⇨ This lab experiment will be performed in EPS room 119.

Scope:
- Review phasor diagrams and apparent power
- Calculate and verify power factor of ac motor
- Practice power factor correction techniques
- Study real, reactive, apparent power

- Investigate DC machine ratings
- Study field and armature circuits
- Study motor voltage/speed characteristics

✒Attention ✒   ☠ DANGER ☠
In this lab experiment you will use voltage levels that can be dangerous. Follow ALL safety guidelines explained by your TA.

The standard precautions include:

- **Connect the apparatus without power connected: have the instructor check your connections BEFORE applying power.**
- **Be careful not to touch "live" terminals.**
- **Make sure the power source is off BEFORE changing connections.**
- **Absolutely no horseplay in the lab.**
- **Eliminate distractions: focus on your work at the lab bench.**

Home preparation:
- Review Hambley Ch 5.4-5.5, Ch 16

Special Note: Your lab TA must sign-off on each step before you proceed.

Pre-lab A: *(Do prior to lab.)*

1) A small AC motor, draws 100 VA from its 120-V_{rms}, 60 Hz ac source and consumes 50 W. Find the rms current the motor draws from the supply.

I = _____

2) Calculate the power factor of the motor.

PF = _____

3) Draw a phasor diagram and a power triangle in the space at right for the AC motor at the above operating point. Calculate the real and reactive power of the motor and the appropriate capacitance to connect in parallel with the motor to correct the power factor to unity (100%).

P = _____

Q = _____

C = _____

4) Calculate the total current, real power, reactive power, and apparent power of the combination of the motor and capacitor? Compare these values with those before connecting the capacitor in parallel with the motor. Tabulate your answers in the table below

With capacitance correction applied:

$I = \underline{\hspace{2cm}}$

$P = \underline{\hspace{2cm}}$

$Q = \underline{\hspace{2cm}}$

$\lvert S \rvert = \underline{\hspace{2cm}}$

	V [V rms]	I [A rms]	P [W]	Q [VAR]	$\lvert S \rvert$ [VA]	PF
Motor only						
Motor and capacitor						

Pre-lab B: *(Do prior to lab.)*

In the space to the right, draw the schematic diagram for a cooling fan (AC motor) connected to the 120-V, 60-Hz single-phase supply through a power analyzer.

Laboratory Exploration 1:
In the first part of this experiment you will measure the real, reactive and apparent power of a small cooling fan and improve its power factor.

1) If the circuit is not already assembled, carefully connect the apparatus from the pre-lab schematic diagram of the fan and power analyzer circuit, ***with the power off***. Have your circuit checked by your lab instructor, **with the power still off**.

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2) Set the fan to high speed, energize the circuit and read the voltage, current, real power, reactive power, and power factor of the fan. Tabulate your data in the table on the next page. Turn off the fan and wait for it to stop. Make sure the power is off.

3) Place a 6µF capacitor in parallel with the fan and energize to high speed. Repeat measurements of step 2. Tabulate your data in the table, then de-energize the circuit and remove the capacitor.

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4) Without the parallel capacitor, set the fan to low speed, then energize the circuit and read the voltage, current, real power, reactive power, and power factor of the fan. Tabulate your data in the table, then turn off the fan and wait for it to stop.

5) Place a 6µF capacitor in parallel with the fan and energize to low speed. Repeat measurements of step 4. Tabulate your data in the table, then de-energize the circuit.

6) In the space below, draw power triangles for the circuit at high and low speeds, with and without the capacitor

Power triangles for high speed: Power triangles for low speed:

	Fan only					Fan and capacitor				
	V [Vrms]	I [Arms]	P [W]	Q [VAR]	PF	V [Vrms]	I [Arms]	P [W]	Q [VAR]	PF
High speed										
Low speed										

Laboratory Exploration 2:

A DC machine has two windings, the armature winding on the rotor (rotating part) and the field winding on the stator (stationary part). When dc current flows through the two windings, a torque is exerted on the rotor conductors as a result of the interaction of the magnetic fields associated with the two windings, and the motor starts turning.

1) Note and record the nameplate ratings of the motor.

Voltage:

Current:

rpm:

Power:

2) The DC motor voltage controller (available at your workbench) has been connected for you, through a power analyzer, to the armature winding of the motor. The DC motor controller converts three-phase AC voltage to DC, which can be varied from zero up to the motor rated voltage. The shunt field winding of the DC motor has been connected for you to a variable 120 VDC supply. While the motor is at rest and de-energized, use an ohmmeter to measure the armature resistance.

$R_A =$

3) Increase the output voltage of the motor controller (in steps) from a low value to the motor rated voltage and note the increase in motor speed. At each step (in increments of about 100 RPM), record the motor armature voltage and speed in the table below.

DC Motor Readings					
Arm. Voltage (V_{rms})					
Speed (rpm)					

4) Note the direction of rotation of the motor.   ⇨Direction:

5) Stop the motor and interchange the connections at the terminals of the field winding.

6) Start the motor and slowly increase its input voltage from zero. Note the direction of rotation.   ⇨Direction:

7) Stop the motor and plot a curve of motor armature voltage versus speed using the recorded data.

8) Comment on the adjustable speed operation of the motor and draw some conclusions based on your observations.