گزارش کار تمرین کامپیوتری سری اول

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Q1)

- $Z_{RL} = 20 + j10\,\Omega$,
- $Z_C = -jX_C = -j\frac{1}{2\pi fC}$.

The imaginary part of $\frac{1}{Z_{\text{total}}}$ is:

$$\text{Imaginary part} = \text{Imaginary part of } \frac{1}{Z_{RL}} + \text{Imaginary part of } \frac{1}{Z_C}$$

$$\frac{1}{Z_{RL}} = \frac{1}{20 + j10} \times \frac{20 - j10}{20 - j10} = \frac{20 - j10}{(20)^2 + (10)^2}$$

$$\frac{1}{Z_{RL}} = \frac{20 - j10}{500} = 0.04 - j0.02$$

$$\text{Imaginary part of } \frac{1}{Z_{RL}} + \text{Imaginary part of } \frac{1}{Z_C} = 0$$

$$-0.02 + (2\pi fC) = 0$$

$$2\pi fC = 0.02$$

$$C = \frac{0.02}{2\pi f}$$

$$C = \frac{0.02}{2\pi(50)} = \frac{0.02}{314.16} \approx 0.0000637\,\mathrm{F}$$

$$C \approx 63.7\,\mu\mathrm{F}$$

Since the capacitors are arranged in a triangle, this value must be multiplied by three:

$$C_{\text{final}} = 3 \times 63.7\,\mu\mathrm{F}$$

$$C_{\text{final}} = 191.1\,\mu\mathrm{F}$$

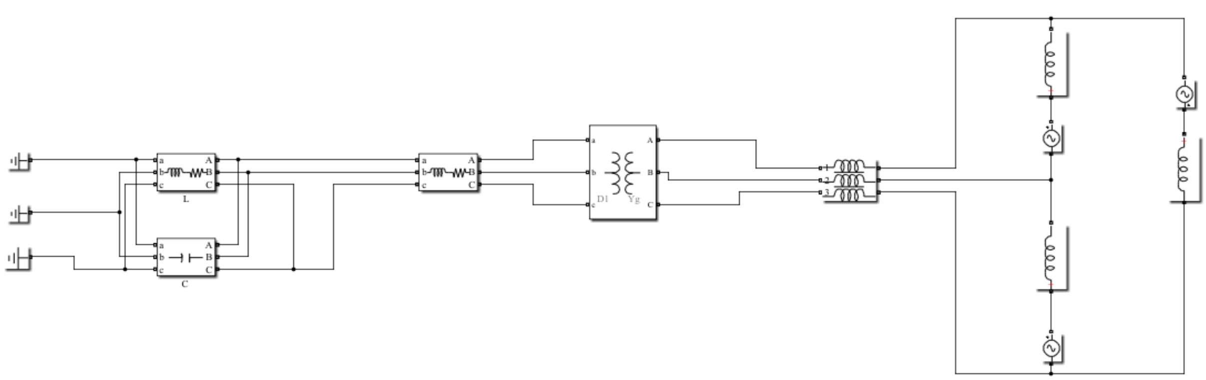
The values of the various elements are as follows:

R1=1,R2=20

L1=0.03/P H,L2=0.02/P H,L3=0.03/P H,L4=0.1/P H

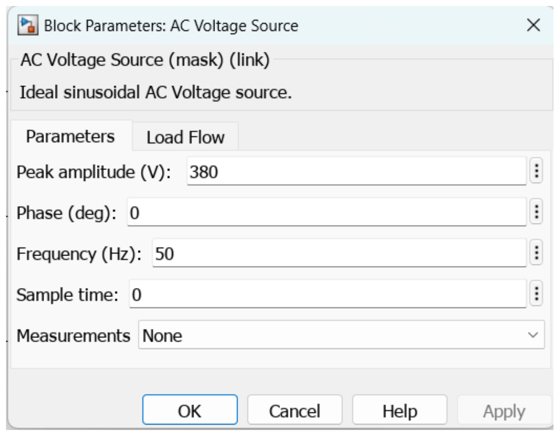
C(In the star arrangement)=200/P uF

N2:N1 = 2rad3

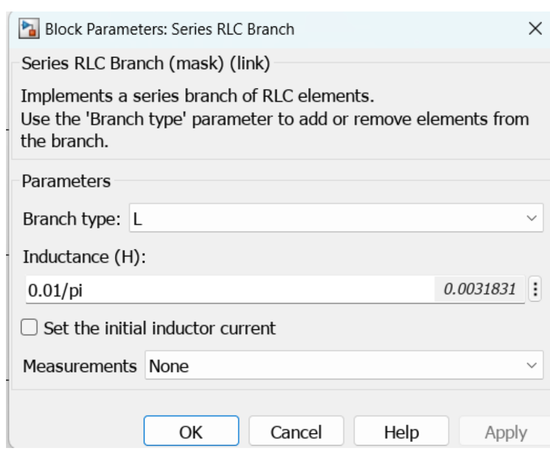


We implemented the circuit as above.

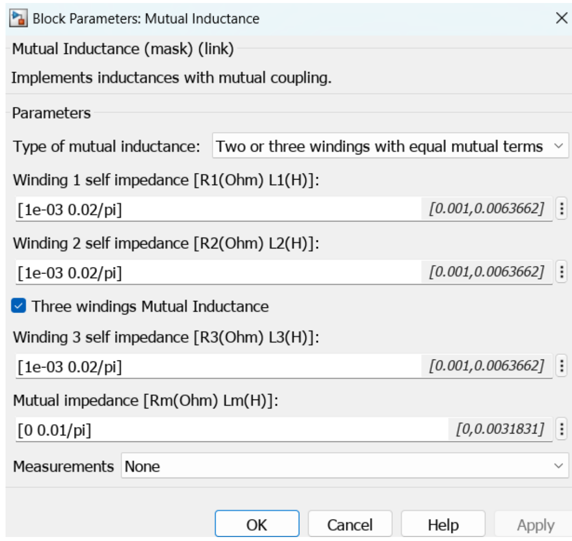
The data sheets of the various elements are as follows:



