EEE Final Lecture

DC Circuit

Circuit analysis: Node analysis

1. Identify all nodes.
2. Let ground reference node.
3. Label non-reference nodes.
4. Write a KCL equation for each node using Ohm's Law.
   (sum the currents leaving the node and set equal to zero)
5. Solve those equations for voltages.

Note: Reference node এবং non-reference node এর মাঝখানে যদি কোন voltage source থাকে, তবে সেই voltage source এর voltage-ই হবে non-reference node এর voltage।

Circuit analysis: Mesh analysis

1. Identify the meshes/loops.
2. Assign a current variable to each loop, using a consistent direction.
   (clockwise or counterclockwise)
3. Write a KVL equations for each loop using Ohm's Law
4. Solve those equations for loop currents.
5. Solve for other element currents and voltages you want using Ohm'sLaw.

Note: যদি কোন লুপে একটা মাত্র current source থাকে, তবে সেটিই হবে ঐ লুপের loop current হবে।

Circuit theorem: Superposition

1. Open current sources and short voltage sources.
2. Find the output (voltage or current) due to that active source using nodal or mesh analysis.
3. Repeat step 1 & 2 for each of the other independent sources.
4. Find the total contribution by adding algebraically all the contributions due to the independent sources.

Circuit theorem: Thevenin

1. Open Current Sources, Short Voltage Sources and Open Load Resistor.
2. Calculate the open circuit resistance. This is the Thevenin resistance (R_{TH}).
3. Calculate the open circuit voltage. This is the Thevenin Voltage (V_{TH}).
4. Now, redraw the circuit with measured V_{TH} and R_{TH}. This is the equivalent Thevenin circuit.
5. Now find the total current flowing through load resistor by using the Ohm's Law: $I_T = \frac{V_{TH}}{(R_{TH} + R_L)}$.

Circuit theorem: Norton

1. Short the load resistor.
2. Calculate the short circuit current. This is the Norton Current (I_N).
3. Open Current Sources, Short Voltage Sources and Open Load Resistor.
4. Calculate the open circuit resistance. This is the Norton resistance (R_N).
5. Now, redraw the circuit with measured I_N and R_N. This is the equivalent Norton circuit.
6. Now find the Load current flowing through load resistor by using Current divider rule.

Tips: Use Thevenin theorem to calculate V_{TH} and R_{TH}. Then $I_N = \frac{V_{TH}}{R_{TH}}$

AC Circuit

Class-1: Complex numbers

Exercise: *14.15–14.26* | *Page: 600*

Rectangular	: $a \pm jb$
Trigonometrical	: $E(\cos\theta \pm \sin\theta)$
Exponential	: $E \cdot e^{j\theta}$
Polar	: $E \angle \pm \theta$

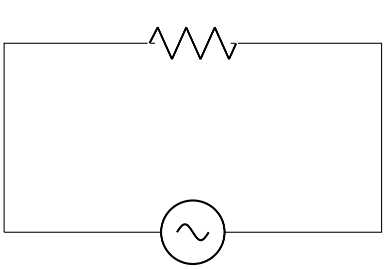
$$E = \sqrt{a^2 + b^2} \qquad a = E\cos\theta$$

