EEE1024: Fundamentals of Electrical and Electronics Engineering

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ASSIGNMENT- Phasor Addition 1

Q1) $v_1(t) = 10\cos(\omega t) + 10\sin(\omega t)$

$$= 10\cos(\omega t) + 10\cos(\omega t - 90^o)$$

STEP 1:
Convert all voltages in cosine function

$$v_1(t) = 10\angle 0^0 + 10\angle -90^0$$

STEP 2:
PHASORS for each voltage

$$v_1(t) = 10(\cos(0^0) + j\sin(0^0)) + 10(\cos(-90^0) + j\sin(-90^0))$$

$$= 10(1 + j0) + 10(0 + j(-1))$$

$$= 10(1 + j0) + 10(0 + j(-1))$$

$$v_1(t) = 10 - 10j$$

STEP 3:
Convert PHASORS to complex

$$v_1(t) = \sqrt{10^2 + (-10)^2}\ \tan^{-1}(-10/10)$$

$$v_1(t) = 14.14\angle -45^0$$

STEP 4:
Convert Complex to PHASORS

$$v_1(t) = 14.14\cos(\omega t - 45^0)$$

STEP 5:
Convert PHASORS back to sinusoid

ASSIGNMENT- Phasor Addition 2

Q2) $i_1(t) = 10\cos(\omega t + 30^{\circ}) + 5\sin(\omega t + 30^{\circ})$

$i_1(t) = 11.18\cos(\omega t + 3.44^{0})$ ANS

Q3) $i_2(t) = 20\sin(\omega t + 90^{\circ}) + 15\cos(\omega t - 60^{\circ})$

$i_2(t) = 30.4\cos(\omega t - 25.3^{0})$ ANS

ASSIGNMENT – Phasor Relationships

3 voltages are given as -

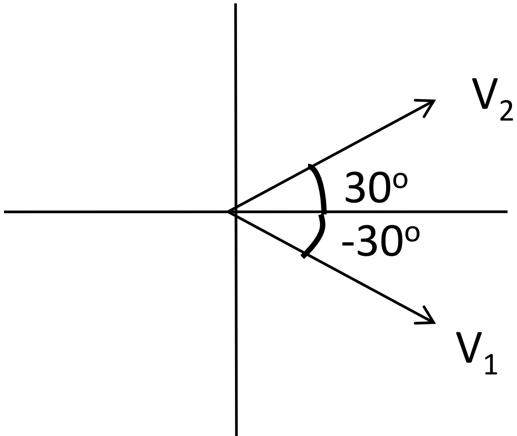
$$v_1(t) = \cos(\omega t - 30^o)$$

$$v_2(t) = \cos(\omega t + 30^o)$$

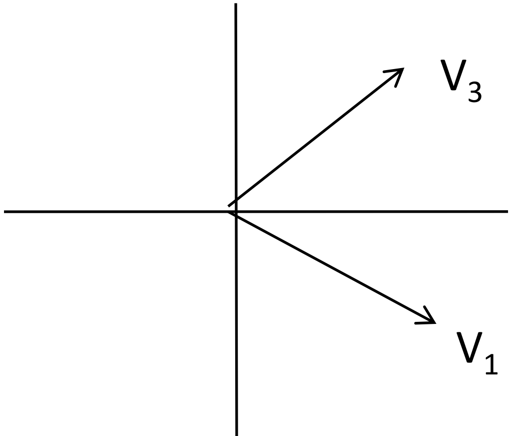
$$v_3(t) = \cos(\omega t + 45^o)$$

State the phase relationship between each pair of voltages

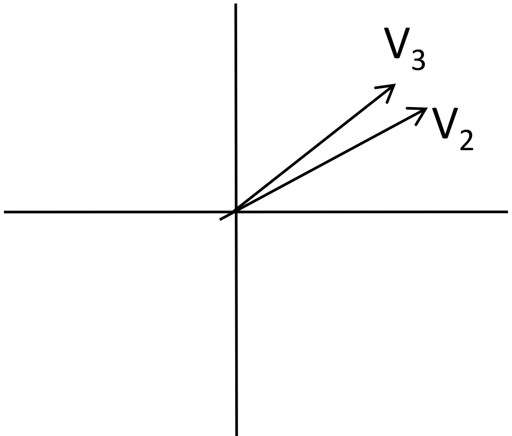
V_1 lags V_2 by 60°



V_1 lags V_3 by 75°



V_2 lags V_3 by 15°



ASSIGNMENT - COMPLEX IMPEDANCES (1)