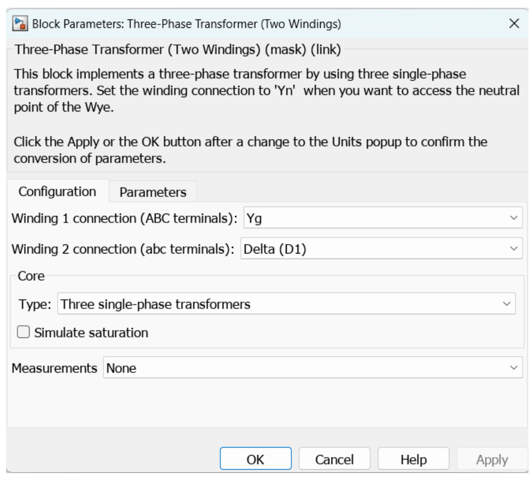
AC voltage source inside the generator

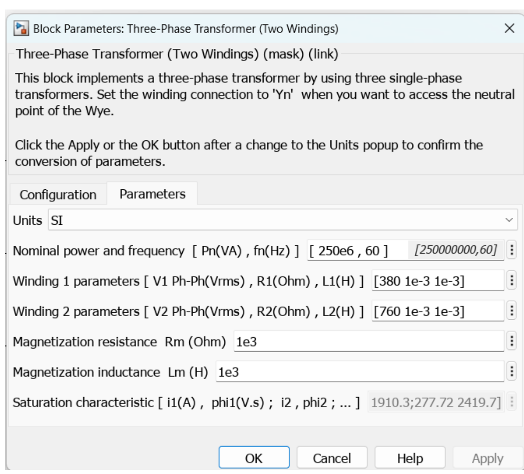


Inductor inside the generator

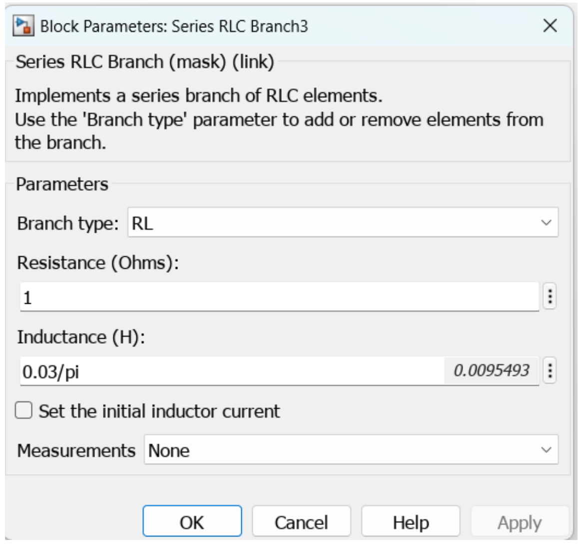


Transmission line coupling inductors

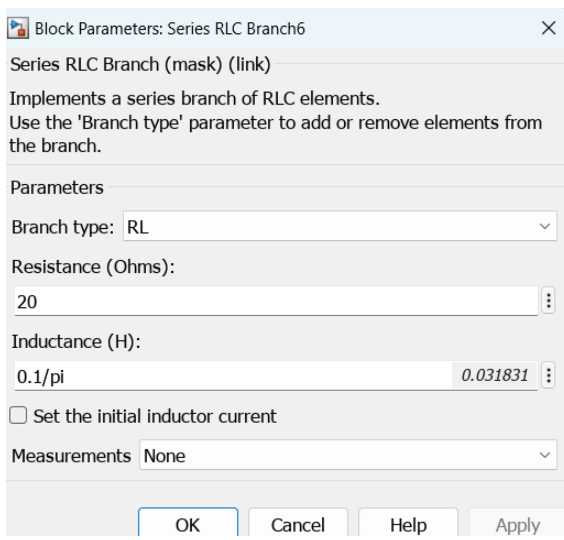




Three-phase transformer

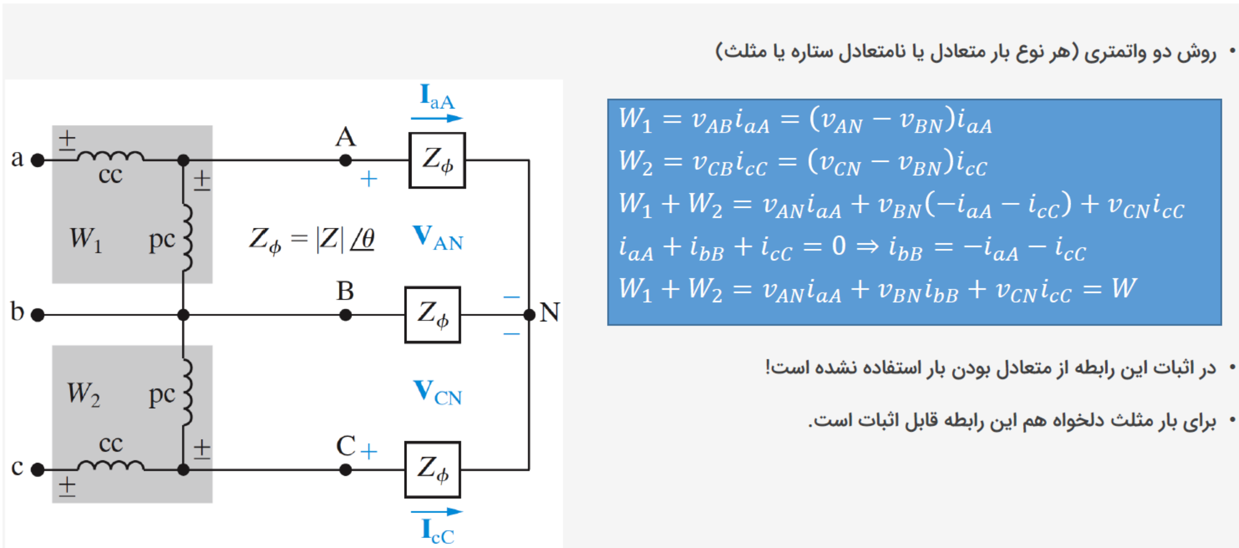


Resistance and inductance in transmission lines

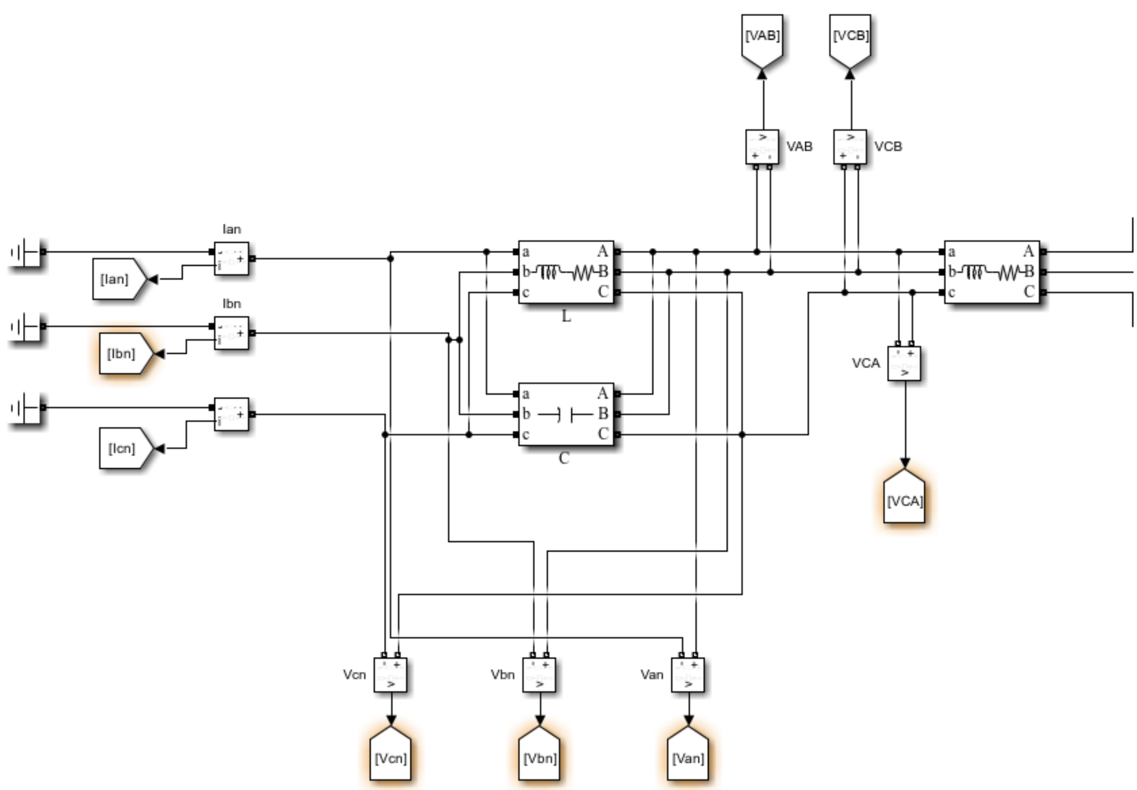


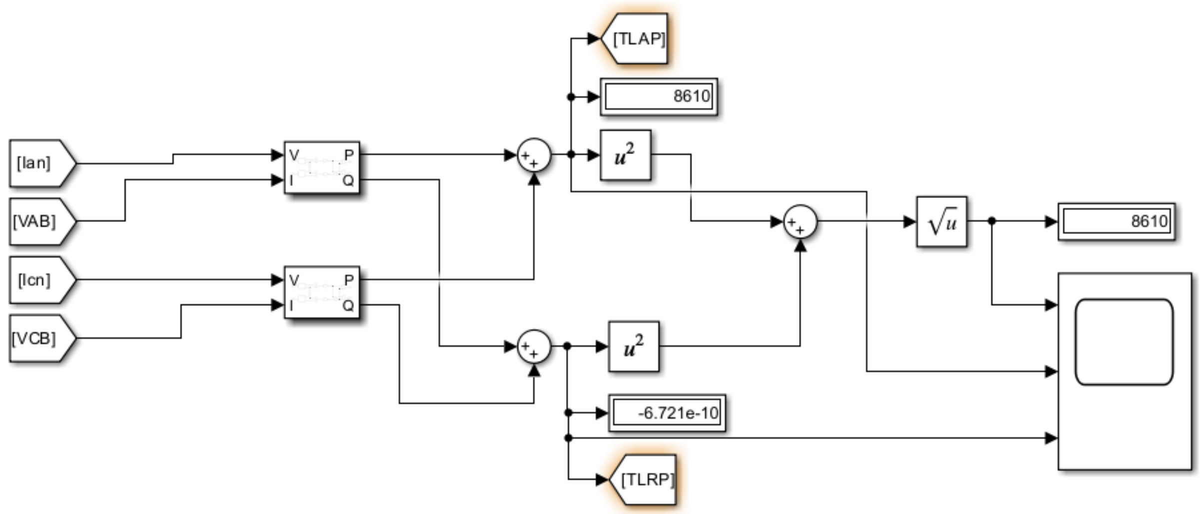
Resistance and inductance in load

Two wattmeter method:



