BEE ASSIGNMENT
ACTIVITY 3 (CRITICAL THINKING)

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SECTION : A-32
SUBJECT CODE : EE10002

Q1) A 50 Hz sinusoidal voltage has a maximum value of 56.56 V. Find the value of voltage 0.0025 seconds after passing through the maximum positive value. At what time measured from a positive maximum value will the instantaneous voltage be 14.14 V?

Ans. $f = 50\ Hz$

$$V = V_m \sin\left(\omega t + \frac{\pi}{2}\right)$$

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

$$= 56.56 \cos(2 \times \pi \times 50 \times 0.0025)$$

$$= \boxed{39.99\ V}$$

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

For $V = 14.14\ V$,

$$14.14\ V = 56.56\ V \cos(2 \times \pi \times 50 \times t)$$

$$\Rightarrow 100\pi t = \cos^{-1}\left(\frac{1}{4}\right)$$

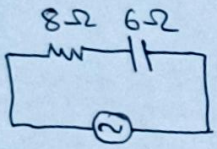
$$\Rightarrow t = \frac{\cos^{-1}(0.25)}{100\pi \times \frac{180}{\pi}}$$

$$= \boxed{4.19\ ms}$$

Q2) A circuit is composed of a resistance of 8Ω and a capacitive reactance of 6Ω in series. A voltage, $V = 141.4 \sin(314t)$ V is applied to the circuit.

(a) Find the complex impedance and draw the impedance triangle
(b) Determine the rms and instantaneous values of current.
(c) Calculate the power delivered to the circuit.
(d) Find the voltage across the resistor and capacitor
(e) Draw the phasor diagram of the circuit.

Sol. $R = 8\Omega$, $X_C = 6\Omega$



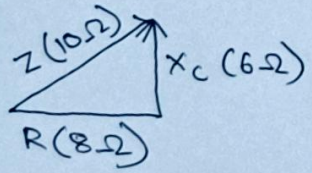
$V = 141.4 \sin(314t)$ V

(a) $Z = R - X_C j$

$= 8 - 6j$

$= 10\angle -36.87°$

$Z = 10\Omega$



(b) $I_{rms} = \frac{I_m}{\sqrt{2}}$

$V_m = 141.4$

$I_m = \frac{V_m}{Z} = \frac{141.4}{10} = 14.14A$

$I_{rms} = \frac{I_m}{\sqrt{2}} = \frac{14.14}{\sqrt{2}} = 9.998A \approx 10A$

$I = 14.14 \sin(\omega t + \phi)$

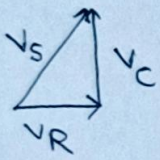
(c) $P = V_{rms} I_{rms} \cos\phi$

$= \frac{141.4}{\sqrt{2}} \times 10 \times \frac{R}{Z}$

$= \frac{141.4}{\sqrt{2}} \times 10 \times \frac{8}{10}$

$= 797.616\ W$

(d) V_R, V_C

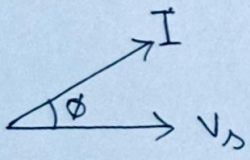


$V_S^2 = V_C^2 + V_R^2$

$V_R = IR = 10 \times 8 = 80V$

$V_C = IX_C = 10 \times 6 = 60V$

(e)



Q3) A circuit is composed of a resistance of 150Ω and an inductive reactance of 100Ω in series. A voltage of 400V, 50Hz is applied to the circuit.

(a) Find the complex impedance and draw the impedance triangle.

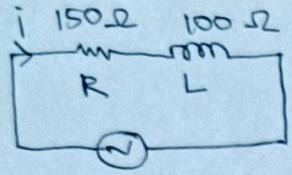
(b) Determine the rms and instantaneous values of current.

(c) Calculate the power delivered to the circuit.

(d) Find the voltage across the resistor and inductor.

(e) Draw the phasor diagram of the circuit.

Ans.



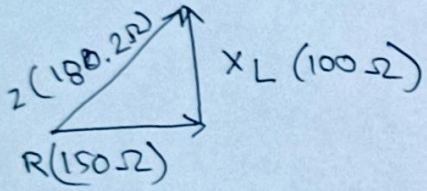
400V, 50Hz

(a) $Z = R + X_L j$

$= 150 + 100j$

$= 180.2 \angle 33.69°$

Impedance Triangle



(b) $i_{rms} = \frac{V_{rms}}{Z} = \frac{400}{180.2} = 2.219\ A$

$i_m = 2.219\sqrt{2}\ A \quad \left(i_{rms} = \frac{i_m}{\sqrt{2}} \right)$

$i = i_m \sin(\omega t - \phi)$

$\cos\phi = \frac{R}{Z} = \frac{150}{180.2}$

$\Rightarrow \phi = 33.65°$

$i = 2.219\sqrt{2} \sin(100t - 33.65°)$

$= 3.138 \sin(100t - 33.65°)$

(c) $P = V_{rms}\, i_{rms} \cos\phi$

$= 400 \times 2.219 \times \cos(33.65°)$

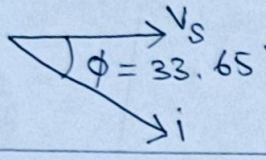
$= \boxed{738.871\ W}$

(d) V_R, V_L

$V_R = iR = 2.219 \times 150 = 332.85$

$V_L = iX_L = 2219 \times 100 = 221.9\ V$

(e) Phasor diagram



Q4). A coil of resistance 12Ω, an inductance of 0.15 H and a capacitance of 100 μF is connected in series across a suffly of 100 V, 50 Hz. Calculate

