

MIDDLE EAST TECHNICAL UNIVERSITY

Electrical & Electronics Engineering

Simulation Project #3

EE 463

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# Introduction

In this project, we are supposed to drive motor by using thyristor full bridge rectifier, design a buck converter for fixed load at Simulink and design boost converter by using ‘Webench’ online design tools.

Firstly, Dc motor speed will be controlled by changing firing angle of three phase fully-controlled thyristor rectifiers. The system is closed loop and the speed of motor will be controlled real time. Secondly, a buck converter will be designed. Switching frequency and components will be chosen. Finally, a boost converter will be designed for wanted value of input and output. In addition, a design strategy will be chosen and basis of the strategy will be explained.

In short, AC to DC and DC to DC converter topologies, theoretical information and simulation results will be investigated at the report.

# Question-1)

In this question, we examined that Dc motor speed control by using fully controlled 3-phase thyristor rectifier.

## Rectifier Circuit:

3-phase thyristor rectifier are used for obtaining high voltages at output with small ripple. The output voltages are not smooth DC but the voltage ripple is much less than single phase pairs. In addition, the output of rectifier can be controlled by changing firing angle of thyristors. If the firing angle is smaller than 90 degree, the circuit operates at rectification.

The output voltage formula is stated as:

(1)

Vm is the peak value of line to line voltage and ‘a’ is the firing angle.

## DC MOTOR:

In this part, we used a permanent magnet DC motor. Thus, the dc motor has back-emf constant by considering the field is independent of the motor operations. The motor is loaded by 24 N.m mechanically.

Dc motor can be controlled by armature or field. The motor is controlled by armature control because the motor is permanent magnet and no field control. Speed of the motor is related to back-emf of the motor. However, we do not control directly the back-emf. Thus, we control the terminal voltage to control speed of the motor. The speed control can be closed loop to ensure that the motor speed converges the desired speed. The closed loop is created by directly switch on-off algorithm or combinations of ‘PID’ controller.

## CONROLLING:

The speed of motor is controlled by terminal voltage. The terminal voltage can be adjustable by changing the firing angle. Thus, the speed of motor is controlled by firing angle. However, the relationship of firing angle and speed is not linear and it is in opposite-relation. In addition, maximum voltage restricts the maximum speed of the motor. The speed of the motor can not climb over the speed.

