MANIPAL INSTITUTE OF TECHNOLOGY

(A constituent Unit of Manipal Academy of Higher Education)

MANIPAL

Drives, Controls and Modelling Laboratory Manual (MTE 3161)

Fifth Semester B. Tech. (Mechatronics Engineering)

Prepared By	Dr. Vijay Babu Koreboina (Lab-in-charge)	
	Dr. Shweta Vincent	
Approved By	Dr. Chandrashekar Bhat (HoD-Department of Mechatronics Engineering)	

DEPARTMENT OF MECHATRONICS ENGINEERING

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Drives, Controls and Modelling Laboratory Manual (MTE 3211)

Fifth Semester B.Tech (Mechatronics Engineering)

NAME: ______________________________

REG NO: ____________________________

ROLL NO: ___________________________

1. General Guidelines in Lab:

1. Conduct yourself in a responsible manner at all times in the laboratory.
2. Follow all written and verbal instructions carefully. If you do not understand a direction or part of a procedure, ASK YOUR TEACHER BEFORE PROCEEDING WITH THE ACTIVITY.
3. Perform only those experiments authorized by your teacher. Carefully follow all instructions, both written and oral. Unauthorized experiments are not allowed.
4. Observe good housekeeping practices. Work areas should be kept clean and tidy at all times.
5. Be alert and proceed with caution at all times in the laboratory. Notify the teacher immediately of any unsafe conditions you observe.
6. Labels and equipment instructions must be read carefully before use. Set up and use the equipment as directed by your teacher.
7. Experiments must be personally monitored at all times. Do not wander around the room, distract other students, startle other students or interfere with the laboratory experiments of others.
8. Report any accident (spill, breakage, etc.) or injury (cut, burn, etc.) to the teacher immediately, no matter how trivial it seems. Do not panic.

2. General Electrical Safety Instructions in Lab:

1. Avoid direct contact with the energized electrical circuits.
2. Disconnect the power source before servicing or repairing electrical equipment.
3. Always ensure that the earth pin is given properly to the main source.
4. Use only tools and equipment with non-conducting handles when working on electrical devices.
5. Never use metallic pencils or ruler, or wear rings or metal watchbands, when working with electrical equipments.
6. If water or chemical spilled onto equipment, shutoff power at the main power at the main switch or MCB breaker and unplug the equipment.
7. Disconnect the power source from the circuit breaker or pull out the plug using a leather belt etc.
8. Never touch another person’s equipment or electrical control devices unless instructed to do so.
9. Never handle electrical equipment when hands, feet, or body are wet or prespiring, or when standing on a wet floor.

DEPARTMENT OF MECHATRONICS ENGINEERING

LIST OF EXPERIMENTS

S. No.	TITLE OF EXPERIMENT	DATE	PAGE NO.	FACULTY SIGN	MARKS
1.	Introduction to Matlab - RL Circuit - RLC circuit				
2.	Open loop control of DC-DC Converters: Buck and Boost Converters				
3.	Open loop control of Controlled Rectifiers and Voltage Regulators				
4.	Closed loop control of DC-DC Converters: Buck and Boost Converters				
5.	Control of DC Motor using Buck Converter				
6.	Closed loop Speed Control of DC Motor using buck converter				
7.	Control of AC Induction Motor using 3ph Inverter				
8.	Implementation of switched mode DC-DC voltage control and DC-AC Inverter control for R-Load.				
9.	Implementation of Inverter Based speed control of Induction Motor Drive.				
10.	Familiarization of PLC based PMSM Drive Control.				
11.	Familiarization of HMI Module.				

Experiment I:

Date : __ /__ /__

Introduction to Matlab

Aim:

i. To understand various simulation environments in Matlab.
ii. To develop the models for DC excited first order RL Circuit in various simulation environments.
iii. To develop RLC network in circuit approach in Matalab/Simulink

Matlab:

- **MATLAB stands for MATrix LABoratory.**
- **It is a software package for high-performance numerical computation and visualization.**
- **It provides an interactive environment with hundreds of built-in functions for technical computation, graphical and animation.**

Problem1:

Matlab Matrix operations: creation of matrix, inv, det, complex matrix, string matrices, etc.

Mathematical operations: Solving general expressions and mathematical functions.