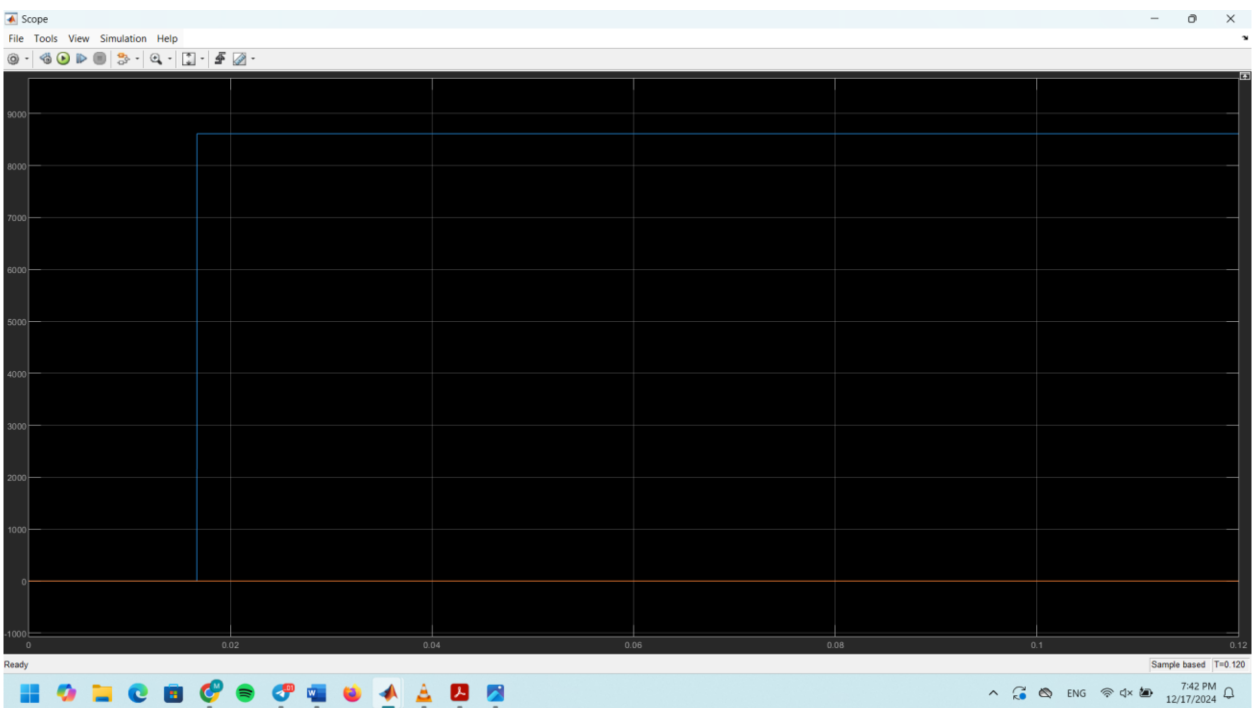
Now let's go ahead and confirm the accuracy of our calculations for the capacitor capacitance by measuring the power using the two-wattmeter method and show that the reactive power is zero!





As we can see, the active power is 8610 watts and the reactive power is almost 0.

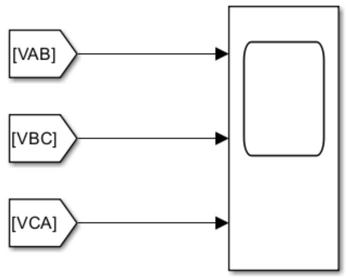
We see the active and reactive power diagram in the figure below:

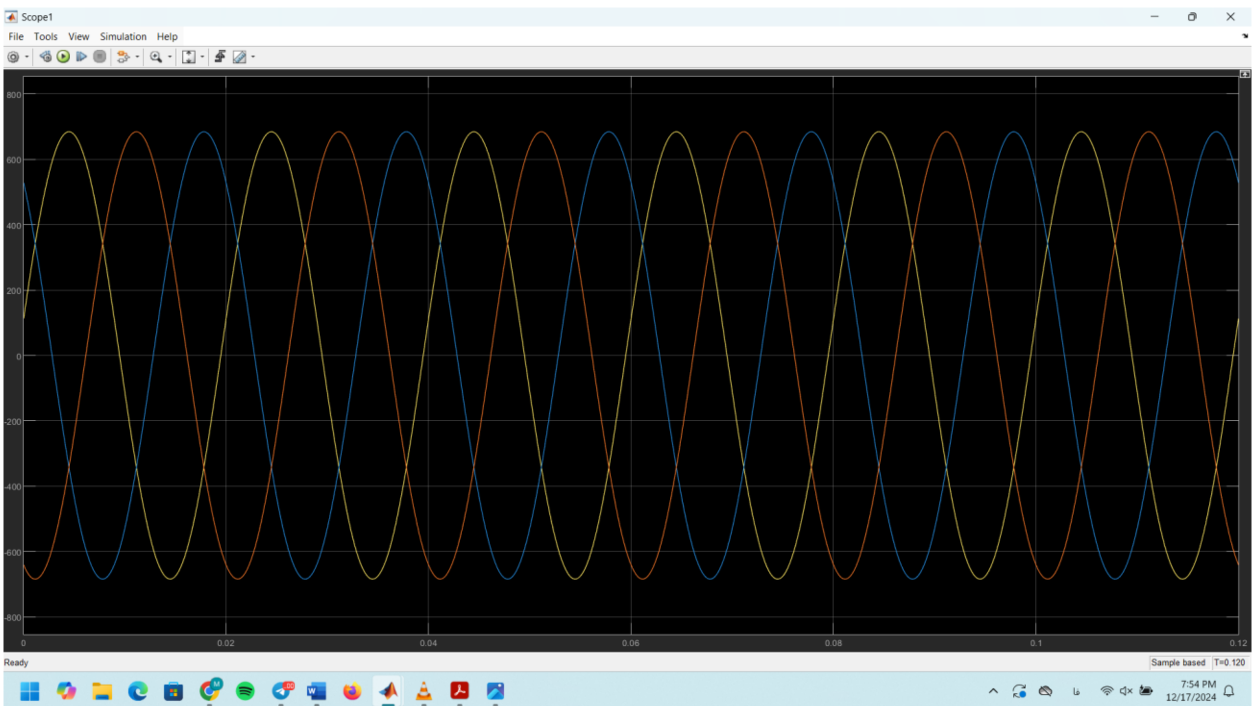


Let's move on to the next question!

Q2)

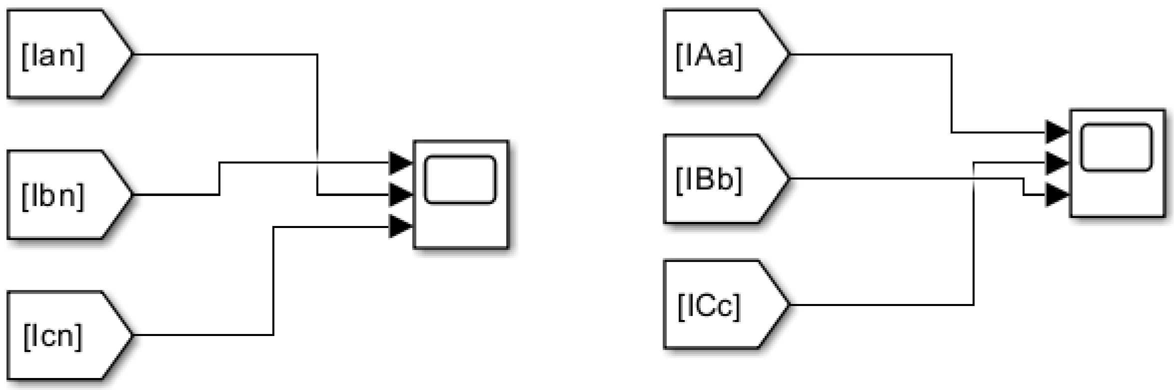
We show the line voltage on the load side:

