Ex. No.:3 Date: 28/08/2020

Steady state AC analysis of an AC series circuit consisting of

Resistor – Capacitor load
Resistor –Inductor load
Resistor-Inductor-Capacitor load

Aim:

To find the current in the series circuit consisting of the following loads –

a) Resistor- Capacitor (R-C) load
b) Resistor – Inductor (R-L) load
c) Resistor – Inductor – capacitor (R-L-C) load

Apparatus/Tool required:

ORCAD / Capture CIS --> Analog Library – R, C, L

Source Library – Vac &

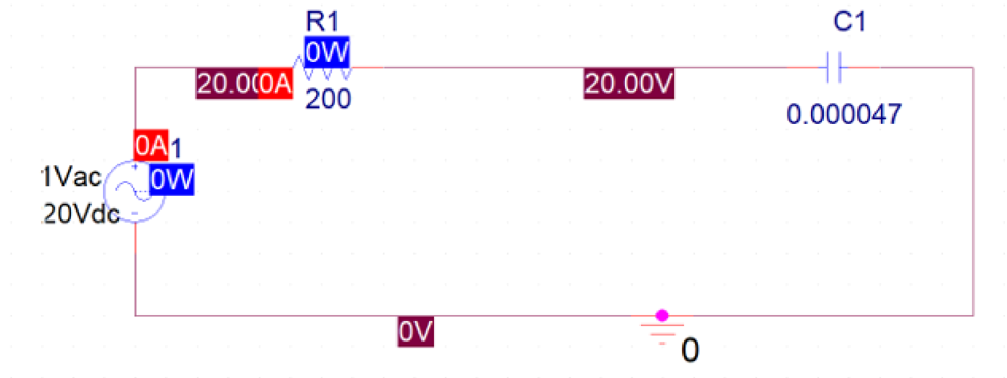
Ground (GND) – 0 (zero)

Simulation Settings: Analysis Type – AC Sweep (1Hz to 10kHz)

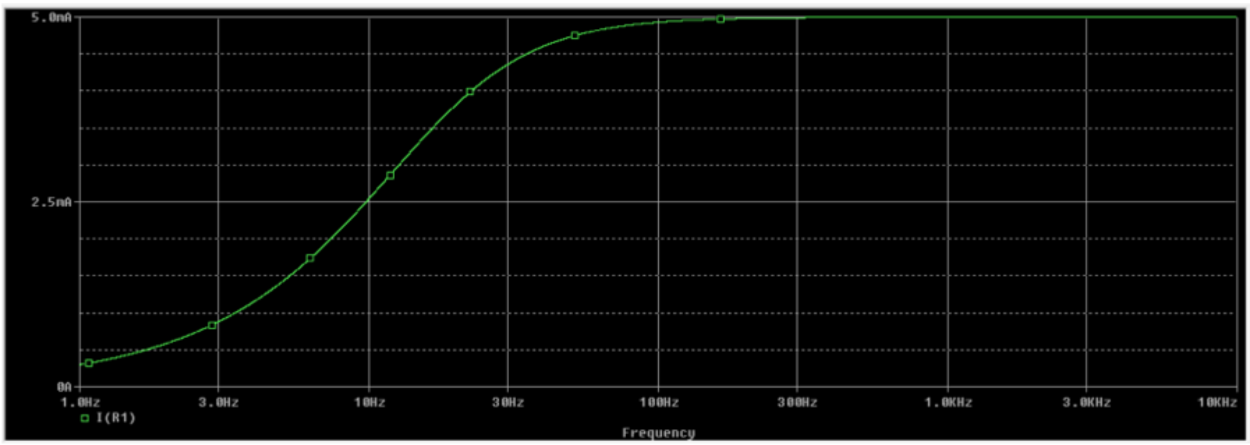
$R = 200\Omega$, $C = 47\mu F$, $L = 47mH$, AC source voltage = 20V, $\omega = 500$ rad/s

a) R-C load

Circuit Diagram



Simulated Result:



Manual calculations: Z_C, I

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1) R-C load:

$R \Rightarrow 200\,\Omega \qquad \omega \Rightarrow 500$ rad/s

$C \Rightarrow 47\,\mu F$

$$Z_c \Rightarrow \frac{-j}{\omega C} \Rightarrow \frac{-j}{500 * 47 * 10^{-6}}$$

$$\Rightarrow \frac{-j\,\cancel{1000}^{\,2}\,10^{3}}{\cancel{500} * 47} \Rightarrow -j\,(0.04255) * 10^{3}$$

$$\boxed{Z_c \Rightarrow -42.55j}$$

Since Z_c & R is in series

$$Z_{eq} \Rightarrow R + Z_c$$
$$\Rightarrow 200 + (-42.55j)$$

$$Z_{eq} \Rightarrow 200 - 42.55j$$

Converting into phasors

Z, θ

$$Z_{eq} \Rightarrow \sqrt{(200)^2 + (42.55)^2} \quad \tan^{-1}\left(\frac{-42.55}{200}\right)$$

$$Z_{eq} \Rightarrow 204.467 \angle -12.011^\circ\ \Omega$$

$$V \Rightarrow 20 \angle 0^\circ$$

$$I \Rightarrow \frac{V}{Z_{eq}} \Rightarrow \frac{20 \angle 0^\circ}{204.467 \angle -12.011^\circ}$$