$$\theta = \tan^{-1}\frac{b}{a} \qquad b = E\sin\theta$$

- Use Rectangular form for : $+\,,-$
- Use Polar form for : $\times\,,\div$

Class-2: Sinusoidal Expression

Exercise: *14.2–14.7* | *Page: 584*

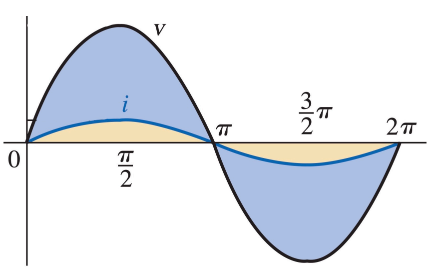


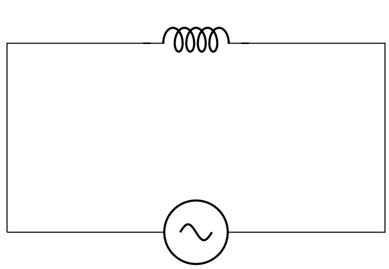
Pure Resistive

$$v = V_m \sin\omega t$$

$$i = I_m \sin\omega t$$

$$I_m = \frac{V_m}{R}$$



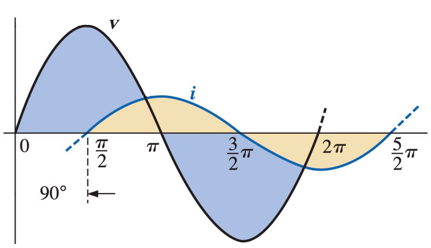


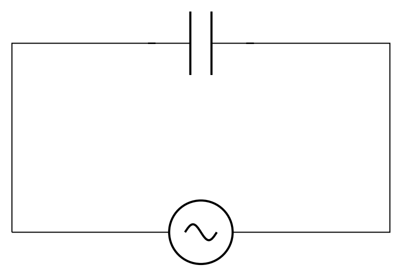
Pure Inductive

$$v = V_m \sin\omega t$$

$$i = I_m \sin(\omega t - 90^\circ)$$

$$I_m = \frac{V_m}{X_L} = \frac{V_m}{\omega L}$$



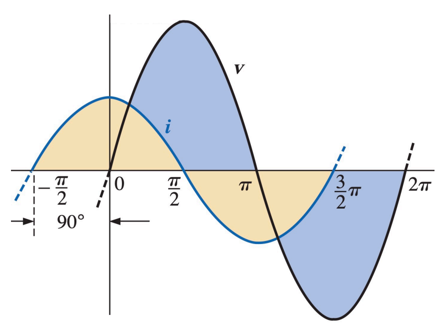


Pure Capacitive

$$v = V_m \sin\omega t$$

$$i = I_m \sin(\omega t + 90^\circ)$$

$$I_m = \frac{V_m}{X_C} = \frac{V_m}{\frac{1}{\omega C}}$$



Class-3: Impedance

Exercise: *16.1, 16.2, 16.3*

Impedance (z): The ratio of the phasor voltage (V) to the phasor current (I) in ohms.

- In pure resistive circuit, volatge (v) and current (i) stay in phase.
- In pure inductive circuit, voltage (v) leads the current (i) by 90°.
- In pure capacitive circuit, current (i) leads the voltage (v) by 90°.

Element	**Impedance** in Rectangular form	**Impedance** in Polar form
(Resistor) R	$Z_R = R$	$Z_R \angle 0^\circ$
(Inductor) L	$Z_L = j X_L = j\omega L$	$Z_L \angle 90^\circ$
(Capacitor) C	$Z_C = -j X_C = -j\dfrac{1}{\omega C}$	$Z_C \angle -90^\circ$

Class-4: Power Factor

P.f is a measure of how effectively electrical equipment converts electric power into useful power.

1. Pf is the ratio of active power to the total power.

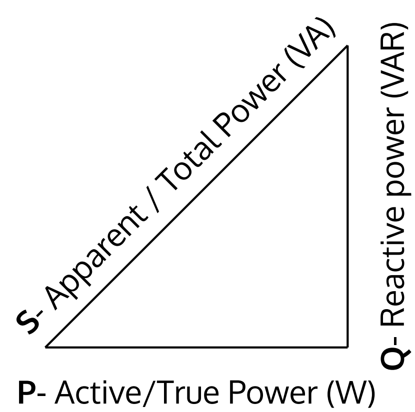
$$P.f = \frac{\text{Active power}}{\text{Total power}} = \frac{P}{S} = \frac{P}{P+Q}$$

2. The cosine angle between the current and the voltage is called pf.

$$\text{Pf} = \cos\theta$$

$$\text{P} = \text{VI}\cos\theta \;\; (watt)$$

$$\text{Q} = \text{VI}\sin\theta \;\; (VAR)$$



Magnetic Circuit

Class-1: Formulas

Flux density:

$$B = \frac{\Phi}{A}$$

Φ = Flux (Wb)

A = Area (m^2)

Permeability:

$$\mu = \frac{B}{H}$$

B = flux density (T)

H = magnetizing force (At/m)

Realtive Permeability:

$$\mu_r = \frac{\mu}{\mu_o}$$

$\mu_o = 4\pi \times 10^7$ (Wb/A.m)

$$NI = Hl$$

Where, H = magnetizing force (At/m)

B = flux density (T)

I = current (A)

l = length (m)

★ 1 mitre = 39.37 inch

★ l = total length

E.g: $l_{ab} = l_{cd} = 0.5$ in and $l_{bc} = 4$ in

$\therefore l = 0.5 + 4 + 0.5 = 5 \text{ in} = \dfrac{5}{39.37}$ m