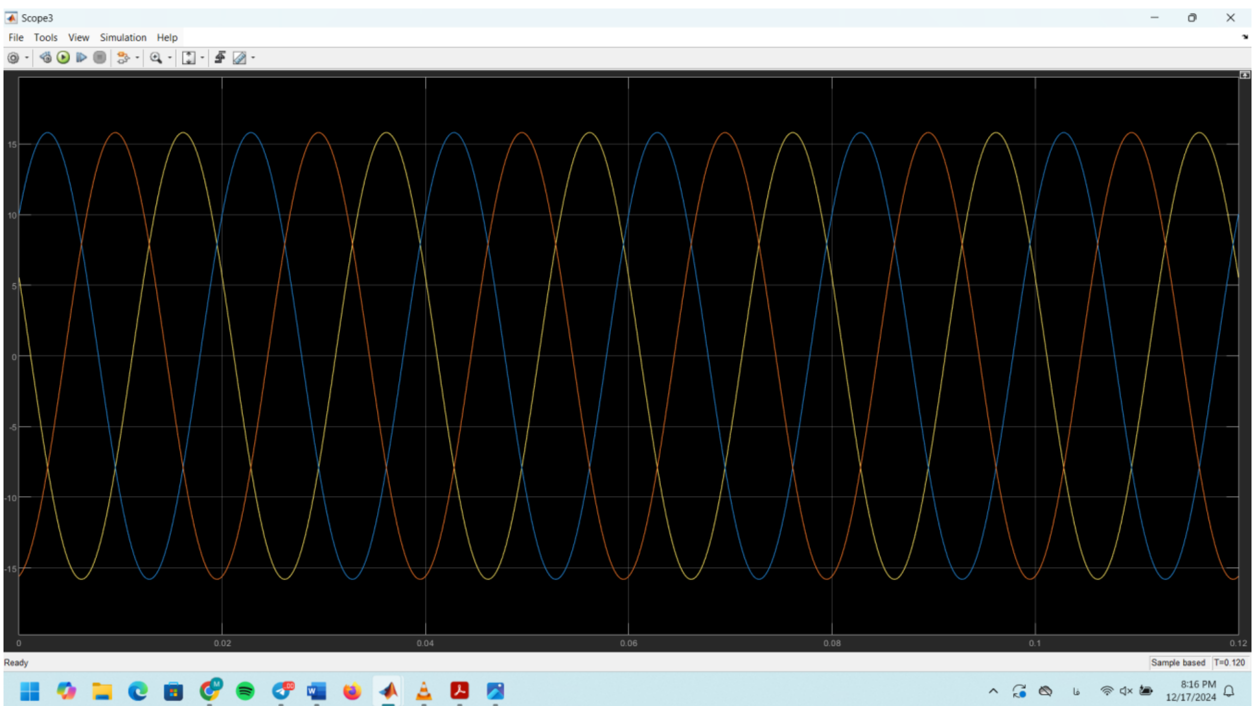




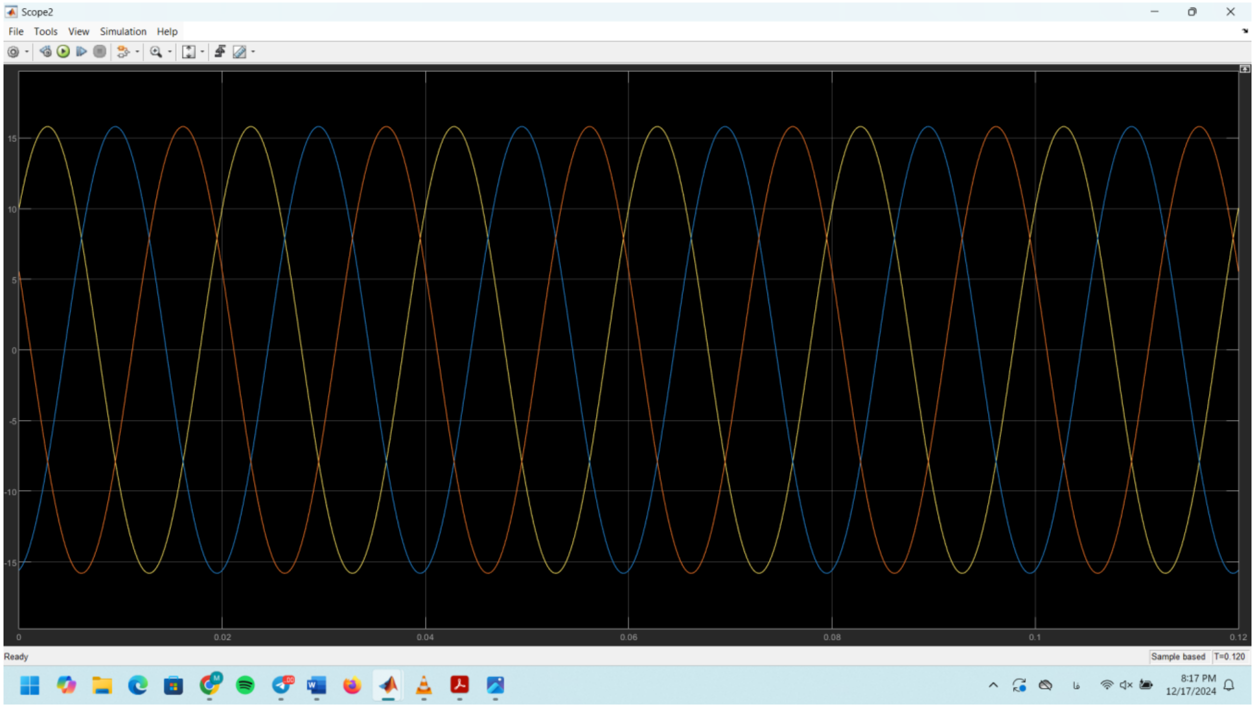
Q3)

Now we want to show the line and phase current waveforms on the secondary side:





Phase current waveform

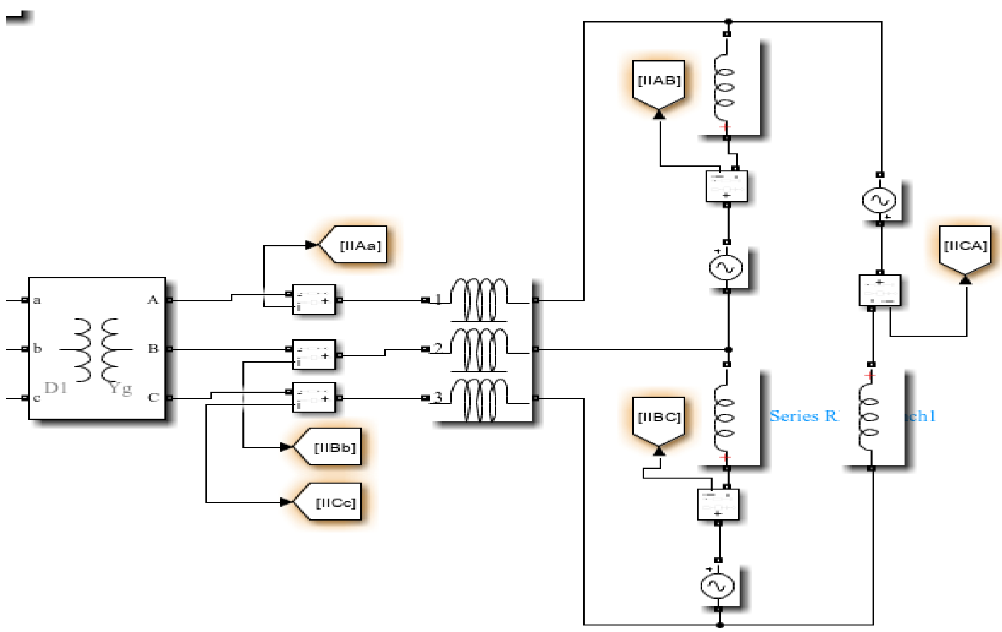


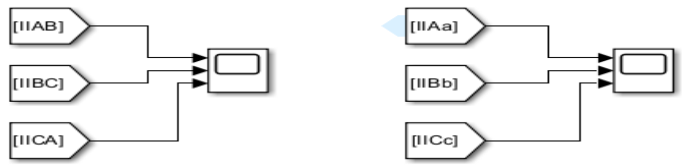
Line current waveform

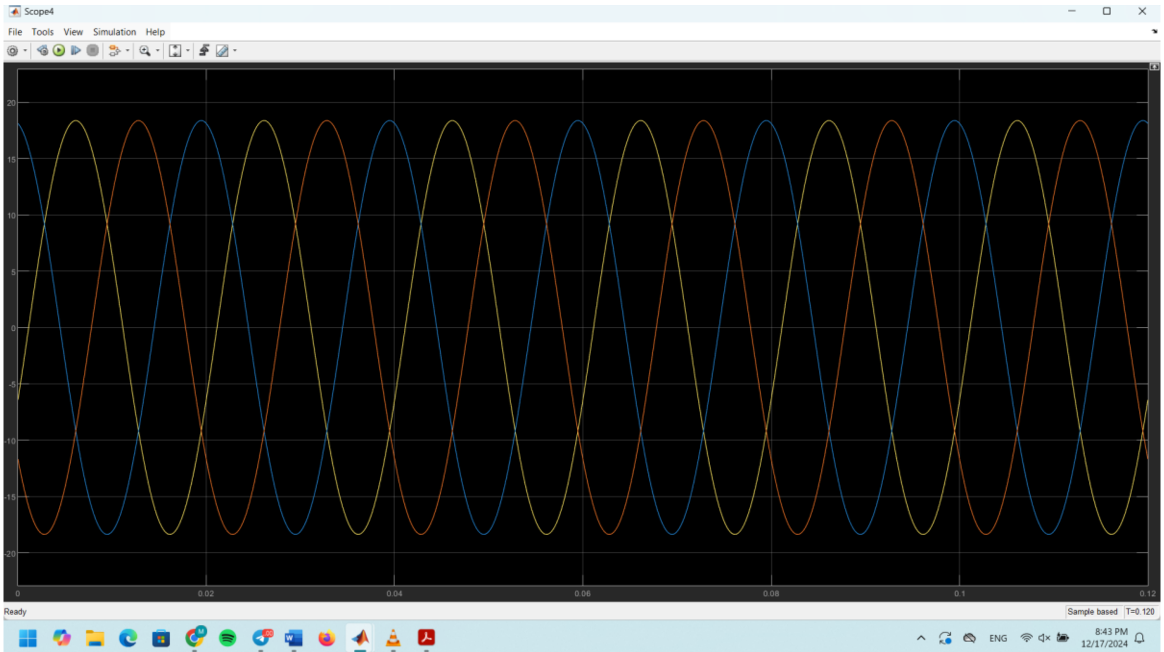
It is clear that since our load is in a star shape, the line and phase currents are equal.

