# ECE 370
# POWER & ENERGY SYSTEMS

## EXPERIMENT 10
## SYNCHRONOUS MACHINES

### Objective
The objectives of this laboratory experiment are that each student will become familiar with the terminal characteristics of synchronous machines and be able to explain the phenomena that creates the characteristics.

### Pre - Lab
Read the material in the class notes on synchronous machines and then review the whole of this lab sheet.

### Procedure (Motor)
Specifications for the laboratory Synchronous Machine (SM-100-3) is provided in the Hampden Manual page B1. Figure 1 shows the proper connection scheme for operation as a motor. Figure 2 shows the wiring diagram.

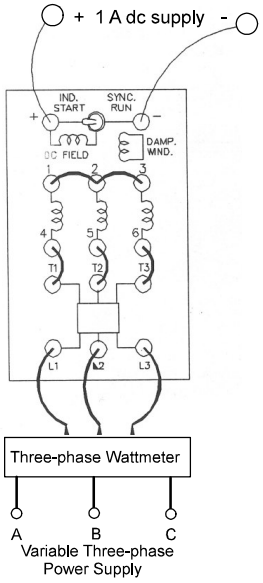


***Figure 1.*** *Synchronous Motor Connections.*

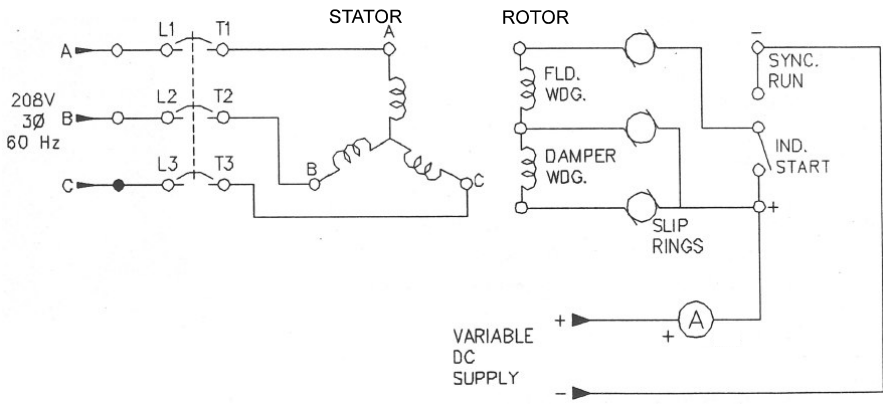


***Figure 2.*** *Synchronous Motor Wiring.*

Note that the synchronous motor is started as an induction motor (IND START) and then switched to synchronous (SYNC RUN) after acceleration to near synchronous speed. Connect the synchronous machine as a motor (Figure 1). Before applying the ac source, switch the field to SYNC RUN and set the field current to 0.5 A then switch back to IND START. The dynamometer is connected as a separately excited dc generator (same connections as in the dc machine lab) to a resistive load of 150 Ω. Apply the ac source and gently raise the voltage to 208 $V_{Line}$ (120 V on the Yokagawa). When you are close to synchronous speed switch to SYNC RUN and the motor will always run at constant speed so speed control is not a problem. Use the oscilloscope to observe the current so you can tell if the power factor is lagging or leading. Vary the motor field current from 0.25 A to 1.0 A and observe the change in power factor.

**Procedure (Alternator)**

Figure 3 shows the proper connection scheme for operation as an alternator. Figure 4 shows the wiring diagram.

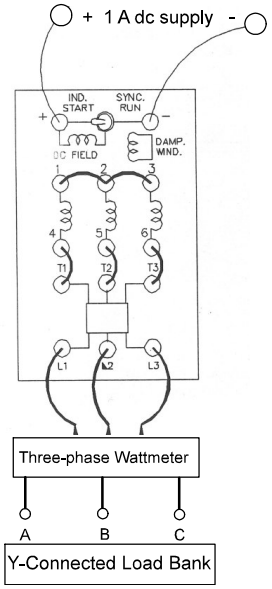


***Figure 3.*** *Alternator Connections.*

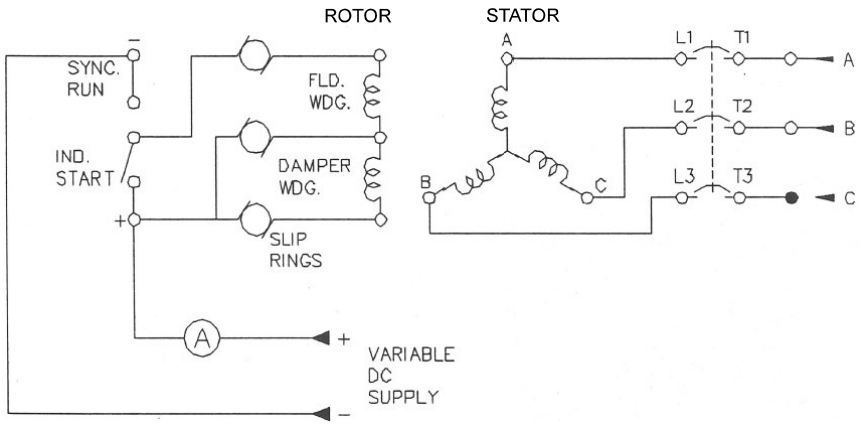


***Figure 4.*** *Alternator Wiring.*

Note that there is no need to use the IND START position so just switch to SYNC RUN. Connect the synchronous machine as an alternator (Figure 3) and set the field current to 0.5 A. Note that you remove the 3ϕ source and connect the armature to Y-connected 600 Ω and 1.6 H in parallel. The dynamometer is connected as a separately excited dc motor (same connections as in the dc machine lab). With the dynamometer field set to 0.5 A apply the remaining dc source to the armature and gently raise the voltage to 120 V. Adjust the dynamometer field current to bring the speed close to synchronous speed. Use the oscilloscope to observe the current so you can tell if the power factor is lagging or leading. Vary the load and observe the changes in ac voltage, current & power factor.