Example 3: A voltage $v_L(t) = 100\cos(200t)$ is applied to a 0.25H inductance. Notice that ω=200 rad/s.

a) Find impedance of inductance, phasor current and phasor voltage (of inductor)

b) Draw phasor diagram

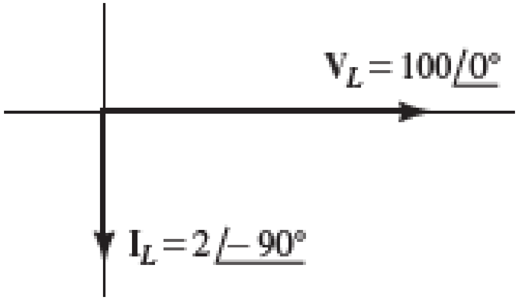
$$Z_L = j\omega L = j \times 200 \times 0.25 \quad = 50j = 50\angle 90^0$$

$$j\omega L = \omega L\angle 90^o$$

$$\mathbf{V}_L = j\omega L \times \mathbf{I}_L$$

Phasor voltage - $V_L = 100\angle 0$

Phasor current - $I_L = \dfrac{V_L}{Z_L} = \dfrac{100\angle 0}{50\angle 90} = 2\angle(0-90) = 2\angle -90^0$



ASSIGNMENT - COMPLEX IMPEDANCES (2)

Example 4: A voltage $v_C(t) = 100\cos(200t)$ is applied to a 100μF capacitance.

a) Find impedance of capacitance, phasor current and phasor voltage (of capacitor)

b) Draw phasor diagram

$$Z_C = \frac{-j}{\omega C} = \frac{-j}{200 \times 100 \times 10^{-6}} = -50j = 50\angle -90^0$$

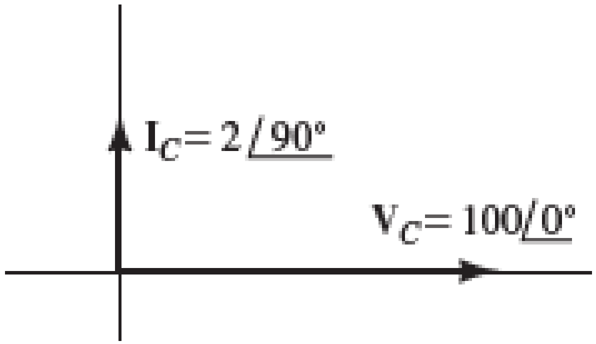
$$-j = \frac{1}{j} = \angle -90^0$$

For angle between V and I of a Capacitor

Phasor voltage - $V_C = 100\angle 0$

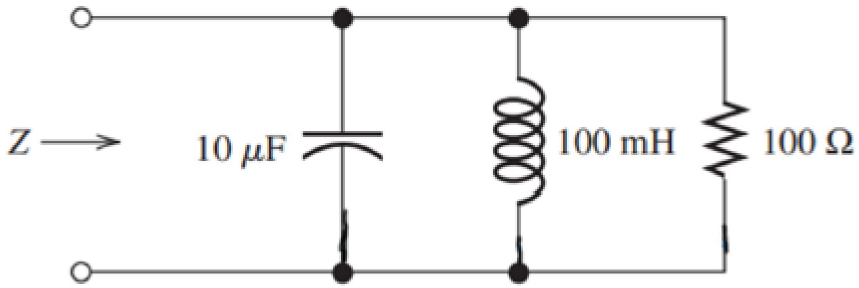
Phasor current - $I_C = \frac{V_C}{Z_C} = \frac{100\angle 0}{50\angle -90} = 2\angle 90^0$