## SIMULATION:

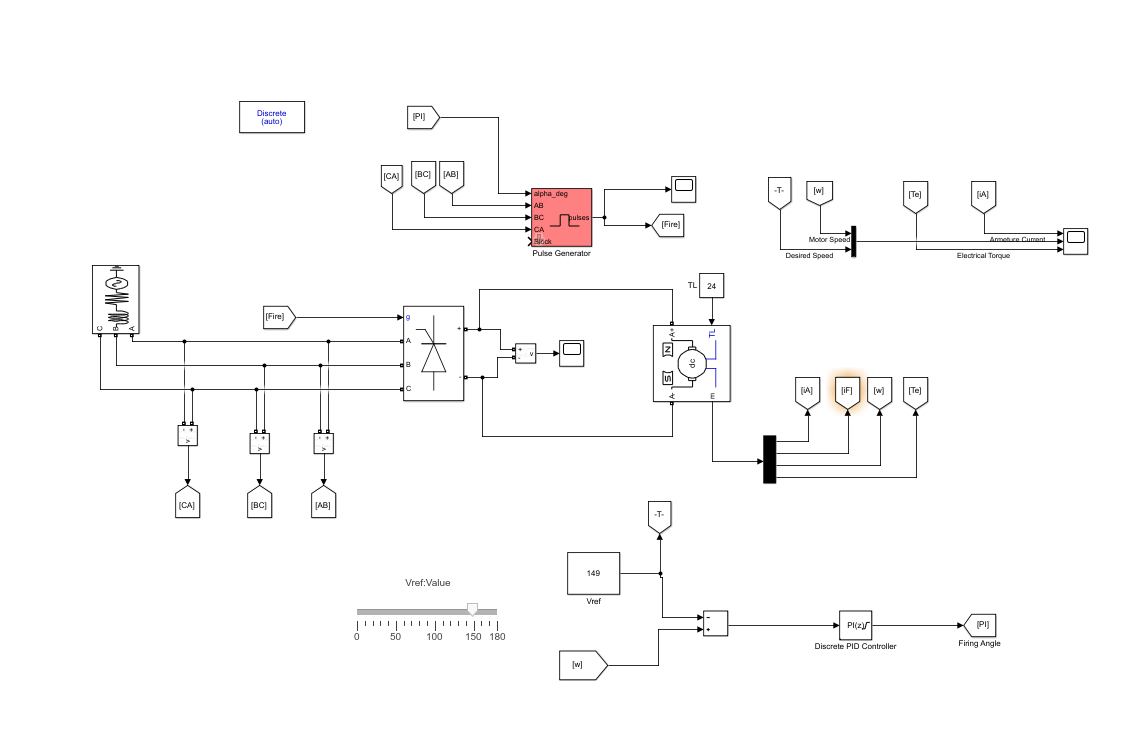


Figure 1 Overall Circuit Diagram of the Speed Control of the DC Motor

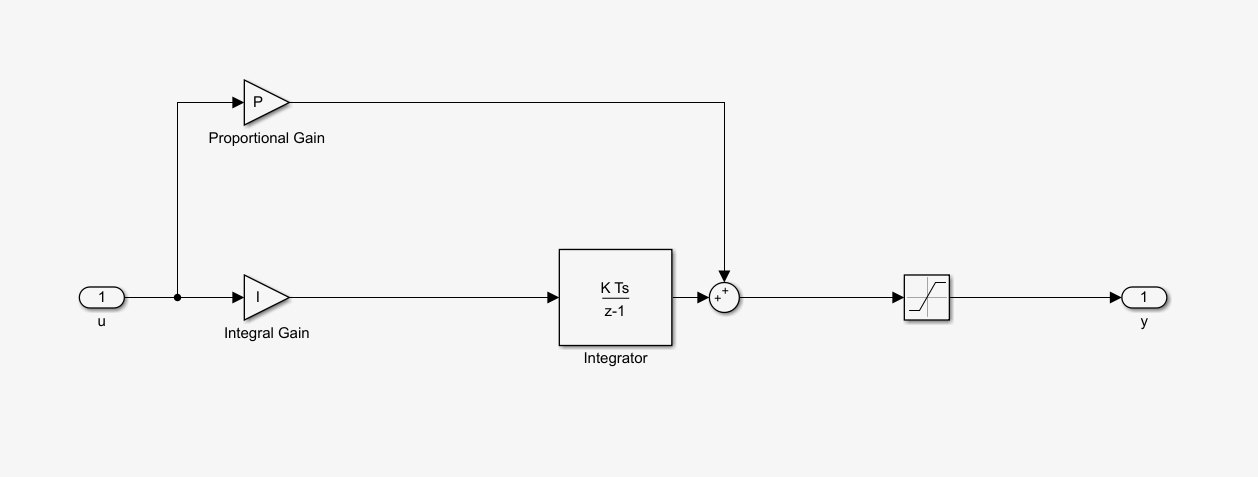


Figure 2: PI Controller

The AC-DC converter and DC motor controlling system are illustrated at Figure 1. The PI controller is illustrated at Figure 2. PI controller has a saturation block because the firing angle is restricted between 0 and 180 degree.