Graphics: plot instructions

Matlab Script: m file and editor.

Functions: creation and operation of functions.

Laplace transform operations: create transfer functions, step function etc

Simulink: various general Simulink block sets, **simscape**

Problem2:

Model the DC excited series RL circuit in following domains.

i) Using direct expression for current in script.
ii) Using transfer function approach in script.
iii) Using Simulink block diagram approach mathematical & transfer function.
iv) Using Simulink simscape.

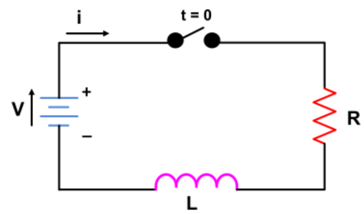
i) **Analytical Expression in matlab script**

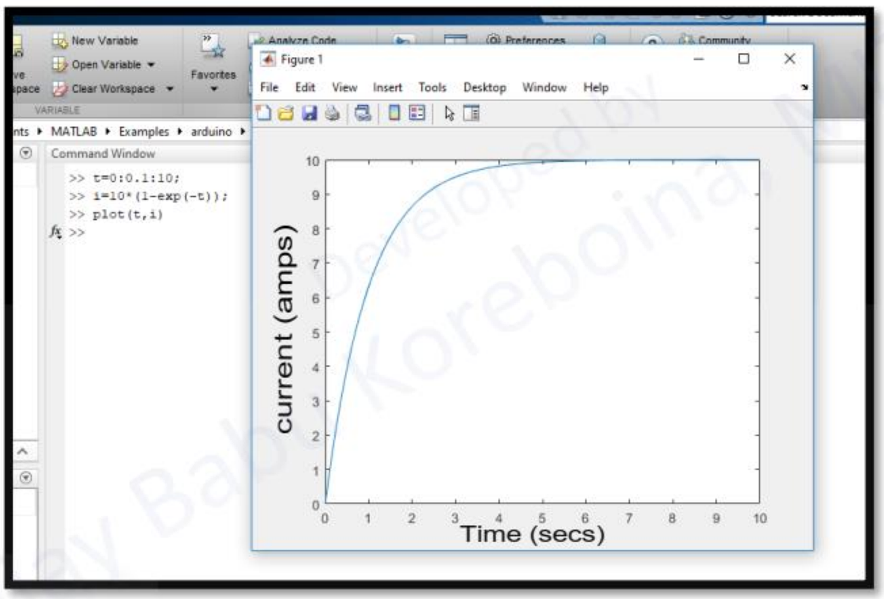
Analytical Solution - Expression

$i = \left(\frac{V}{R}\right)\left(1 - e^{-\left(\frac{R}{L}\right)*t}\right) \qquad V = 10, R = 1, L = 1$

