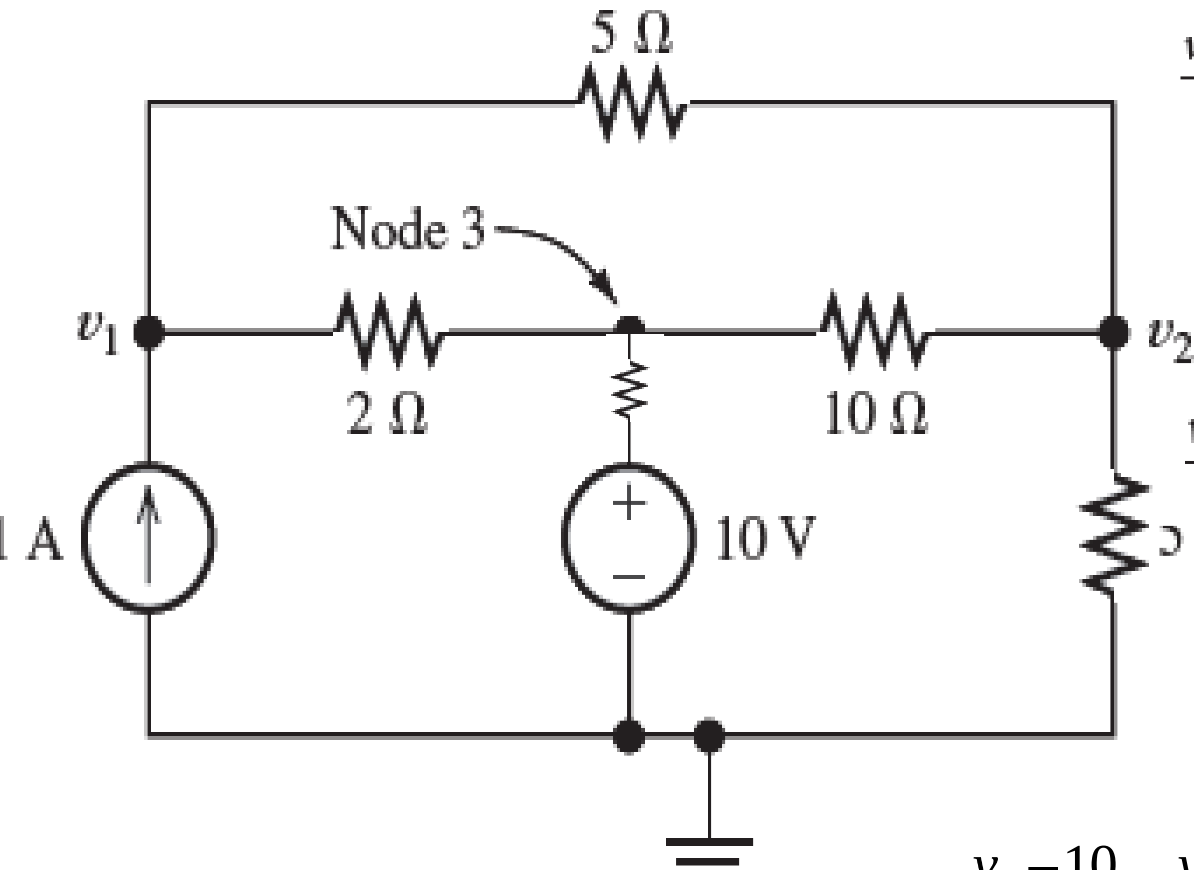
@3

$$-0.2v_2 + 0.35v_3 = 2$$

V_1 = -5V **V_2 = 5V** **V_3 = 10V**

Practice 2

Q 2:



