K. J. SOMAIYA COLLEGE OF ENGINEERING
DEPARTMENT OF ELECTRONICS ENGINEERING
ELECTRONIC CIRCUITS
AC CIRCUITS

Numerical 1:

A series RLC circuit containing a resistance of 10Ω, an inductance of 0.4H and a capacitor of 20μF are connected in series across a 220V, 60Hz supply.
Calculate:
a. The current drawn by circuit in Figure 1.
b. V_R, V_L and V_C
c. Power Factor.
d. Draw the voltage phasor diagram.

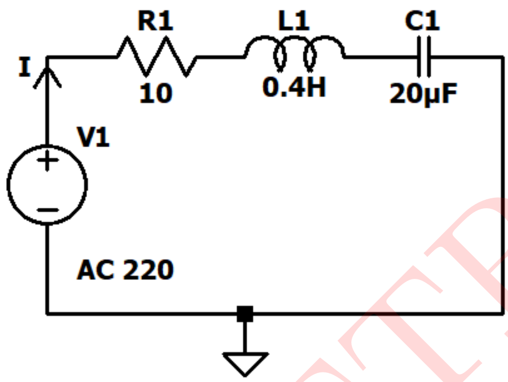

Figure 1: Circuit 1

Solution:

$X_L = \omega L_1 = 2\pi f \times 0.4$
$X_L = 150.72\,\Omega$

$X_C = \dfrac{1}{\omega C_1} = \dfrac{1}{2\pi f \times 20 \times 10^{-6}}$

$X_C = 132.69639\,\Omega$

$Z = R_1 + j(X_L - X_C)$
$Z = 10 + j(150.72 - 132.69639)$
$Z = 10 + j18.0236$
$\therefore Z = 20.611\angle 60.97^\circ\,\Omega$

$I = \dfrac{V_1}{Z} = \dfrac{220}{20.611\angle 60.97^\circ}$
$\therefore I = \mathbf{10.67\angle -60.97^\circ\ A}$

$V_R = R_1 I = 10 \times 10.67\angle -60.97^\circ$
$\therefore V_R = \mathbf{106.7\angle -60.97^\circ\ V}$

$V_L = X_L I = 150.72 \times 10.67\angle - 60.97°$

$\therefore V_L = \mathbf{1608.18\angle 29° \ V}$ ..(For X_L, phase is$\angle 90°$)

$V_C = X_C I = 132.696 \times 10.67\angle - 60.97°$

$\therefore V_C = \mathbf{1415.866\angle - 150.97° \ V}$ ..(For X_C, phase is$\angle - 90°$)

Power factor$(cos\phi) = \frac{I}{V_1} = \frac{106.7\angle - 60.97°}{220}$

$\therefore$ Power factor$(cos\phi) = \mathbf{0.4849}$

PHASOR DIAGRAM

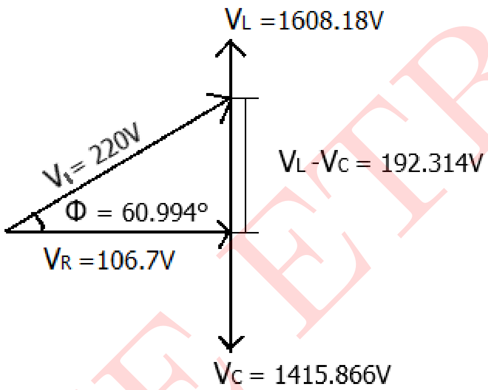

Figure 2: RLC Circuit Phasor diagram

SIMULATED RESULTS:

Above circuit is simulated in LTspice. The results are presented below:

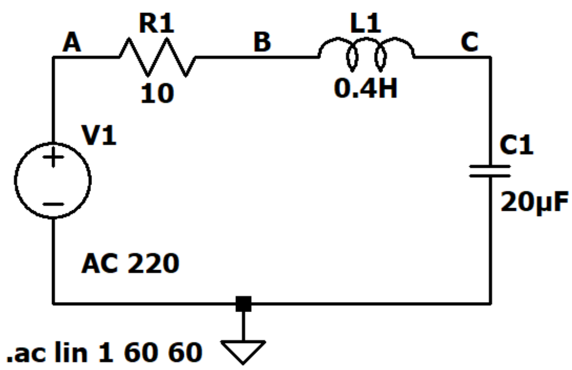

Figure 3: Circuit Schematic for RLC Circuit

Simulated results are shown in Figure 4.

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* C:\Users\lenovo\Desktop\LTspiceXVII\TASK2\sanika.p_week2_day1_circuit1.asc
       --- AC Analysis ---