$$Z_C = -j\frac{1}{\omega C} = \frac{1}{\omega C}\angle -90^\circ$$



COMPLEX IMPEDANCES - Example

Example 4: Find complex impedance of the network shown, take ω = 500 rad/s



$$R_{eq} = \frac{1}{(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3})} \qquad Z_{eq} = \frac{1}{(\frac{1}{R} + \frac{1}{Z_C} + \frac{1}{Z_L})}$$

$$Ans = 30.76 + 46.15j$$

A.C. Power Calculations

$$P = V_{rms} I_{rms} \cos\theta$$

ACTIVE power **W**

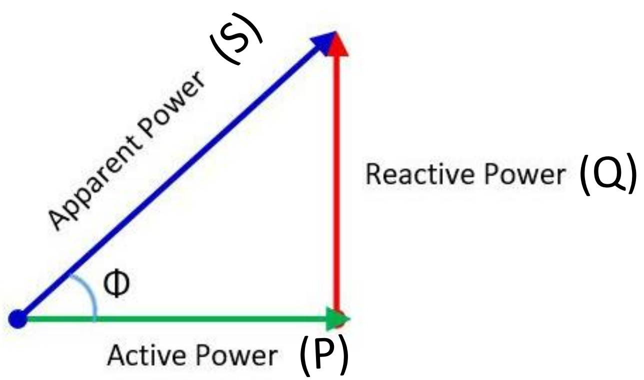
Power Factor for phase of voltage to be ZERO

$$v(t) = V_m \cos(\omega t)$$

$$i(t) = I_m \cos(\omega t - \theta)$$

$$\theta = \theta_V - \theta_I$$

for non-zero phase of voltage



POWER TRIANGLE

$$Q = V_{rms} I_{rms} \sin\theta$$

REACTIVE power **VAR**

$$S = \sqrt{P^2 + Q^2}$$

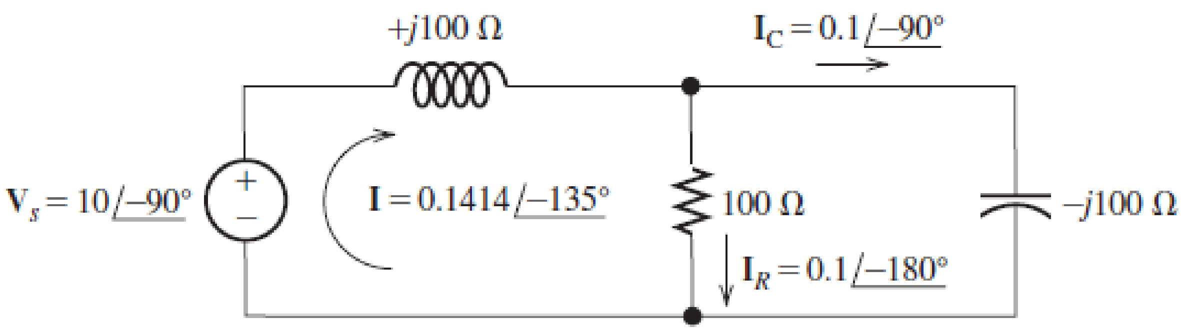
$$= V_{rms} I_{rms}$$

APPARENT power **VA**

A.C. Power Calculations

Example:

Compute the active, apparent and reactive power supplied by the source for the circuit given



Impedances are already calculated !!!

$$V_{rms} = \frac{V_m}{\sqrt{2}} = \frac{10}{\sqrt{2}} = 7.07$$

$$I_{rms} = \frac{I_m}{\sqrt{2}} = \frac{0.1414}{\sqrt{2}} = 0.1$$

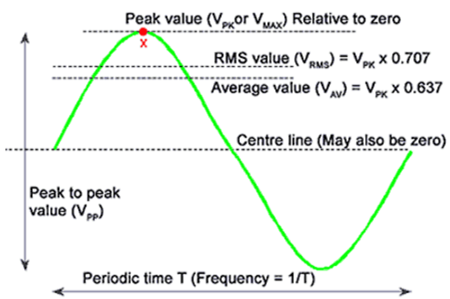
$$\theta = \theta_v - \theta_I \qquad = -90 - (-135)$$

