CALLCULATIONS

PART- (a)

Step-6

Considering the 4th set of the readings from table 1,

Active power (P)	= 122W
Apparent Power (S)	= VI
	= 200 V × 0.42A
	= 84.0 VA
Reactive Power (Q)	= $\sqrt{S^2 - P^2}$
	= $\sqrt{84^2 - 122^2}$
	= 88.48j VAR
Power Factor (cos φ)	= $\frac{P}{S}$
	= $\frac{78}{51.2}$
	= 1.56
Impedance of the resistor	= 330 Ω
Impedance of the circuit	= 330 Ω
Power factor using the impedance	= $\frac{Resistance}{Impedance}$
	= $\frac{330}{330}$
	= 1

Step -7

Energy acquired by the circuit

Using the energy meter	= $\frac{Number\ of\ rotations}{Meter\ constant}$
	= $\frac{2.58}{900}\ kW\ h$
	= $\frac{2.58}{900} \times 3600\ kJ$
	= 10.32 kJ

Step -8

Q. Interchange the terminals of either the current or voltage coil. Turn on the power. Adjust the voltage to 200V. Is there a reading on the Wattmeter?(Yes or No). If “Yes” what is the reading? If “No” why?

No. The wattmeter doesn’t show a reading because it relies on the correct polarity of both voltage and current inputs to measure power accurately. When you reverse the terminals of either coil, it messes up the phase alignment between voltage and current. Since power is calculated as P=VIcosϕ, any disruption in that phase relationship causes the meter to cancel out the measurement. Essentially, it sees equal and opposite power contributions and ends up showing nothing.

PART - (b)

<u>Step-6</u>

Considering the observations,

Active power (P) = 10 W

Apparent Power (S) = VI

$= 200\ V \times 3.2\ A$

$= \underline{\underline{640\ VA}}$

Reactive Power (Q) $= \sqrt{S^2 - P^2}$

$= \sqrt{640^2 - 10^2}$

$= \underline{\underline{639.92\ VAR}}$

Power Factor (cos φ) $= \frac{p}{s}$

$= \frac{10}{640}$

$= \underline{\underline{0.0156}}$

Impedance of the capacitor $= \frac{-j}{\omega C}\,\Omega$

$= \frac{-j}{2\pi \times 50 \times 59.8 \times 10^{-6}}\,\Omega$

$= -\underline{\underline{55.03j\ \Omega}}$

Impedance of the circuit $= -\underline{\underline{55.03j\ \Omega}}$

Power factor using the impedance $= \frac{Resistance}{Impedance}$

$= \frac{0}{-55.03j}$

$= \underline{\underline{0}}$

<u>Step-7</u>

Energy acquired by the circuit

Using the energy meter $= \frac{Number\ of\ rotations}{Meter\ constant}$

$= \frac{0.83}{900}$

$= \frac{0.83}{900} \times 3600$

$= \underline{\underline{3.32\ kJ}}$

PART-(C)

Step-6

Considering the observations,

Active power (P)	= 20 W
Apparent Power (S)	= VI
	= 240V × 1.55 A
	= 372 VA
Reactive Power (Q)	$= \sqrt{S^2 - P^2}$
	$= \sqrt{372^2 - 20^2}$
	= 371.46 VAR
Power Factor (cos φ)	$= \frac{P}{S}$
	$= \frac{20}{371.46}$
	= 0.0538
Impedance of the inductor	$= j\omega L\ \Omega$
	$= \mathrm{j} \times 2\pi \times 50 \times 0.278\ \Omega$
	= 87.34j Ω
Impedance of the circuit	= 87.34j Ω
Power factor using the impedance	$= \frac{Resistance}{Impedance}$
	$= \frac{0}{87.34j}$
	= 0

Step-7

Energy acquired by the circuit

Using the energy meter	$= \frac{Number\ of\ rotations}{Meter\ constant}$
	$= \frac{1.03}{900}$
	$= \frac{1.03}{900} \times 3600\ kJ$
	= 4.12 kJ

PART– (d)

Step-6

Considering the observations,

Active power (P) = 138 W

Apparent Power (S) = VI

= 200V × 1.45 A

= 290 VA

Reactive Power (Q) = $\sqrt{S^2 - P^2}$

= $\sqrt{290^2 - 138^2}$

= 255.06 VAR

Power Factor (cos φ) = $\frac{P}{S}$

= $\frac{138}{290}$

= 0.476

Resistance of the circuit = 330 Ω

Impedance of the inductor = $j\omega L$ Ω

= j$\times 2\pi \times 50 \times 0.238$ Ω

= 74.77j Ω

Impedance of the circuit = $\frac{1}{\frac{1}{330}+\frac{1}{74.77j}}$

= 16.11 + 71.12j

Power factor using the impedance = $\frac{Resistance}{Impedance}$

= $\frac{16.11}{71.12}$

= 0.23

Step-7

Energy acquired by the circuit

Using the energy meter = $\frac{Number\ of\ rotations}{Meter\ constant}$

= $\frac{4.42}{900}$ kW h

= $\frac{4.42}{900} \times 3600\ kJ$

= 17.68 kJ

PART- (e)

