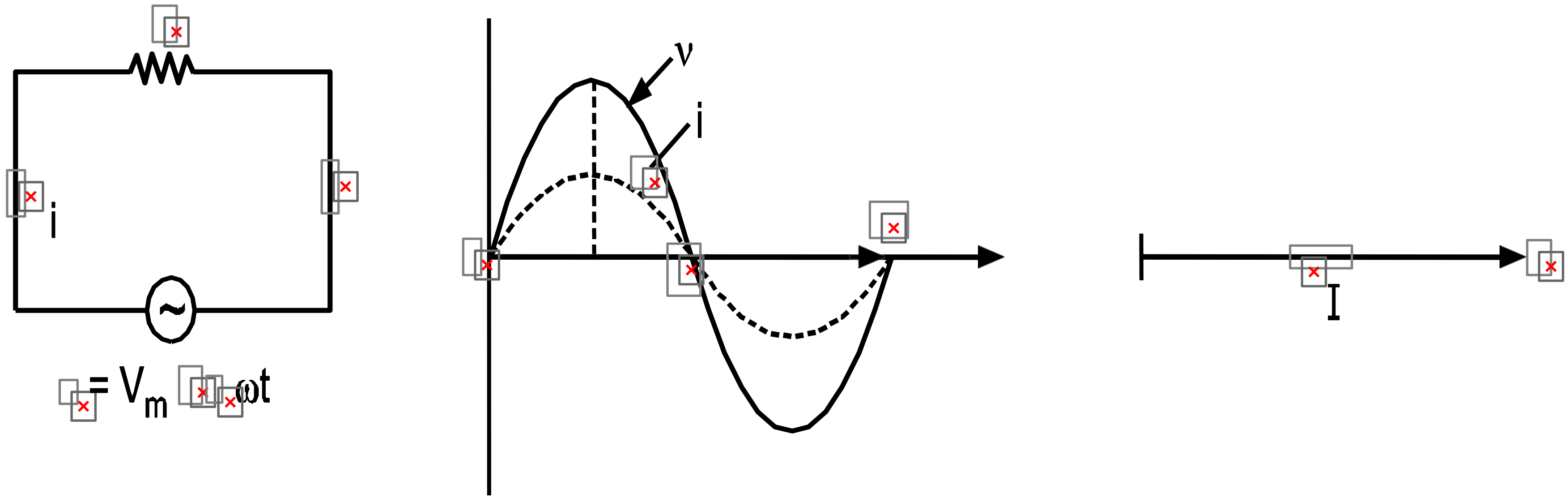
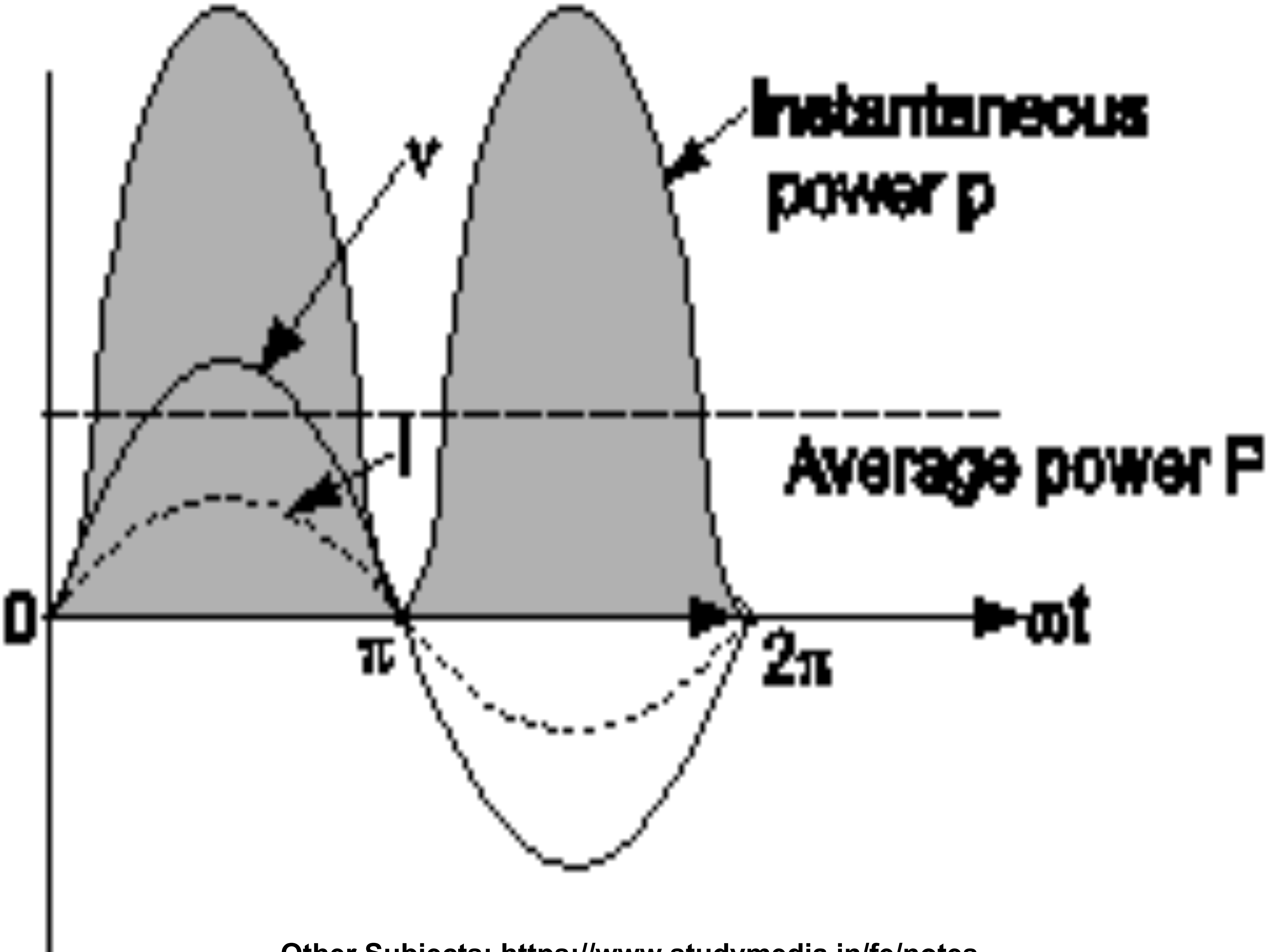
UNIT NO.3