$$\frac{v_1 - v_2}{5} + \frac{v_1 - 10}{2} = 1$$

@1

$$0.7v_1 - 0.2v_2 = 6$$

$$\frac{v_2}{5} + \frac{v_2 - 10}{10} + \frac{v_2 - v_1}{5} = 0$$

@2

$$-0.2v_1 + 0.5v_2 = 1$$

$$\frac{v_3 - 10}{2} + \frac{v_3 - v_1}{2} + \frac{v_3 - v_2}{10} = 0$$

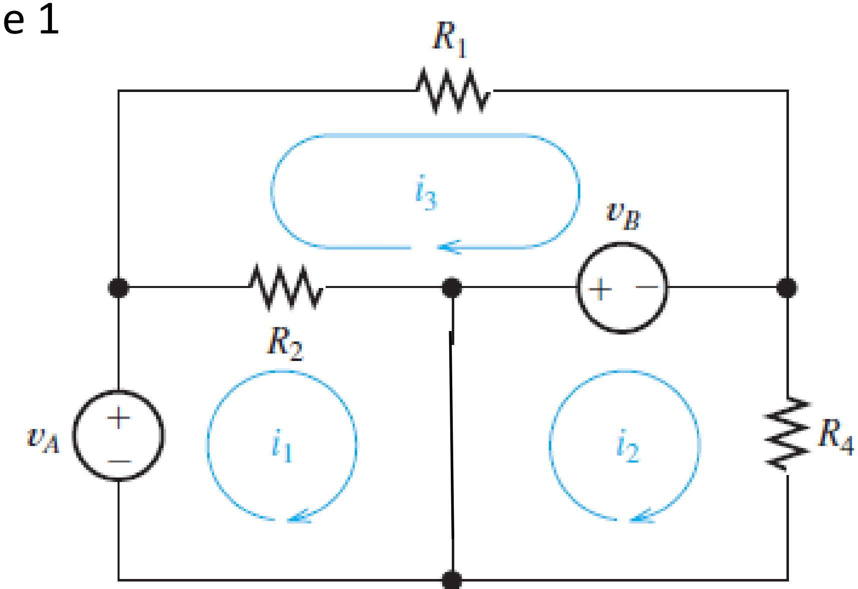
Assuming R=2Ω

V_1 = 10.32V **V_2 = 6.129V**

V_3 = 10 V

Practice - 3

Example 1



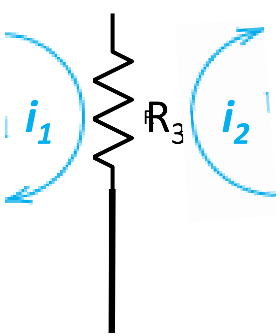
$$(R_2 + R_3)i_1 - R_3 i_2 - R_2 i_3 = v_A$$
$$-R_3 i_1 + (R_3 + R_4)i_2 = -v_B$$
$$-R_2 i_1 + (R_1 + R_2)i_3 = v_B$$

Apply KVL to each mesh, starting with Mesh 1

$$R_2(i_1 - i_3) = v_A$$
$$R_2(i_1 - i_3) + R_3(i_1 - i_2) - v_A = 0$$

KVL @ Mesh 2

$$R_4 i_2 = -v_B$$
$$R_3(i_2 - i_1) + R_4 i_2 + v_B = 0$$

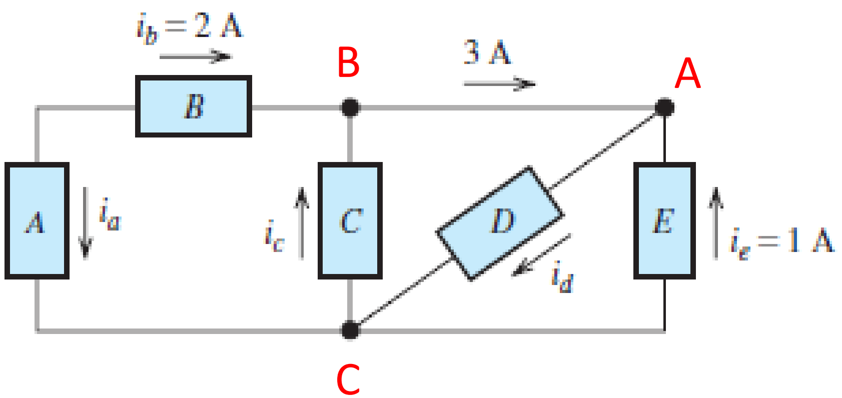


KVL @ Mesh 3

$$R_2(i_3 - i_1) + R_1 i_3 - v_B = 0$$

R times current in the mesh under consideration minus the adjacent mesh!