(i) Current produced in the circuit

(ii) The phase difference between the current and the suffly voltage

(iii) The voltage across each element

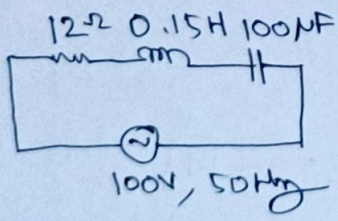
(iv) Power consumed by the circuit

(v) Active Power

(vi) Reactive Power

(vii) Draw the phasor diagram of the circuit

Sol. $R = 12\Omega,\ L = 0.15H,\ C = 100\mu F$



(i) $Z = R + (X_L - X_C)j$

$X_L = 2\pi fL$ $\quad X_C = \frac{1}{2\pi fC}$

$= 2 \times \pi \times 50 \times 0.15$ $\quad = \frac{1}{2 \times \pi \times 50 \times 100 \times 10^{-6}}$

$= 47.12\ \Omega$ $\quad = 31.83\ \Omega$

$Z = 12 + (47.12 - 31.83)j$

$= 12 + 15.29j$

$= 19.44 \angle 51.87°$

$Z = 19.44\ \Omega$

$i_{rms} = \frac{V_{rms}}{Z} = \frac{100}{19.44} = \boxed{5.144\ A}$

(ii) $\cos\phi = \frac{R}{Z}$

$\phi = \cos^{-1}\left(\frac{R}{Z}\right)$

$= \boxed{51.88°}$

(iii) V_R, V_L, V_C

$V_R = iR = 5.144 \times 12 = 61.728\ V$

$V_L = iX_L = 5.144 \times 47.12 = 242.385\ V$

$V_C = iX_C = 5.144 \times 31.83 = \boxed{163.733\ V}$

(iv) $P = V_{rms}\, i_{rms} \cos\phi$

$= 100 \times 5.144 \times \frac{12}{19.44} = \boxed{317.530\ W}$

(v) Active power = P_{avg}

$= V_{rms} i_{rms} \cos\phi$

$= \boxed{317.56\ W}$

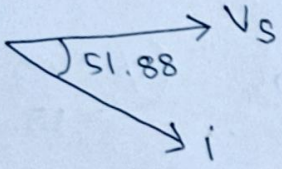
(vi) Reactive Power = $Q = V_{rms} i_{rms} \sin\phi$

$= 100 \times 5.144 \times \sin(51.88)$

$= \boxed{404.688\ W}$

(vii) Phasor diagram

$X_L > X_C$



Q5) A balanced delta-connected load having a resistance of 15Ω and capacitance of 600 μF per phase is connected to a balanced three-phase supply of 440V, 50Hz. Find the (i) line voltage (ii) phase voltage (iii) line current (iv) phase current (v) power factor (vi) active power (vii) Reactive power (viii) what will be the change in power consumed if the connection changed to star and also calculate the (i) line voltage (ii) phase voltage (iii) line current (iv) phase current (v) power factor (vi) active power (vii) Reactive power for star connection also

Ans. $R = 15\Omega$, $C = 600\,\mu F$, $V_{PR} = 440V$, 50Hz

(i) Delta

$V_L = V_{PR} = 440V$

(ii) $V_{ph} = 440V$

(iii) $I_L = I_{ph}\sqrt{3}$ $\quad I_{ph} = \frac{V_{ph}}{Z} = \frac{440}{\sqrt{15^2 + (5.305)^2}}$

$= 27.65\ A$

$C = 600nF$

$X_C = \frac{1}{100\pi \times 600 \times 10^{-6}}$

$= 5.305\Omega$

$\therefore I_L = 27.65 \times \sqrt{3}$

$= 47.89\ A$

(iv) $I_{ph} = 27.65A$

(v) $\cos\phi = \frac{R}{Z} = \frac{15}{\sqrt{15^2 + (5.305)^2}} = 0.94$ $\quad (\phi = \cos^{-1}(0.94)) = 19.94°$

(vi) $P_{active} = V_L I_L \cos\phi$

$= 440 \times 47.89 \times 0.94$

$= 19807.304\ W$

(vii) $P_{reac} = Q = V_L I_L \sin\phi = 440 \times 47.89 \times \sin\phi$

$= 440 \times 47.89 \times \sin(19.94°)$

$= 7186.172W$

(viii) $P = 7186.172W$

Star connection

(i) $V_L = \sqrt{3} V_{ph} = \sqrt{3} \times 440 = 762.10V$

(ii) $V_{ph} = 440V$

(iii) $I_L = 27.65\ A$

(iv) $I_{ph} = 27.65A$

(v) $\cos\phi = \frac{R}{Z} = 0.94$

(vi) $P_{active} = 19807.304\ W$

(vii) $P_{reac} = 7186.172W$