SINGLE PHASE A.C CIRCUIT

A.C. THROUGH PURE RESISTANCE

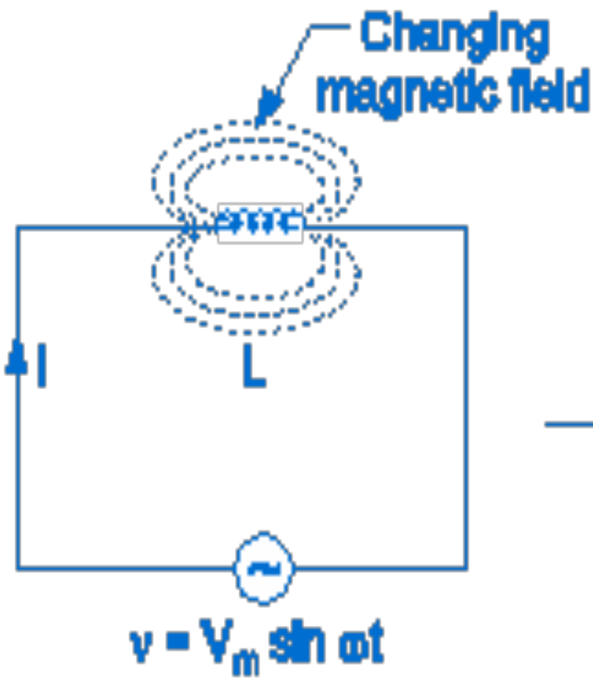


(a) Circuit Dig (b) Voltage & Current Waveform (c) Phasor Dig

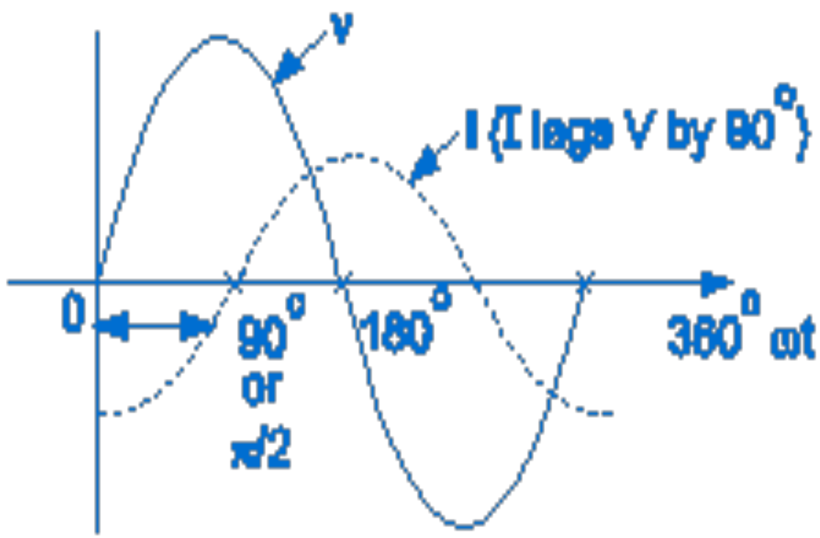


Instantaneous
power p
v
I
Average power P
0
π
2π
ωt

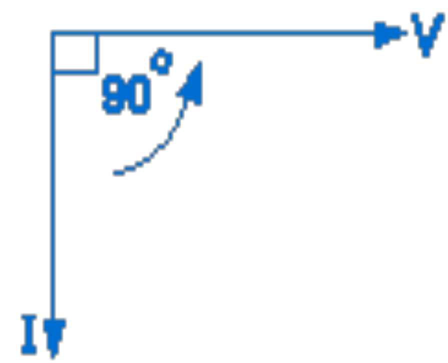
A.C. THROUGH PURE INDUCTANCE



(a) Circuit Diagram

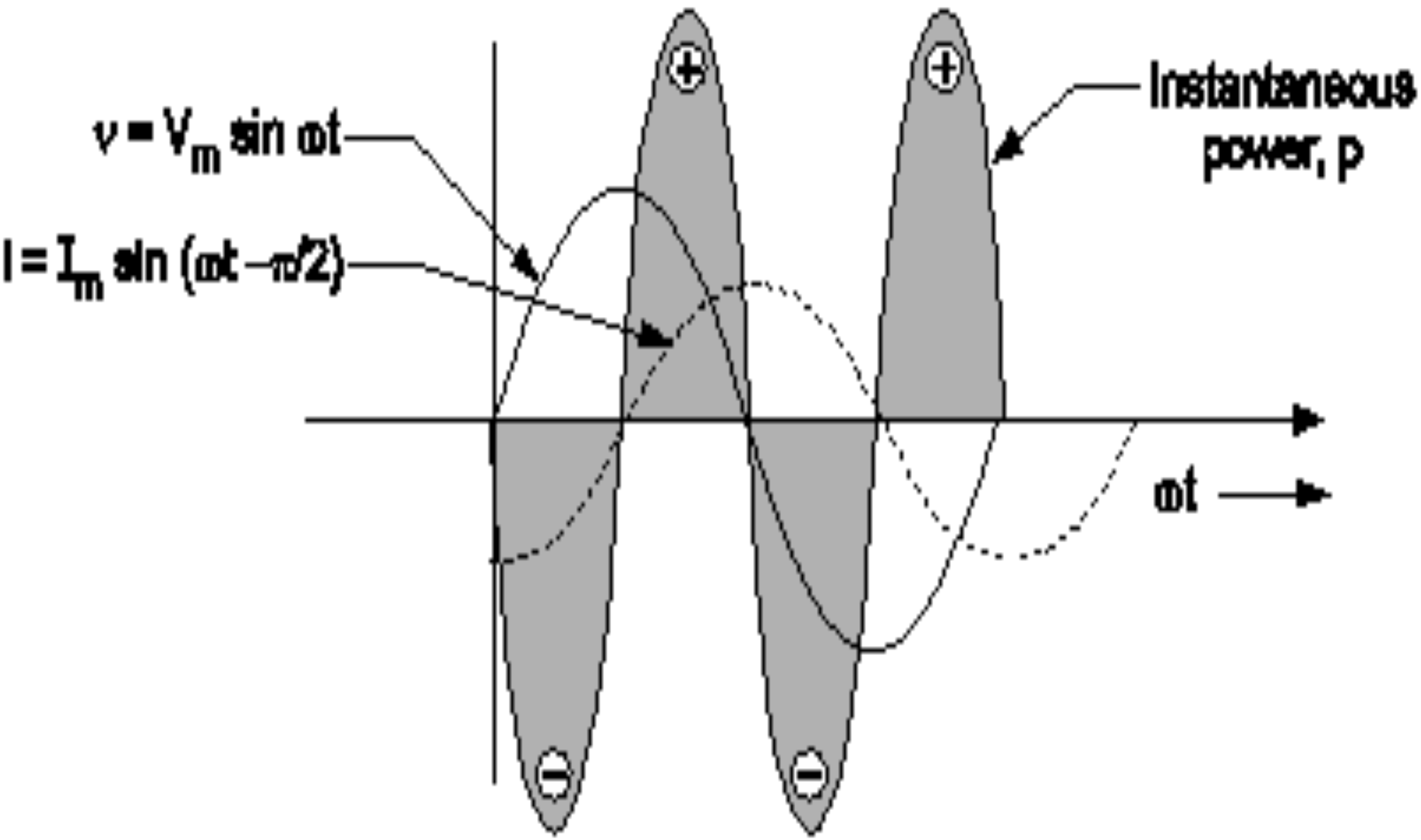


(b) Waveforms

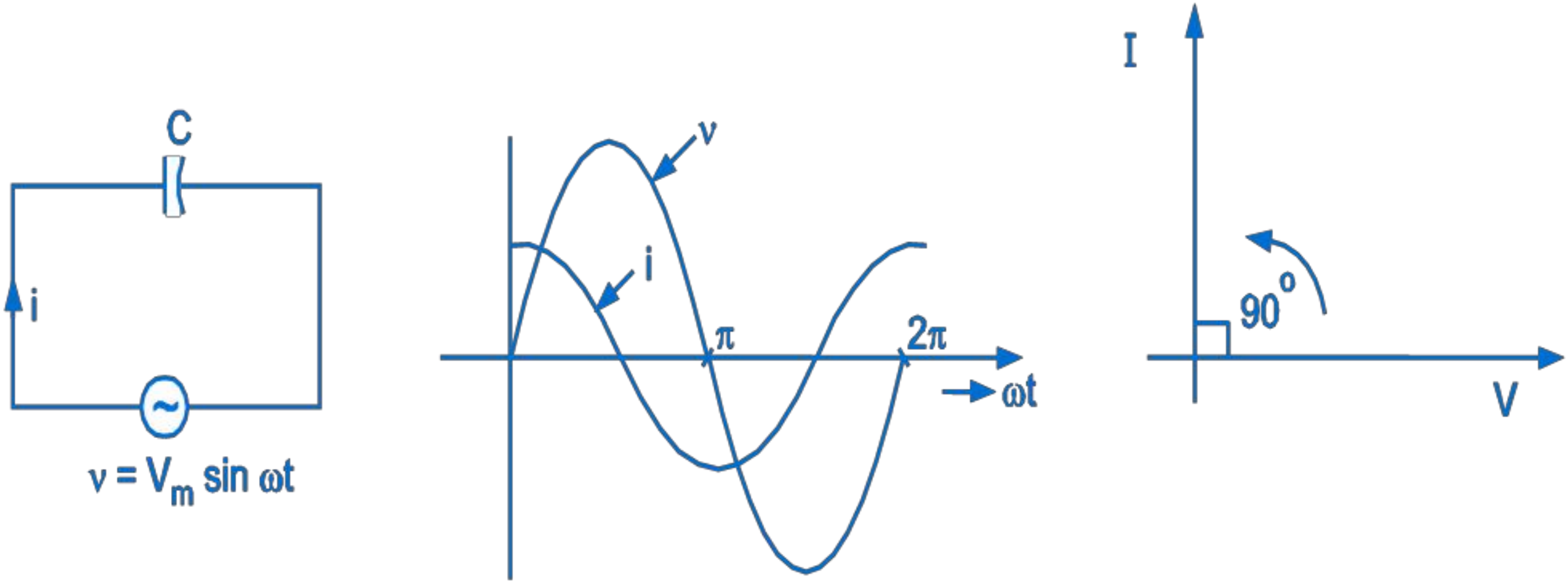


(c) Phasor diagram

Wave forms

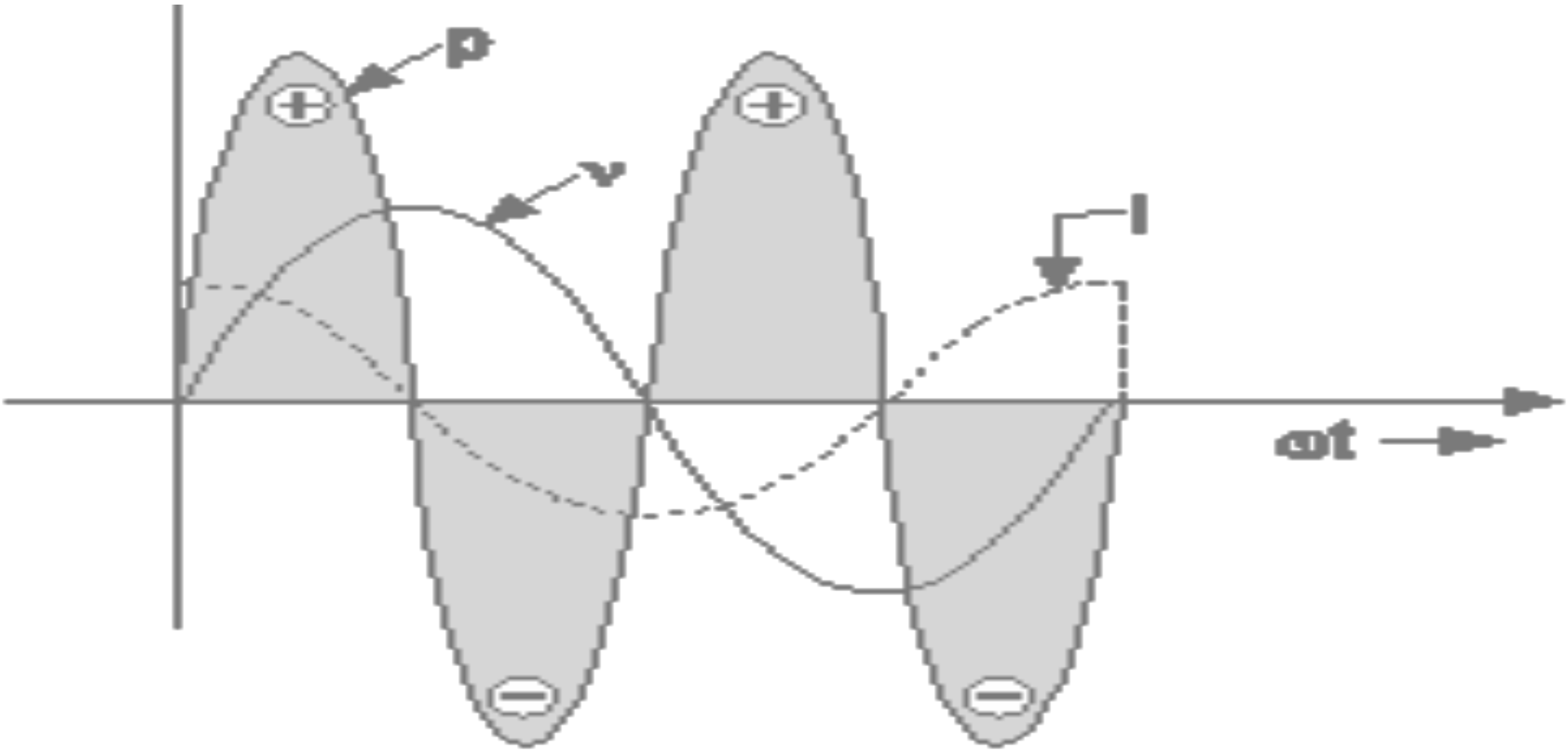


A.C. THROUGH PURE CAPACITANCE



(a) Circuit Diagram (b) Waveforms (c) Phasor Diagram

Wave forms



Numerical

Find the current taken by a 100 μF capacitor when it is connected across single phase 230 V, 50 Hz supply.

A pure inductance L = 0.1 H has an applied voltage v = 250 sin 314.28t. Find rms value of current, instantaneous power, average power. Write down equation for current.