Q)4

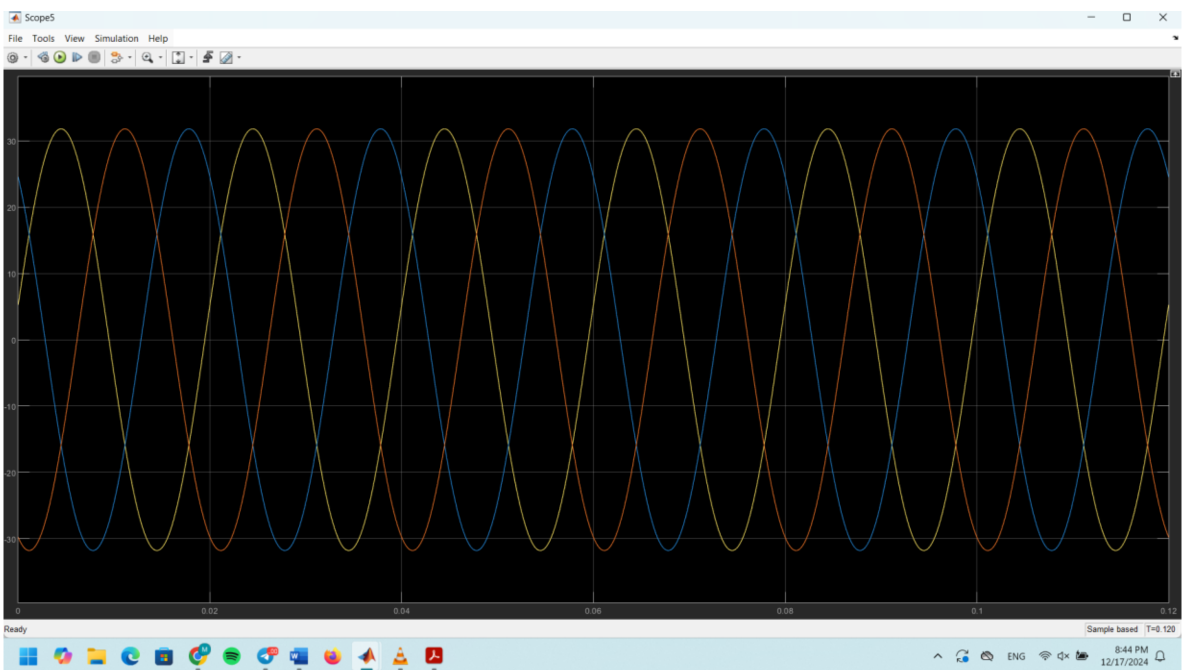
Now we want to show the line and phase current waveforms on the source side:







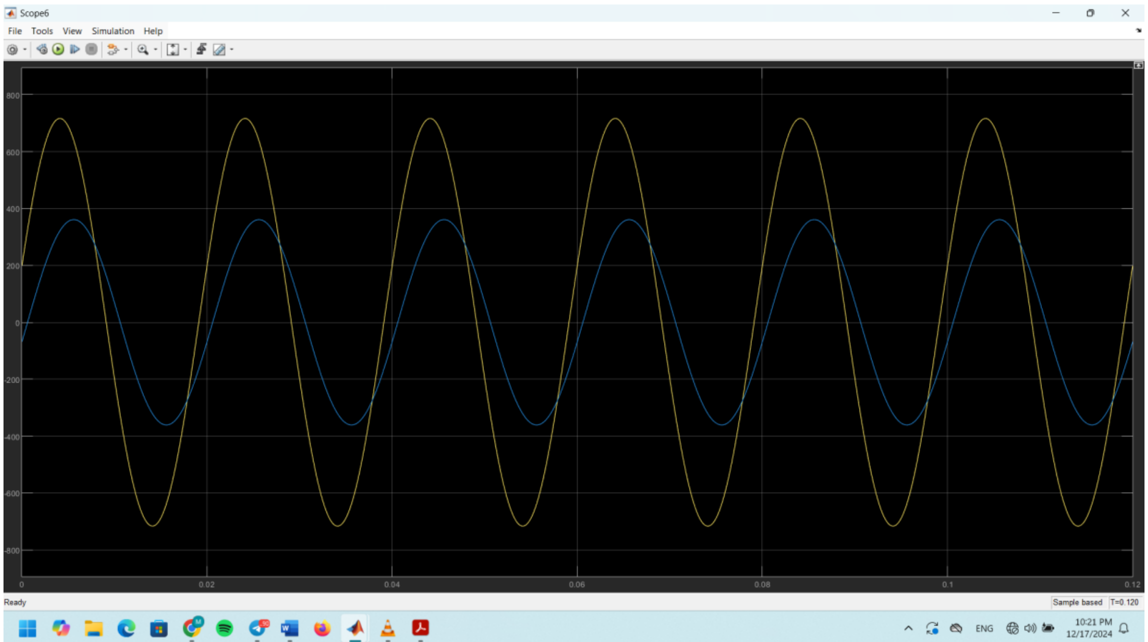
Phase current waveform



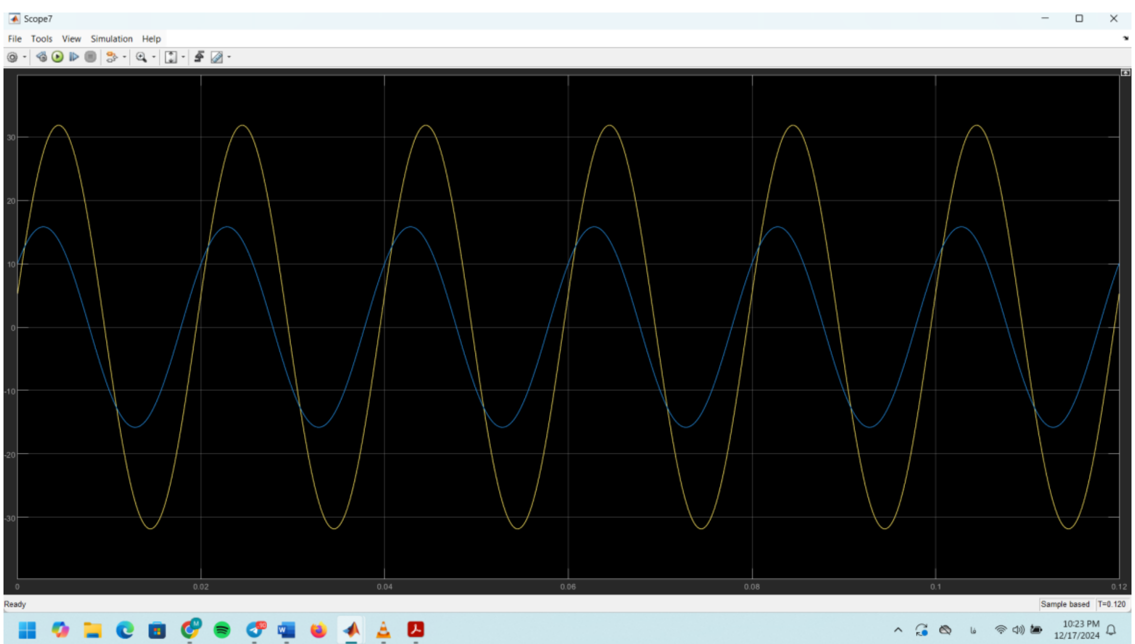
Line current waveform

On the source side, since the arrangement is in the form of a triangle, the current flowing through each voltage source is the line current, and the phase current is the current flowing through the transmission lines. Given their waveforms, the radical line current is 3 times the phase current, and its phase is 30 degrees ahead.