$i = (10)\,(1 - e^{-t})$

$\gg t = 0:0.1:10;$
$\gg i = 10 * \left(1 - exp(-t)\right);$
$\gg plot(t, i)$





ii) **Using transfer function approach in script.**

Using Laplace domain transfer function

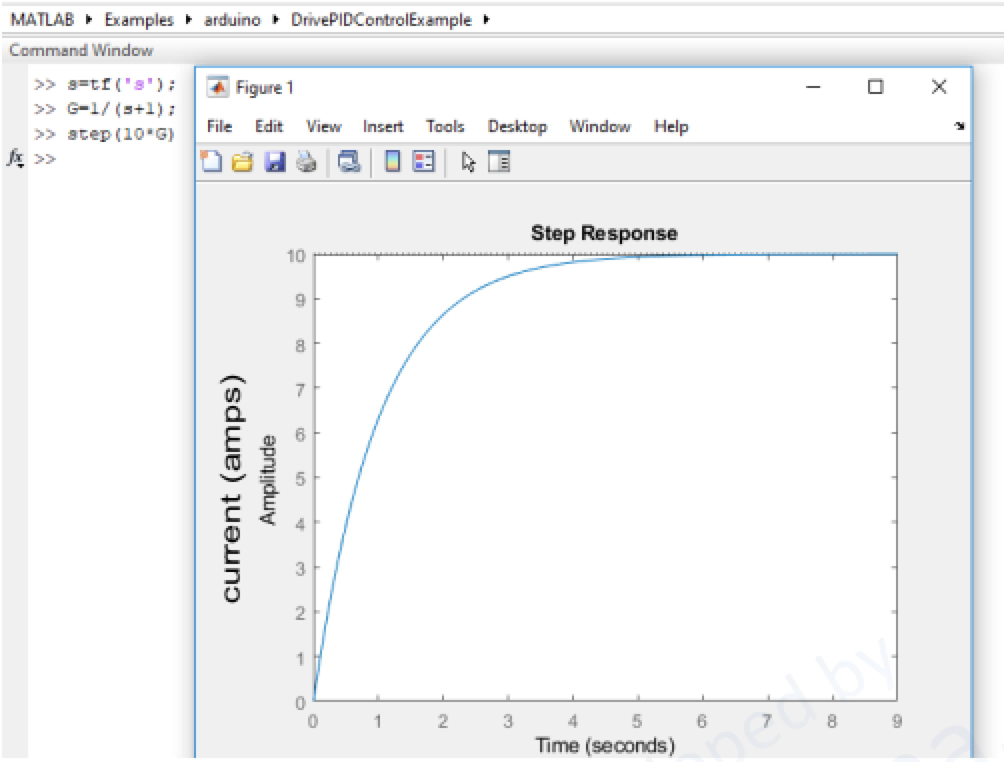
$V = R * i + L\,\frac{di}{dt} \qquad taking\ Laplace\ transform\ for\ this\ equation$

$V(s) = R * I(s) + sL * I(s)$

$I(s) = \frac{V(s)}{R + sL} \quad \longrightarrow \quad transfer\ function\ \frac{I(s)}{V(s)} = \frac{1}{R + sL} = 1/(1+s)$

For given $V = 10, R = 1, L = 1,$ $the\ step\ response\ for\ the\ transfer\ function$

$\gg s = tf('s'); \quad This\ is\ for\ transfer\ function\ variable\ 's'$
$\gg G = {}^{1}/_{(s+1)}; \quad The\ tranfer\ function$
$\gg step(10 * G) \quad 10\ is\ for\ magnitude\ of\ Vdc\ applied$



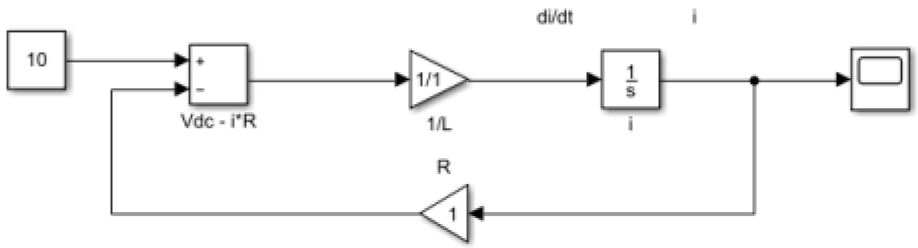
iii) Using Simulink block diagram approach.