Ans:

5.62 A, -993.75 sin(628.56t) W, 0

$i = 7.95 \sin (314.28t - \pi/2)$

A 50 Hz, alternating voltage of 150 V is applied independently to (i) Resistance of 10 ohm (ii) Inductance of 0.2 H (iii) Capacitance of 50 μF. Find the expression for the instantaneous current in each case.

$21.213 \sin(100\pi t)$ A

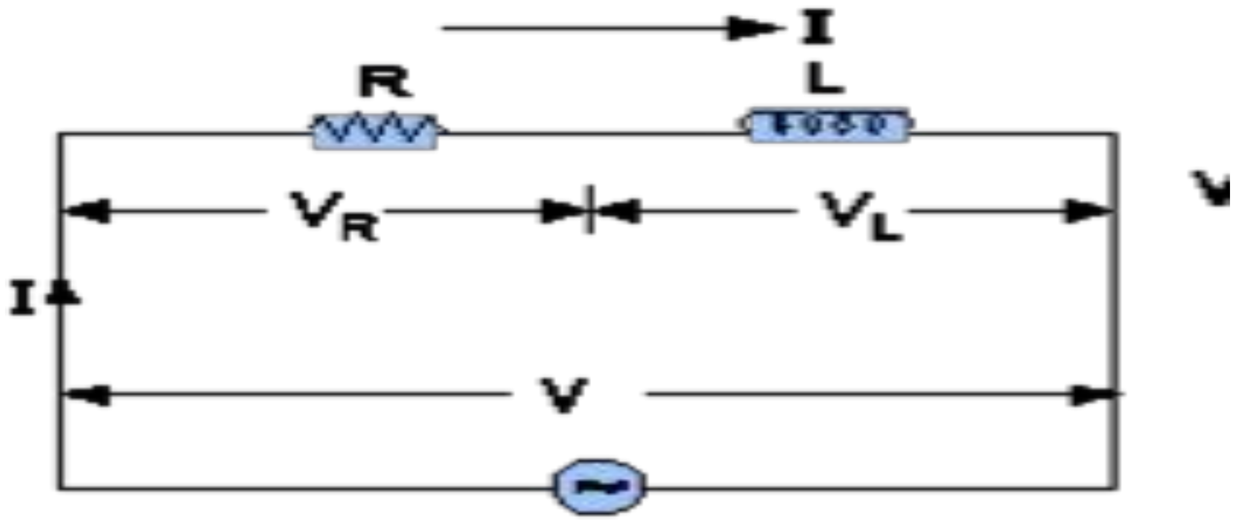
$3.37 \sin(100\pi t - \pi/2)$ A

$3.33 \sin(100\pi t + \pi/2)$

1. Circuit diagram
2. Phasor diagram
3. Current equation
4. Voltage triangle
5. Impedance
6. Impedance triangle
7. Power
8. Power triangle
9. Waveforms

SINGLE PHASE A.C CIRCUIT

A.C. THROUGH RESISTANCE AND INDUCTANCE



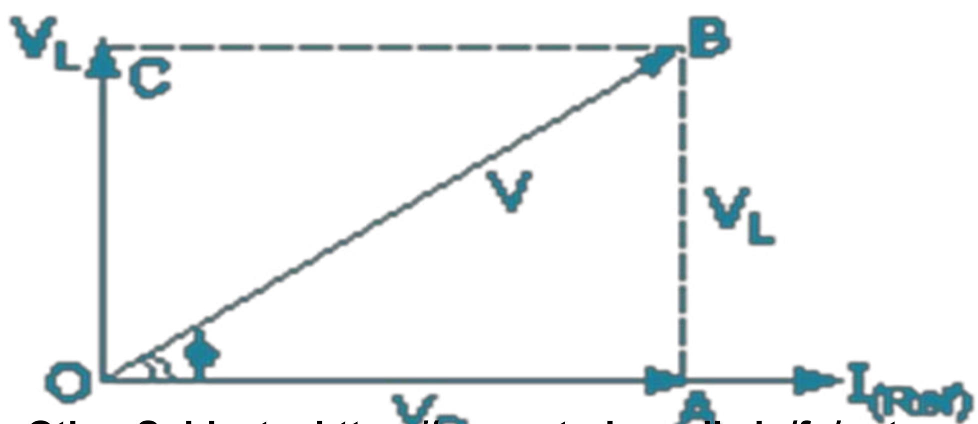
TO GET EXPRESSION FOR CURRENT,POWER OF SUCH CIRCUIT

USING PHASOR DIAGRAM

- Let, $V =$ rms value of the applied voltage.
- $I =$ rms value of the resultant current in the circuit.

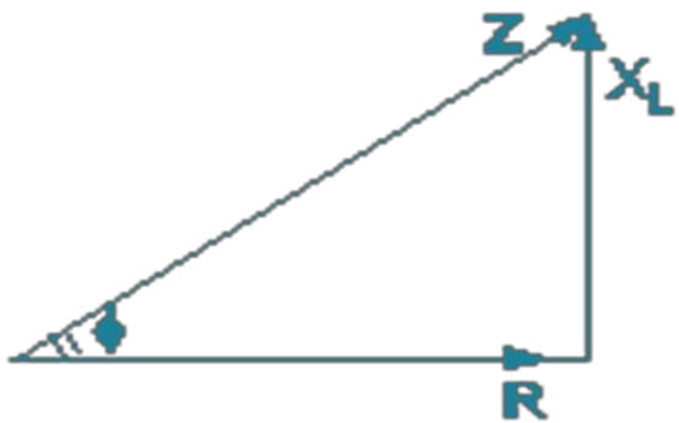
- Voltage drop across R, $V_R = I.R$ (V_R in phase with I)

- Voltage drop across L, $V_L = I.X_L$ (V_L is leading I by 90^0)

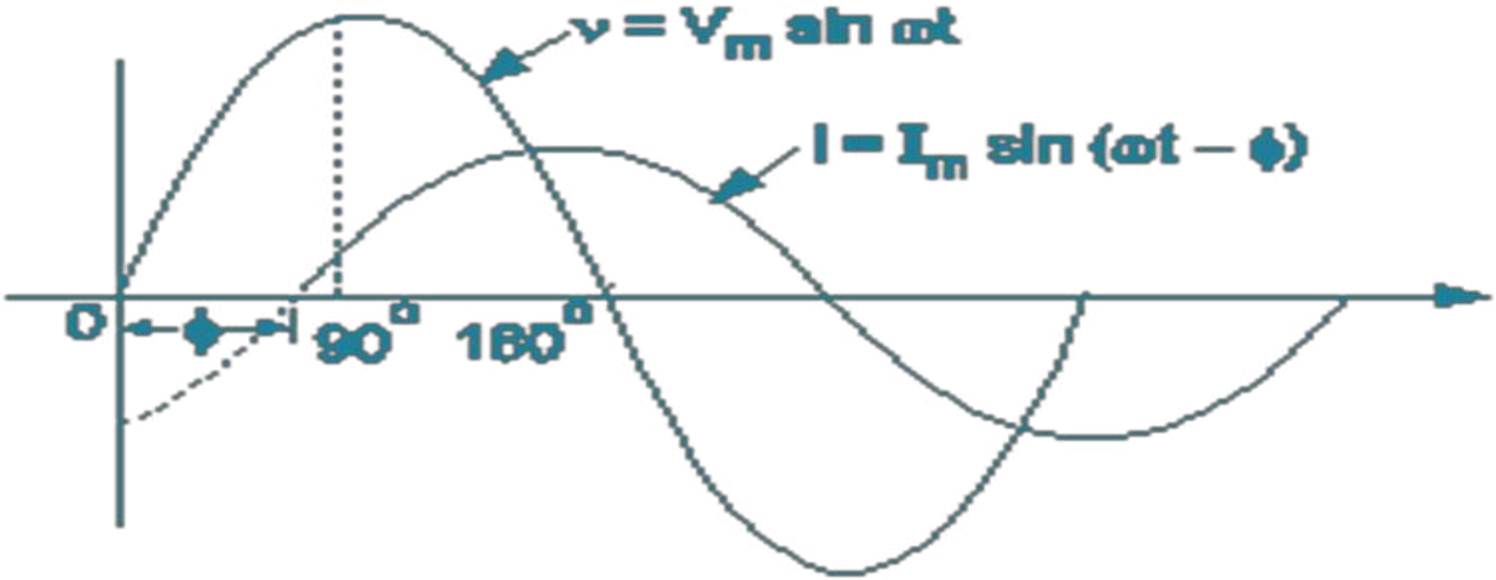


VOLTAGE TRIANGLE

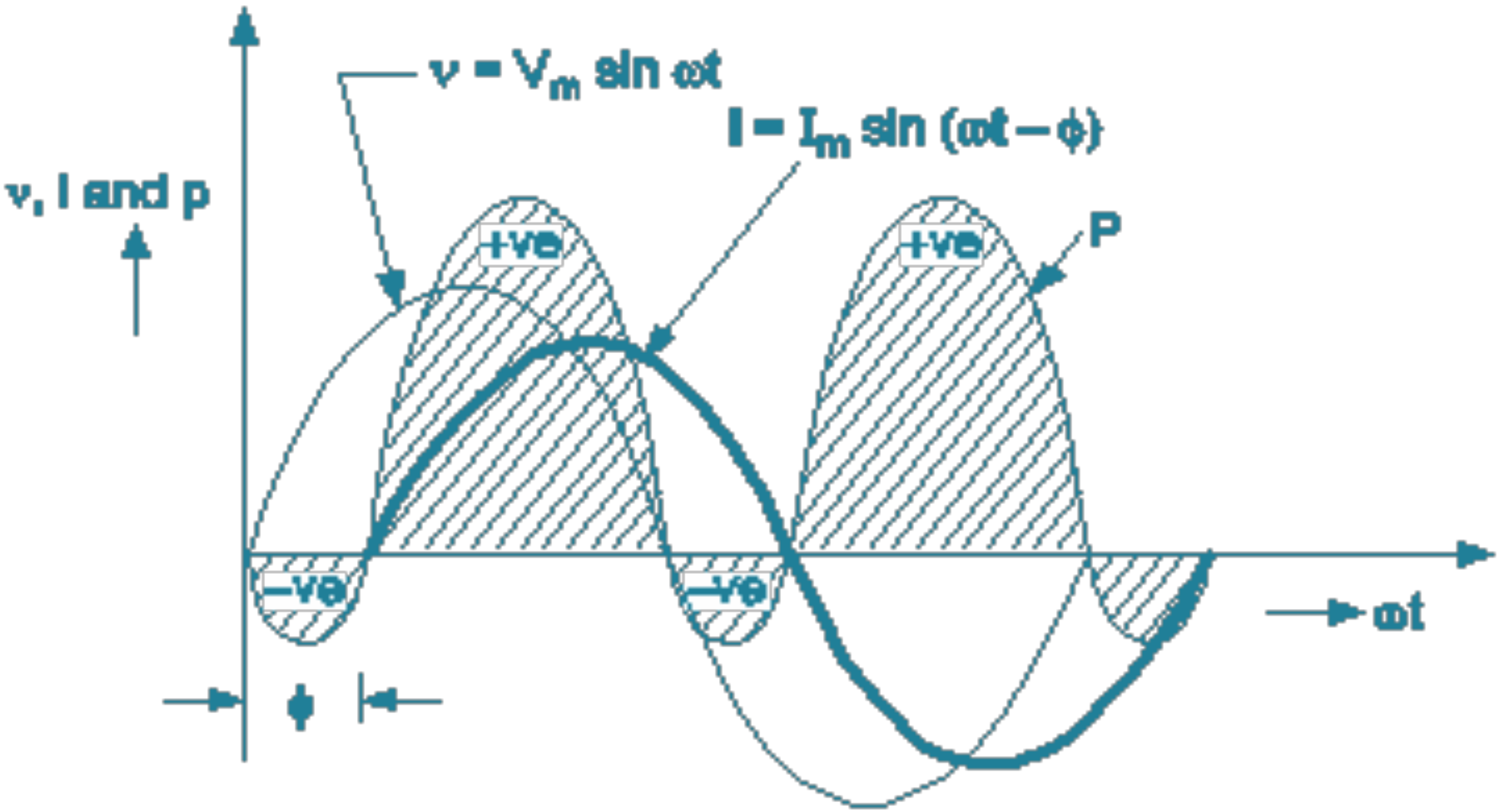
IMPEDENCE TRIANGLE



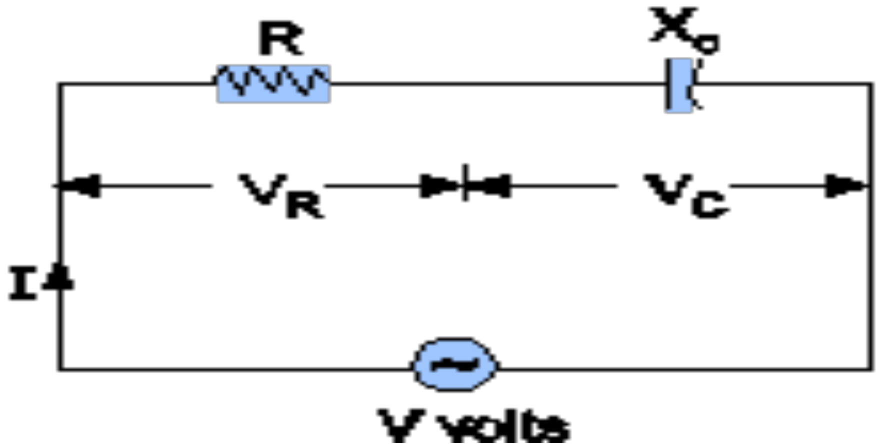
WAVE FORM OF VOLTAGE AND CURRENT



Wave form of voltage, current and power

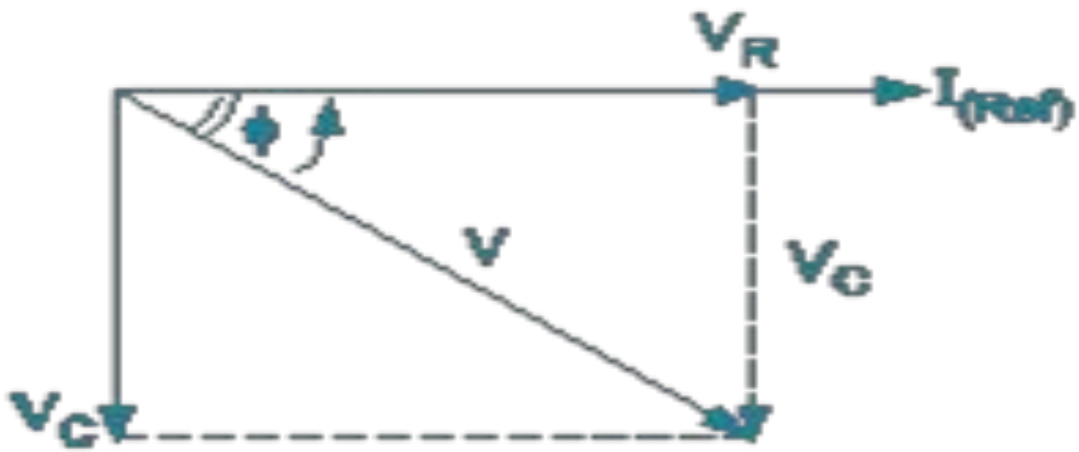


A.C. THROUGH R-C SERIES CIRCUIT

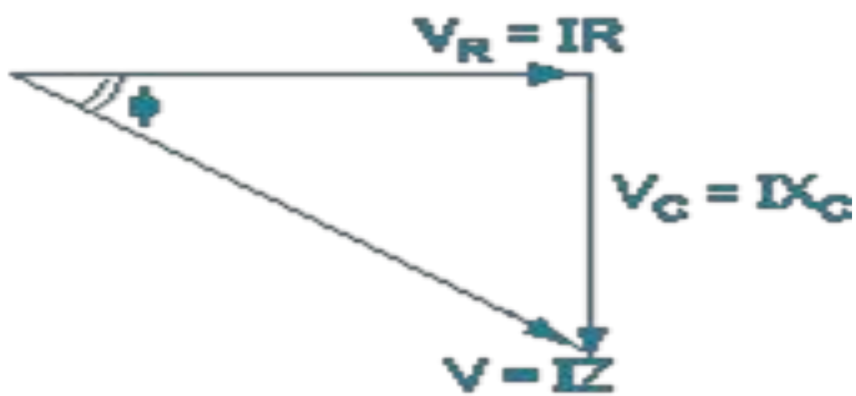


- Let, V = rms value of the applied voltage.
- I = rms value of the resultant current in the circuit.

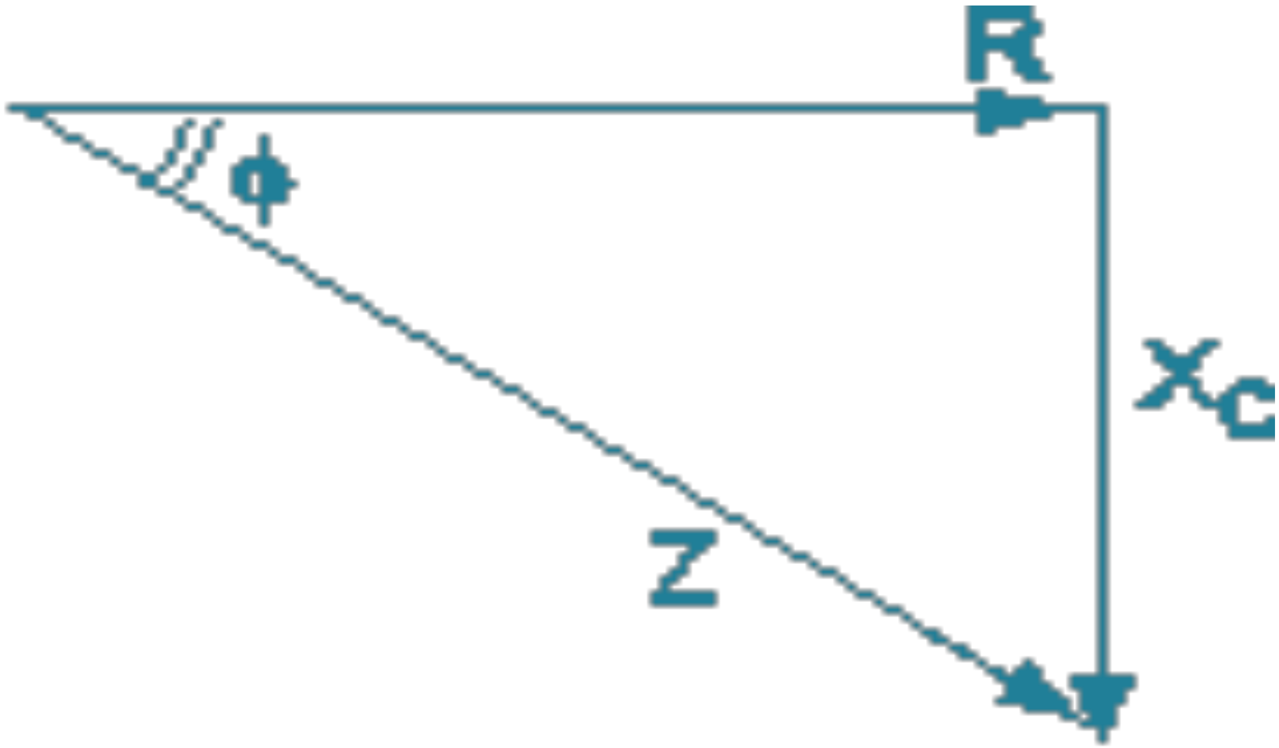
- Voltage drop across R, $V_R = I.R$ (V_R in phase with I)



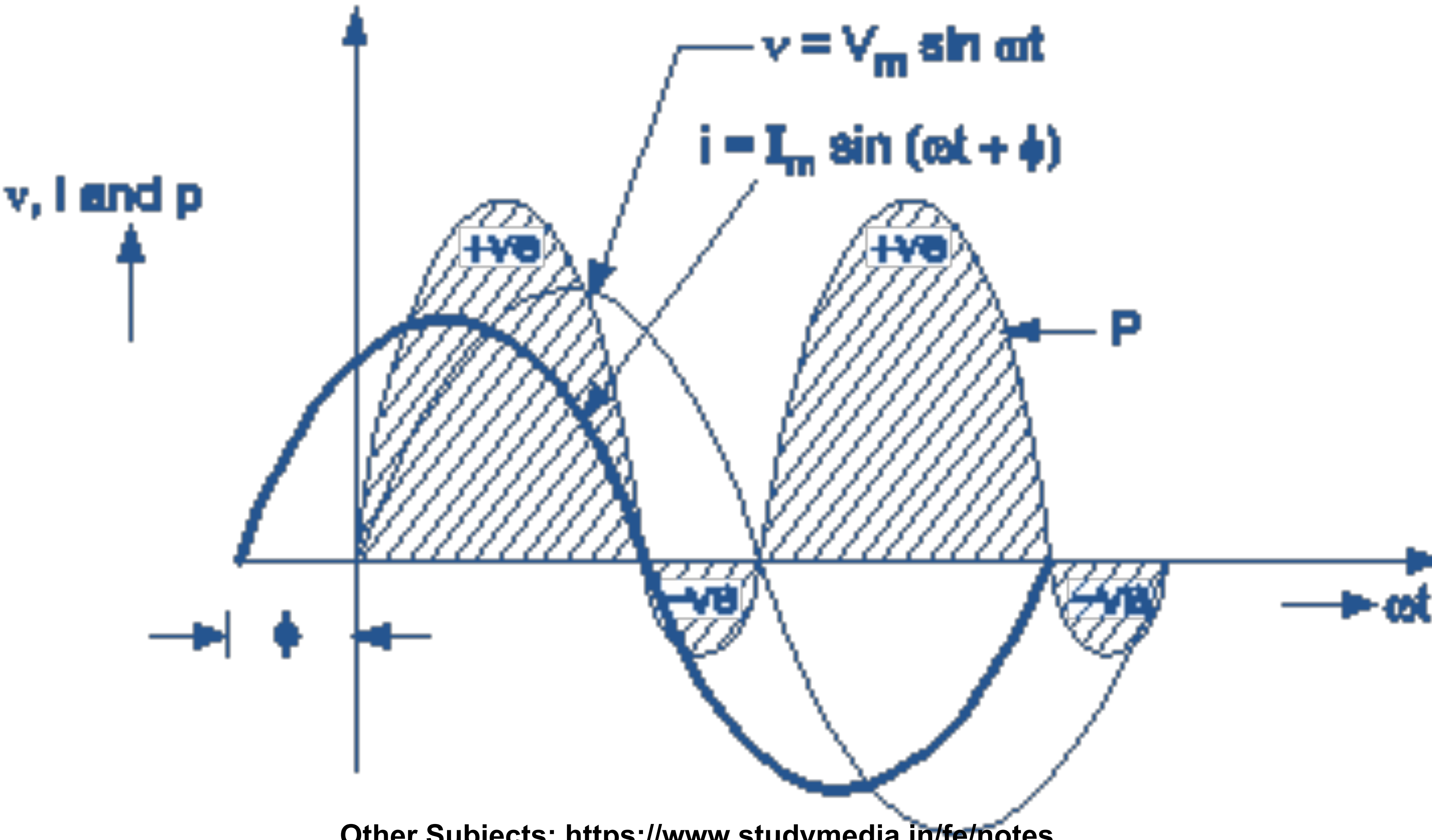
VOLTAGE TRIANGLE



IMPEDENCE TRIANGLE



Waveforms of voltage , current and power



Numerical

1. A coil has inductance of 20 mH and resistance of 5 Ω. It is connected to supply voltage $v = 48 \sin 314t$. Obtain the expression for the current drawn

2. A coil is connected across a 250 V, 50 Hz supply takes a current of 10 A at 0.8 p.f. lagging. What will be power taken by choke coil, when connected across 200 V, 25 Hz supply? Also calculate resistance and inductance of coil.

3. A resistance of 100 Ω and 50 μF capacitor are connected in series across a 230 V, 50 Hz supply. Find

i. Current in circuit

ii. Voltage across the resistance

iii. Voltage across the capacitor

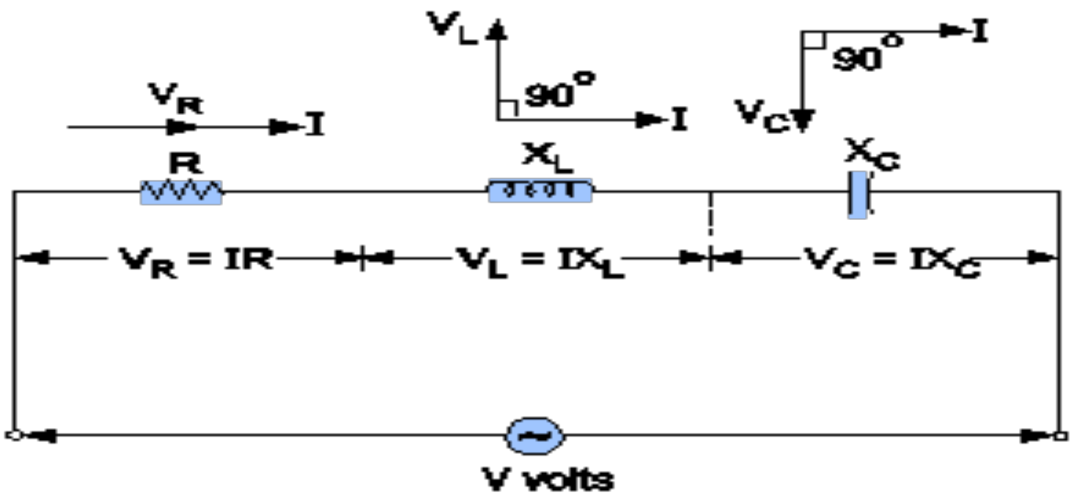
iv. Power factor

v. Power

4. A room heater of 2 kW, 125 V rating is to be operated at 230 V, 50 Hz ac supply. Calculate the value of inductance, that must be connected in series with the heater so that heater will not get damaged due to over voltage.

5. Derive the expression for power when voltage $v = V_m \sin \omega t$ is applied across R-L and then to R-C series circuit. Draw the waveforms for voltage, current and power

