

Date: _____

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LABORATORY EXPERIMENT NO. 1

Introduction to the Lab & Lab Equipment



OBJECTIVE

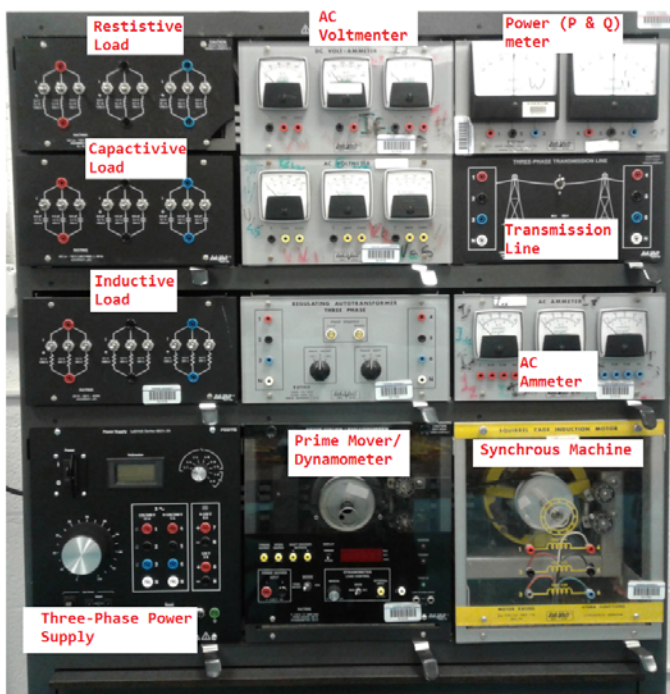
1. To introduce the lab experiments for the class.
2. To understand the laboratory facilities and equipment.

DISCUSSION

The Fundamentals of Energy Systems Lab course intends to closely accompany with its lecture counterpart, Fundamentals of Energy Systems, and its contents: electric power system, power industry, distributed generation, and wind and solar power systems. The Lab contains the following experimentations:

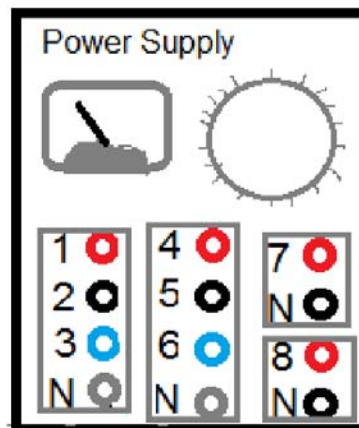
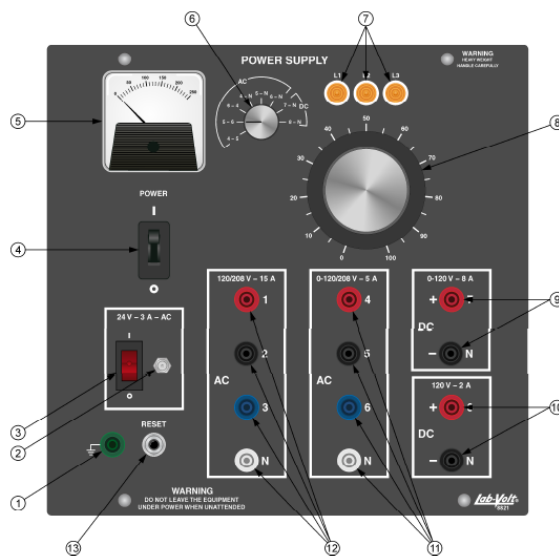
- Lab 1: Introduction
- Lab 2: Single-phase system
- Lab 3: Three-phase system real and reactive power
- Lab 4: Power Flow and Voltage Regulation
- Lab 5: Phase Angle and Voltage Drop
- Lab 6: Power Flow between Two Sources
- Lab 7: Synchronous Generator
- Lab 8: Induction Machine
- Lab 9: Stand-Alone Micro-power System
- Lab 10: Grid-connected Micro-Power System
- Lab 11: Renewable Micro-Power System

INSTRUMENTS AND ELEMENTS:



Power Supply (EMS 8821):

The 8821 power supply module is the heart of the lab volt EMS (Electromechanical system) system. It is used to supply all power to operate the various modules used to perform the experiments. It is necessary to become familiar with the different voltage and current ratings of the power supply.



The module must be connected to a three-phase, 120/208 volt, four-wire system. Power is brought in through five-prong, twist-lock connector located at the rear of the module. An input power cable with mating connector is provided for this purpose. The power supply furnishes the following outputs:

1. Fixed 120/208 volts, 3-phase power is brought out to four terminals, labeled 1, 2, 3, and N. Fixed 208 volts ac may be obtained between terminals 1 and 2, 2 and 3, or 1 and 3. Fixed 120 volts ac may be obtained between any one of the 1, 2, or 3 terminals and the N terminal. The current rating of this supply is 15A per phase.

2. Variable 120/208 volts, 3-phase is brought out to four terminals, labeled 4, 5, 6, and N. Variable 0 - 208 volts ac may be obtained from terminals 4 and 5, 5 and 6, and 4 and 6. Variable 0 - 120 volts ac may be obtained between any one of the 4, 5, or 6 terminals and the N terminal. The current rating of this supply is 5A per phase.

3. Fixed 120Vdc is brought out to terminals labeled 8 and B. The current rating of this supply is 2A.

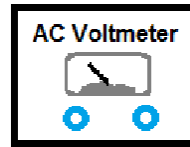
4. Variable 0-120Vdc is brought out to terminals labeled 7 and N. The current rating of this supply is 8A.

The variable ac and dc outputs are controlled by the single control knob on the front of the module. The built-in voltmeter will indicate all the variable ac and the variable and fixed dc output voltages according to the position of the voltmeter selector switch. The power supply is fully protected against overload or short circuit. Besides the main 15A 3 ϕ on-off circuit breaker on the front panel, all of the outputs have their own circuit breakers. They can be reset by a common button located on the front panel.

The rated current output may be exceeded considerably for short periods of time without harming the supply or tripping the breakers. This feature is particularly useful in the study of dc motors under overload or starting conditions where currents of up to 200A may be drawn.

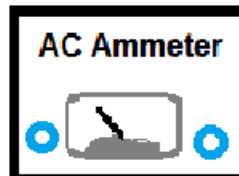
All of the power sources may be used simultaneously providing that the total current drawn does not exceed the 15A per phase input breaker rating. Your power supply, if handled properly, will provide years of reliable operation and will present no danger to you.

AC voltmeter module (EMS 8426):



The EMS 8426 AC metering module contains three AC voltmeters. Each voltmeter has three connection terminals. One terminal is labeled (+/-), one is labeled 100, and the third is labeled 250. The (+/-) terminal is the common terminal of the voltmeter. If one lead is connected to the (+/-) terminal and the other lead is connected to the 100 terminal, the AC voltmeter has a full scale value of 100 V. If one lead is connected to (+/-) terminal and the other lead is connected to the 250 terminal, the AC voltmeter has a full scale value of 250 V. Because this is an AC meter, it is not polarity-sensitive.

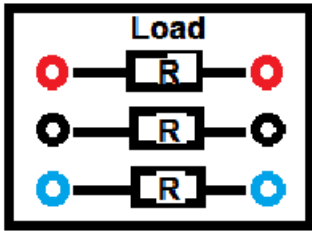
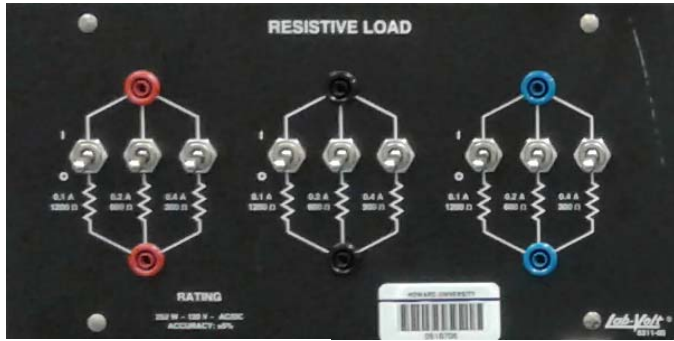
AC ammeter (EMS 8425):



This AC ammeter module, like the voltmeter, contains more than one range setting. The (+/-) terminal is the common terminal of the ammeter. Different ammeter ranges are obtained by connecting one lead to the (+/-) terminal and the other lead to the terminal indicating the desired range. An ammeter must never be connected across a voltage source. If an ammeter were connected directly to the power supply, it would produce a short circuit and damage the ammeter. An ammeter must always be connected in series with some type of current-limiting device.