Practice - 4



@A $3+1=i_d$

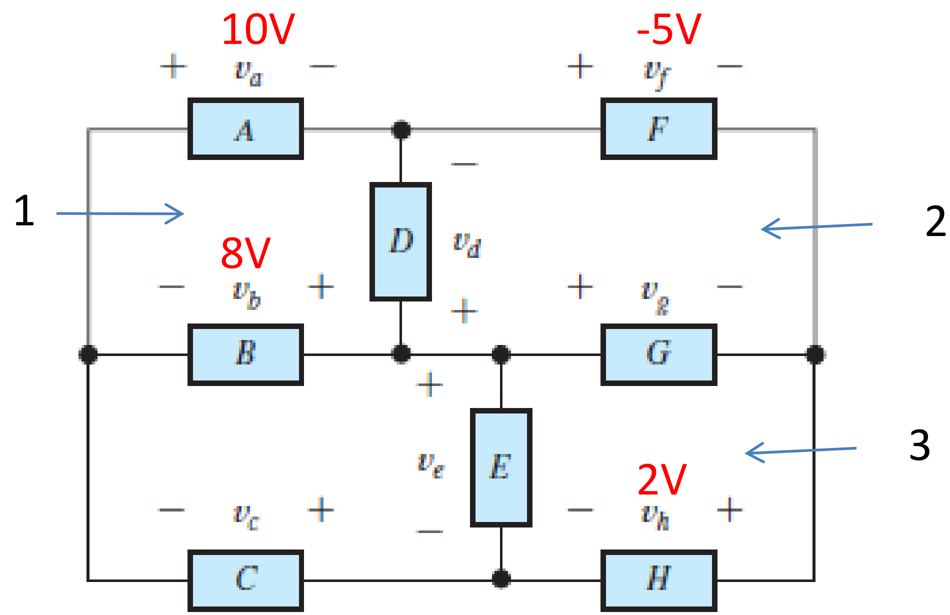
$i_d = 4A$

@B $2+i_c = 3$

$i_c = 1A$

@C $i_a + 4 = 1+1$

$i_a = -2A$



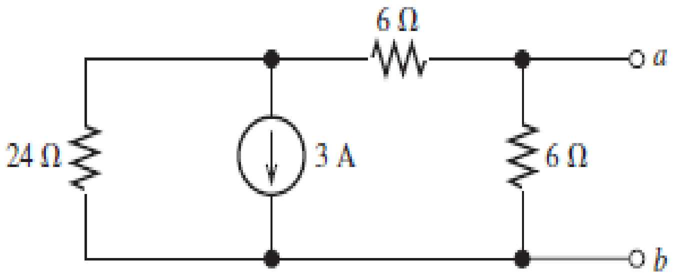
$10 - v_d + 8 = 0$ $v_d = 18V$

$18 - 5 - v_g = 0$ $v_g = 13V$

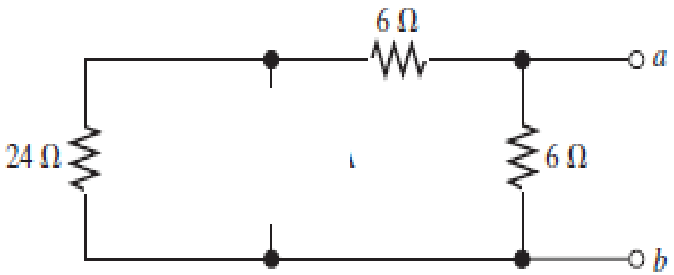
$13 + 2 - v_e = 0$ $v_e = 15V$

$-8 + 15 + v_c = 0$ $v_c = -7V$

Practice - 5



Solving for R_{th}



$$R_{eq1} = 24 + 6 = 30\Omega$$

$$R_{th} = R_{eq1} // 6\Omega$$

$$R_{th} = \frac{30 \times 6}{30 + 6} = \frac{180}{36} = 5\Omega$$

Acknowledgements

1. https://www.allaboutcircuits.com
2. https://learnabout-electronics.org