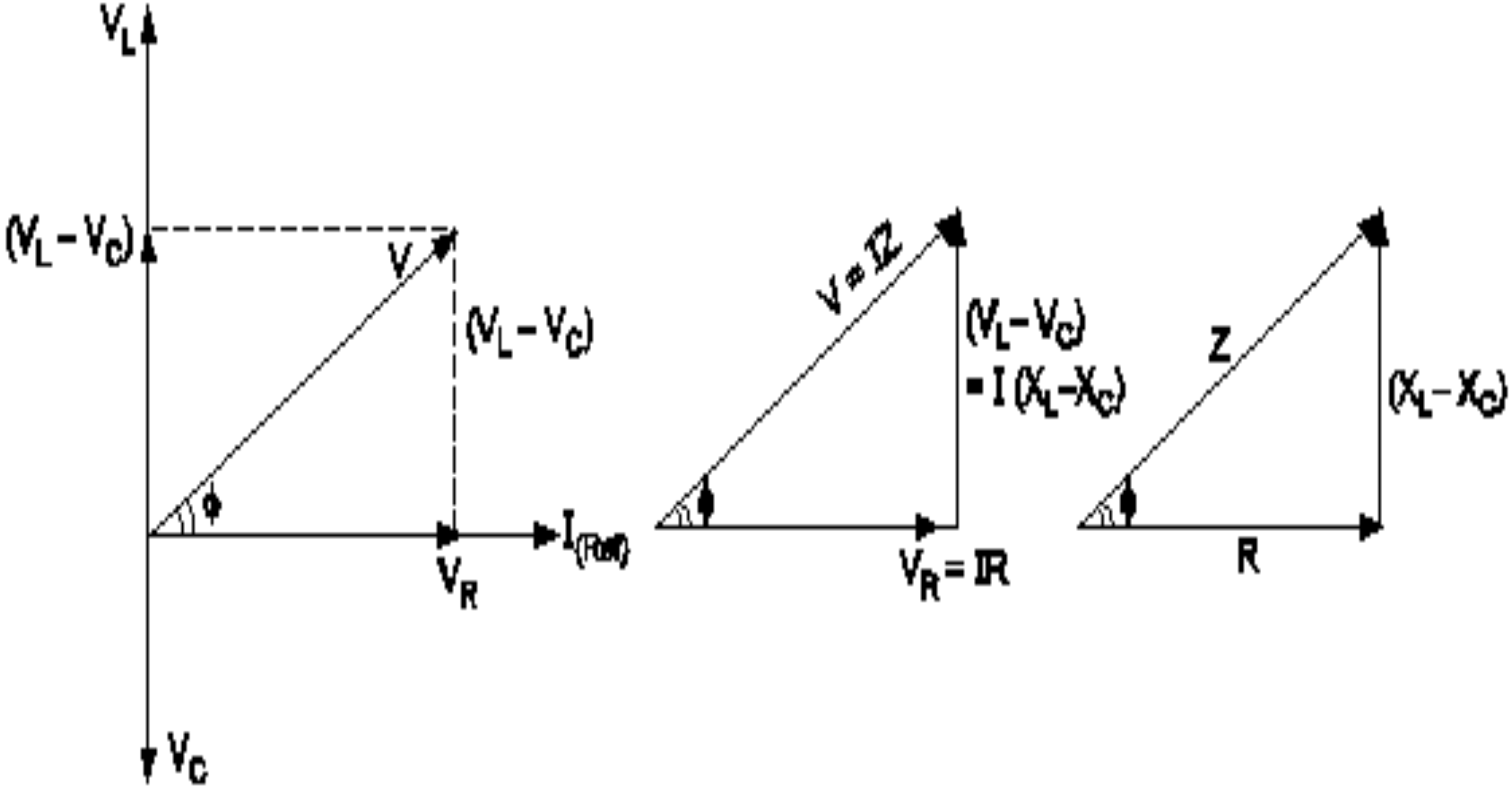
A.C. THROUGH SERIES R-L-C CIRCUIT



Case I : Inductive reactance (X_L) > Capacitive reactance, (X_C).
Case II : Inductive reactance (X_L) < Capacitive reactance, (X_C).

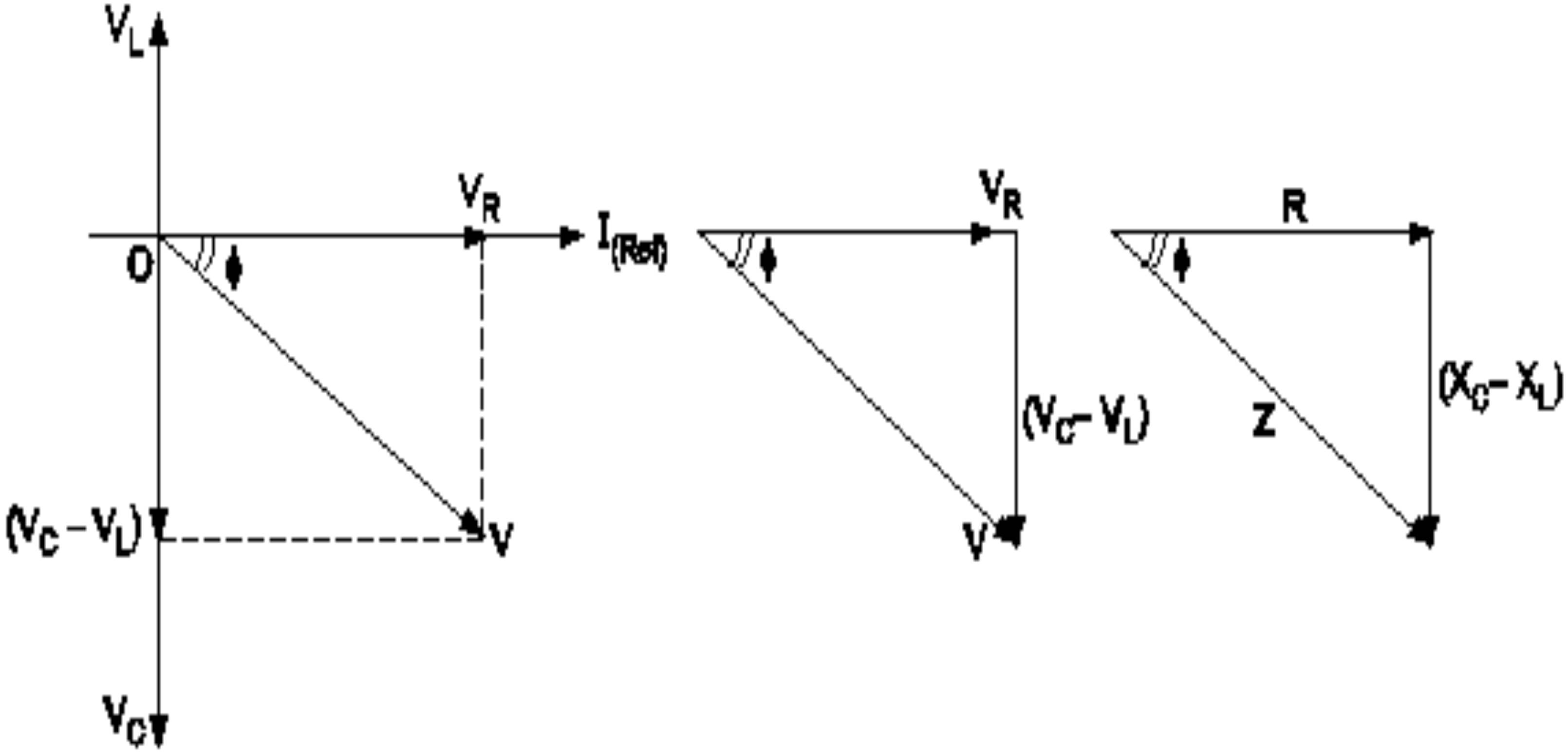
Case III : Inductive reactance (X_L) = Capacitive reactance, (X_C).

Case I : Inductive reactance (X_L) > Capacitive reactance, (X_C)

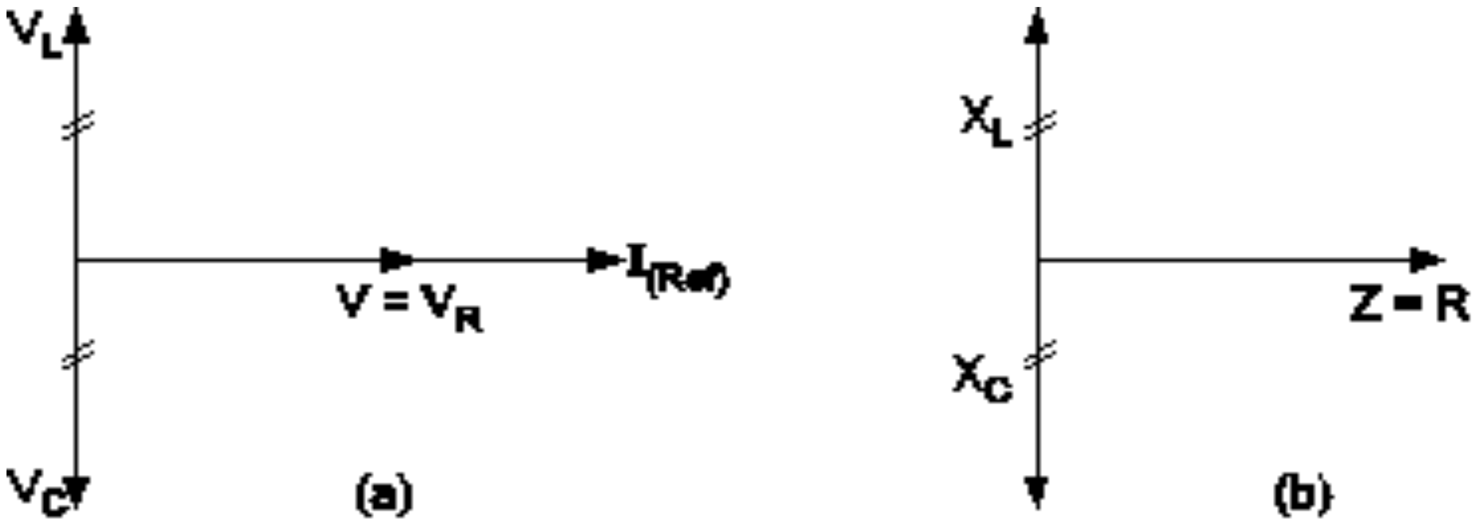


CURRENT LAG BEHIND THE VOLTAGE BY ϕ

Case II : Inductive reactance (X_L) < Capacitive reactance, (X_C).



