Experiment #7: Three Phase Induction Motor, Mechanical Characteristics

This experiment is a continuation of Experiment #6. The purpose of the experiment is to study the Induction Motor (IM) under load, and to derive the torque-speed characteristic. This will be done for the “forward” as well as the “backward” directions.

The “forward” direction is that in which the motor would rotate when it is excited with a balanced 3φ supply. The opposite direction of rotation (with the same connections) is the “backward” direction.

Experiment Outline:

The “forward” or “motor” characteristic.

1. Mechanically connect the shaft of the motor to the DC Dynamometer (DCD). Adjust the screws on the DCD arm as explained in the lecture so the torque can be measured.
2. Check which way the motor would run when connected to a 3φ AC supply. Remember these connections and the direction of rotation, they are the “forward” way to run the motor. Turn the power OFF.
3. Connect the shunt field of the DCD to a DC supply and the armature to the resistance bank. Select a load (resistance) which at full voltage of the DCD would be near the maximum power of the IM.
4. Measure the following: power to the IM, power to the load, significant currents and voltages, and speed and torque at each reading.
5. Start the IM in the “forward” direction and run it at full voltage. Leave it alone for the time being. Remove the resistive load (open it so it is infinite resistance, hence zero load). Take a reading.
6. Re-connect the resistive load. Start to increase the field of the DCD. Take readings as the field of the DCD is varied from near zero to full value. At all times be careful to stop before the motor stalls.
7. This completes the “forward” characteristic portion of the experiment. Power down.

The IM as an asynchronous generator:

1. Remove the resistive load and connect a DC source to the armature of the DCD.
2. Make sure the power to the IM is turned down to the minimum. Increase the power to the DCD in the following manner: first increase the DC field to full value, then gradu-
ally increase the armature voltage till the motor begins to rotate. If it is in the “forward” direction, power down. If it is in the “reverse” direction, reverse the connections to the armature. Make sure the DCD will rotate in the “forward” direction when power is supplied to it. Switch all power down to minimum value (DC field last).

3. Start the DCD and get it going at slightly below synchronous speed. Slowly increase power to the IM till full voltage is applied (same value as was used in the previous part of the experiment).

4. Now increase the speed of the DCD (by decreasing the field voltage or increasing the armature voltage). Take readings along the way. At these readings the IM is generating power and delivering it to the line (but it consumes vars from the line). Go as high in speed as the DCD allows without exceeding any of its ratings.

5. Power down in a safe manner (reduce the armature voltage then the field of the DCD, then reduce the IM voltage). [N.B. This is not a very desirable way to generate electric power, however, in certain traction applications, it is desirable to convert speed (kinetic) energy into electricity which is returned to the AC supply.]

Now we shall find the “reverse” or “brake” characteristic.

1. Reverse the connections to the armature of the DCD. Make sure the DCD will rotate in the “reverse” or “backward” direction when power is supplied to it.
2. Increase the voltage to the DCD till it is running at almost minus synchronous speed.
3. Increase the voltage to the IM till it is at full value. Take a reading of the instruments at this point.
4. Start to reduce the speed of the DCD and take readings as far as possible before exceeding any machine ratings. This tests the motor as a “brake”.
5. Power down safely.

In the previous experiment we used a value of \( k = 2 \) to estimate the AC resistance of the field (\( R_{AC} = kR_{DC} \)). Using the model found in the previous experiment, find the best value for \( k \) so that experimental results match those found from the model. Find the complete IM characteristic and make estimates where needed.