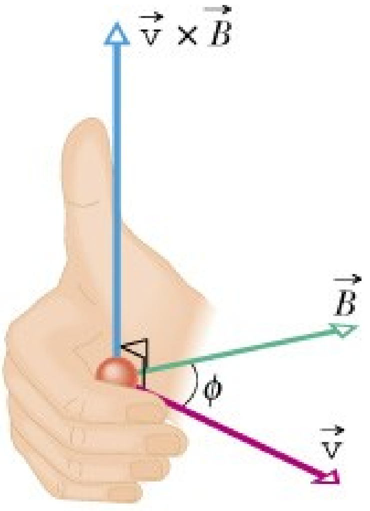
Content

MIDTERM REVIEW

Chapter 4: Magnetism

- Magnetic field: $\vec{B}$, unit: T - Tesla
- Magnetic force: $\boxed{\vec{F}_B = q\vec{v} \times \vec{B}}$

$$F_B = |q| vB \sin\phi$$

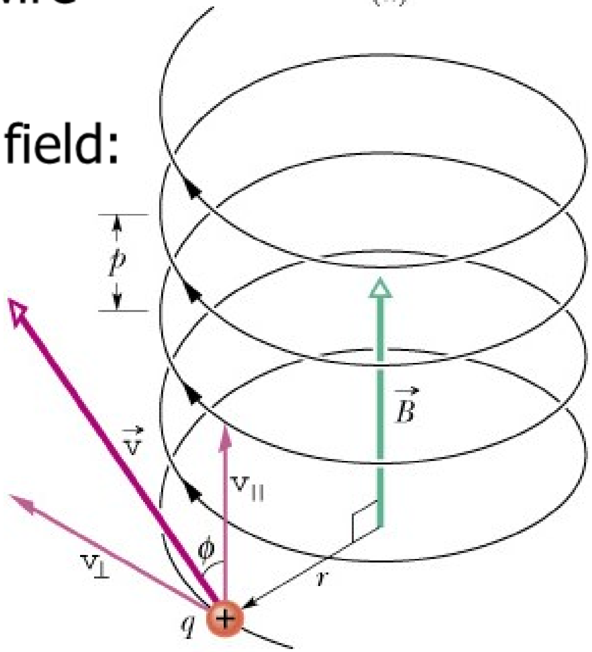


(a)

- The Hall affect: conduction electrons in a wire are deflected by a magnetic field.
- Motion of a charged particle in a magnetic field:

$$F_B = qvB = m\frac{v^2}{r}$$

$$T = \frac{2\pi r}{v} = \frac{2\pi m}{qB} \qquad r = \frac{mv}{qB}$$

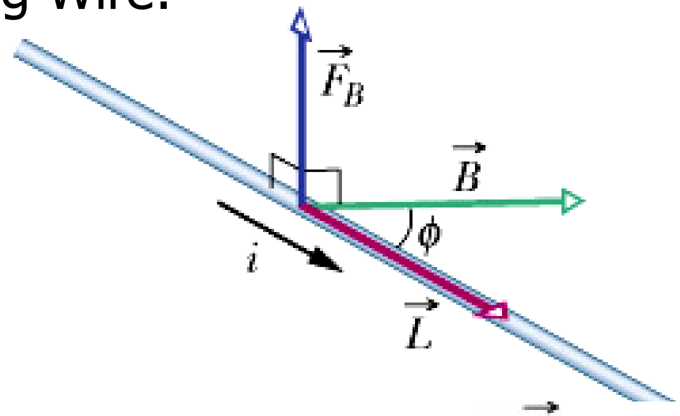


- Magnetic Force on a Current-Carrying Wire:

$$\boxed{\vec{F}_B = i\vec{L} \times \vec{B}}$$

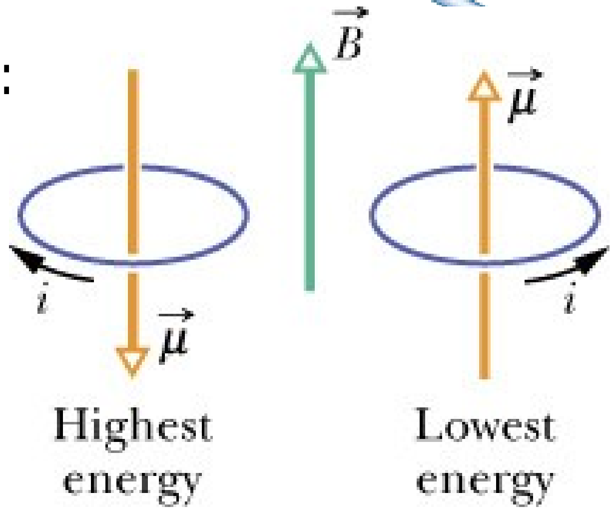
$$F_B = iLB\sin\phi$$

$$d\vec{F}_B = id\vec{L} \times \vec{B}$$



- Magnetic Torque on a Current-Carrying Wire:

$$\boxed{\tau = N\tau' = NiAB\sin\theta}$$



- Magnetic dipole moment:

$$\boxed{\mu = NiA}$$

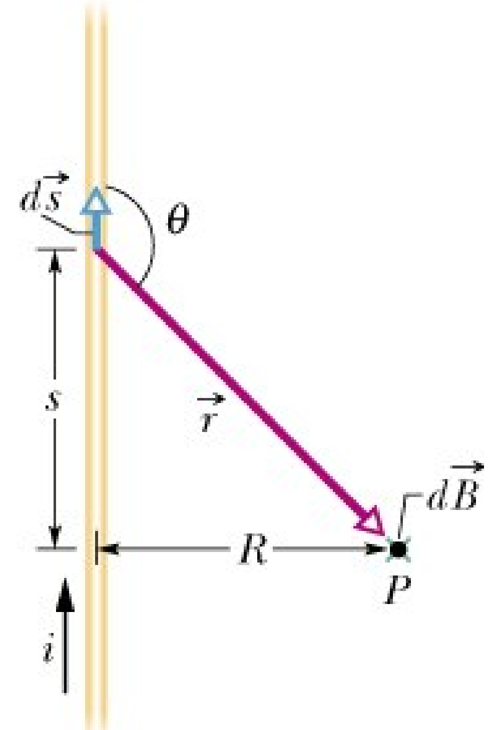
  - Torque: $\boxed{\vec{\tau} = \vec{\mu} \times \vec{B}}$ $\qquad \tau = \mu B \sin(\vec{\mu}, \vec{B})$
  - Potential energy: $\boxed{U(\theta) = -\vec{\mu}\vec{B} = -\mu B\cos\theta}$

- The Biot-Savart law:

$$\boxed{d\vec{B} = \frac{\mu_0}{4\pi}\frac{i d\vec{s} \times \vec{r}}{r^3}}$$

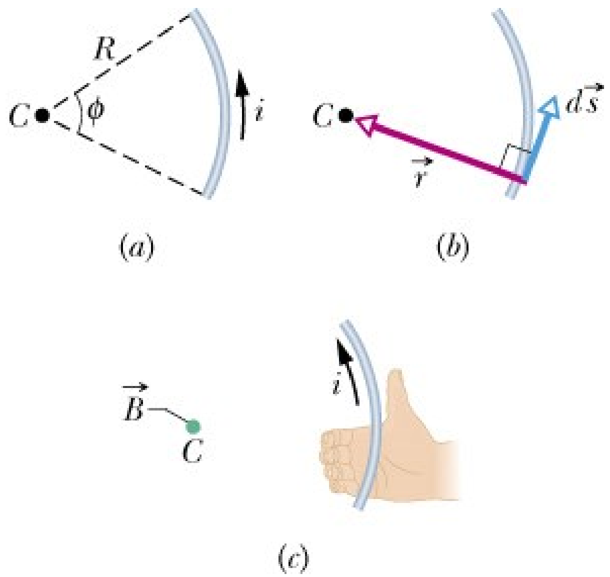
- Magnetic Field Due to a Current in a Long Straight Wire:

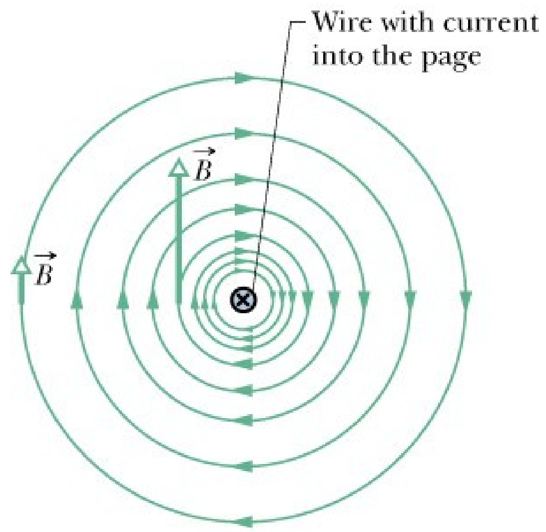
$$\boxed{dB = \frac{\mu_0}{4\pi}\frac{i ds \sin\theta}{r^2}} \qquad \boxed{B = \frac{\mu_0 i}{2\pi R}}$$



- Magnetic Field Due to a Current in a Circular Arc of Wire

$$\boxed{B = \frac{\mu_0 i \phi}{4\pi R}}$$

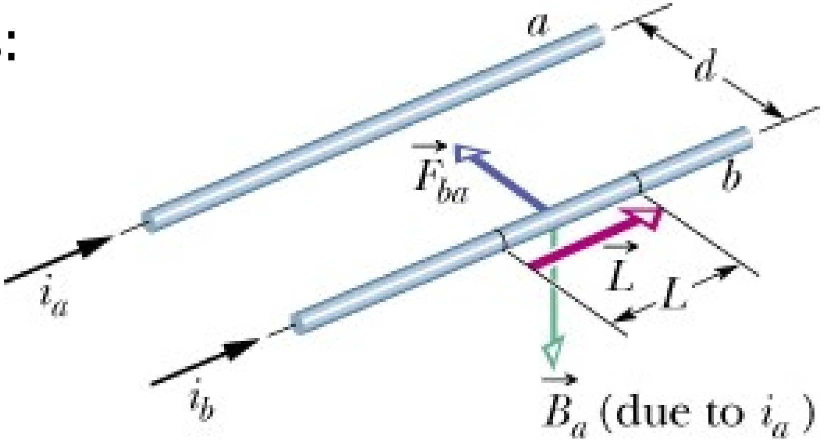




- Force Between Two Parallel Currents:

$$\boxed{\vec{F}_{ba} = i_b \vec{L} \times \vec{B}_a}$$

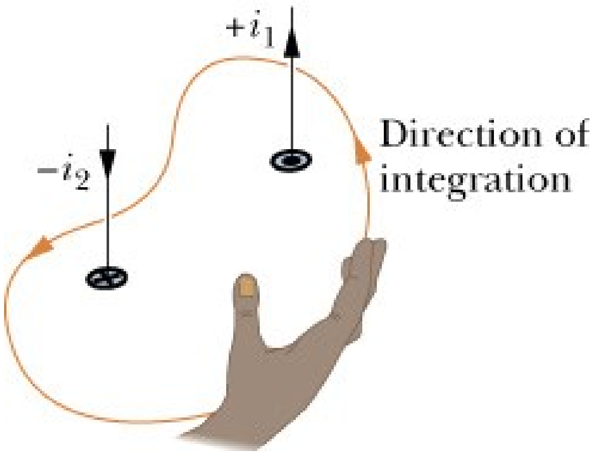
$$\boxed{F_{ba} = \frac{\mu_0 L i_a i_b}{2\pi d}}$$



- Ampere's Law

$$\boxed{\oint \vec{B} d\vec{s} = \mu_0 i_{\text{enc}}}$$

$$i_{\text{enc}} = i_1 - i_2$$



  - The Magnetic Field Outside a Long Straight Wire with Current:

$$\boxed{B = \frac{\mu_0 i}{2\pi r}}$$

  - The Magnetic Field Inside a Long Straight Wire with Current:

$$\boxed{B = \left(\frac{\mu_0 i}{2\pi R^2}\right) r}$$

- Magnetic Field of a Solenoid: $$\boxed{B = \mu_0 in}$$

$n \leftarrow n = \frac{N}{L}$

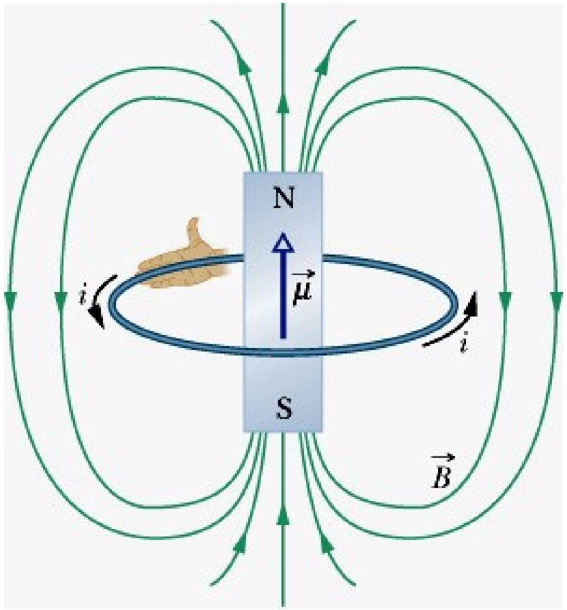
N

- Magnetic Field of a Toroid: $$\boxed{B = \frac{\mu_0 iN}{2\pi}\frac{1}{r}}$$

- The Magnetic Field of a Current-Carrying Coil: $$\boxed{\vec{B}(z) = \frac{\mu_0}{2\pi}\frac{\vec{\mu}}{z^3}}$$