frequency:     60          Hz
V(b):          mag:    192.727 phase:    28.8294°       voltage
V(a):          mag:        220 phase: -3.70101e-015°    voltage
V(c):          mag:    1406.99 phase:   -151.167°       voltage
I(C1):         mag:    10.6085 phase:   -61.1675°       device_current
I(L1):         mag:    10.6085 phase:   -61.1675°       device_current
I(R1):         mag:    10.6085 phase:    118.833°       device_current
I(V1):         mag:    10.6085 phase:    118.833°       device_current
```

Figure 4: Simulated Results for Figure 3

For the circuit given in Figure 3,

$V_R = I_{R1}R_1 = 10.6085\angle-61.1675°$

$\therefore V_R = \mathbf{106.085\angle-61.1675°\ V}$

$V_L = X_L I_{L1} = 150.72 \times 10.6085\angle-61.1675°$

$\therefore V_L = \mathbf{1598.913\angle 28.83°\ V}$ ..(For X_L, phase is$\angle 90°$)

Comparison of theoretical and simulated values:

Parameters	Theoretical Values	Simulated Values
I	$10.67\angle-60.97°$A	$10.6085\angle-61.1675°$A
V_R	$106.7\angle-60.97°$V	$106.085\angle-61.1675°$V
V_L	$1608.18\angle 29°$V	$1598.913\angle 28.83°$V
V_C	$1415.866\angle-150.97°$V	$1406.99\angle-151.167°$V

Table 1: Numerical 1

Numerical 2:

A voltage $V_1 = 200\sin 314t$V is applied to a circuit consisting of a 10Ω resistor and an 120μF capacitor in series. Determine
a. An expression for the value of the current flowing at any instant in Figure 9.
b. V_R and V_C
c. Power factor

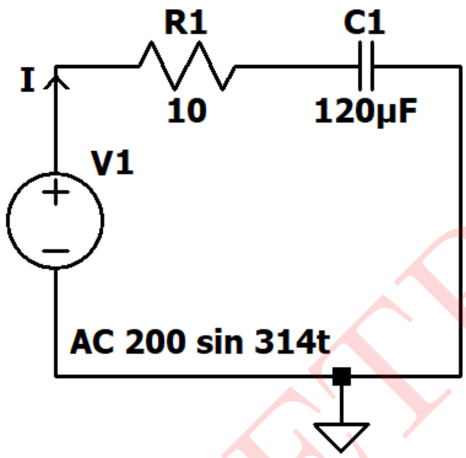


Figure 5: Circuit 2

Solution:

$V_1 = 200\sin 314t$ ..(Given)

Comparing the given equation with $V_1 = v\sin\omega t$ we get,

$\omega = 314\, rad/sec$

$\therefore n = \dfrac{314}{2\pi} = 50\, Hz$

$V_{rms} = \dfrac{v}{\sqrt{2}} = \dfrac{200}{\sqrt{2}}$

$\therefore V_{rms} = 141.421\, V$

$X_C = \dfrac{1}{\omega C_1} = \dfrac{1}{314 \times 12 \times 10^{-6}}$

$\therefore X_C = 26.539278\, \Omega$

$Z = R_1 - jX_C$

$Z = 10 - \jmath 26.539$

$\therefore Z = 28.36077\angle -69.353°\Omega$

$I_{rms} = \frac{V_{rms}}{Z} = \frac{141.421}{28.36077\angle-69.353°}$

$I_{rms} = 1.7582 + j4.666$

$I_{rms} = 4.9865\angle 69.353°\ A$

$I = I_{rms} \times \sqrt{2} = 4.9865\angle 69.353° \times \sqrt{2}$

$I = 2.4865 + j6.599$

$\therefore I = 7.052\ A$

$i = Isin(\omega t + \phi)$

$\therefore i =$ **7.052 sin(314t+69.353)** $\boldsymbol{A}$

$V_R = I_{rms}R_1 = 4.9865\angle 69.353° \times 10$

$\therefore V_R = 49.865\angle 69.353°\ V$

$V_C = I_{rms}X_C = 4.9865\angle 69.353° \times 26.539278$

$\therefore V_C = 132.338\angle-20.64°\ V$ ..(For X_C, phase is$\angle-90°$)

Power factor$(cos\phi) = \frac{R}{Z} = \frac{10}{28.36077\angle-69.353°}$

Power factor$(cos\phi) = 0.1243 + j0.3299$

$\therefore$ Power factor$(cos\phi) =$ **0.3526**

PHASOR DIAGRAM

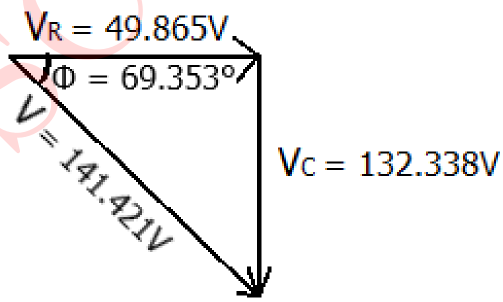


Figure 6: RC Circuit Phasor diagram

SIMULATED RESULTS:

Above circuit is simulated in LTspice. The results are presented below:

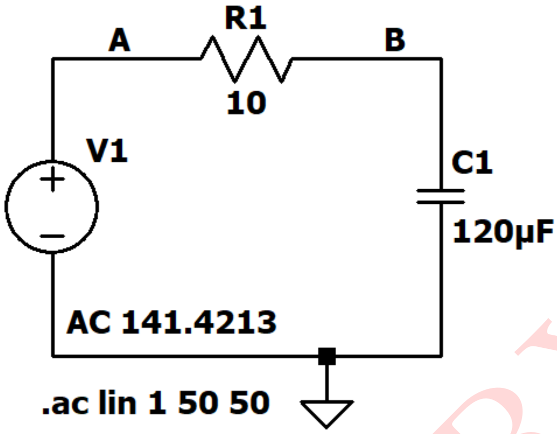
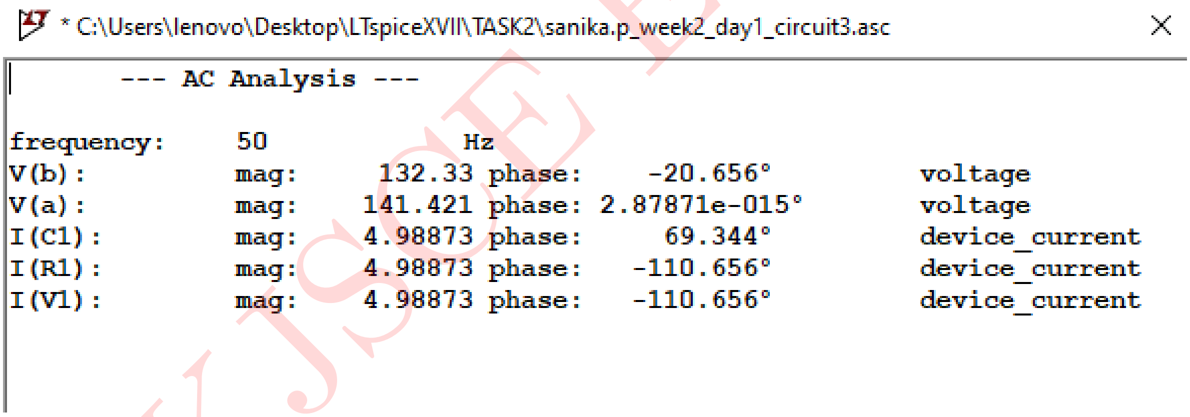


Figure 7: Circuit Schematic for RC Circuit

Simulated results are shown in Figure 8.




