K. J. Somaiya College of Engineering, Mumbai-77
(A Constituent College of Somaiya Vidyavihar University)
Department of Electronics Engineering

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Course Name:	EEEE	Semester:	I
Date of Performance:	25/01/2022	Batch No:	A2
Faculty Name:	Maruti Zalte	Roll No:	16010121045
Faculty Sign & Date:		Grade/Marks:	

Experiment No: 8
Title: Power factor improvement (parallel)

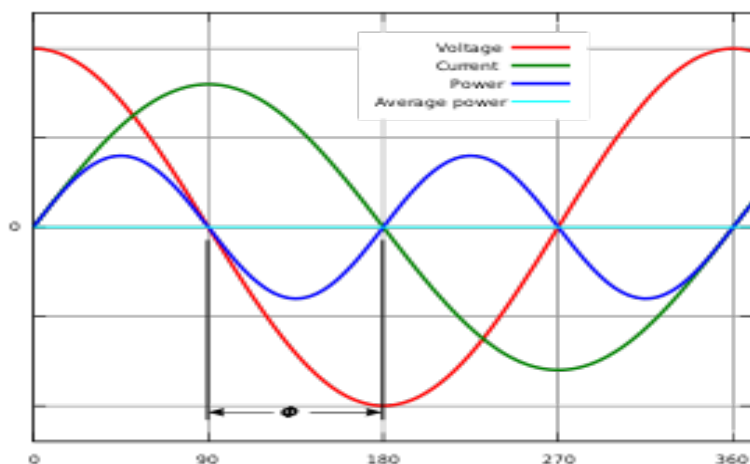| Aim and Objective of the Experiment: |
| --- |
| • To improve power factor of a single phase inductive AC circuit using capacitor across the load. |

| Requirements: |
| --- |
| Inductor box, 1 KΩ-3W Resistor, Capacitor box, AC Ammeter and AC Voltmeter. |

Theory:
When we need to convert electrical energy to mechanical energy, electric motors are used for it. These AC motors converts electric energy in two forms namely mechanical energy in the form of rotary motion and other is magnetic field. Magnetizing currents are lagging to the supply voltage. This magnetic energy is not a mechanical energy so it is kind of wastage, but without which motor will not run and convert electric energy into mechanical energy. Such form of energy is called as reactive power. Reactive power must be as less as possible so that the load will utilize maximum power and current requirement will be less for the same amount power. As the current requirement is less, so wire thickness will be small in diameter. Installation cost and energy cost will be also reduced. To reduce reactive power of the circuit, different power factor improvement methods are used. One of the most familiar method is the use of capacitor bank. We can use capacitor in series with the load or across the load. Following diagrams are illustrating effect of PF on active power.