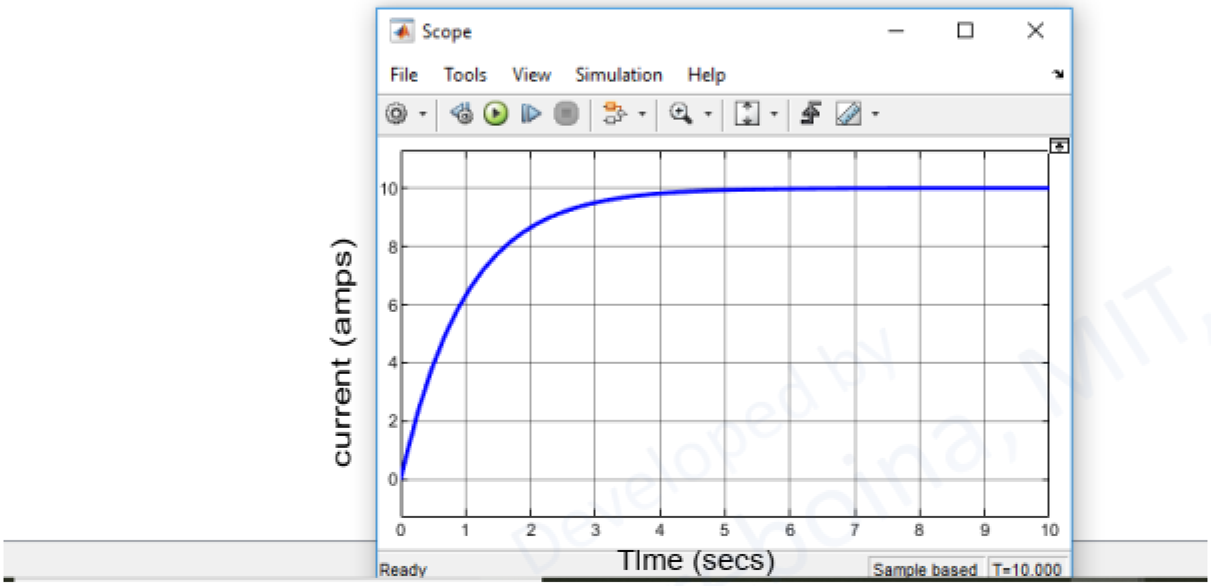
Using Simulink block diagram approach

$V = R * i + L\,\frac{di}{dt}$ *rearranging this equation for di/dt*

$\frac{di}{dt} = \frac{V - R * i}{L}$ *Integrating on both sides*

$\int \frac{di}{dt}\,dt = \int (V - R * i)/L\ dt = i \longrightarrow \boldsymbol{i * R}$



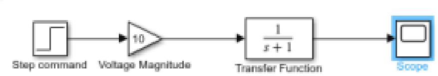


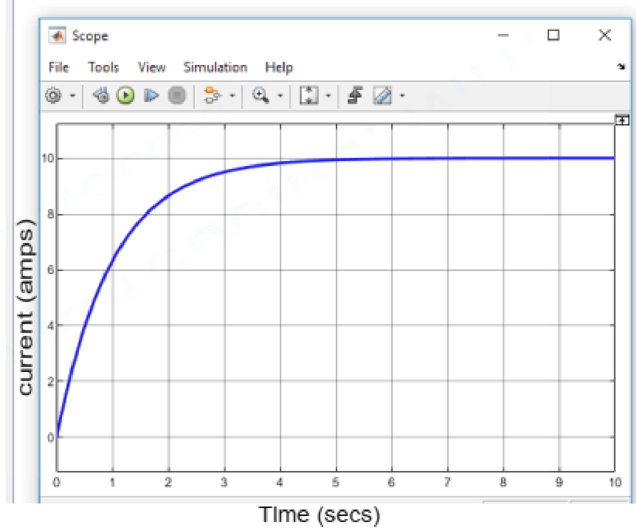
Using Simulink Transfer function (Continuous Blocks)