$$B(z) = \frac{\mu_0 NiA}{2\pi z^3}$$

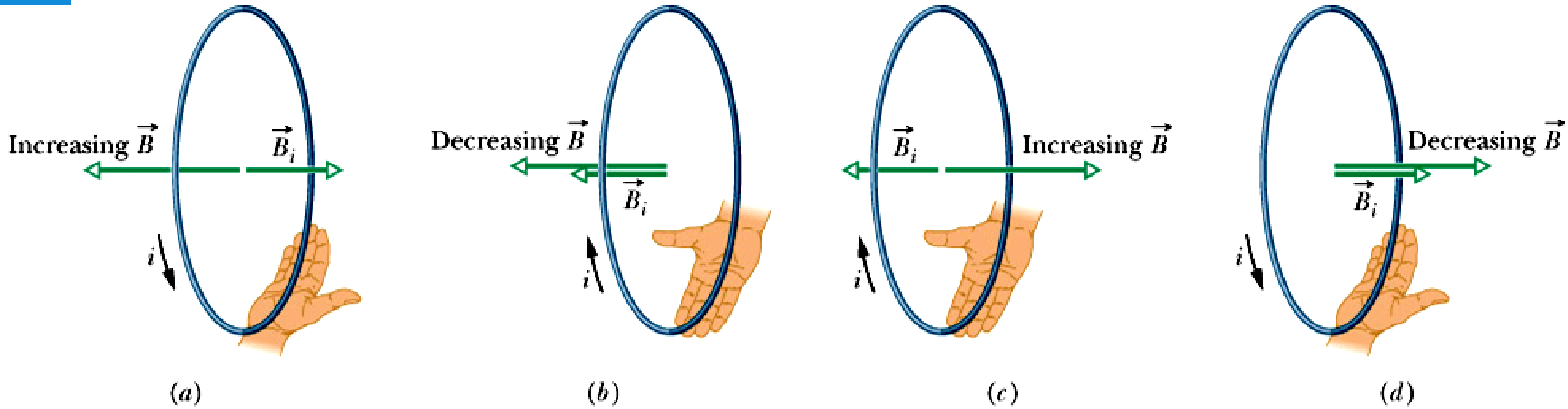
$z =$



Chapter 5: Electromagnetic Induction

- Faraday's law: induced emf: $$\boxed{\varepsilon = -\frac{d\Phi_B}{dt}}$$ $$\boxed{\Phi_B = \int \vec{B} d\vec{A}}$$

- Len's law:



- Induced electric field: $$\boxed{\oint \vec{E} d\vec{s} = -\frac{d\Phi_B}{dt}}$$

- Inductance L (unit: Henry): $\boxed{L = \dfrac{N\Phi_B}{i}}$
- Inductance of a solenoid: $\boxed{\dfrac{L}{l} = \mu_0 n^2 A}$
- Self-Induced emf: $\boxed{\varepsilon_L = -L\dfrac{di}{dt}}$
- RL Circuits
  - Rise of current: $\boxed{i = \dfrac{\varepsilon}{R}\left(1 - e^{-t/\tau_L}\right)}$
  - Decay of current: $\boxed{i = \dfrac{\varepsilon}{R} e^{-t/\tau_L} = i_0 e^{-t/\tau_L}}$
- Magnetic potential energy: $\boxed{U_B = \dfrac{1}{2} L i^2}$

Chapter 6: Alternating Current Circuits

- LC Oscillations: Conservation of energy

$$U_E = \frac{q^2}{2C} = \frac{Q^2}{2C}\cos^2(\omega t + \phi)$$

$$q = Q\cos(\omega t + \phi)$$

$$i = -I\sin(\omega t + \phi)$$

$$U_B = \frac{1}{2}Li^2 = \frac{1}{2}L\omega^2 Q^2 \sin^2(\omega t + \phi)$$

$$\omega = \frac{1}{\sqrt{LC}}$$ $\omega = 2\pi f$

- Alternating current: $\boxed{\varepsilon = \varepsilon_m \sin\omega_d t}$ $\boxed{i = I\sin(\omega_d t - \phi)}$