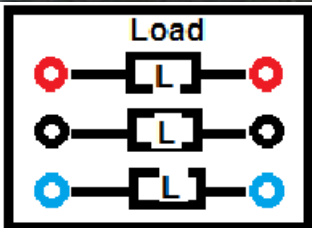
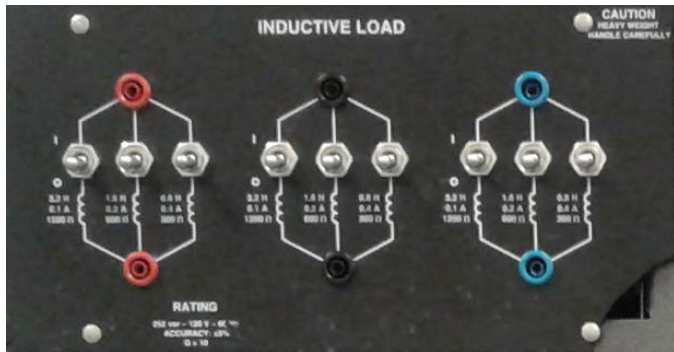
RLC load modules:

Resistive load module



The resistive load module is divided into three groups of three resistors. Each of the three sections on the load module contains three resistors: 1200 ohm, 600 ohm, and 300 ohm. These three resistors can be connected separately or in parallel with other by closing (turning on) the switch that controls that particular resistor. To obtain 100 ohm value, connect all three sections of the load module together in parallel with only 300 ohm switch closed in each of the 3 section.

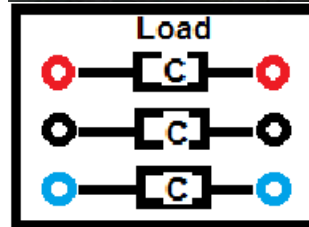
Inductive load module



The variable-inductance load module (EMS 8321) contains a total of 9 inductors. The inductors are divided into three groups of three inductors

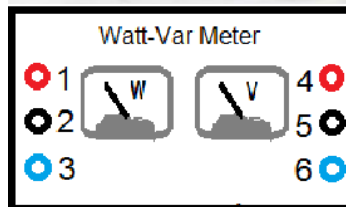
each. Each group contains inductors that produce an inductive resistance of 1200 ohm, 600 ohm, and 300 ohm at a frequency of 60 Hz.

Capacitive load module



The variable capacitance load module is very similar to the resistive and inductive load modules. The module is divided into three sections. Each section contains three capacitors that can be connected in parallel by closing (turning on) the appropriate switch.

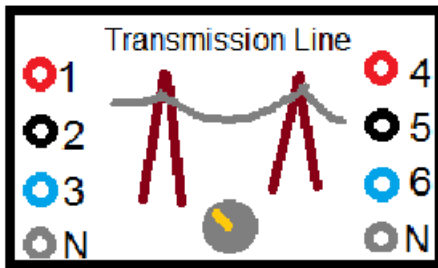
Wattmeter/Varmeter (EMS 8446):



The Wattmeter/Varmeter module is fitted with one wattmeter and one varmeter designed to indicate direct measurement of active and reactive power in balanced three-phase circuits. Each meter has a zero-center cable scale to show the direction of power flow. Its electronic design uses voltage

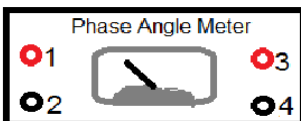
and current sensors to sample line voltage and current. Voltage and current circuits are internally connected so that experimenters only have to connect the "line" and "load" terminal of the module. The rating of the wattmeter is 300 - 0 - 300 W and that of the varmeter is 300 - 0 - 300 var. The maximum voltage/current is 240V/1.5A.

Three-Phase Transmission Line (EMS 8329):



The three-phase transmission line module consists of three iron-core inductors enclosed in a half-size EMS module. The inductors are specifically designed to simulate high-voltage ac transmission line. The line impedance can be adjusted to four different values using a selector switch mounted on the front panel: 0, 60, 120, and 300 ohms. A three-pole switch is used to induce transients by momentarily interrupting the power flow.

Phase Angle Meter



The phase meter is fitted with a meter designed to indicate the phase angle (in degrees) between two ac voltages. Two LED indicators are built in to the meter face: one is marked "lead" and the other is marked "lag." The range of angle is 0 - 180 degrees. The rating of voltage is 25 - 400 V and the frequency rating range is 40 - 70 Hz.

QUESTIONS AND PROBLEMS

1. Examine the construction of the power supply model EMS 8821, and state voltage of the following terminals:
 - (a) Terminals 1 and N: _____ V
 - (b) Terminals 2 and N: _____ V
2. How would you connect an ac voltmeter to measure the voltage of the terminals 1 and 2. Draw your diagram.
3. What would be the reading of the ac voltmeter for the terminals 1 and 2 as stated in the problem 2 above? Why do you think it reads as you state the reading?