Power Electronics Laboratory (EE3P004)

EXPERIMENT-7

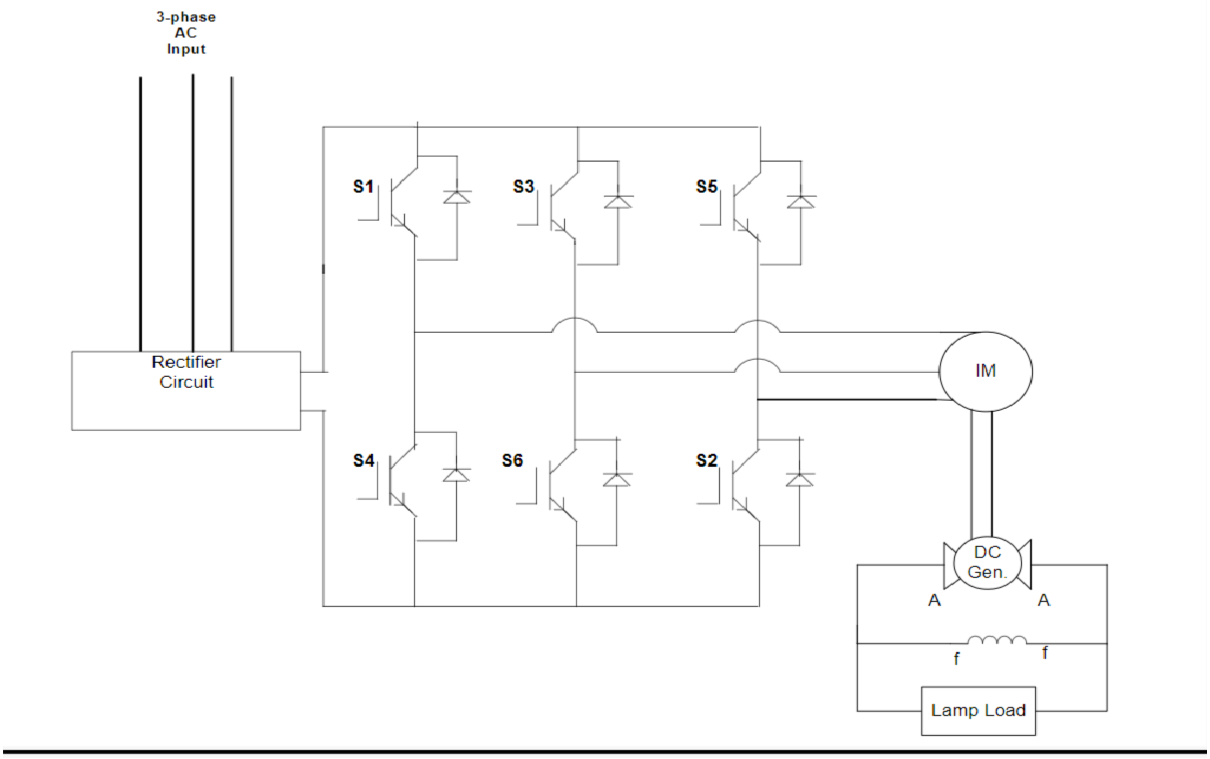
Speed Control of Induction Motor by Variable Speed and Variable Frequency

Shorya Sharma
19EE01017

Aim of the Experiment:

To control the speed of induction motor by variable voltage and variable frequency VVVF method.

Circuit Diagram:



Theory:

As we know that synchronous speed of machine is given as:

N (rpm) = 120*f/P, where f is frequency and P is number of poles.

Thus, if we can change the frequency f then it is possible to change the speed of induction motor. Thus for 60 Hz operation, a 2-pole motor can go no faster than 3600 rpm. As load is added to the shaft of an induction motor, the machine slows slightly and develops torque. The difference between the machine speed and synchronous speed is called slip. The general-purpose induction motor (Class B) may be expected to operate with a slip of about 2 or 3% at full load. Thus, the motor would run at 3492 to 3528 rpm (say 3500 rpm as a round number). In order to change this operating speed, we must change the frequency of the applied voltage. Now frequency of power supply can easily be varied using power electronics devices like inverter. The inverter converts DC power into AC power and feeds to induction motor. Inverter output may be either constant voltage variable frequency or variable voltage variable frequency.

The relationship between motor speed and frequency:

The AC induction motor is a relatively simple, inexpensive, and rugged device which requires little maintenance. However, the induction motor is virtually a fixed speed device when operated from a constant frequency source. Since some applications require a fairly wide range of operating speeds, DC machines were often required. With the advent of power electronics, devices have become available that allow induction machines to be operated over a range of speeds.

$$V(rms) = 4.44*f*N*B(max)*A$$

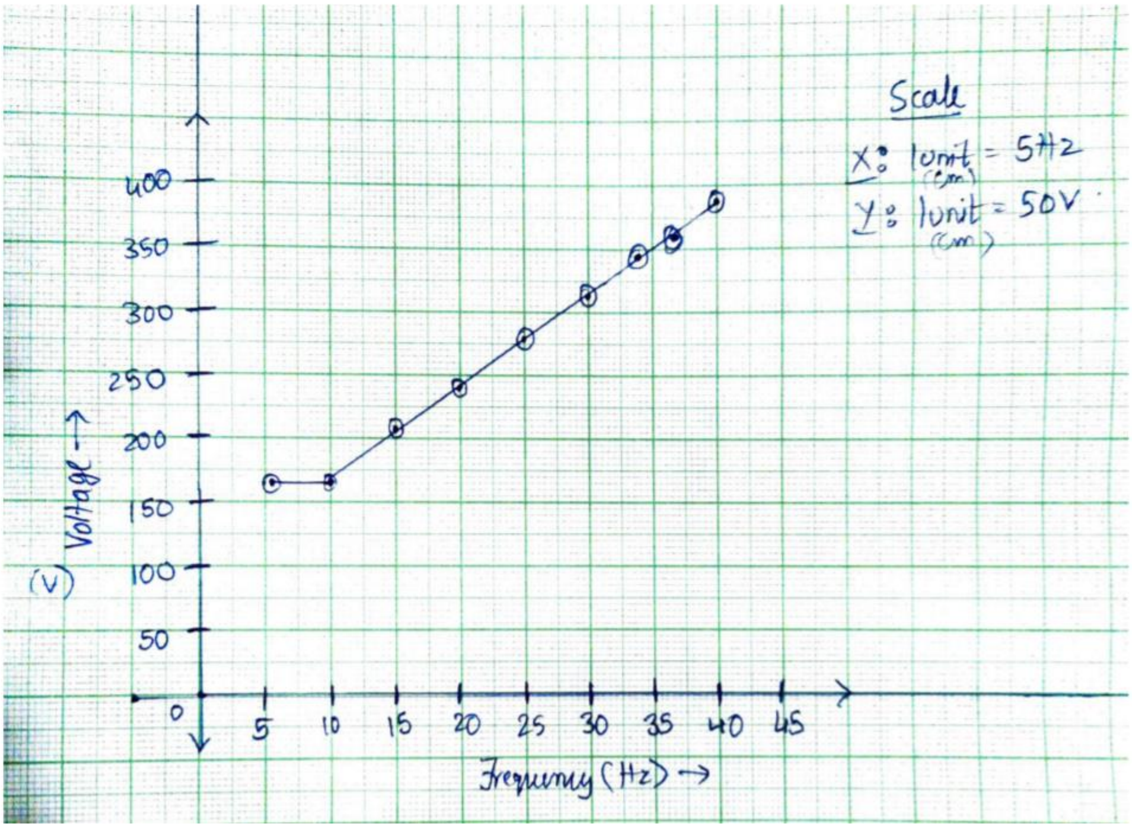
Clearly, if a constant voltage is applied to the motor and the frequency is reduced, the flux density in the motor would increase. This would drive the motor iron far into saturation causing excessive excitation current and core loss. To prevent this, we must make the applied voltage directly proportional to the applied frequency, making the flux density constant. When the frequency is raised above the rated value, the voltage must be held constant at its rated value. Thus, the flux in the motor decreases below rated frequency. The result of the flux considerations is that the motor can produce rated torque below rated frequency, but must produce less than rated torque above rated frequency.

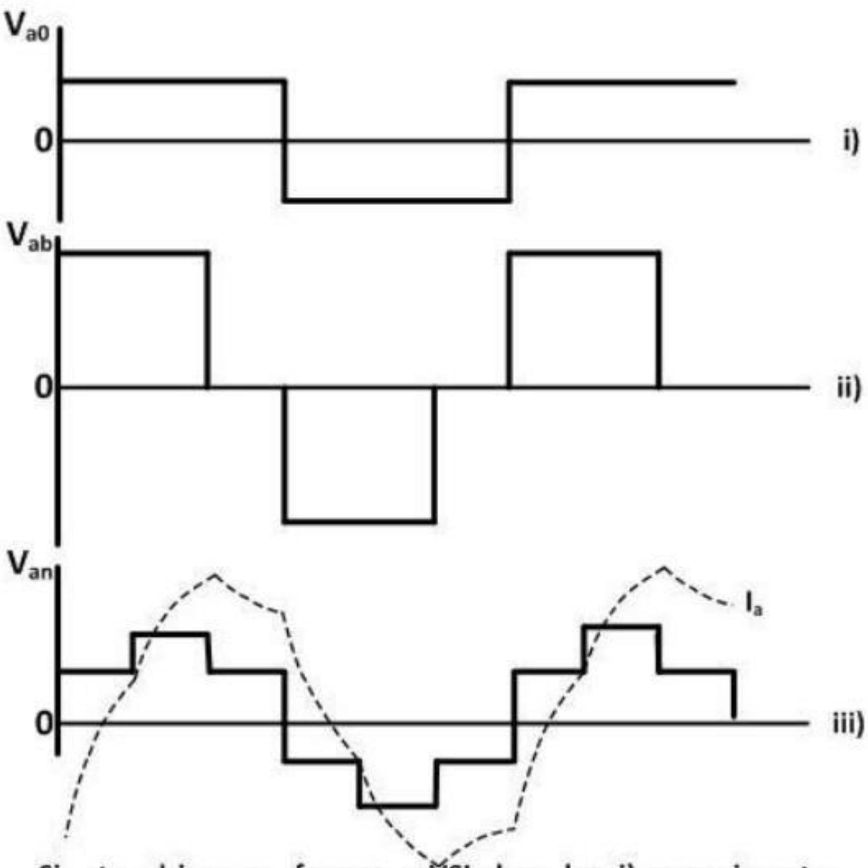
Observation Table:

Sl. No.	Frequency (Hz)	Voltage Line to Line (V)	Speed (RPM)	V/Frequency
1	5.5	164.7	288.3	29.94
2	10	165.0	284.5	16.50
3	15	207.1	428.6	13.80
4	20	241.2	570.0	12.06
5	25	277.8	714.8	11.11
6	30	313.8	845.5	10.46
7	32	328.5	897.0	10.26
8	34	343.8	966.0	10.11
9	36	358.7	1026.0	9.96
10	38	374.4	1088.0	9.85
11	40	388.1	1166.0	9.70

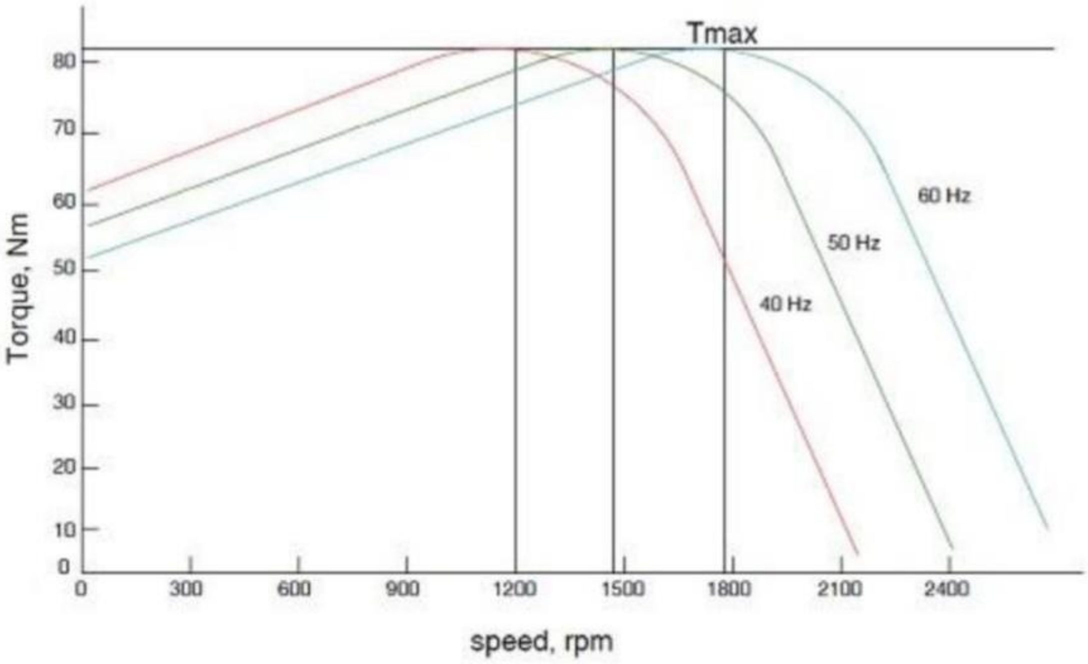
Graphs:

V vs f





Six-step drive waveforms per VSI phase leg: i) across inverter bridge, ii) line-to-line, and iii) line-to-neutral



CONCLUSION

Hence, the experiment videos were seen and the theory was understood and the calculations were made from the data provided.

The plot was plotted between V and f and the conclusion understood is frequency and voltage are proportional and V/f decreases when speed increases.