## SIMULATION RESULTS:

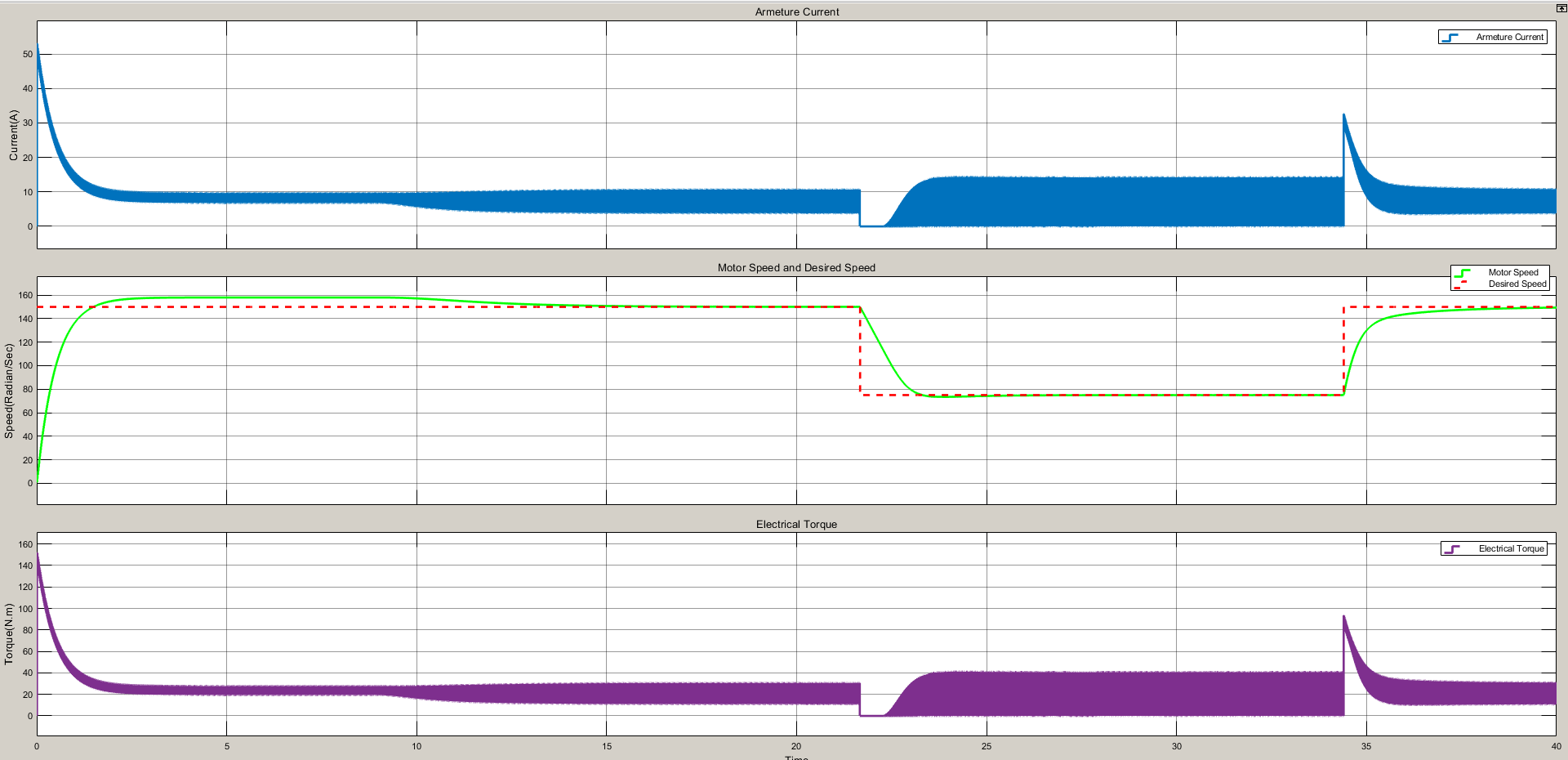


Figure 3 Armeture Current ,Motor Speed,,and Electrical Torque with 150 rad/sec and 75 rad/sec Desired Speed

The desired speed is adjusted to 150 rad/sec until the 22 second. The motor maximum speed is 157 rad/sec with restriction of terminal voltage. Thus, the overshoot effect can not be observed at initial. If there was no restriction, overshoot could be observed. For the, 150 rad/sec to 75/rad sec transitions are much smoother than initial because the inertia of the motor was overcame at initially. Thus, there is no overshooting effect at 150 to 75 and 75 to 150 rad/sec transitions at t=22 sec and t=34 sec.

The desired speed can be increased by slowly. The response of the motor changes.

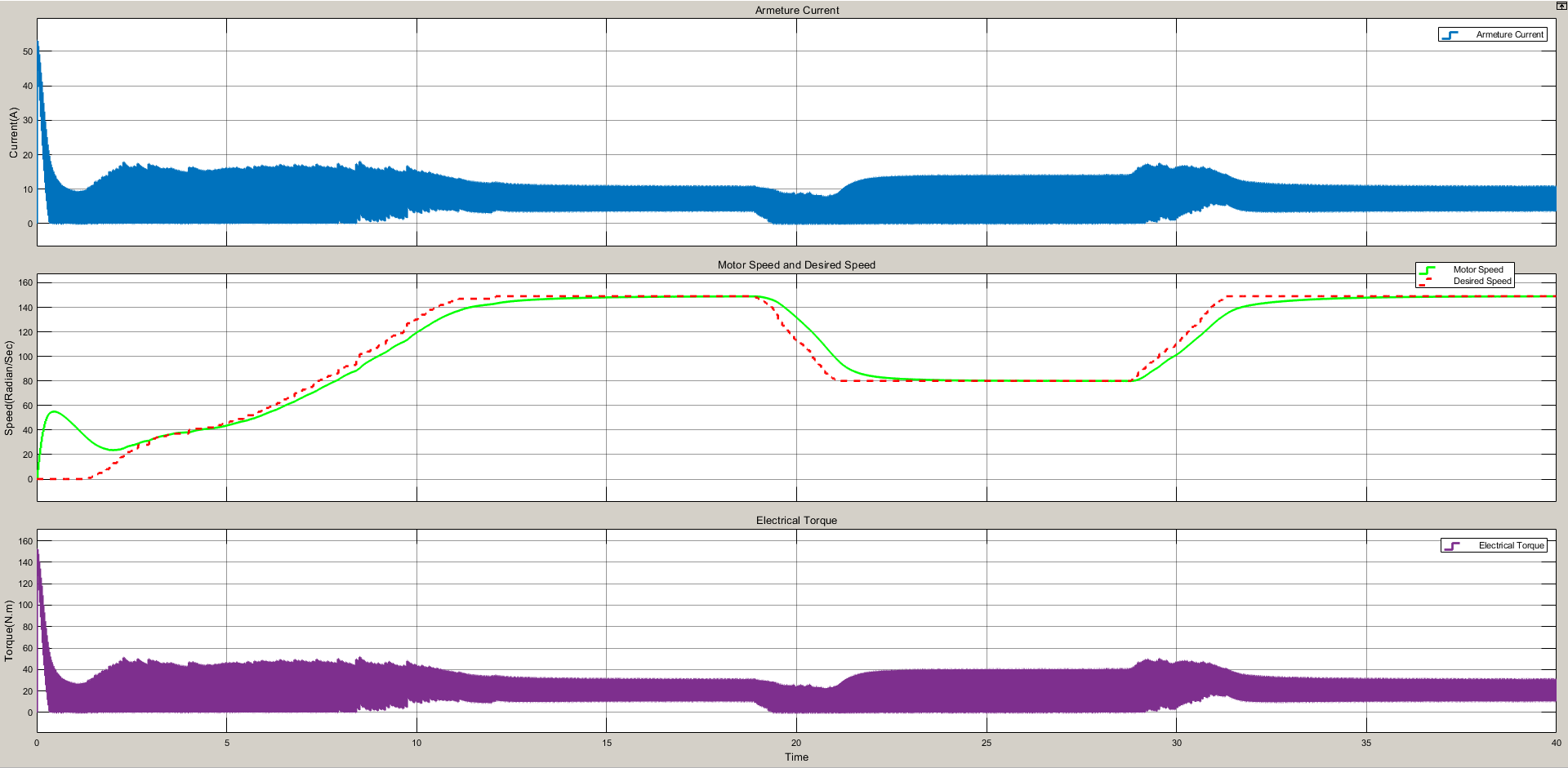


Figure 4 Armeture Current ,Motor Speed,,and Electrical Torque with Slowly Changing Desired Speed

The motor speed follows the desired speed narrowly by avoiding abrupt changes at desired speed. Also, the overshoot is observed at initially.

# Question-2)

# Question-3)

# Conclusion

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