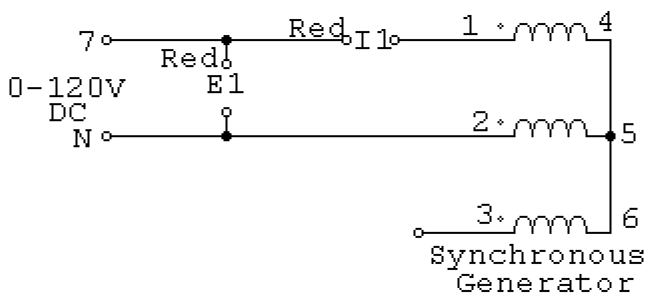
MACHINES LABORATORY 8

SYNCHRONOUS GENERATORS

In this experiment you will determine the equivalent circuit of a three phase synchronous generator (Alternator). You will determine the open circuit characteristic and regulation for several loads. You will also connect the machine on infinite bus (the local power network) and study the variation of excitation and input power.

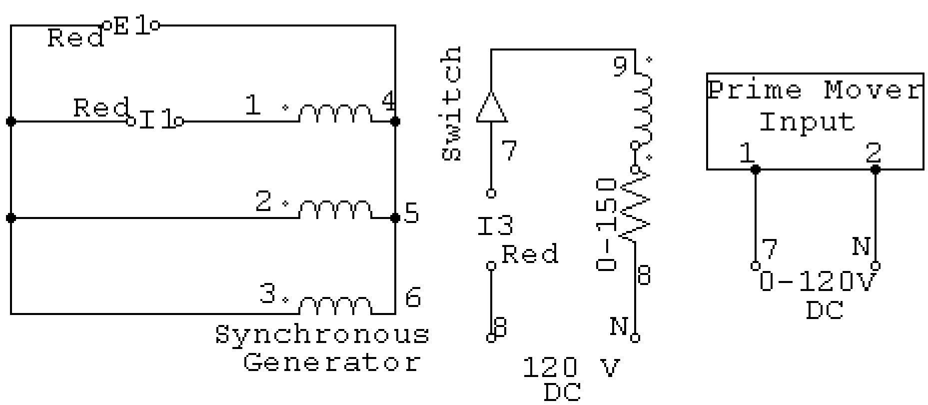
PART A: EQUIVALENT CIRCUIT.

Step 1: Set the voltage control at zero. Connect the circuit shown.



Step 2: Set E1 and I1 to read dc quantities. Set the voltage control at about 15. The current I1 should not exceed 1 A. Find E1/I1. It is twice the value of phase resistance.

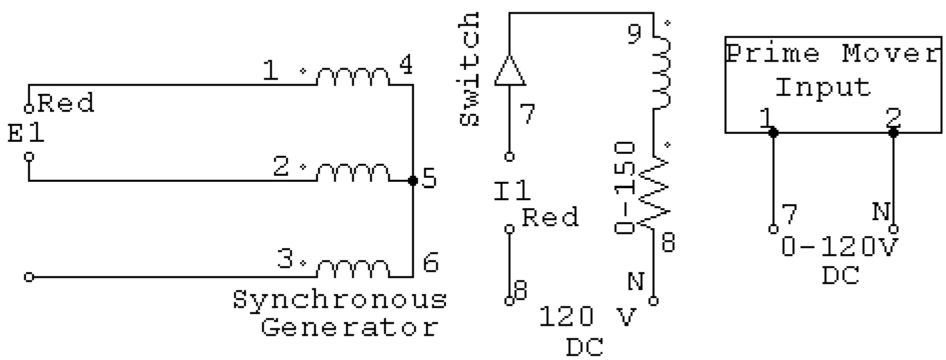
Step 3. Set the voltage control at zero. Connect the circuit shown.



Step 3: Close the switch in the field circuit. Make sure that I3 reads dc current. Set the voltage regulator at about 50 such that the speed is 1200 rpm. Determine E1/I1. It is the phase impedance at 40 Hz. We know phase resistance. Calculate the reactance at 40 Hz. Calculate the reactance at 60 Hz. Find the synchronous impedance per phase.

PART B: OPEN CIRCUIT CHARACTERISTIC.

Step 1: Set the voltage control at zero. Open the switch in the field circuit. Connect the circuit shown.

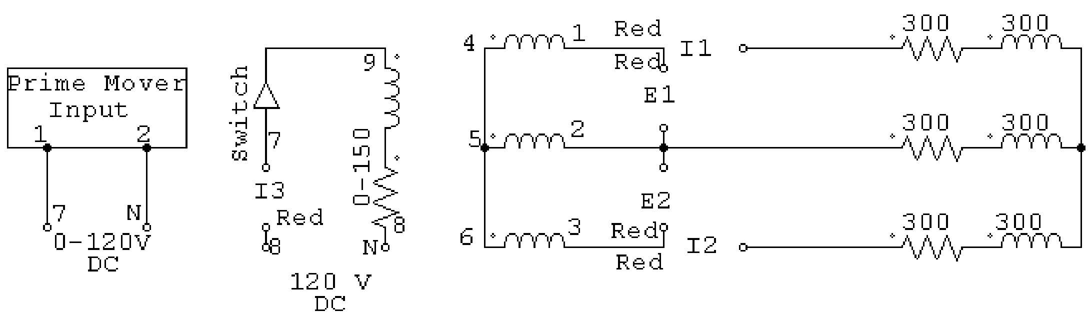


Step 2: Set the voltage control such that the prime mover speed is 1800 rpm. Record the data.