- Resistive load: $v_R = \varepsilon_m \sin\omega_d t = V_R \sin\omega_d t$

$$i_R = \frac{v_R}{R} = \frac{V_R}{R}\sin\omega_d t$$

- Capacitive load: $v_C = V_C \sin\omega_d t$

$$i_C = I_C \sin(\omega_d t + 90)$$

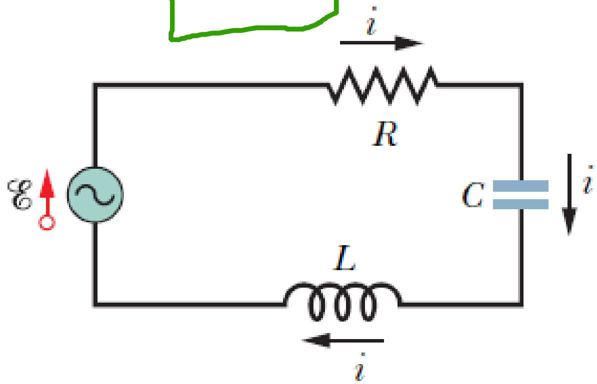
$$\boxed{X_C = \frac{1}{\omega_d C}}$$

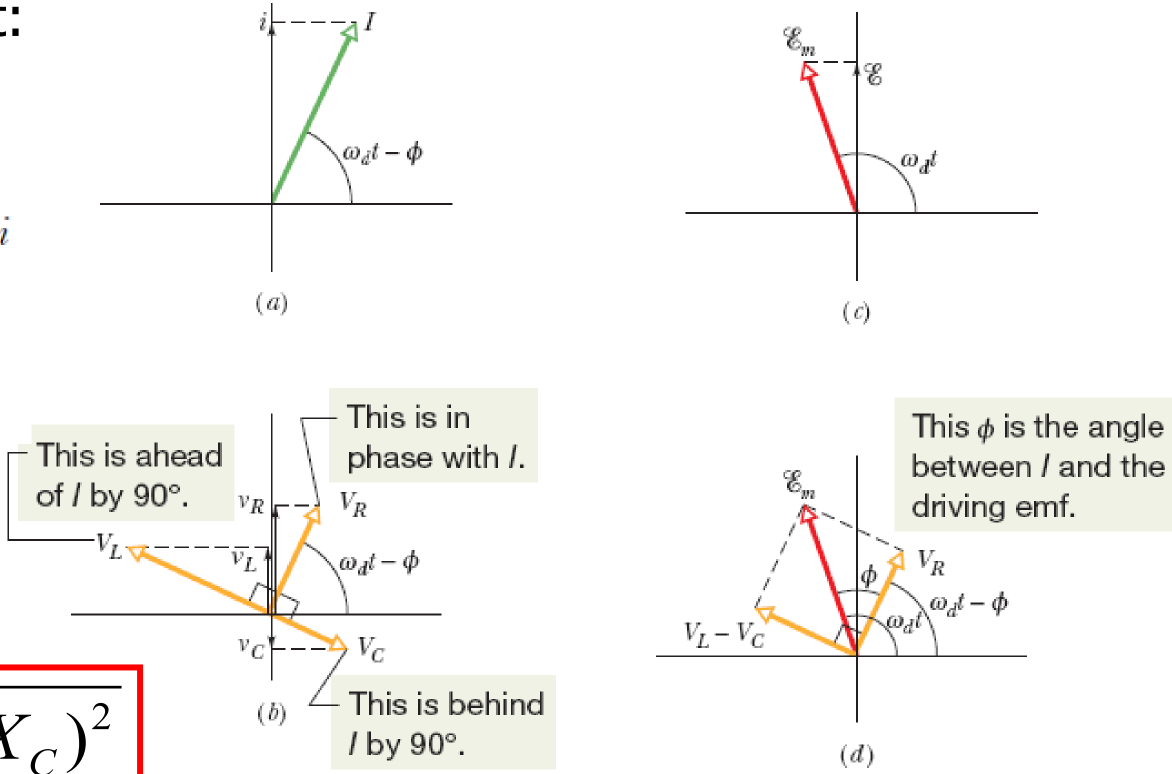
- Inductive load: $v_L = V_L \sin \omega_d t$

$$i_L = I_L \sin(\omega_d t - 90)$$

$$\boxed{X_L = \omega_d L}$$

- The Series RLC Circuit:





$$\varepsilon = \varepsilon_m \sin \omega_d t$$

$$i = I \sin(\omega_d t - \phi)$$

$$\boxed{Z = \sqrt{R^2 + (X_L - X_C)^2}}$$

$$\boxed{I = \frac{\varepsilon_m}{\sqrt{R^2 + (\omega_d L - 1/\omega_d C)^2}}}$$

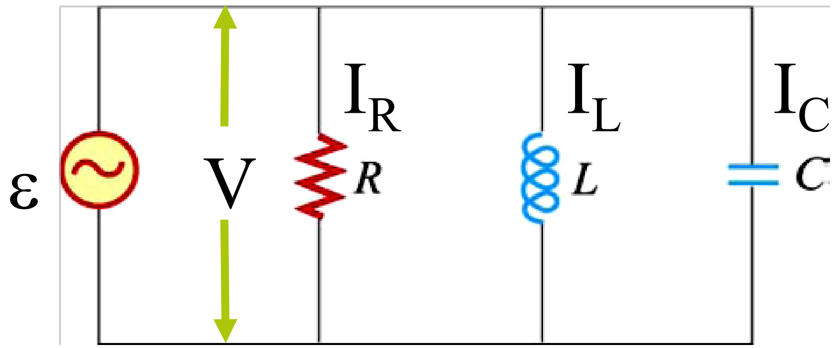
$$\boxed{\tan \phi = \frac{X_L - X_C}{R}}$$

- Resonance: $$\boxed{\omega_d = \omega = \frac{1}{\sqrt{LC}}}$$ $\omega = 2\pi f$

- The Parallel RLC Circuit

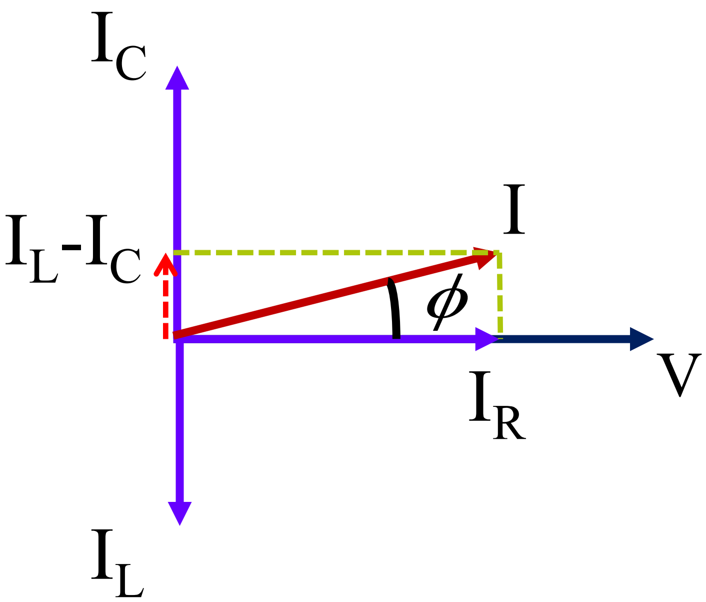
$$\varepsilon = \varepsilon_m \sin \omega_d t$$

$$i = I_m \sin(\omega_d t - \phi)$$



$$\boxed{\frac{1}{Z} = \sqrt{\left(\frac{1}{R}\right)^2 + \left(\frac{1}{\omega_d L} - \omega_d C\right)^2}}$$

$$\boxed{\tan\phi = \frac{\frac{1}{\omega_d L} - \omega_d C}{\frac{1}{R}}}$$



- Power in Alternating Current Circuits:

$$V_{rms} = \frac{V}{\sqrt{2}} \text{ and } \varepsilon_{rms} = \frac{\varepsilon_m}{\sqrt{2}}$$

$$I_{rms} = \frac{\varepsilon_{rms}}{Z} = \frac{\varepsilon_{rms}}{\sqrt{R^2 + (X_L - X_C)^2}}$$

$I = \frac{u}{R}$

$$\boxed{P_{avg} = \varepsilon_{rms} I_{rms} \cos\phi} \qquad \cos\phi = \frac{VR}{\varepsilon m} = \frac{IR}{IZ} = \frac{R}{Z}$$

- Transformer:

$$\boxed{V_S = V_P \frac{N_S}{N_P}} \qquad \boxed{I_S = I_P \frac{N_P}{N_S}} \qquad \boxed{R_{eq} = \left(\frac{N_P}{N_S}\right)^2 R}$$