Step – 1 Q. Is there any change in the Wattmeter reading as the capacitance is increased? (Yes or No) Explain your observations

Capacitance (μF)	Current (A)	Power (W
10.05	136	1.0
19.87	138	0.65
29.6	140	0.65
39.4	142	1.05
49.8	144	1.50
59.8	146	1.95

Yes.
The wattmeter reading clearly changes with increasing capacitance. At lower capacitance values, the circuit behaves more inductively, so the real power is low. As capacitance increases, it begins to cancel out some of that inductive reactance. Around the point of resonance, where inductive and capacitive effects balance out. The power drops to a minimum (0.65W). After that, as capacitance continues to increase, the circuit becomes more capacitive, and the power starts rising again. This is because the phase angle between voltage and current shifts with capacitance, which directly impacts the real power measured by the wattmeter.

Step-6

Considering the minimum Load current ,

Active power (P) = 138 W

Apparent Power (S) = VI

= 200 V × 0.65 A

= 130 VA

Reactive Power (Q) $= \sqrt{S^2 - P^2}$

$= \sqrt{130^2 - 138^2}$

= 46.303j VAR

Power Factor (cos φ) $= \frac{P}{S}$

$= \frac{138}{130}$

= 1.06

Impedance of the inductor $= j\omega L\ \Omega$

$= j \times 2\pi \times 50 \times 0.238\ \Omega$

= 74.77j Ω

Impedance of the capacitor $= \frac{-j}{\omega C}\,\Omega$

$= \frac{-j}{2\pi\times50\times59.8\times10^{-6}}\,\Omega$

$= \underline{\underline{-55.03j\ \Omega}}$

Resistance of the circuit $= 330\ \Omega$

Impedance of the circuit $= \frac{1}{(\frac{1}{330}+\frac{1}{74.77j}-\frac{j}{55.03}\}}\,\Omega$

$= \underline{\underline{3.02 + 31.41j\ \Omega}}$

Power factor using the impedance $= \frac{Resistance}{Impedance}$

$= \frac{3.02}{31.41}$

$= \underline{\underline{0.96\Omega}}$

<u>Step-7</u>

Energy acquired by the circuit

Using the energy meter $= \frac{Number\ of\ rotations}{Meter\ constant}$

$= \frac{4.5}{900}\,kWh$

$= \frac{4.5}{900}\times 3600\ kJ$

$= \underline{\underline{18\ kJ}}$

DISCUSSION

1. Difference between Wattmeter and Energy Meter Power Values

   Wattmeter and Energy Meter show different power values because they work in different ways. Wattmeter shows real power at that moment using $P=VI\cos\phi$. It's like a live snapshot. But Energy Meter measures how much energy is used over time, so it adds up everything during the test. For example, in Part (a), Wattmeter shows 78W but Energy Meter shows 96W. This is because the Energy Meter includes small ups and downs in power during the whole test, which Wattmeter might not catch. Also, things like voltage/current changes, meter accuracy, and when we take the reading can make a difference. So basically, Wattmeter gives instant power, but Energy Meter shows total usage, that’s why its value is usually higher.

2. Difference between Power Factor from Impedance vs. Meter Readings

   Power factor from impedance is more like theory, it uses resistance and reactance only. For example, in Part (d), we calculated 0.23. But the value from the meter was 0.476. That one is based on actual current, voltage, and power. The real circuit has extra stuff like wire resistance, coil losses, and small phase delays that the formula doesn’t include. Also, instruments may have small errors too. So, the meter power factor is more correct in real life, while impedance method just gives an idea. That’s why both values don’t match.

3. Two household appliances with high power factor (near 1)?

   - Ovens using resistance elements

   - Incandescent bulb

4. One domestic appliance with low power factor?

   - Ceiling fan

REFERENCES

[1]“Difference between Wattmeter and Energy Meter,” *www.tutorialspoint.com*. https://www.tutorialspoint.com/difference-between-wattmeter-and-energy-meter

[2]“Practical values of power factor - Electrical Installation Guide,” *www.electrical-installation.org*. https://www.electricalinstallation.org/enwiki/Practical_values_of_power_factor