Objective: Study of self-excitation characteristics of an induction machine.

Theory: The increasing importance of fuel saving has been responsible for the revival of interest in so-called alternative source of energy. The induction generator’s ability to generate power at varying speed facilitates its application in various modes such as self-excited stand-alone (isolated) mode; in parallel with synchronous generator to supplement the local load, and in grid-connected mode. The induction generators are being considered as an alternative choice to the well-developed synchronous generators because of their lower unit cost, inherent ruggedness, operational and maintenance simplicity. The induction machine can be operated as an induction generator in isolated mode by using external capacitor. However, in most of the cases it suffered from the frequency drop and poor voltage regulation. Series capacitors were used to improve the voltage regulation.

Self Excited Induction generators (SEIGs) are increasingly being considered for autonomous applications in micro-hydro, biogas and wind powered systems. The lower unit costs, brushless cage rotor construction, absence of a separate dc source, better transient performance are its main advantages over the conventional alternators.

If an appropriate capacitor bank is connected across an externally driven induction machine, an EMF is induced in the machine windings due to the excitation provided by the capacitor. The induced voltage and current would continue to raise, until the VAR supplied by capacitor meets demand of machine. This results in an equilibrium position and the machine now operates as an SEIG at a voltage and frequency decided by the value of the capacitor, speed of the prime mover, parameters of the machine and the load.

Procedure:

1. Connect the circuit as shown in figure.
2. Connect the capacitor bank (delta connected) of appropriate value across the stator terminals of induction machine. The value of capacitance should be more than the calculated value.
3. Start the D.C machine in motoring mode. (Field circuit resistance should be in minimum position & armature circuit resistance should be in maximum position.)
4. Increase the shaft speed of induction motor gradually with the help of D.C motor which is mechanically coupled to IM.
5. At a certain speed, self excitation takes place and the stator voltage shoots up. The speed and voltage readings are noted.
6. Increase the speed till the voltage generated reaches to Rated voltage of IM and take the readings.
7. Repeat the experiment for another value of capacitance and differentiate the readings.
Exercise:

1. Plot the graph of Induced voltage against speed for different values of capacitances.

Questions:

1. Why delta connected capacitor bank is chosen for self excitation?
2. What is the difference between the self excitation curves of DC separately excited machine and Induction machine?
3. Why IM stator is subjected to application of momentary DC supply in case it is unable to induce voltage?
4. Whether induced voltage depends on the core (yoke) of the machine?
Objective: Determination of the performance characteristics of a grid-connected induction generator.

Theory:
An induction machine connected to an ac source of appropriate voltage and frequency can operate either as a motor or as a generator. Regeneration is possible, if the rotor of the induction machine is made to rotate above synchronous speed decided by the supply frequency and the pole number of the machine. The terminal voltage applied to the machine maintains the excitation by supplying lagging magnetizing current, which in turn results in rotating magnetic field for both the motoring, and generating mode of operation.

The grid-connected induction generator (GCIG) takes its excitation from the lines and generates real power via slip control when driven above the synchronous speed. The operation is relatively simple as voltage and frequency are governed by the grid voltage and grid frequency respectively. The GCIG results in large inrush and voltage drop at connection, and its operation makes the grid weak. The excessive VAR drain from the grid can be compensated by the shunt capacitors, but it cause large over voltage during disconnection. Therefore, the operation of GCIG should be carefully chalked out from the planning stage itself. The performance of the GCIG under balanced and unbalanced faults should be thoroughly investigated to ensure good quality and reliable power supply.

Procedure:
1. Connect the circuit as per the circuit diagram.
2. Note down the frequency of the supply and thereby calculate the synchronous speed (N_s) of the D.C machine.
3. Make sure that the DPST which connects DC armature terminals and DC supply should be kept open. Moreover, be ensure with the DPST internal connections.
4. Now give DC supply to field circuit of DC machine only. (not to the armature. SPST should still kept open)
5. Start the induction motor. Make sure that 3-ph variac is varied in smooth steps at initial stage so as to allow the measurement instruments not to exceed their ratings due to sudden inrush current.
6. Note down the voltage generated along with the polarity at the DC machine terminals at one end of DPST terminals.
7. Compare the above value along with polarity with the other end of DPST.
8. If both match each other, then close the DPST.
9. Now increase the speed of machine above synchronous speed (N_s) and note down the wattmeter reading and corresponding speed.

Exercise:
1. Plot the graph of power delivered by IM against speed.
CIRCUIT DIAGRAM:

[Diagram showing a circuit with labels for Rotor, Stator, Delta, Wattmeter, 3 ph load, and DC supply with a fuse.]