Step 3: Close the field circuit switch. Set the field current to the minimum. Record data. Increase excitation current and record data. Plot E1 Vs I1. The graph is called Open Circuit Characteristic. Clear the Data.

PART C: VOLTAGE REGULATION.

Step 1: Set the voltage control at zero. Connect the circuit shown.



Step 2: Close the switch in the field circuit. Open the three switches in series with the three resistances. Note that the load is balanced. It is wye connected and the phase load is 300 + j300 Ohms.

Step 3: Adjust the speed to 1800 rpm. Adjust I3 such that E1 is 208 V. It is called the No-Load Voltage. Note that load power (Sum of P1 and P2) and Load Current (I1 or I2) are zero.

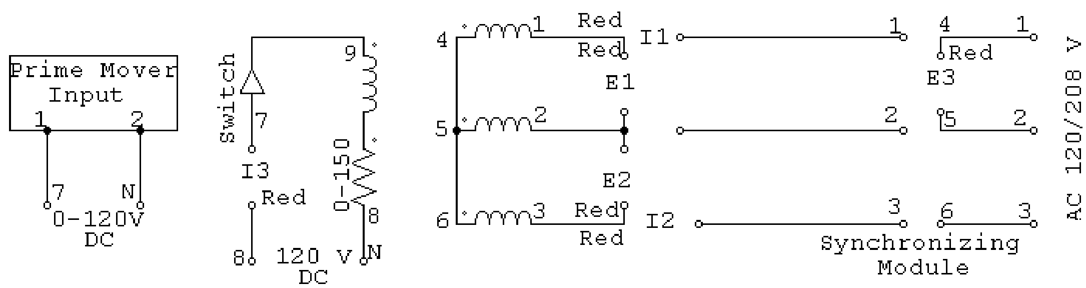
Step 4: Close the three switches in series with the load. Adjust the speed to 1800 rpm. Do not change I3. Read E1, I1, P1 and P2. Calculate the load power (P1+P2) and percentage regulation {(No-load voltage – E1) / E1}100. Calculate reactive power as 1.732 (P2 – P1).

Step 5: Find the phase angle of E2 with E1 as reference. Find the phase angle of I2 with I1 as reference. Switch off the field current. Reduce the speed to zero.
Step 6: Replace the 300-Ohm inductive reactance by a 300 Ohm capacitive reactance and repeat steps 2 to 5.

PART D: SUNCHRONIZATION.

The generator is an independent source of AC power (even though it derives its power from the mains). The alternator can be "hooked to the mains." To do so, the output voltage and frequency of the incoming machine i.e., the generator should be same as that of the mains. In this experiment, you would put the machine on infinite bus (the mains).

Step 1: Connect the circuit shown.



Step 2: Run the alternator at the desired speed (1800-RPM) and adjust the voltage such that E1 is equal to E3. You would see the three lamps brighten and darken together. (If they do not vary in step, your connections may be wrong). If the lights stay bright (or dark) increase the speed of the generator slightly). Close the switch, when all the lamps are dark. The machine is now "synchronized.'

Step 3: The power delivered by the generator is P1+P2. Measure input power. Increase prime mover voltage by about 10%. Measure power delivered. Decrease prime mover voltage by about 20%. Measure power delivered. It would be negative (The machine is running as asynchronous motor).

Step 4. The reactive power Q, delivered by the machine is given by 1.732(P2-P1). When I3 is changed, the reactive power delivered changes. An under excited synchronous machine acts like a three phase capacitor load. Set the field current control resistor half way between max. and min. position. Adjust voltage control (prime mover input) such that P1+P2 is approximately zero. Vary I3 and determine I3 for which Q is zero. Increase I3 by 10%. Determine Q. Decrease I3 by about 20% and determine Q. Note that the sign of Q changes.

Step 5: Disconnect the machine from the mains. Switch off the field excitation. Reduce the speed (decrease prime mover input). Switch off the power.

DATA: Part A:

Step 2: E1 = ___________V, I1 = ____________ A. R = ________Ohms/Phase

Step 3: E1 = ___________V, I1 = ____________ A. Z = ________Ohms/Phase

X at 40 Hz. = ___________ Ohms X at 60 Hz. = ___________Ohms/Phase

Part B:

E1 Volts							
I1 Amps							

Part C:

Load	E1	I1	P1	P2	P	Q	%Reg
300+j300							
300-j300							

Part D:

Step 2: E1= _______ V I1 = _______ A P1 = ____________ P2 = ___________

I3 = _________ A P = __________ W Q = __________ Vars

Position of voltage control : _______________

Step 3: Position of voltage control: _____________

P1: _______ P2: _________ P = ____________ W Q = _____________ Vars

Position of voltage control: _____________

P1: _______ P2: _________ P = ____________ W Q = _____________ Vars

Step 4: Position of voltage control: _____________

I3 : ___________ A

P1: _______ P2: _________ P = ____________ W Q = _____________ Vars

I3: ___________ A

P1: _______ P2: _________ P = ____________ W Q = _____________ Vars