Q5)



Primary and secondary side voltage



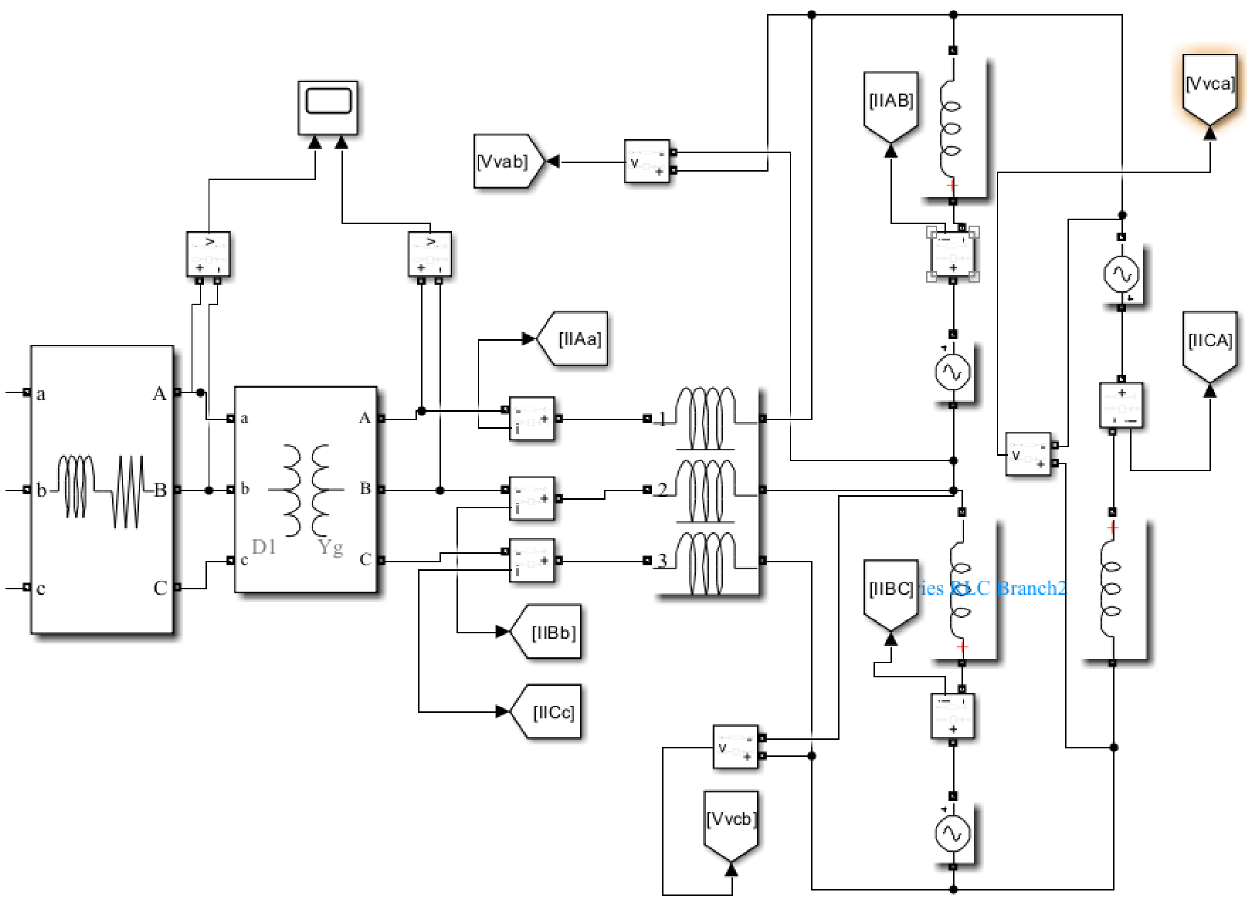
Primary and secondary side current

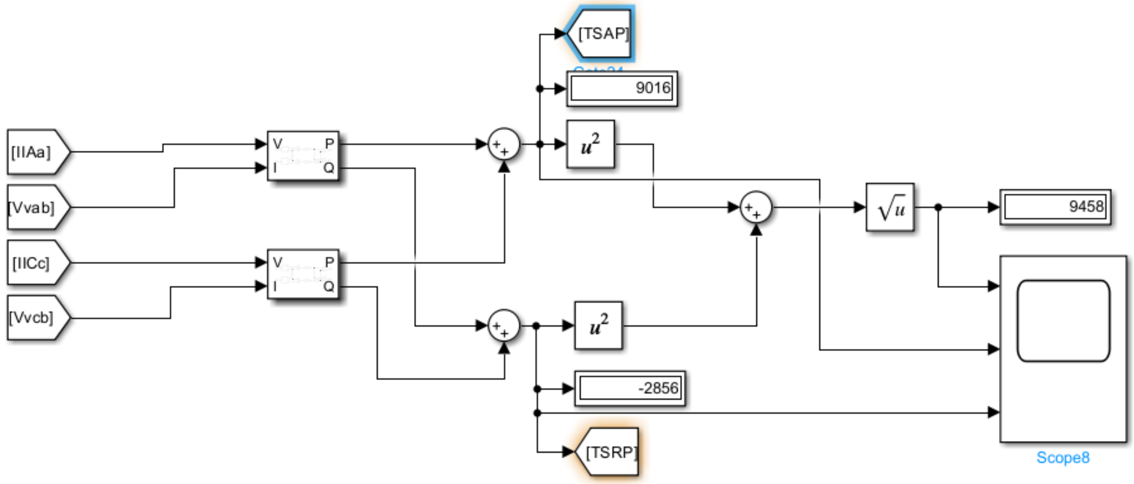
$$|\frac{V_2}{V_1}| = \frac{N_2}{N_1}$$

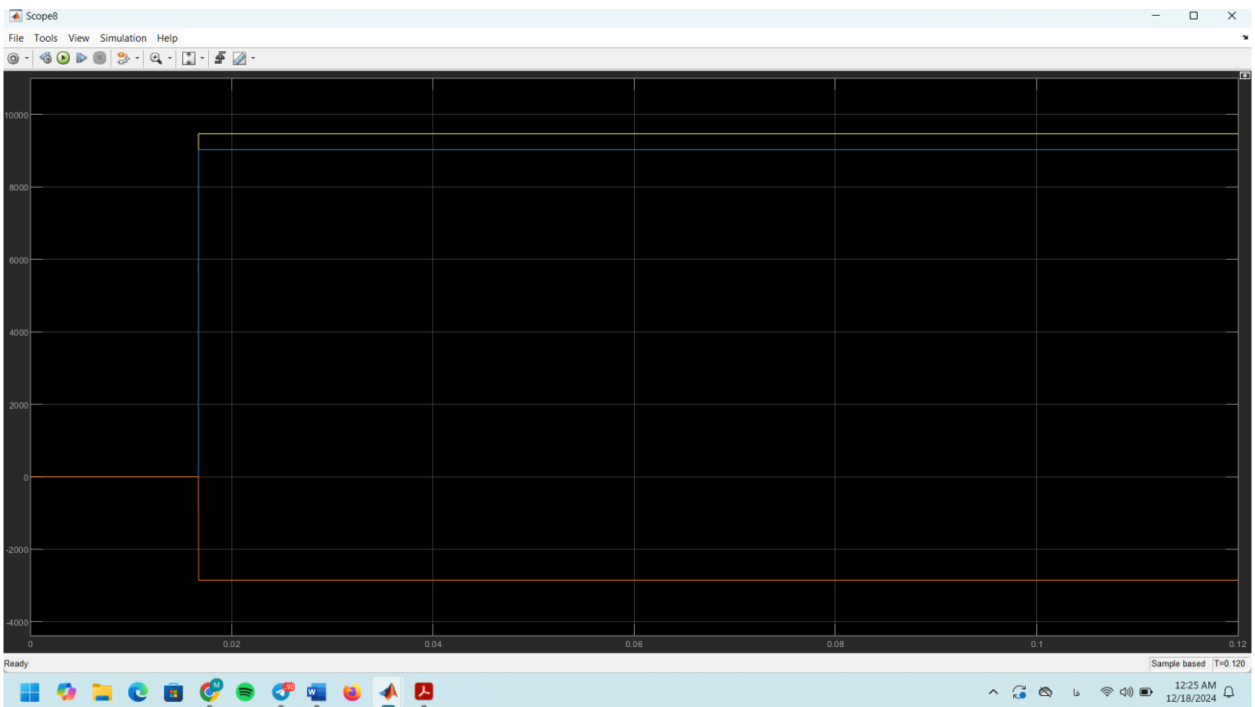
$$|\frac{I_2}{I_1}| = \frac{N_1}{N_2}$$

Q6)

We use the same two-wattmeter method explained in the previous sections:

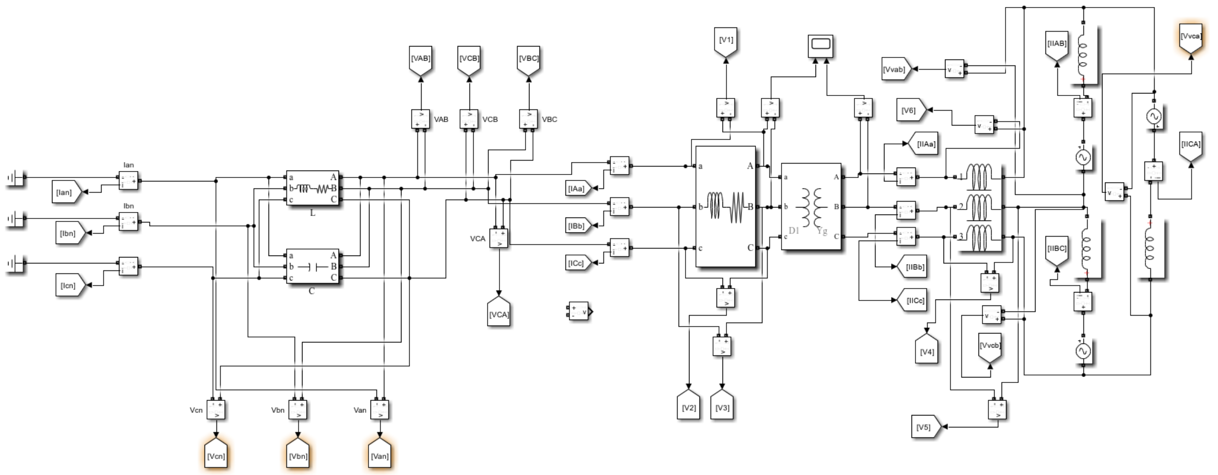


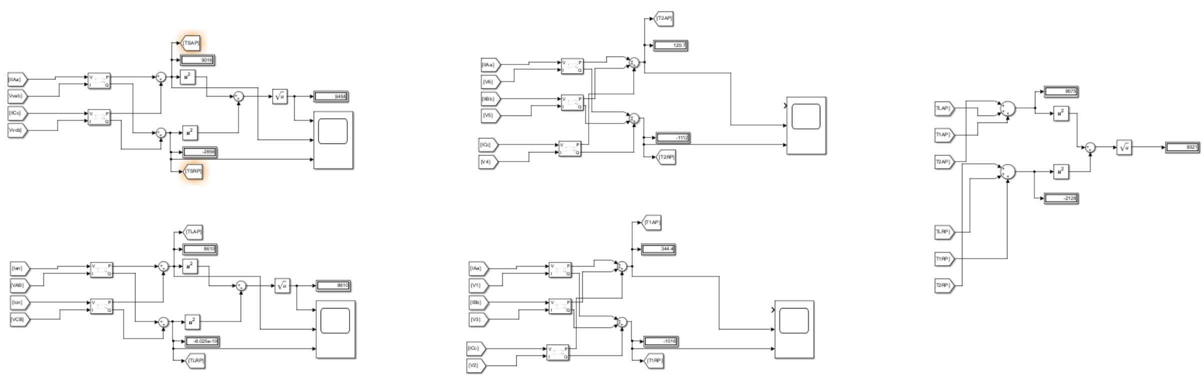




Apparent power waveform, active power and reactive power

Now we examine the power conservation theorem in the system:





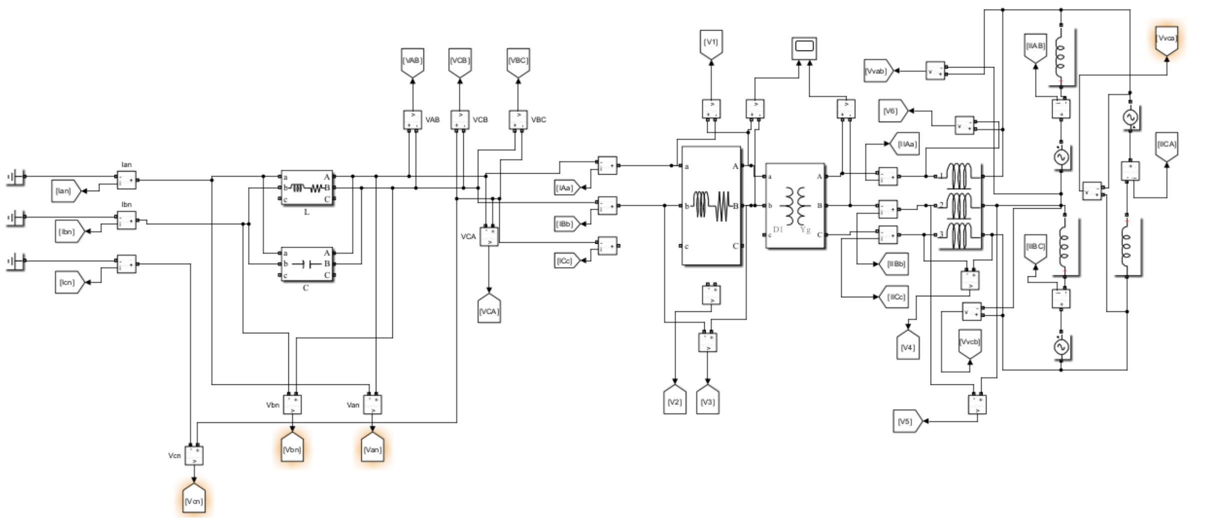
The apparent power produced by the source is 9458 watts.

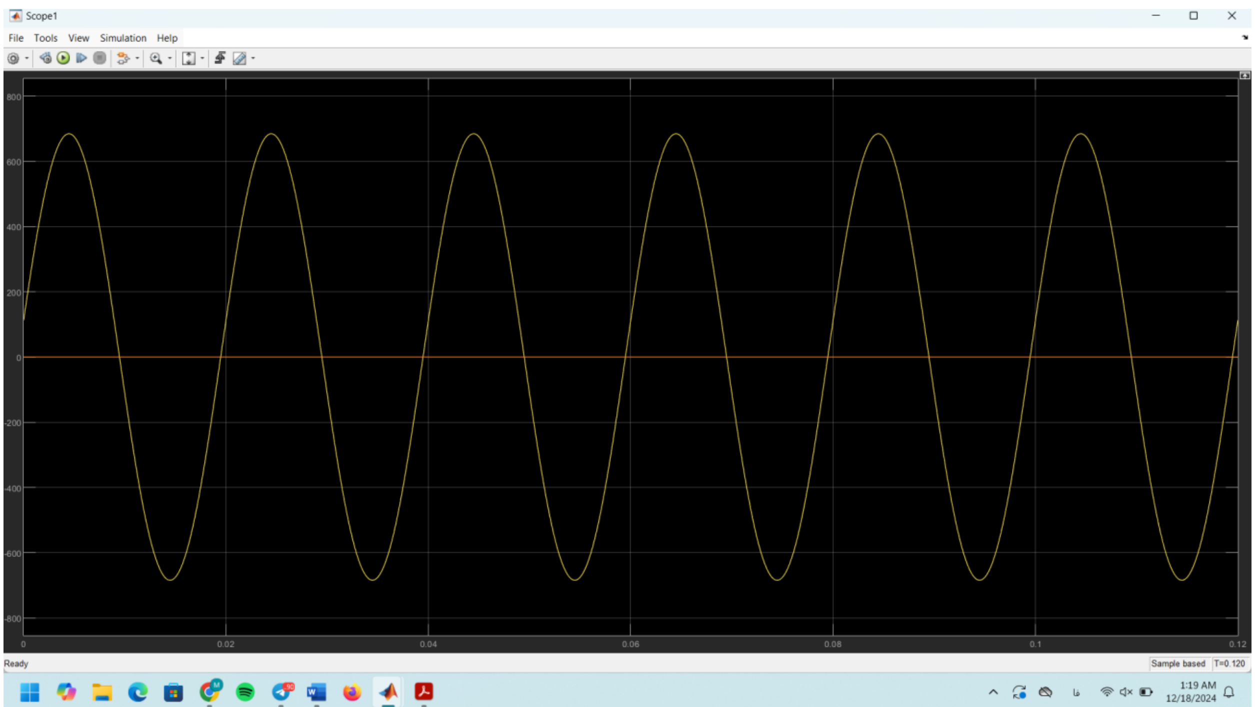
The apparent power consumed by the passive elements is 9321 watts, which is a good approximation of the power conservation equation.

The reason for this slight difference is that the elements are not ideal.

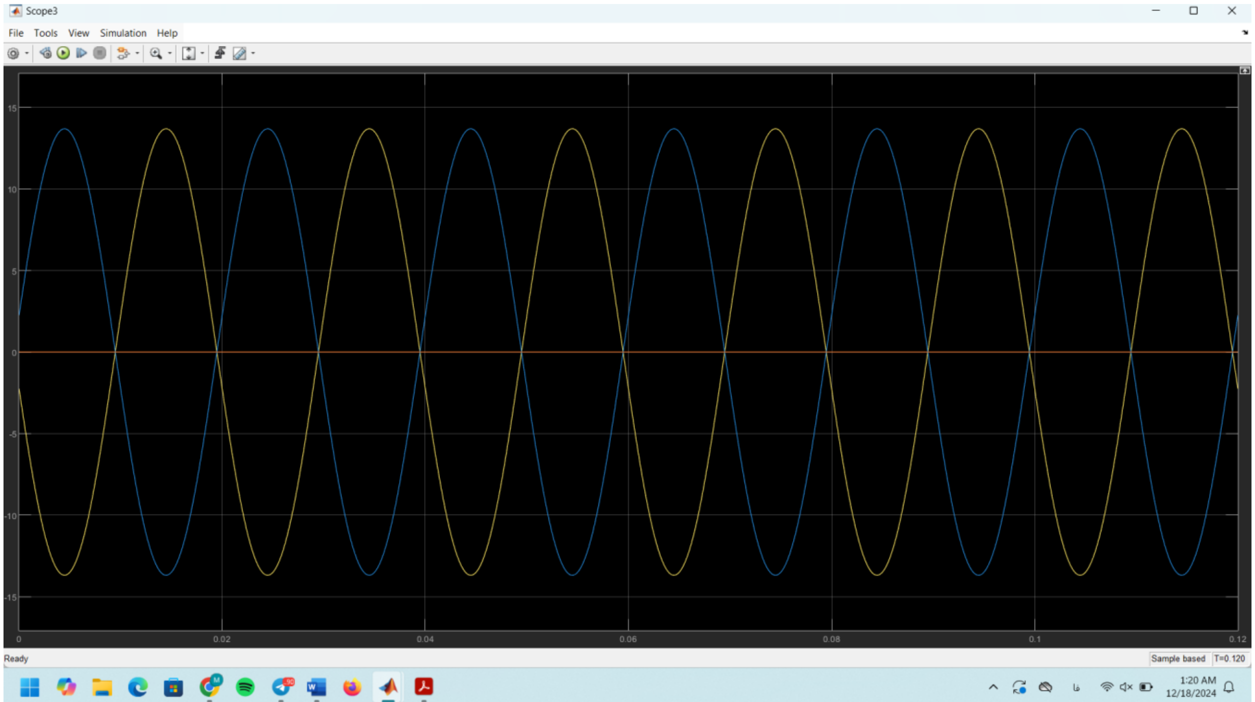
Q7)