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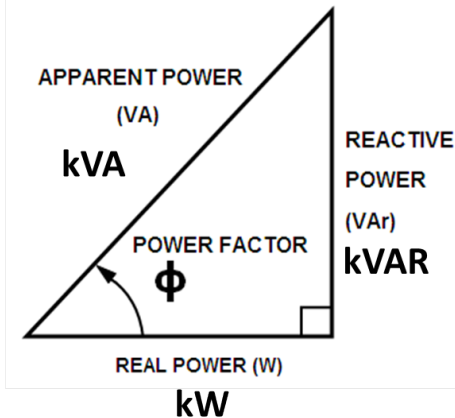
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In the above figure instantaneous and average power calculated from AC voltage and current with a zero power factor. The blue line shows all the power is stored temporarily in the load during the first quarter cycle and returned to the grid during the second quarter cycle, so no real power is consumed by the load which is shown by sky-blue colour line.
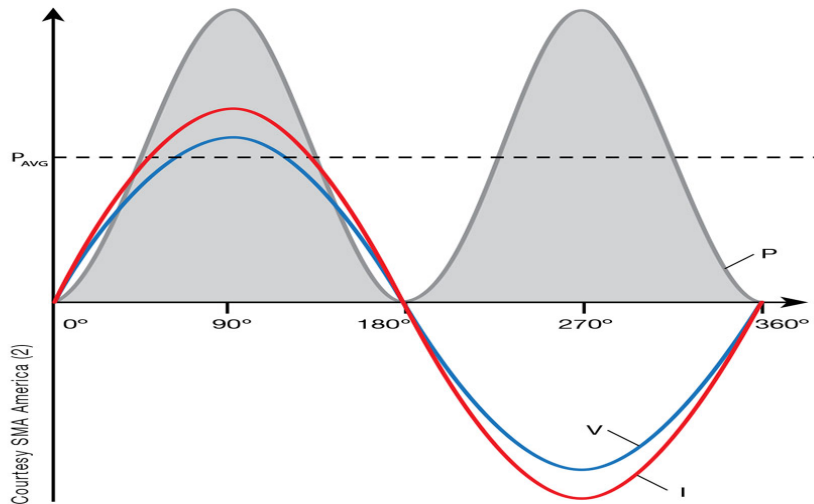
In the above figure instantaneous and average power calculated from AC voltage and current with a unity power factor. The gray part shows all the power is absorbed in the load during the first half cycle as well as the second half cycle, so real power is fully consumed.
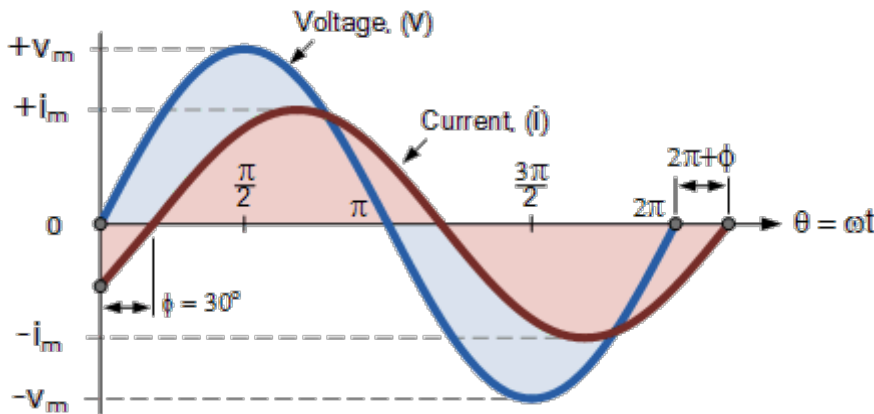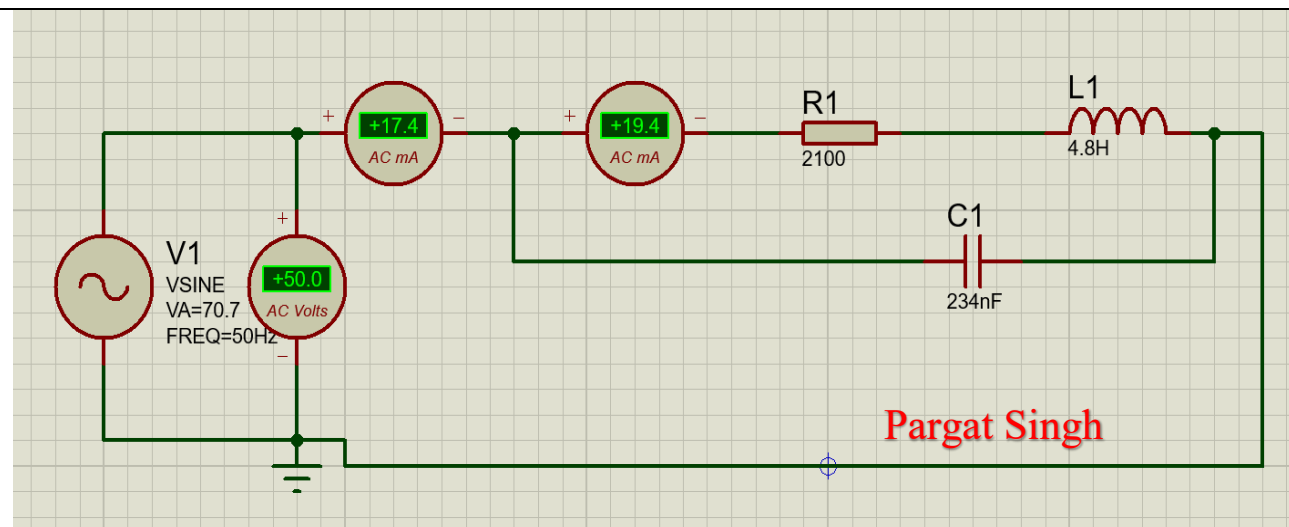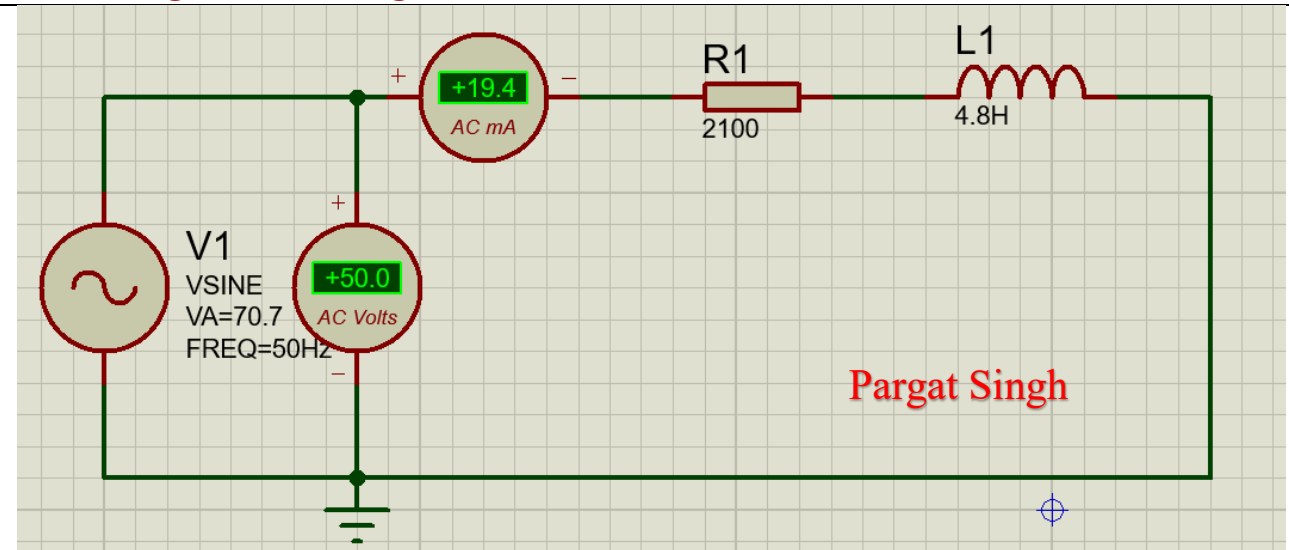