```
       --- AC Analysis ---

frequency:    50            Hz
V(b):         mag:    132.33 phase:    -20.656°       voltage
V(a):         mag:   141.421 phase: 2.87871e-015°     voltage
I(C1):        mag:   4.98873 phase:     69.344°       device_current
I(R1):        mag:   4.98873 phase:   -110.656°       device_current
I(V1):        mag:   4.98873 phase:   -110.656°       device_current
```

Figure 8: Simulated Results for Figure 7

For the circuit given in Figure 7,

$V_R = I_{R1}R_1 = 4.98873\angle 69.344° \times 10$

$\therefore V_R = \mathbf{49.8873\angle 69.344°\ V}$

$V_C = V_b$

Comparison of theoretical and simulated values:

Parameters	Theoretical Values	Simulated Values
I_{rms}	$4.9865\angle 69.353°$A	$4.98873\angle 69.344°$A
V_R	$49.865\angle 69.353°$V	$49.8873\angle 69.344°$V
V_C	$132.338\angle -20.64°$V	$132.33\angle -20.656°$

Table 2: Numerical 2

Numerical 3:

A circuit consists of resistance of 15Ω, an inductance of 84mH and a capacitor of 60μF are connected in parallel across a 110V, 50Hz supply.
Calculate :
a. Individual currents drawn by each element.
b. Total current drawn from the supply.
c. Overall power factor of the circuit.
d. Draw the phasor diagram.

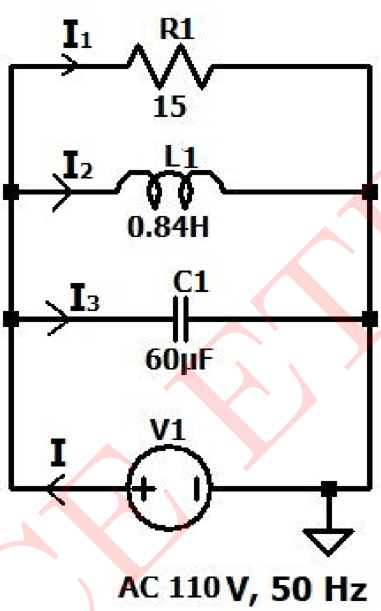


Figure 9: Circuit 3

Solution:

Let I_1, I_2, I_3 be the currents drawn by RLC respectively.

$$I_1 = \frac{V_1}{R_1} = \frac{110}{15} = \mathbf{7.33\angle 0^\circ} A \qquad ...(I_1 = I_R)$$

$$X_L = \omega L_1 = 2\pi f L_1 = 2 \times 3.14 \times 50 \times 84 \times 10^{-3} = 263.76\Omega$$

$$I_2 = \frac{V_1}{X_L} = \frac{110}{263.76} = \mathbf{0.417\angle -90^\circ} A \qquad ...(I_2 = I_L)$$

$$X_C = \frac{1}{\omega C_1} = \frac{1}{2\pi f C_1} = \frac{1}{2 \times 3.14 \times 50 \times 60 \times 10^{-6}} = 53.078\Omega$$

$$I_3 = \frac{V_1}{X_{C_1}} = \frac{110}{53.078} = \mathbf{2.072\angle 90^\circ} A \qquad ...(I_3 = I_C)$$

$I = I_1 + I_2 + I_3$

$I = 7.33\angle 0^\circ + 0.417\angle -90^\circ + 2.072\angle 90^\circ$

$\therefore I = \mathbf{7.514\angle 12.73^\circ} A$

Power Factor$(cos\phi)$ = cos(12.73) = **0.9754**

PHASOR DIAGRAM

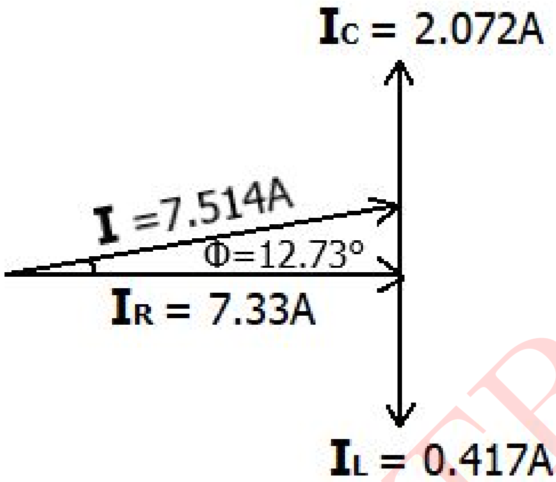


Figure 10: RLC Circuit Phasor diagram

SIMULATED RESULTS:

Above circuit is simulated in LTspice. The results are presented below:

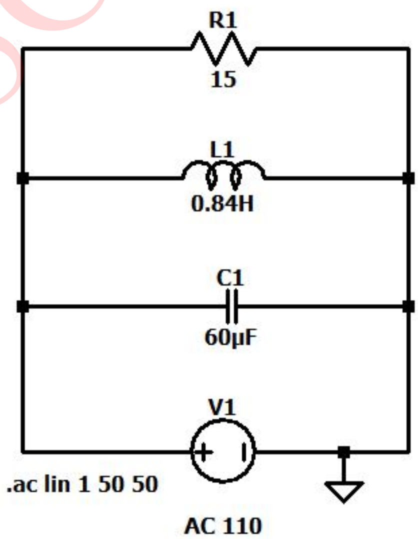
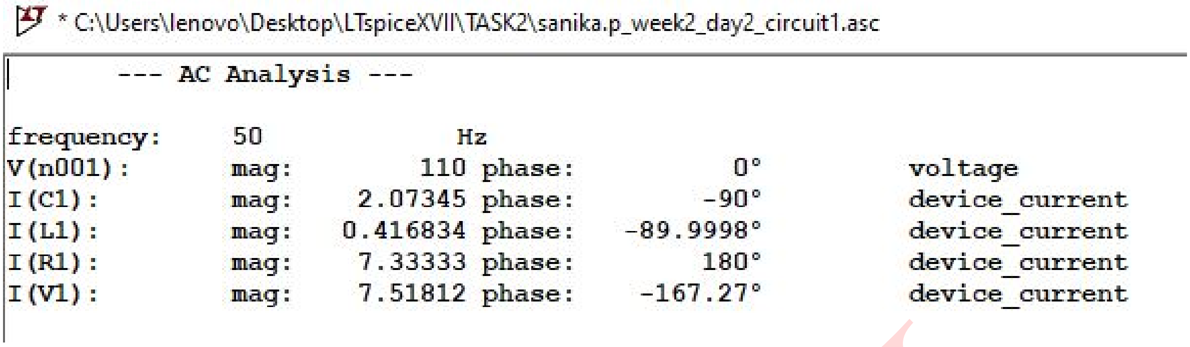


Figure 11: Circuit Schematic for Parallel RLC Circuit

Simulated results are shown in Figure 12.



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```
       --- AC Analysis ---

frequency:    50              Hz
V(n001):      mag:        110 phase:            0°        voltage
I(C1):        mag:    2.07345 phase:          -90°        device_current
I(L1):        mag:   0.416834 phase:     -89.9998°        device_current
I(R1):        mag:    7.33333 phase:          180°        device_current
I(V1):        mag:    7.51812 phase:      -167.27°        device_current
```

Figure 12: Simulated Results for Figure 11

Comparison of theoretical and simulated values:

Parameters	Theoretical Values	Simulated Values
I_1	$7.33\angle 0^\circ$A	$7.33\angle 0^\circ$A
I_2	$0.417\angle -90^\circ$A	$0.416\angle -89.9^\circ$A
I_3	$2.072\angle 90^\circ$A	$2.07\angle 90^\circ$A
I	$7.514\angle 12.73^\circ$A	$7.518\angle 12.73^\circ$A

Table 3: Numerical 3

Numerical 4:

Find I, I_1, I_2 and V_1 in Figure 13, if $R_1 = 6\Omega, X_{L_1} = j4\Omega, R_2 = 20\Omega, X_{L_2} = j8\Omega,$
$R_3 = 9\Omega, X_{C_1} = -j6\Omega$
$f = 50Hz$

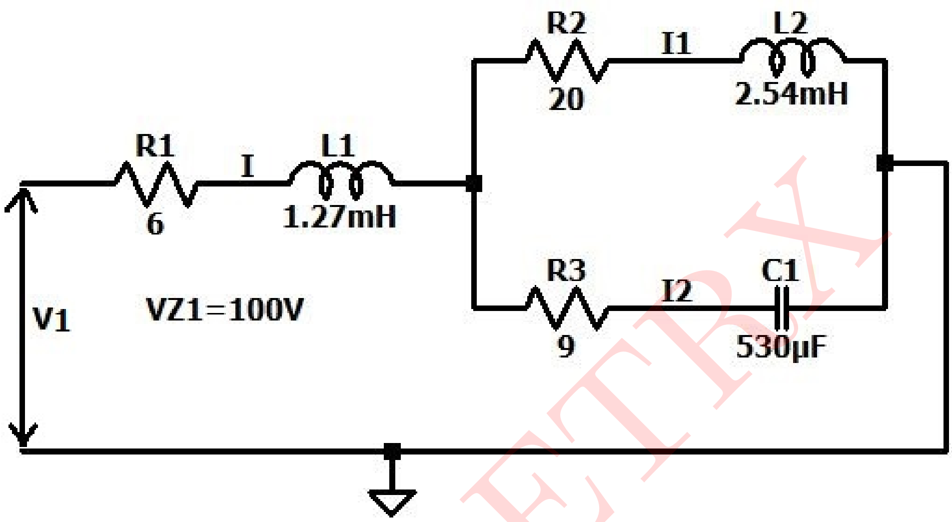

Figure 13: Circuit 4

Solution:

For Z_1,

$R_1 = 6\Omega, X_{L_1} = j4\Omega$

$Z_1 = 6 + j4$

$\therefore Z_1 = 7.21\angle 33.69°\Omega$

$$I = \frac{V_{Z_1}}{Z_1} = \frac{100}{7.21\angle 33.69°}$$

$\therefore I = \mathbf{13.86\angle - 33.69°} A$

$R_2 = 20\Omega, X_{L_2} = j8\Omega$

$Z_2 = R_2 + X_{L_2}$

$Z_2 = 20 + j8$

$\therefore Z_2 = 21.54\angle 21.8°\Omega$

$R_3 = 9\Omega, X_{C_1} = -j6\Omega$

$Z_3 = 9 - j6 = 10.816\angle - 33.69°\Omega$

$Z = Z_1 + (Z_2||Z_3)$

$Z = 7.21\angle 33.69° + (21.54\angle 21.8°||10.816\angle - 33.69°)$

$Z = 7.21\angle 33.69° + 8.0149\angle - 15.83°$

$\therefore Z = 13.829\angle 7.533°\Omega$

$V_1 = IZ$
$V_1 = 13.86\angle - 33.69° \times 13.829\angle 7.53°$
$\therefore V_1 = \mathbf{191.6699}\angle - \mathbf{26.157}°V$

$V_{Z_2} = V_{Z_3}$
$V_{Z_2} = I \times (Z_2||Z_3)$
$V_{Z_2} = 13.86\angle - 33.69° \times 8.0149\angle - 15.83°$
$\therefore V_{Z_2} = 111.8\angle - 49.52°V$

$$I_1 = \frac{V_{Z_2}}{Z_2} = \frac{111.08\angle - 49.52°}{21.54\angle 21.8°} = \mathbf{5.1569}\angle - \mathbf{71.32}°A$$

$$I_2 = \frac{V_{Z_3}}{Z_3} = \frac{111.08\angle - 49.52°}{10.816\angle - 33.69°} = \mathbf{10.26997}\angle - \mathbf{15.83}°A$$

$$X_{L_1} = \omega L_1 \qquad \therefore L_1 = \frac{X_{L_1}}{2\pi f}$$

$$L_1 = \frac{4}{2 \times 3.14 \times 50} = 1.27mH$$

$$X_{L_2} = \omega L_2 \qquad \therefore L_2 = \frac{X_{L_2}}{2\pi f}$$

$$L_2 = \frac{8}{2 \times 3.14 \times 50} = 2.54mH$$

$$X_{C_1} = \frac{1}{\omega C_1} \qquad \therefore C_1 = \frac{1}{X_{C_1} \times 2\pi f}$$

$$C_1 = \frac{1}{6 \times 2 \times 3.14 \times 50} = \frac{1}{1884} = 530\mu F$$

SIMULATED RESULTS:

Above circuit is simulated in LTspice. The results are presented below:

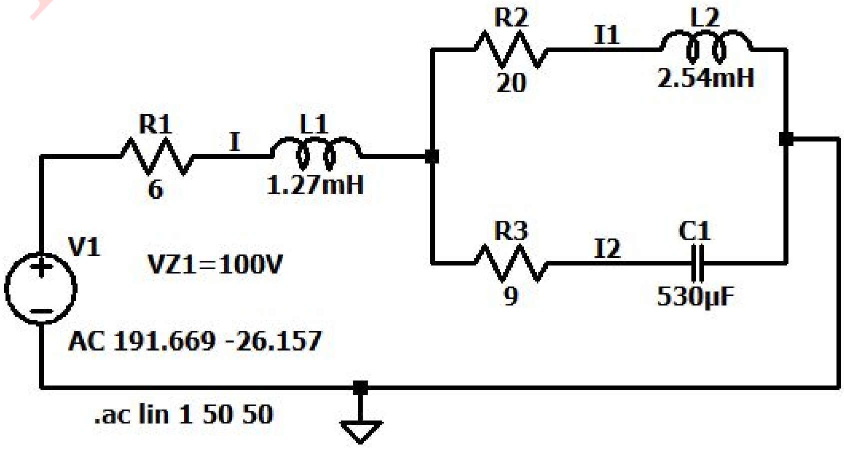

Figure 14: Circuit Schematic for Combination Circuit

Simulated results are shown in Figure 15.

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* C:\Users\lenovo\Desktop\LTspiceXVII\TASK2\sanika.p_week2_day2_circuit2.asc

       --- AC Analysis ---

frequency:    50          Hz
V(i):         mag:    105.991 phase:    -34.455°        voltage
V(n002):      mag:    191.669 phase:    -26.157°        voltage
V(i1):        mag:    4.30379 phase:    50.2319°        voltage
V(n001):      mag:     107.96 phase:   -37.4116°        voltage
V(i2):        mag:     59.926 phase:   -93.6958°        voltage
I(C1):        mag:    9.97795 phase:    176.304°        device_current
I(L2):        mag:    5.39346 phase:   -39.6963°        device_current
I(L1):        mag:    14.6875 phase:   -16.1609°        device_current
I(R3):        mag:    9.97795 phase:    176.304°        device_current
I(R2):        mag:    5.39346 phase:    140.304°        device_current
I(R1):        mag:    14.6875 phase:    163.839°        device_current
I(V1):        mag:    14.6875 phase:    163.839°        device_current
```

Figure 15: Simulated Results for Figure 14

Comparison of theoretical and simulated values:

Parameters	Theoretical Values	Simulated Values
I	$13.86\angle-33.69°$A	$14.687\angle-33.8°$A
I_1	$5.1569\angle-71.32°$V	$5.393\angle-79.3°$V
I_2	$10.269\angle-15.83°$V	$9.977\angle-8.6°$

Table 4: Numerical 4

Numerical 5:

A series resonance network consisting of a resistor of 30Ω, a capacitor of 1uF and an inductor of 30mH is connected across a sinusoidal supply voltage which has a constant output of AC 9 volts at all frequencies. Calculate, the resonant frequency, the current at resonance, the voltage across the inductor and capacitor at resonance, the quality factor and the bandwidth of the circuit shown in Figure 16.
Plot the resonance curve, the current at resonance, the voltage across the inductor and capacitor at resonance in LTspice.

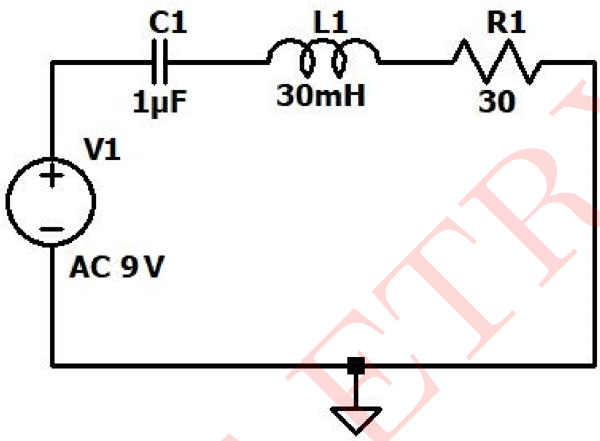

Figure 16: Circuit 5

Solution:

$f_o = \dfrac{1}{2\pi\sqrt{L_1C_1}} = \dfrac{1}{2\times 3.14\times 3\times 10^{-3}\times 1\times 10^{-6}}$

$\therefore f_o = \mathbf{919.345Hz}$

$V = V_{rms}\times\sqrt{2} = 9\times\sqrt{2}$ $\quad\quad ...(V_{rms} = V_1)$

$\therefore V = 12.72V$

$I_o = \dfrac{V}{R_1} = \dfrac{12.72}{30}$

$\therefore I_o = \mathbf{424.26mA}$

$V_R = R_1\times I_o = 30\times 424.26$

$\therefore V_R = 12.72V$

$V_L = X_LI_o = 2\pi f_oL_1I_o = 2\times 3.14\times 919.345\times 30\times 10^{-3}\times 424.26\times 10^{-3}$

$\therefore V_L = \mathbf{73.438V}$

$V_C = X_CI_o = \dfrac{1}{2\pi f_oC_1}\times I_o = \dfrac{1}{2\times 3.14\times 919.345\times 1\times 10^{-6}}\times 424.26$

$\therefore V_C = \mathbf{73.479V}$

Quality factor$(Q) = \dfrac{1}{R_1}\sqrt{\dfrac{L_1}{C_1}} = \dfrac{1}{30}\times\sqrt{\dfrac{30\times 10^{-3}}{1\times 10^{-6}}}$

$Q = \mathbf{5.77}$

$$\text{Bandwidth} = \frac{R_1}{2\pi L_1} = \frac{30}{2 \times 3.14 \times 30 \times 10^{-3}}$$

$\therefore$ Bandwidth = **159.235Hz**

SIMULATED RESULTS:

Above circuit is simulated in LTspice. The results are presented below:

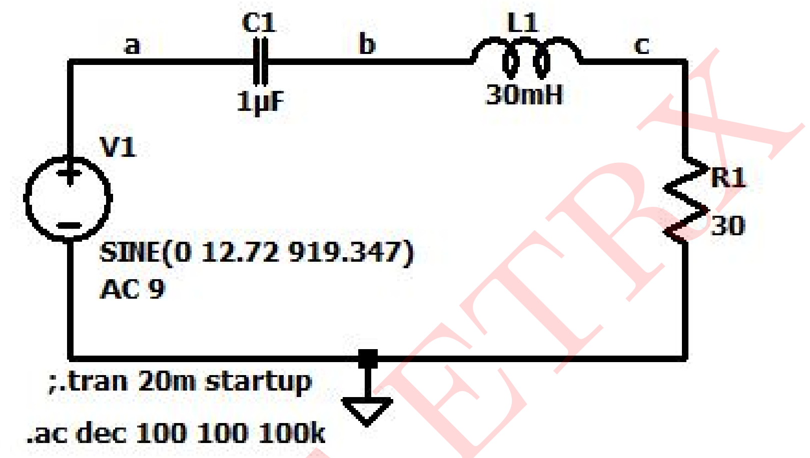

Figure 17: Circuit Schematic for RLC Circuit

Graphs are shown in Figure 18, 19, 20.

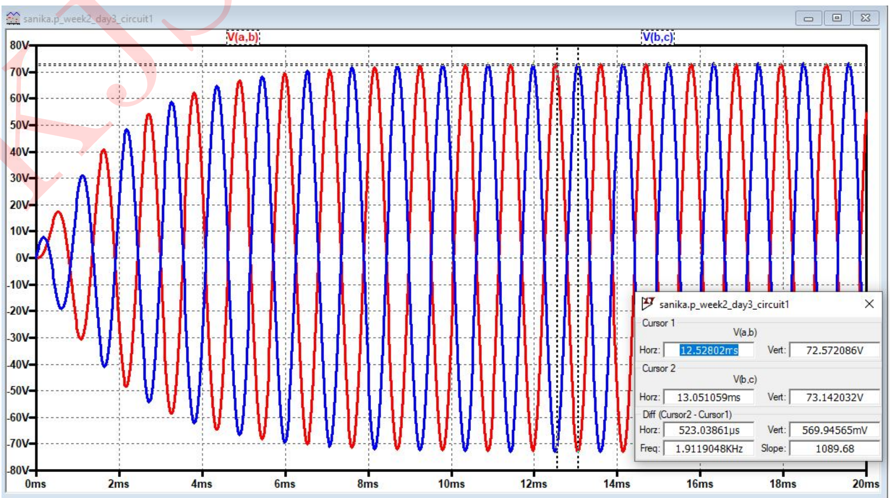

Figure 18: Graph for Figure 17 - V_L and V_C

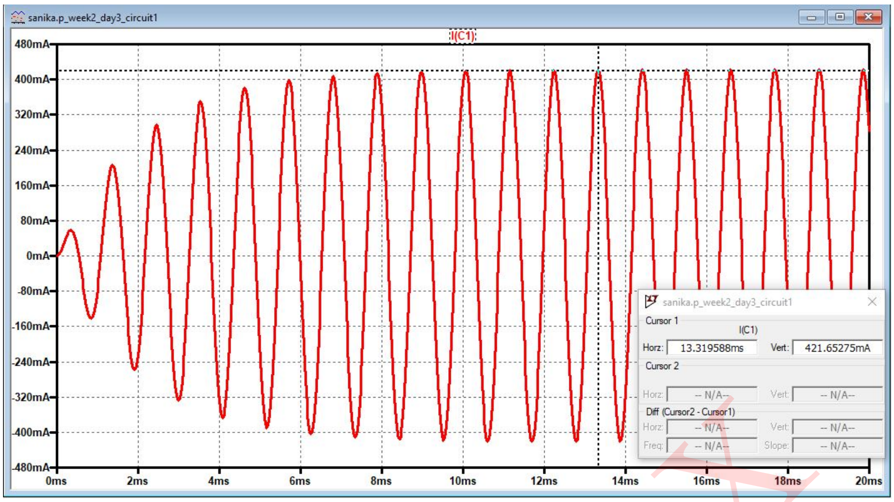

Figure 19: Graph for Figure 17 - current at resonance

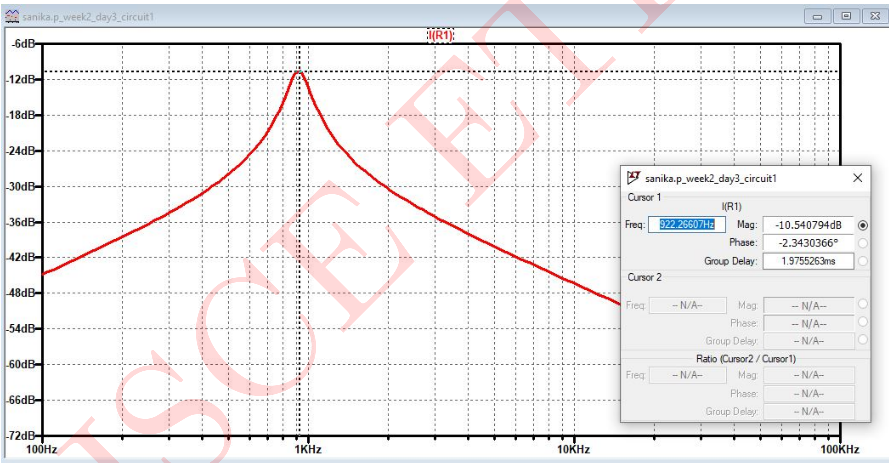

Figure 20: Graph for Figure 17 - resonance curve

Comparison of theoretical and simulated values:

Parameters	Theoretical Values	Simulated Values
I_o	424.26A	421.42A
V_L	73.43V	72.56V
V_C	73.479V	72.91V

Table 5: Numerical 5

Numerical 6:

A 50 Hz sinusoidal voltage $V_1 = 141$ sinωt is applied to a series R-L circuit. The values of the resistance and the inductance are 5Ω and 0.02 H respectively.
Determine the following:
a. Calculate the peak voltage across resistor and inductor and amp; also find the peak value of source current in LTspice.
b. Plot input source voltage $V_{S(t)}$ Vs input source current $I_{S(t)}$ in LTspice
c. Measure the phase delay/difference between $V_{S(t)}$ Vs $I_{S(t)}$ in time and amp; degrees
d. Plot input source voltage $V_{S(t)}$ Vs voltage across resistor $V_{R(t)}$ in LTspice
e. Measure the phase delay/difference between $V_{S(t)}$ Vs $V_{R(t)}$ in time and amp; degrees.
f. Plot input source voltage $V_{S(t)}$ Vs voltage across inductor $V_{L(t)}$ in LTspice
g. Measure the phase delay/difference between $V_{S(t)}$ Vs $V_{L(t)}$ in time and amp; degrees.
h. Calculate the power factor of the circuit.

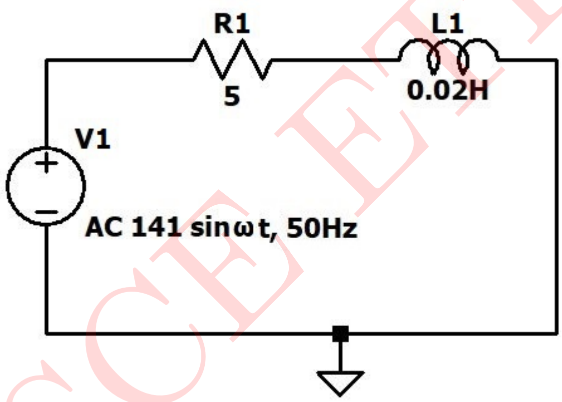

Figure 21: Circuit 6

Solution:

$X_L = \omega L_1 = 2\pi f L_1 = 2 \times 3.14 \times 50 \times 0.02$

$X_L = 6.28\Omega$

$Z = R_1 + jX_L$

$Z = 5 + j6.28$

$\therefore Z = 8.027\angle 51.47°\Omega$

$$I = \frac{V_1}{Z} = \frac{141}{8.027\angle 51.47^{circ}}$$

$\therefore I = \mathbf{17.56\angle - 51.47°A}$

$V_L = X_L I = 6.28 \times 17.56\angle - 51.47$

$\therefore V_L = \mathbf{110.276\angle 38.53°V}$

$V_R = R_1 I = 5 \times 17.56\angle - 51.47$

$\therefore V_R = \mathbf{87.8\angle - 51.47°V}$

Calculation for time:

$$t = \frac{\angle\theta \times T_{period}}{360}$$

$$T_{period} = 20sec$$

$$t_I = \frac{\angle 51.47^\circ \times 20}{360} = \mathbf{2.859ms}$$

$$t_L = \frac{\angle 38.53^\circ \times 20}{360} = \mathbf{2.14ms}$$

$$t_R = \frac{\angle 51.47^\circ \times 20}{360} = \mathbf{2.8594ms}$$

Power factor$(cos\phi) = cos(-51.47) = \mathbf{0.6229}$

SIMULATED RESULTS:

Above circuit is simulated in LTspice. The results are presented below:

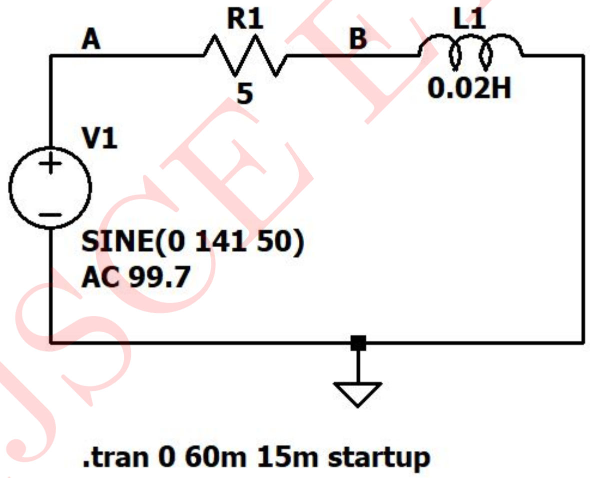

Figure 22: Circuit Schematic for RL Circuit

Graphs are shown in Figure 23, 24, 25.

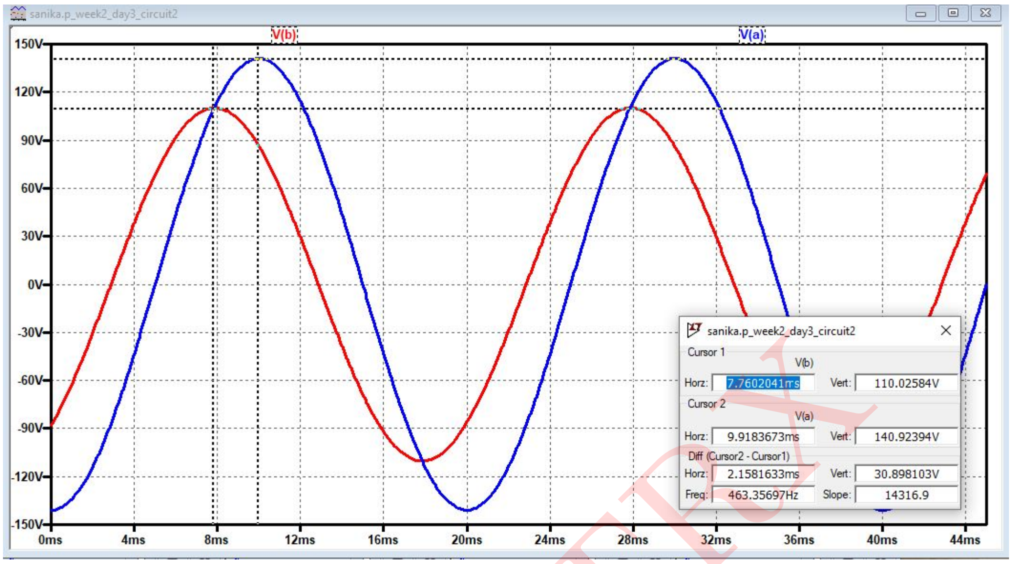

Figure 23: Graph for Figure 22 - $V_{S(t)}$ Vs V_L

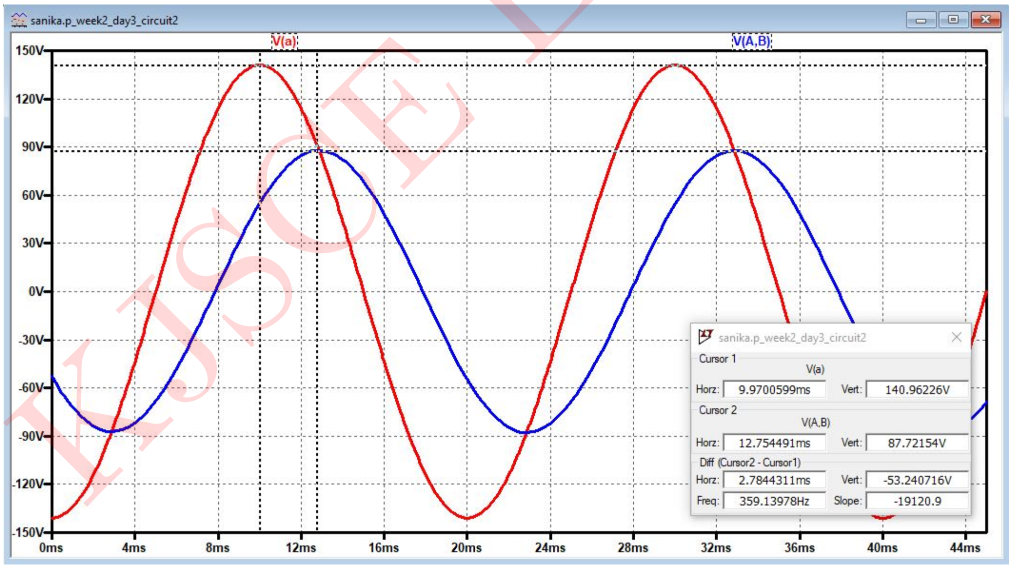

Figure 24: Graph for Figure 22 - $V_{S(t)}$ Vs V_R

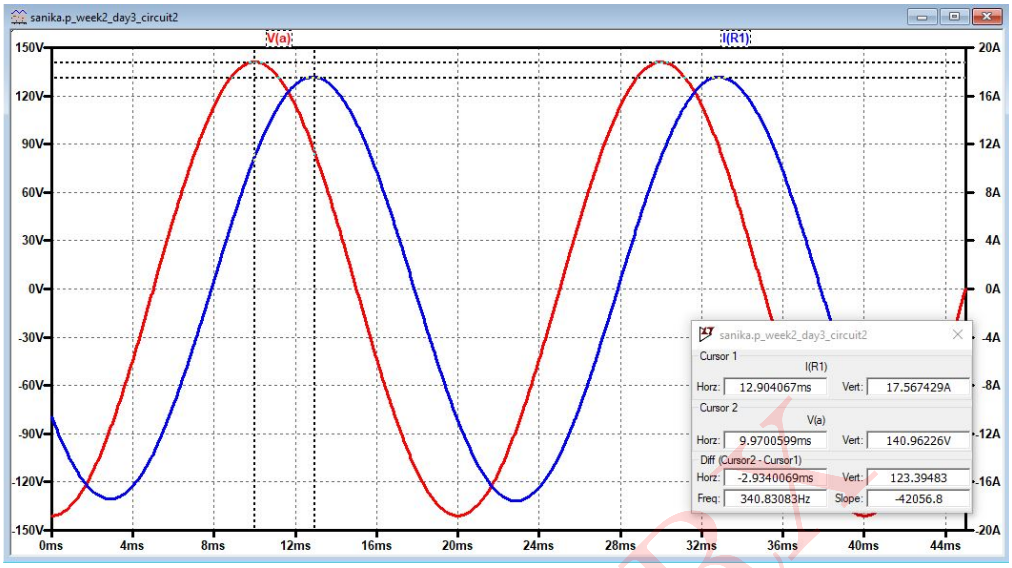

Figure 25: Graph for Figure 22 - $V_{S(t)}$ Vs $I_{S(t)}$

For circuit simulated in Figure 22,

$$\angle\theta = \frac{t \times 360}{T_{period}}$$

$$\angle\theta_{(I)} = \frac{2.934 \times 360}{20} = \angle 52.812^\circ$$

$$\angle\theta_{(L)} = \frac{2.15 \times 360}{20} = \angle 38.7^\circ$$

$$\angle\theta_{(R)} = \frac{2.78 \times 360}{20} = \angle 50.04^\circ$$

Comparison of theoretical and simulated values:

Parameters	Theoretical Values	Simulated Values
V_R	87.8V	87.7V
V_L	110.276V	110.02V
I	17.56A	17.56A
t_I	2.859ms($\angle 51.47^\circ$)	2.934ms($\angle 52.812^\circ$)
t_L	2.14ms($\angle 38.53^\circ$	2.15ms($\angle 38.7^\circ$)
t_R	2.8594ms($\angle 51.47^\circ$)	2.78ms($\angle 50.04^\circ$)

Table 6: Numerical 6

Numerical 7:

A pure resistance of 40 ohms is in series with a pure capacitance of 47uF. The series combination is connected across 220V, 50 Hz supply.
a. Calculate the peak voltage across resistor and capacitor and amp; also find the peak value of source current in LTspice
b. Plot input source voltage $V_{S(t)}$ Vs input source current $I_{S(t)}$ in LTspice
c. Measure the phase delay/difference between $V_{S(t)}$ Vs $I_{S(t)}$ in time and amp; degrees
d. Plot input source voltage $V_{S(t)}$ Vs voltage across resistor $V_{R(t)}$ in LTspice
e. Measure the phase delay/difference between $V_{S(t)}$ Vs $V_{R(t)}$ in time and amp; degrees
f. Plot input source voltage $V_{S(t)}$ Vs voltage across capacitor $V_{C(t)}$ in LTspice
g. Measure the phase delay/difference between $V_{S(t)}$ Vs $V_{C(t)}$ in time and amp; degrees
h. Calculate the power factor of the circuit.

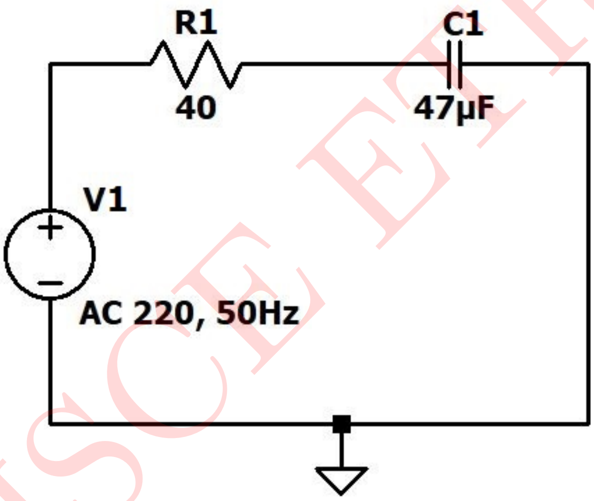

Figure 26: Circuit 7

Solution:

$V = V_{rms} \times \sqrt{2} = 220 \times \sqrt{2}$ $\quad ...(V_{rms} = V_1)$

$\therefore V = 311.1269V$

$X_C = \dfrac{1}{2\pi f C_1} = \dfrac{1}{2 \times 3.14 \times 50 \times 47 \times 10^{-6}}$

$\therefore X_C = 67.75\Omega$

$Z = R_1 - jX_C$

$Z = 40 - j67.75$

$\therefore Z = 78.67\angle - 59.44°\Omega$

$I = \dfrac{V}{Z} = \dfrac{311.1269}{78.67\angle - 59.44°} = 3.954\angle 59.44°A$

$\therefore I = \mathbf{3.954\angle 59.44°A}$

$V_R = R_1 I = 40 \times 3.954\angle 59.44°$

$\therefore V_R = \mathbf{158.16\angle 59.44°V}$

$V_C = X_C I = 67.75 \times 3.954\angle 59.44°$

$\therefore V_C = \mathbf{267.92\angle -30.56°V}$

Power factor$(cos\phi) = cos(59.44) = \mathbf{0.508}$

Calculation for time:

$$t = \frac{\angle\theta \times T_{period}}{360}$$

$T_{period} = 20sec$

$$t_I = \frac{\angle 59.44° \times 20}{360} = \mathbf{3.30ms}$$

$$t_C = \frac{\angle 30.56° \times 20}{360} = \mathbf{1.697ms}$$

$$t_R = \frac{\angle 59.44° \times 20}{360} = \mathbf{3.30ms}$$

SIMULATED RESULTS:

Above circuit is simulated in LTspice. The results are presented below:

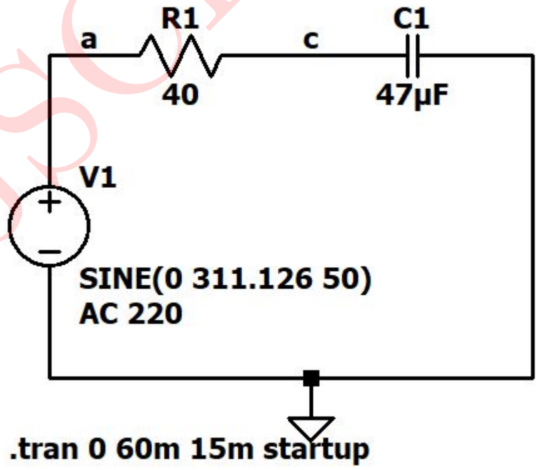

Figure 27: Circuit Schematic for RC Circuit

Graphs are shown in Figure 28, 29, 30.

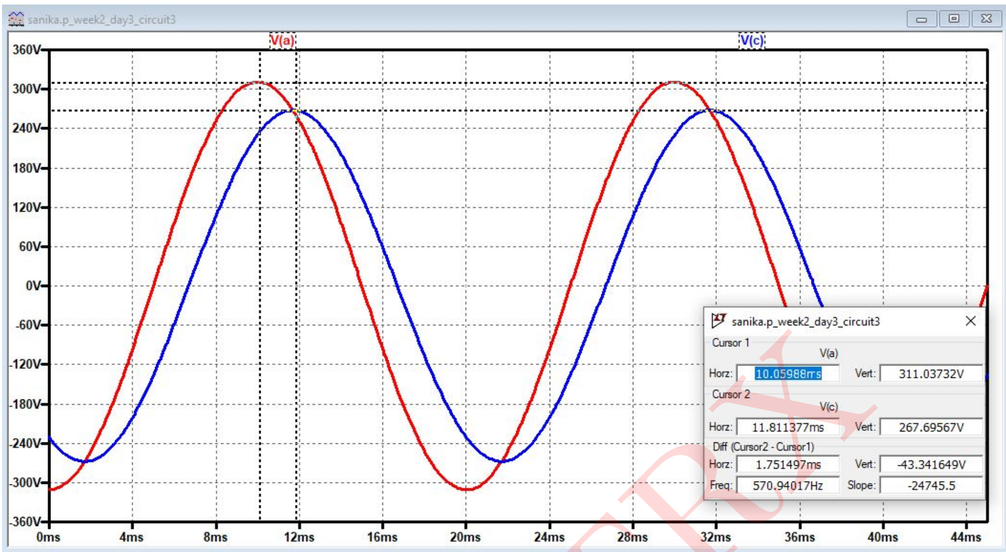

Figure 28: Graph for Figure 27 - $V_{S(t)}$ Vs V_C

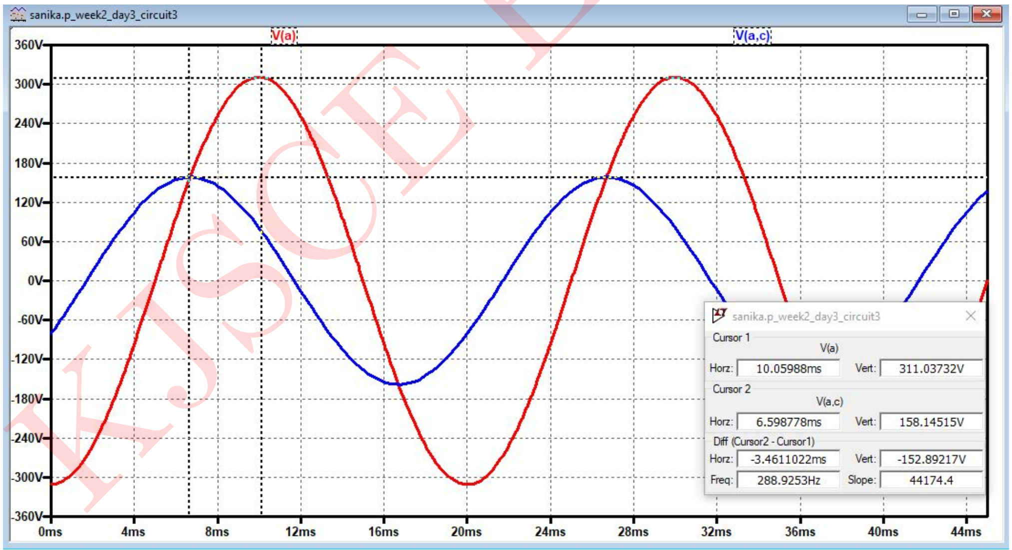

Figure 29: Graph for Figure 27 - $V_{S(t)}$ Vs V_R

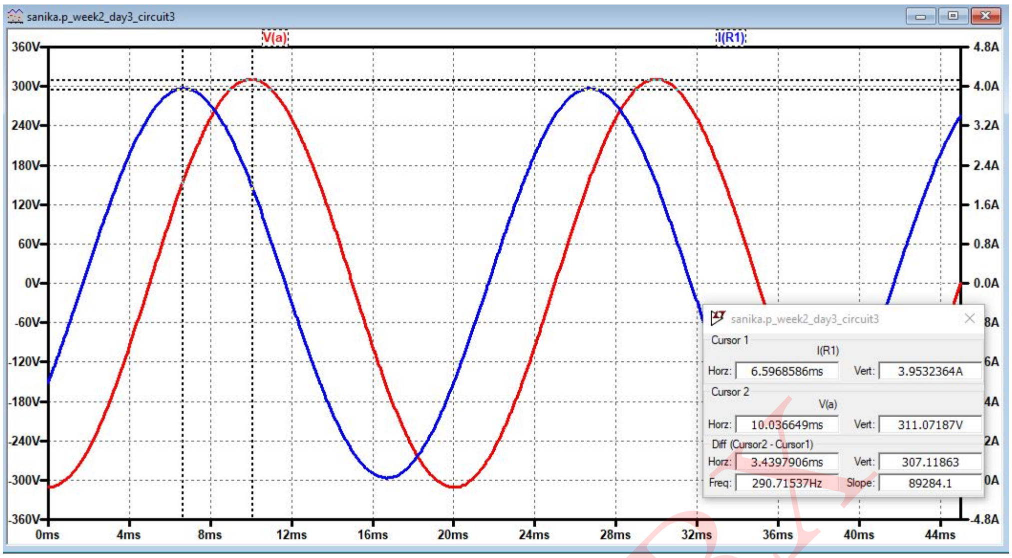

Figure 30: Graph for Figure 27 - $V_{S(t)}$ Vs $I_{S(t)}$

For circuit simulated in Figure 27,

$$\angle\theta = \frac{t \times 360}{T_{period}}$$

$$\angle\theta_{(I)} = \frac{3.43 \times 360}{20} = \angle 61.74°$$

$$\angle\theta_{(C)} = \frac{1.75 \times 360}{20} = \angle 31.5°$$

$$\angle\theta_{(R)} = \frac{3.46 \times 360}{20} = \angle 62.28°$$

Comparison of theoretical and simulated values:

Parameters	Theoretical Values	Simulated Values
V_R	158.16V	158.145V
V_C	267.92V	267.69V
I	3.954A	3.95A
t_I	3.30ms($\angle$59.44°)	3.43ms($\angle$61.74°)
t_C	1.697ms($\angle$30.56°)	1.75ms($\angle$31.5°)
t_R	3.30ms($\angle$59.44°)	3.46ms($\angle$62.28°)

Table 7: Numerical 7

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