$\gg s = tf('s');$

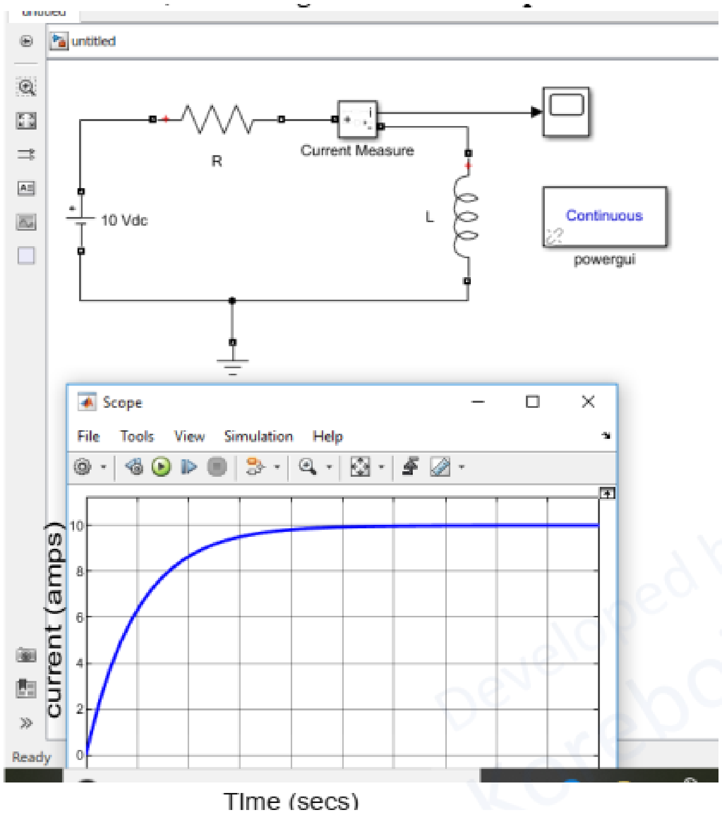
$\gg G = {}^{1}/_{(s+1)};$

$\gg step(10 * G)$



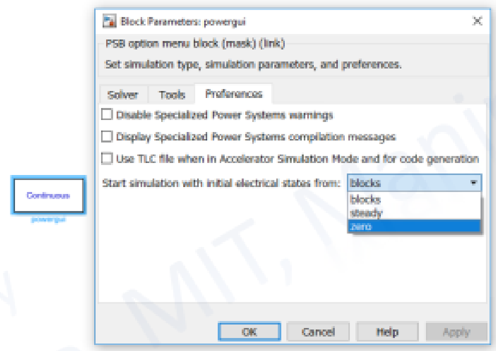


iv) Using Simulink simscape



powergui must be included to run

In powergui preferences set initial electrical conditions zero

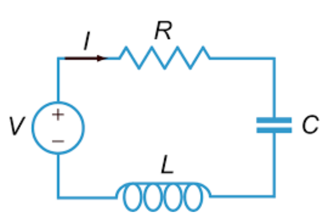


Problem3:

Model and analyze the effects of damping in DC excited series RLC circuit.

Second order system

Series RLC circuit



$$\frac{R}{2L} < \frac{1}{\sqrt{LC}} \quad Underdamped$$

$$\frac{R}{2L} = \frac{1}{\sqrt{LC}} \quad critical\ damped$$

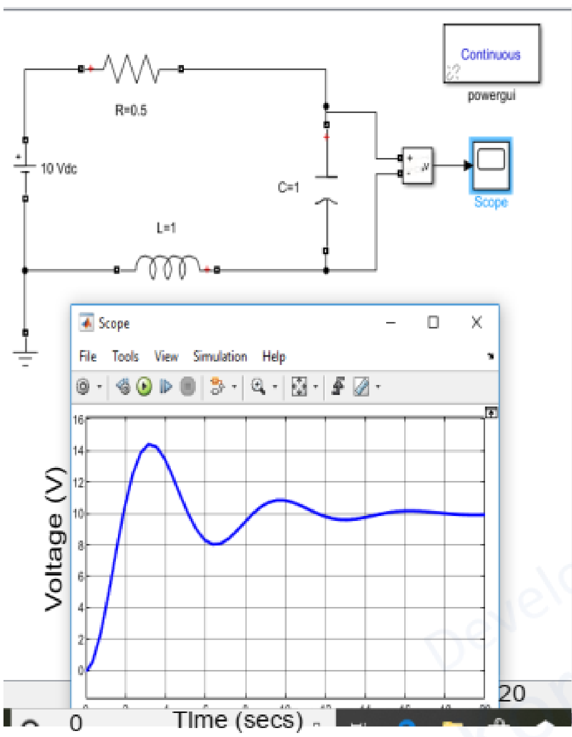
$$\frac{R}{2L} > \frac{1}{\sqrt{LC}} \quad Overdamped$$