When power factor is between zero and unity, then real power consumed by the load depends upon PF of the circuit. Greater the power factor is always better to consume power.

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Power Factor $= \dfrac{\text{True Power}}{\text{Apparent Power}}$

Power Factor $= \cos \Phi = \dfrac{\text{kW}}{\text{kVA}}$

Circuit Diagram/ Block Diagram:

Pargat Singh

Pargat Singh

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Stepwise-Procedure:

1. Connect series R and L circuit across 230V, 1ø, 50 Hz AC supply and note down circuit voltage and current.

2. Calculate practical value of circuit power factor by taking ratio of active power (P) and apparent power (S).

3. Connect required value of capacitor in parallel with R-L load and switch on power supply to note circuit voltage and current.

4. Calculate practical value of circuit power factor by taking ratio of active power (P) and apparent power (S).

5. Compare theoretical and practical values of PF before connecting the capacitor and after connecting capacitor.

Observation Table:

Sr No	Type of load	Voltage (V)		Current (I) (mA)		P (mW)= $(I_{coil})^2 \times R$		S (mVA) VX In		Power factor	
		Th	Pr	Th	Pr	Th	Pr	Th	Pr	Th	Pr
1	R-L	50	50	19.33	19.4	784	790	966.5	970	0.81	0.81
2	R-L-C	50	50	17.39	17.4	784.6	790	869.5	870	0.9	0.9

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Calculations

$$I = \frac{V}{Z} = 50 \angle 0$$

$$I = \frac{V}{Z} = \frac{50 \angle 0}{Z} \qquad Z = R + jXL$$

$$Z = 2100 + j \, 2\pi \times 50 \times 4.8$$

$$Z = 2100 + j \, 1507.2$$

$$Z = 2584.88 \angle 35.66°$$

$$I = \frac{50 \angle 0}{2584.88 \angle 35.66}$$

$$I = 19.33 \, mA \angle -35.66°$$

$$P = (0.01933)^2 \times 2100$$

$$P = 784 \, mW$$

$$S = 966.5 \, mVA$$

$$\cos\phi = \frac{P}{S} = \frac{784}{966.5} = 0.81$$

$$\overline{I_n} = \overline{I_{coil}} + \overline{I_c}$$

$$PF_n = \cos\phi_n = 0.9$$

$$\phi_N = \cos^{-1}(0.9) = 25.84°$$

Real parts of currents

$$\Rightarrow I_{coil} \cos\phi_{coil} = I_n \cos\phi_n$$

$$I_n = \frac{I_{coil} \cos\phi_{coil}}{\cos\phi_n}$$

$$= \frac{(19.33 \times 10^{-3}) \cos(35.66)}{0.9}$$

$$I_n = \frac{19.33 \times 10^{-3} \times 0.81}{0.9} \quad \Rightarrow \quad \boxed{I_n = 17.39 \, mA}$$

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Imaginary part of current

$$I_n \sin \phi_n = I_{coil} \sin \phi_{coil} = I_c \sin 90°$$

$$I_c = I_{coil} \sin \phi_{coil} - I \sin \phi_n$$

$$I_c = 19.33 - \sin(35.66) - 17.39 \sin(25.84°)$$

$$I_c = 3.69 mA$$

$$X_c = 50 \angle 0° = \frac{50}{I_c} \qquad \frac{50}{3.69 mA} = 13550 \, \Omega$$

$$X_c = \frac{1}{2\pi f c} = 13550$$

$$C = \frac{1}{2\pi \times 50 \times 13550} = 0.34 nF$$

$$P = (I_{coil})^2 R = (19.33 mA)^2 \times 2100 = 784.6 mA$$

$$S = V \times I_n = 50 \times 17.39 mA = 869.5$$

$$\cos \phi = \frac{P}{S} = \frac{784.6}{869.5} = 0.9$$

Post Lab Subjective/Objective type Questions:

1. **What are benefits of connecting capacitor across the load to improve circuit PF?**

i. Reduced electrical power bills

ii. Reduces I2R losses in electrical conductors

iii. Reduces loading on transformers by releasing system capacity

iv. Improves voltage on the electrical distribution system thereby allowing motors to run more efficiently and cooler. This helps to prolong the operation and life to the motor.

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Conclusion:

Improved power factor of a single phase inductive AC circuit using parallel capacitor across the load.

Signature of faculty in-charge with Date: