U N I V E R S I T Y O F C A P E T O W N

Department of Electrical Engineering

EEE4117F – Electrical Machines and Power Electronics

AC Motor Lab Report

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Questions based on VFD-FED INDUCTION MOTOR video on Jove

1. **What is a VFD? Explain the necessity for soft starting an induction motor? What happens if we connect a large 3 phase induction motor directly to a fixed 3phase power supply? How is this avoided in practical applications?**

   ⇨ A Variable Frequency Drive (VFD) is a type of a motor controller that drives an electric motor [induction motor in our case] by varying the frequency and voltage supplied to the motor.
   ⇨ Soft starting eliminates high starting torques and surge currents which helps to reduce mechanical stresses and increases reliability and the induction motor's life.
   ⇨ If a large 3 phase induction motor is connected directly to a fixed 3 phase power supply, it would have a rough start due to high current and lower voltage. And since supply frequency is constant, the V/Hz ratio would be low which results in low stator flux which affects the motor speed and torque.
   ⇨ This is avoided by connecting the 3-phase power supply to a VFD which is then connected to a 3-phase induction motor.

2. **Draw the block diagram of a Motor-VFD system and briefly explain the function of each component.**

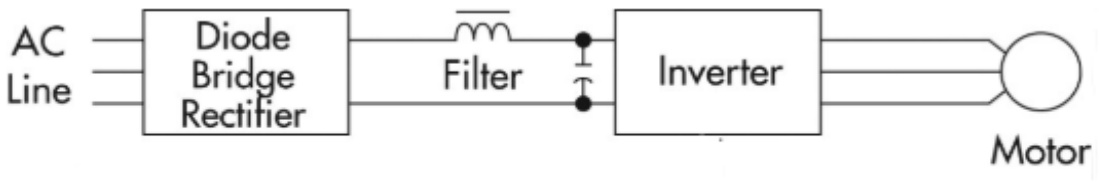

Figure 1: Block diagram of a Motor-VFD System

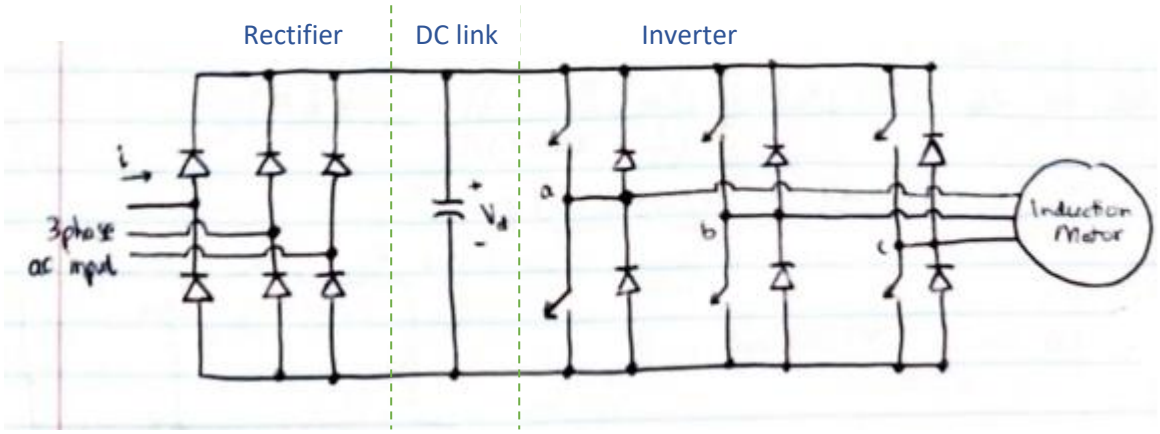

Figure 2: Circuit diagram of a Motor-VFD System

   a. The Diode Bridge Rectifier converts the three phase AC supply into DC.
   b. The DC power usually contains voltage ripples which are smoothed using the filter capacitor. This block is usually referred to as the DC Link.
   c. The Inverter converts the DC voltage back to AC using Pulse Width Modulation and feeds it to the Induction motor.

3. What do you understand by "Open-loop speed control" of an Induction Motor, and explain why is it important to keep the voltage to frequency ratio constant when operating an induction motor? Explain how a VFD can be used to operate an Induction Motor above its rated speed. What does a VFD do to respect the machines rated voltage when operating above rated speed?

- ⇨ Open-loop speed control is one of the methods of speed control in an induction motor when operating at or below its rated voltage, to output a constant drive power (by providing a constant V/Hz ratio) without feedback.
- ⇨ It is important to keep the V/Hz ratio constant because this ratio is proportional to the stator magnetic field and therefore also proportional to motor speed. Thus, a constant V/Hz ratio enables a constant induction motor speed during operation.
- ⇨ The VFD increases the frequency to enable the motor to operate above its rated speed.
- ⇨ To respect the machines rated voltage when operating above rated speed, the VFD does not keep the V/Hz ratio constant and instead limits the maximum voltage to the rated voltage.

4. Answer the following questions considering we are running a 380V (L-L), 50 Hz, 375W, 4 pole, 3phase induction motor by a VFD in open-loop speed control:

a. What is the volt to frequency ratio?
Volt to frequency ratio = 380V / 50Hz = 7.6 V/Hz

b. How does the VFD respond if we change the frequency to 20Hz, 30Hz, 40Hz, 50 Hz, 60Hz and 70Hz? How does the induction motor respond to these changes in the no-load condition?

Up until the rated frequency and rated voltage, the VFD will ensure a constant V/Hz ratio and the induction motor speed will increase with an increase in frequency.

Frequency	20 Hz	30 Hz	40 Hz	50 Hz	60 Hz	70 Hz
Voltage	152 V	228 V	304 V	380 V	380 V	380 V
V/Hz ratio	7.6	7.6	7.6	7.6	6.3	5.43
Motor speed	600 rpm	900 rpm	1200 rpm	1500 rpm	1800 rpm	2100 rpm