$For\ given\ Vdc = 10, \quad L = 1, C = 1, \quad then$

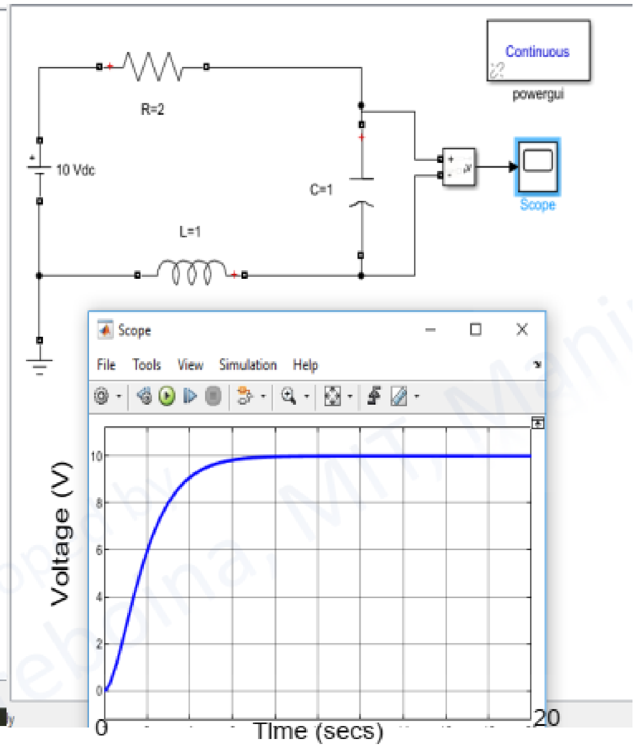
$R < 2 \quad underdamped,$

$R = 2 \quad critical\ damped$

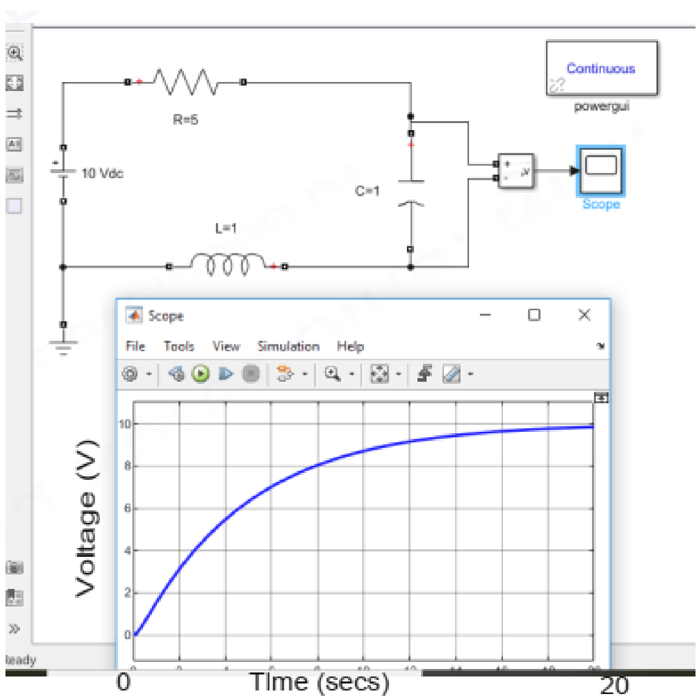
$R > 2 \quad over\ damped$



R=0.5 underdamped



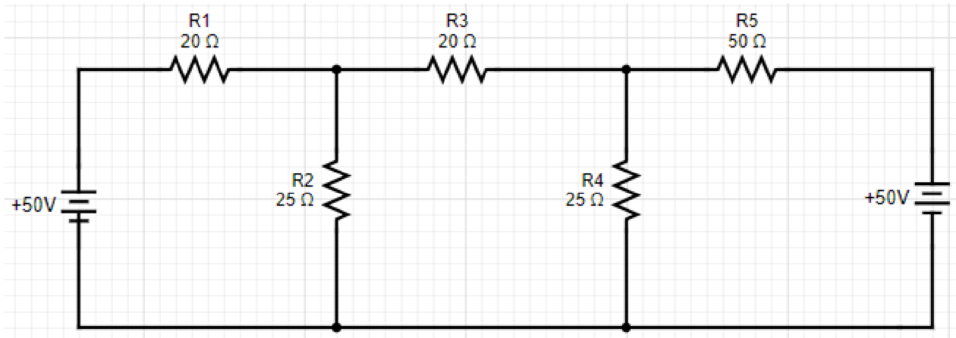
R=2 critical damped



R>2 overdamped

Open-Ended Lab Exercises - 1:

1. Find the roots of equation x^4 + 2*x^3+2*x+1=0. **(1)**
2. For the circuit shown below find the value of current through resistor R5 using any of the approaches in Matlab. **(1)**



3. Simulate a critically damped series RLC circuit powered by 100V DC supply and having component values as R=10Ω, C=0.5F. **(1)**
4. For the same system in Q3, identify the calculate the value of R to get 20% overshoot in output voltage and simulate the same. Mark the overshoot in output voltage. **(1)**
5. Identify applications with first order system in any other domains (Mechanical, Chemical, etc). **(1)**

Experiment II:

Date : __/__/__

Open loop control of DC-DC Converters: Buck and Boost Converters

Aim:

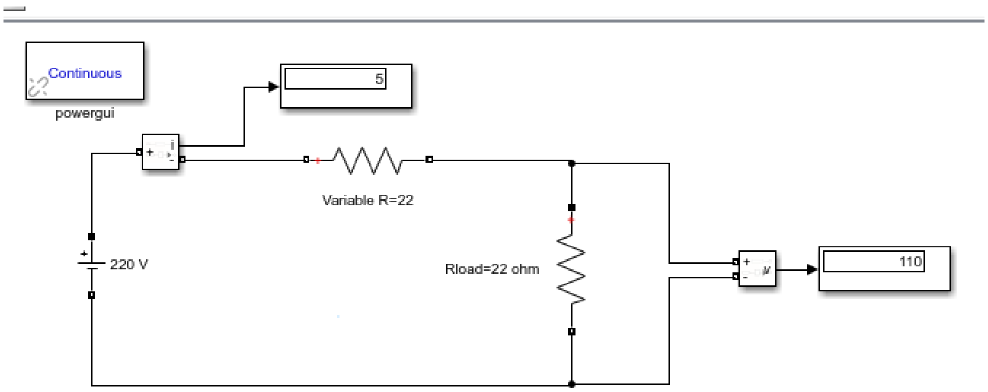
To simulate the open loop control of DC-DC converters: Buck and Boost Topology

Problem 1:

Understand the concept switched mode power conversion.

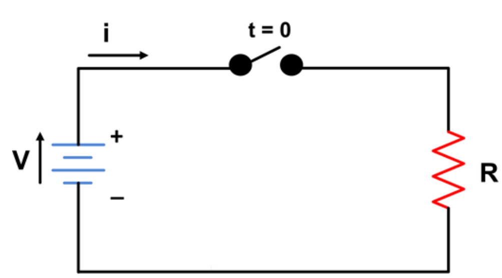
Conventional Voltage Divider Circuit

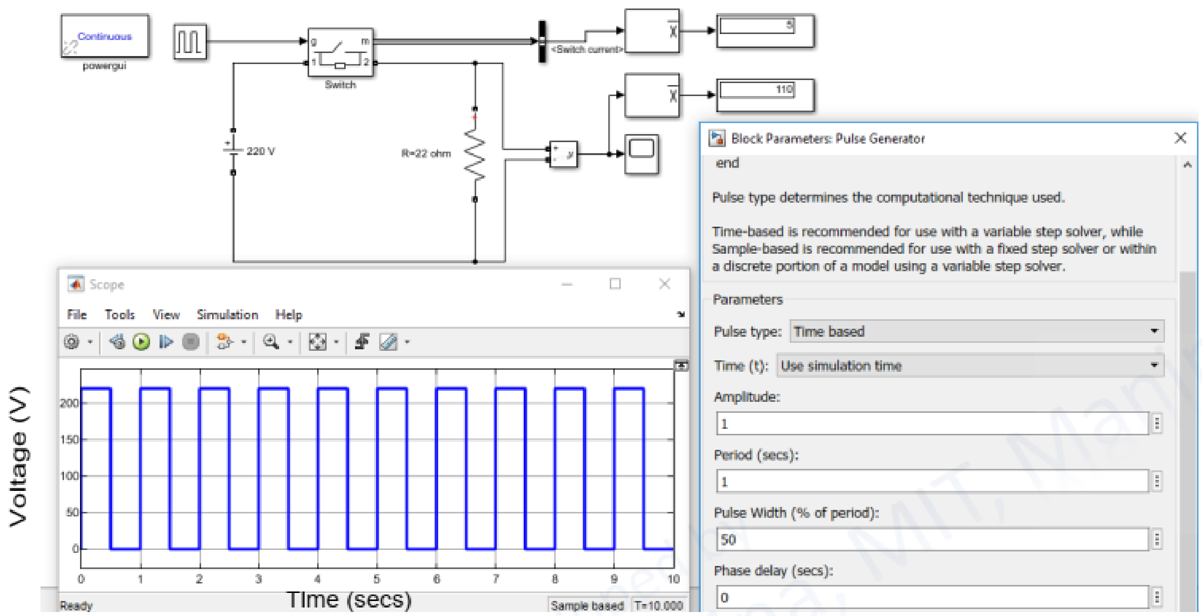
- Using resistive drop



$$vout = 110, \quad iout = 5, \quad pout = 110 * 5 = 550\, Watts$$
$$vin = 220, \quad iin = 5, \quad pin = 220 * 5 = 1100\, Watts$$
$$efficiency = \frac{pout}{pin} * 100 = \frac{550}{1100} * 100 = 50\ \%$$