One of the transmission lines has been removed from the circuit:

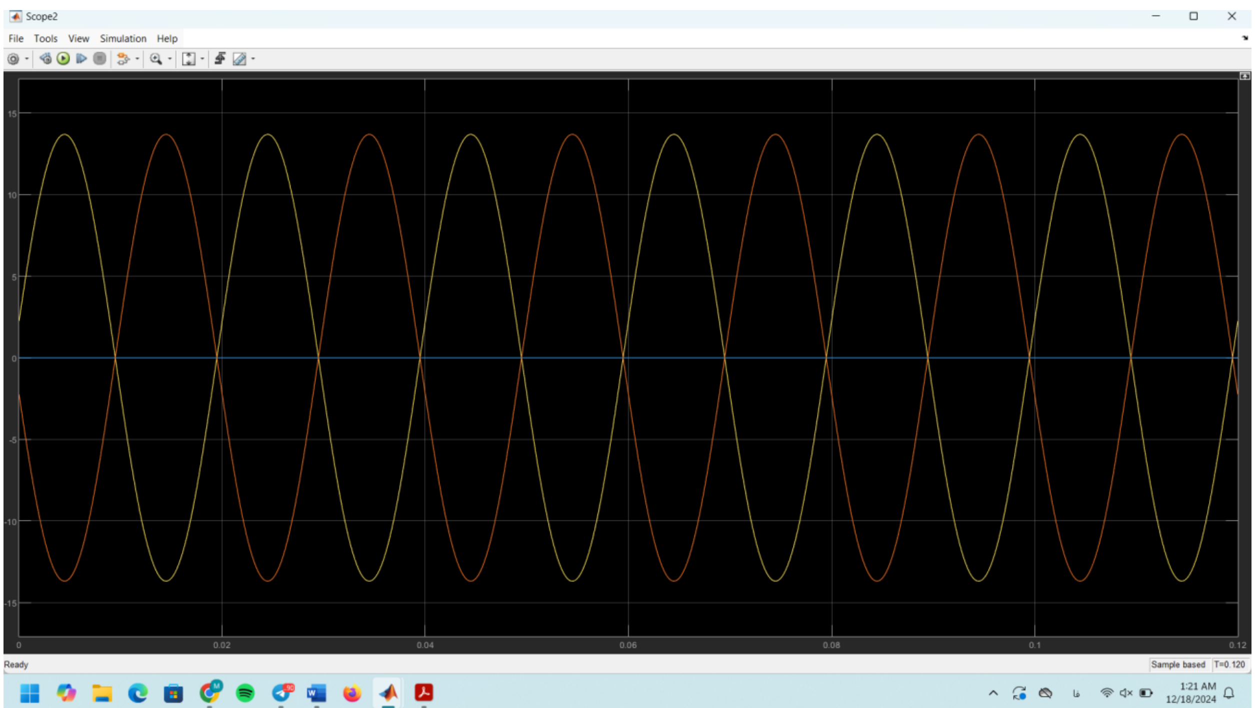




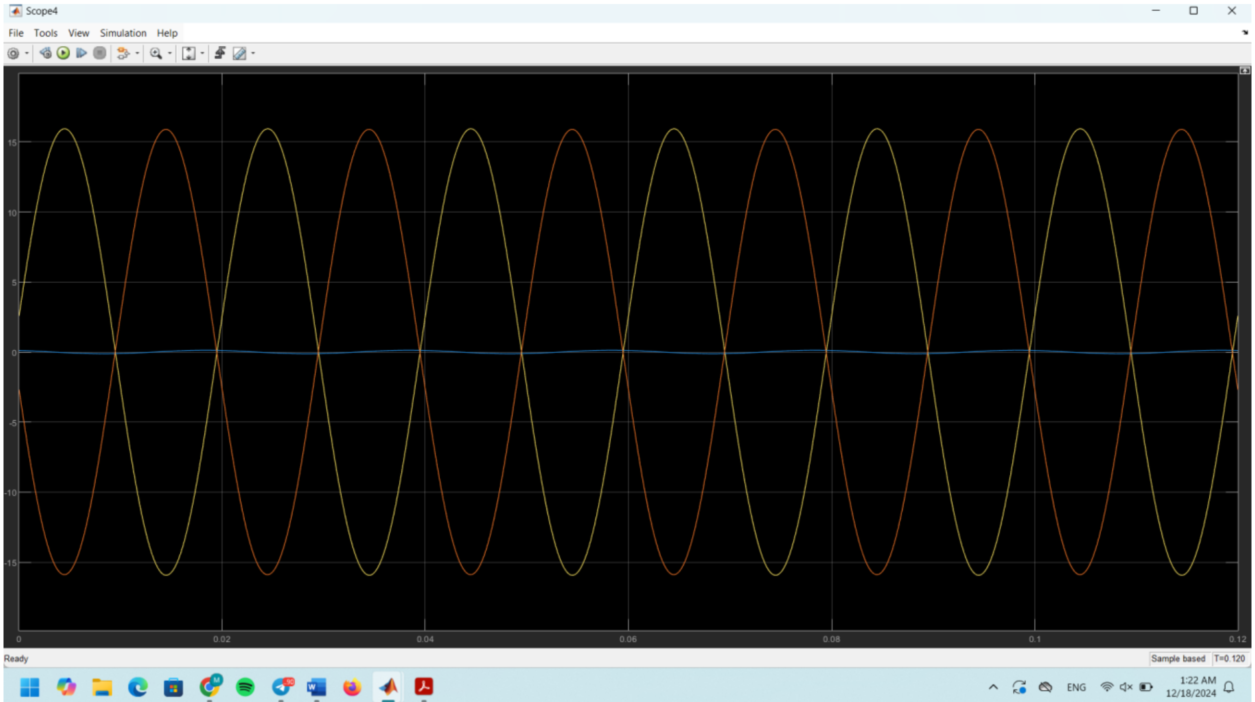
Line voltages at both ends of the load



Phase current of loads

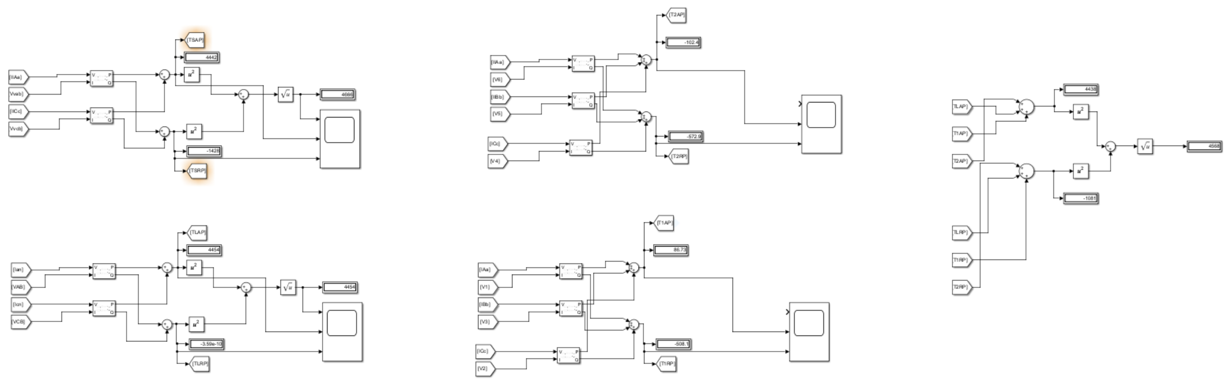


Load current of loads



Transmission line current on the primary side

Line current on the source side



As we can see, the conservation of energy theorem also holds

As we can see, even though one of the secondary side windings is out of the circuit, the transformer is still capable of transmitting three-phase power to the load.

Q)8

The efficiency in a symmetrical three-phase system is 98.55 percent.

(9321/9458)*100=98.55

The efficiency in an asymmetric three-phase system is 97.89 percent.

(4568/4666)*100=97.89

As we can see, the efficiency has decreased.