Case III : Inductive reactance (X_L) = Capacitive reactance (X_C)



Numerical on R-L-C Series Circuit

1. A series circuit consists of 50 Ω resistance, 0.1 H inductance and 50 μF capacitance connected across single phase, 230 V 50 Hz supply. Calculate the current dra by circuit, the pow wn circuiter its nature. factor of and Also calculate total power consumed by circuit. Draw the phasor diagram.

2. The load taken from supply consists of a

i. Lamp load 10 kW at unity p. f.

ii. Motor load of 80 kVA at 0.8 p.f. lagging

iii. Motor load of 40 kVA at 0.7 p.f. lagging

Calculate total load taken from the supply in kW and in kVA. Also pf of combined load.

3. Emf given by $v = 100 \sin 100\pi t$ is impressed across a circuit consists of resistance of $40\ \Omega$ in series with $100\ \mu F$ capacitor and 0.25 H inductor.

Determine

i. RMS value of current

ii. Power consumed

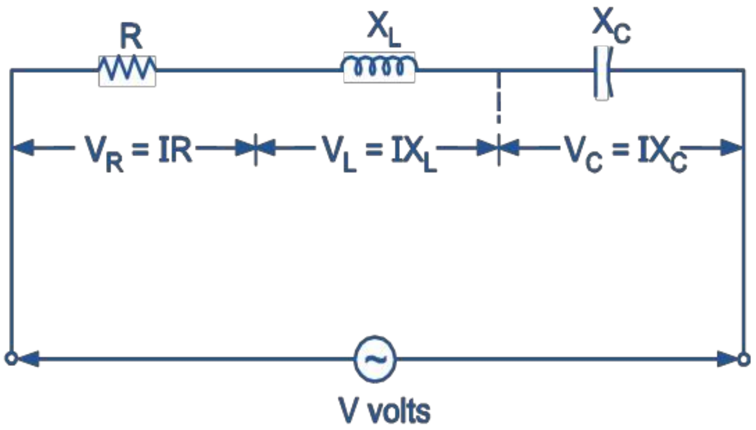
iii. Power factor

4. A coil of pf 0.6 is in series with 100 μF capacitor. When whole circuit is connected across 50 Hz supply, the p. d. across the coil is equal to p. d. across capacitor. Find resistance and inductance of coil.

5. A coil of resistance 10 Ω and inductance 0.1 H is connected in series with a 50 μF capacitor across a 230 V, 50 Hz supply. Find the current taken and the phase difference between supply voltage and current. Find also the voltage drop across the coil and capacitor

6. Two impedances connected in series are $Z_1 = 40\angle 30^0$ and $Z_2 = 30\angle 60^0$ across 230 V, 50 Hz supply. Find current, power factor and power consumed by circuit

RESONANCE IN THE R–L–C SERIES CIRCUIT



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Resonant Frequency

$$X_L = X_C$$

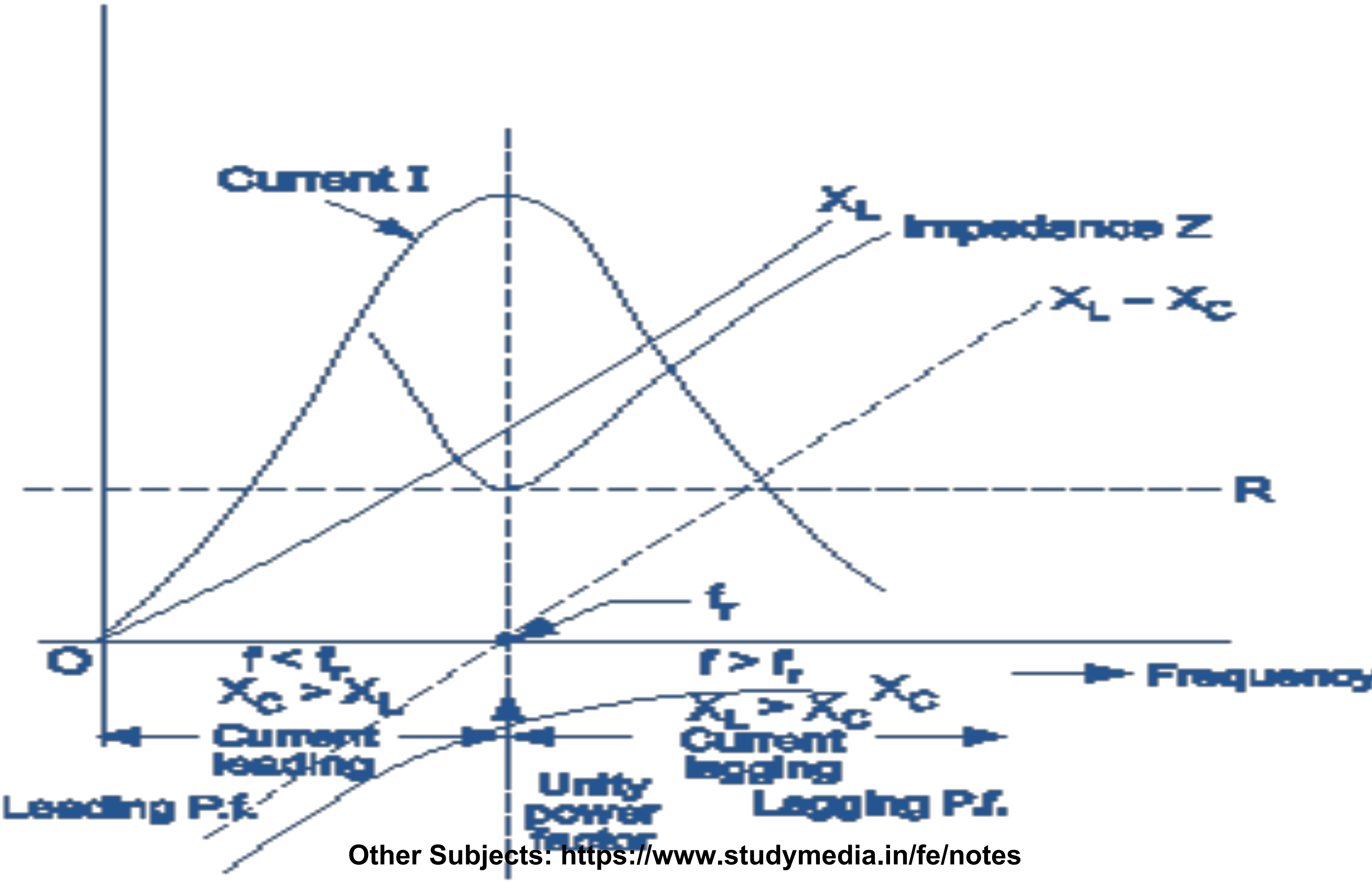
$$\omega_r L = \frac{1}{\omega_r C}$$

$$2\pi f_r L = \frac{1}{2\pi f_r C}$$

$$\therefore \quad f_r^2 = \frac{1}{4\pi^2 LC}$$

$$\therefore \quad f_r = \frac{1}{2\pi\sqrt{LC}} \ \text{Hz}$$

Resonance



Other Subjects: https://www.studymedia.in/fe/notes

Numerical on Resonance

A series circuit consisting of a coil and a variable capacitance having reactance X_C. The coil has a resistance of 10 Ω, inductive reactance of 20 Ω. It is observed that at certain value of capacitance, current in the circuit is maximum.

Find

i. The value of capacitance

ii. Impedance of the circuit

iii. Power factor

iv. Current

If applied voltage is 100 V, 50 Hz.

- For the given circuit find at what value of frequency will current become maximum? Calculate the current and voltage across coil and across capacitor for this frequency.

A coil of 15 mH is connected in series with 25Ω resistance and a capacitor across 230 v, 50 Hz supply. Find the value of capacitor so that circuit draws maximum current. What will be the power factor and power consumed?

AC Parallel Circuit

- Concept of Admittance (Y)
- Components of Admittance(Y)
- Conductance (G)
- Susceptance (B)
- Unit Mho or Siemens

$Y = G + jB \quad Y = G - jB$

- Admittance Triangles