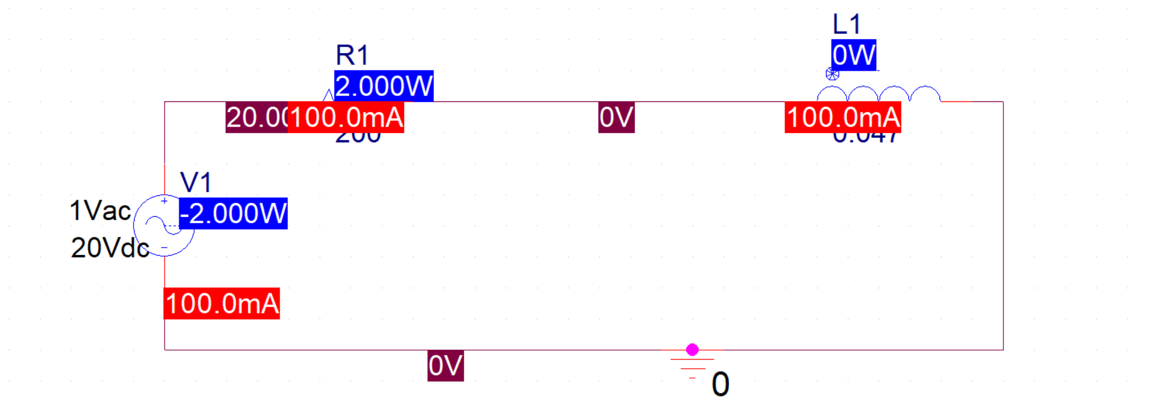
$$\Rightarrow 0.09781 \angle 12.011^\circ$$

Converting phasors back to normal sinusoidal form

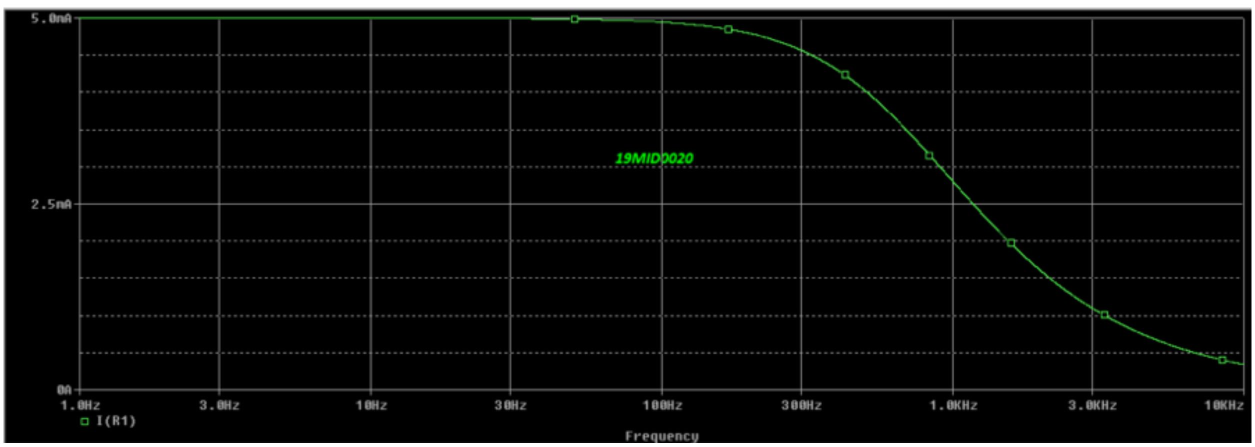
$$\boxed{I \Rightarrow 0.09781\,(\cos(500t) + 12.011)\,A}$$

b)R-L load

Circuit Diagram



Simulated Result:



Manual calculations: Z_L, I

R-L load

$R \Rightarrow 200\,\Omega$

$L \Rightarrow 47\text{ mH}$

$Z_L \Rightarrow j\omega L$

$\Rightarrow j(500)(47 * 10^{-3})$

$\boxed{Z_L \Rightarrow 23.5j}$

Since Resistor & Inductor are in series

$Z_{eq} \Rightarrow R + Z_L$

$Z_{eq} \Rightarrow 200 + 23.5j$

Converting complex to phasor form.

$Z_{eq} \Rightarrow \sqrt{(200)^2 + (23.5)^2} \quad \tan^{-1}\left(\frac{23.5}{200}\right)$

$Z_{eq} \Rightarrow 201.375 \angle 6.701^\circ$

$I \Rightarrow \frac{V}{Z_{eq}} \Rightarrow \frac{20 \angle 0^\circ}{201.375 \angle 6.701^\circ} \Rightarrow 0.0993 \angle -6.701^\circ$

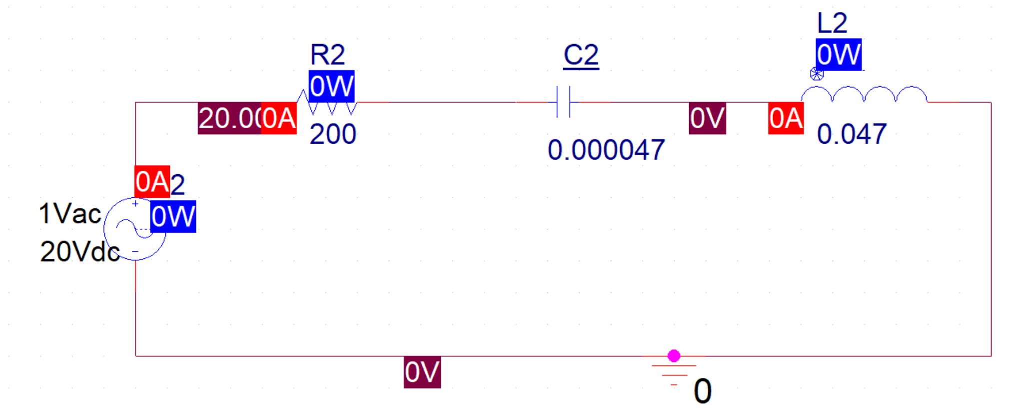
Converting phasors to sinusoidal form

$\cancel{I \Rightarrow 0.0993(500t - 6.701)}$

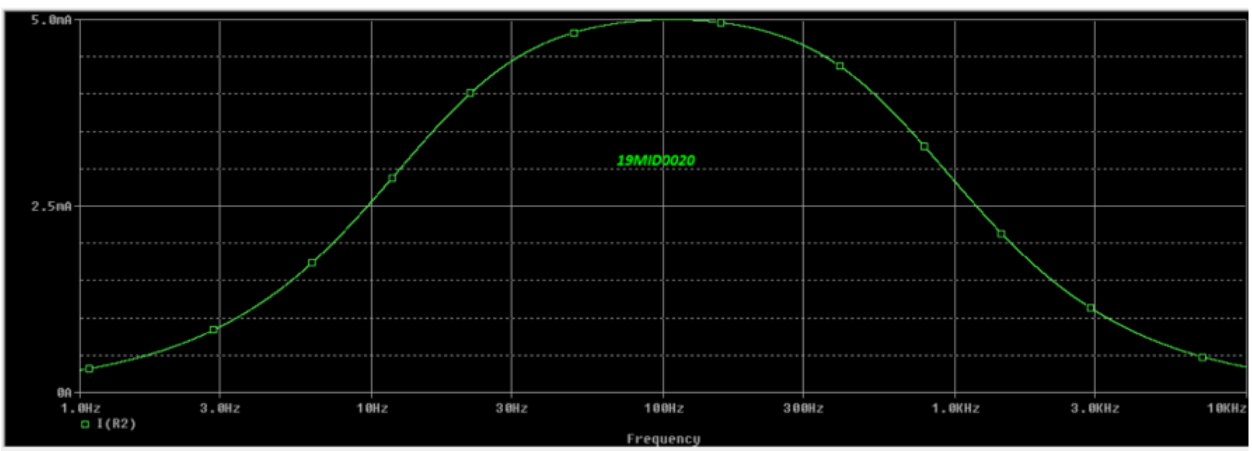
$\boxed{I \Rightarrow 0.0993 \cos(500t - 6.701)\,A}$

c)R-L-C load

Circuit Diagram



Simulated Result:



Manual calculations: Z_C , Z_L, I

RLC circuit

$R \Rightarrow 200\,\Omega$

$C \Rightarrow 47\,\mu F$

$L \Rightarrow 47\,mH$

$Z_C \Rightarrow -42.55j$

$Z_L \Rightarrow 23.5j$

Since resistor, inductor & capacitor are in series

$$Z_{eq} \Rightarrow 200 + (-42.55j) + 23.5j$$

$$Z_{eq} \Rightarrow 200 - 19.05j$$

Converting complex to phasor form

$$Z_{eq} \Rightarrow \sqrt{(200)^2 + (19.05)^2} \quad \tan^{-1}\left(\frac{-19.05}{200}\right)$$

$$Z_{eq} \Rightarrow 200.905 \angle -5.441^\circ$$

$$I = \frac{V}{Z_{eq}} \Rightarrow \frac{20\angle 0}{200.905\angle -5.441}$$

$$\underline{I} \Rightarrow 0.09954 \angle +5.441$$

Converting phasor back to sinusoidal form

$$\boxed{I \Rightarrow 0.09954\left(\cos(500t) + 5.441\right) A^\circ}$$

Inference:

The graph of RC load has positive slope as Capacitor accumulates and stores charges (charging).

The graph of RL load has negative slope as Inductor is an insulator and it loses charge (discharging).

The slope of graph increases in the first half and decreases in the next half. It looks like normal curve

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