$$P = 7.07 \times 0.1 \times \cos(45) = 0.5W$$

$$Q = 7.07 \times 0.1 \times \sin(45) = 0.5VAR$$

$$S = 7.07 \times 0.1 = 0.707VA$$

Sinusoidal Voltage and current



Peak,
Average,
RMS
For V,I

Phasors

Definition,
Addition

Complex Impedances

Z_C and Z_L

Steady state analysis

KCL, KVL,
Node,
Mesh

A.C. Power Calc.

Power
Triangle
and its
terms

MODULE 3:

DIGITAL SYSTEMS

NUMBER SYSTEMS

DECIMAL	BINARY	HEXADECIMAL	OCTAL
BASE - 10	**BASE - 2**	**BASE - 16**	**BASE - 8**

DECIMAL 743.2 $= 7 \times 10^2 + 4 \times 10^1 + 3 \times 10^0 + 2 \times 10^{-1}$

BINARY 1101.1 $= 1 \times 2^3 + 1 \times 2^2 + 0 \times 2^1 + 1 \times 2^0 + 1 \times 2^{-1} = 13.5$

In Binary – a 3-bit word = ?? combinations $\rightarrow$ $\mathbf{2^3 = 8}$

8 binary numbers = ?? Decimal integers

000	0
001	1
010	2
011	3
100	4
101	5
110	6
111	7

In Binary – a 4-bit word = ?? combinations $\rightarrow$ $\mathbf{2^4 = 16}$

DECIMAL ⟺ BINARY CONVERSIONS

Decimal to Binary

- Repeatedly divide the decimal by 2, till quotient is zero
- **Remainders, read in reverse order, give the binary form**

Conversion of

343_{10} to binary

		Quotient	Remainder
343/2	=	171	1
171/2	=	85	1
85/2	=	42	1
42/2	=	21	0
21/2	=	10	1
10/2	=	5	0
5/2	=	2	1
2/2	=	1	0
1/2	=	0	1

101010111_2

Read binary equivalent in reverse order

Stop when quotient equals zero

$$343_{10} = 101010111_2$$

DECIMAL ⟷ BINARY CONVERSIONS

Decimal Fraction to Binary

➢ **Repeatedly multiply the fractional part by 2, and retain the whole parts of the result.**

➢Stop till the desired precision is reached.

Conversion of

0.392_{10} to binary

$$
\begin{array}{lcccl}
2 \times 0.392 & = & 0 & + & 0.784 \\
2 \times 0.784 & = & 1 & + & 0.568 \\
2 \times 0.568 & = & 1 & + & 0.136 \\
2 \times 0.136 & = & 0 & + & 0.272 \\
2 \times 0.272 & = & 0 & + & 0.544 \\
2 \times 0.544 & = & 1 & + & 0.088
\end{array}
$$

$\overbrace{0.011001_2}$ (approximate binary equivalent)

$$0.392_{10} \cong 0.011001_2$$

To convert a decimal which has a both a whole part and a fractional part,
Convert each part seperately and combine the two

343.392_{10} to binary

$$343_{10} = 101010111_2 \qquad 0.392_{10} \cong 0.011001_2$$

$$343.392_{10} \cong 101010111.011001_2$$

DECIMAL ⟷ BINARY CONVERSIONS

Binary to Decimal

- **Multiply by the power of 2 based on its place value**

Conversion of

10011.011 to Decimal

$$10011.011_2 = 1 \times 2^4 + 0 \times 2^3 + 0 \times 2^2 + 1 \times 2^1 + 1 \times 2^0 + 0 \times 2^{-1}$$
$$+ 1 \times 2^{-2} + 1 \times 2^{-3} = 19.375_{10}$$

Acknowledgements

1. Allan R. Hambley, ‘Electrical Engineering - Principles & Applications, Pearson Education, First Impression, 6/e, 2013
2. https://circuitglobe.com/difference-between-active-and-reactive-power.html