DC-DC switched converter



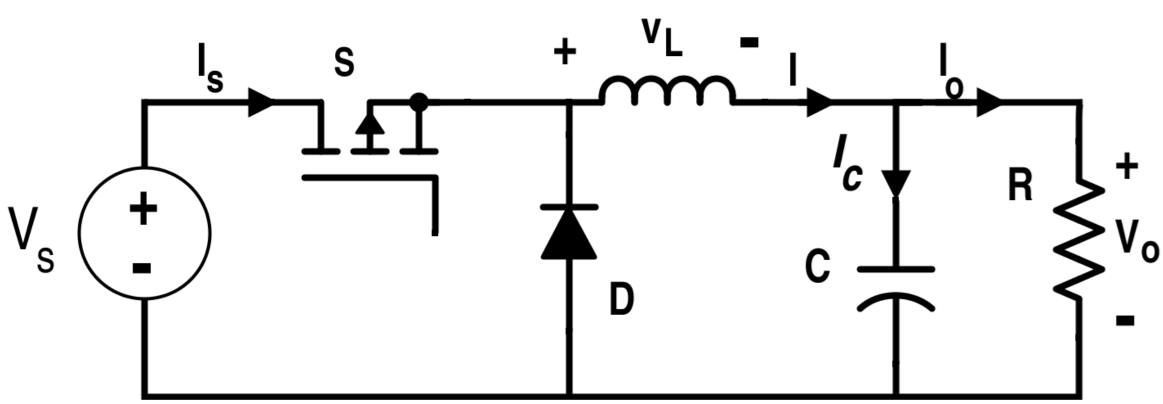


$$Vout = d * Vin = 50\% * 220 = 0.5 * 220 = 110\ V$$

$$*** \ d \text{ is duty cycle } (\text{Pulse width})$$

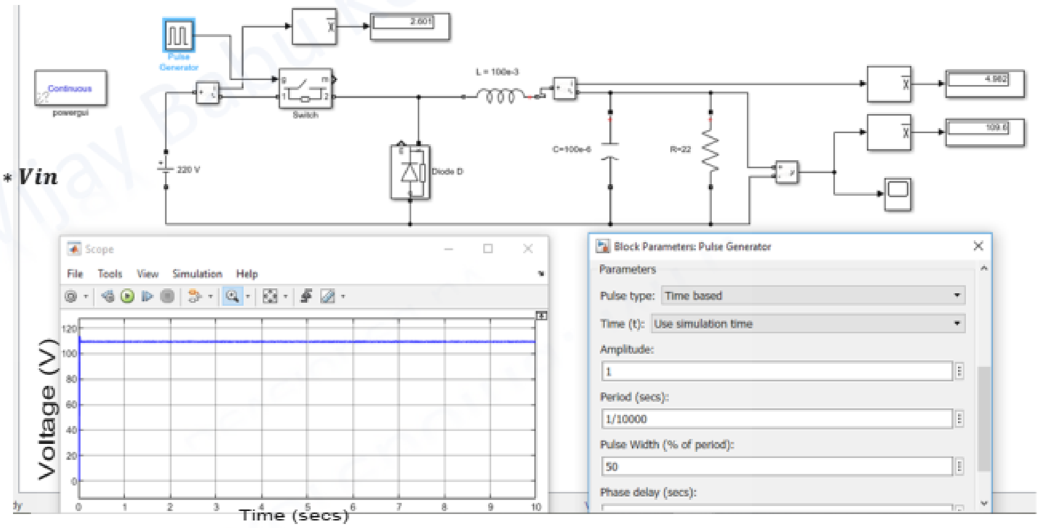
Problem 2:

Plot the voltage response of a Buck converter across a resistive load of 22 ohm. The source voltage is 220 V and PWM signal has 50% duty cycle and 10kHz switching frequency. Also plot the current in the circuit. Model the circuit with ideal switching devices and L = 100 $\times 10^{-3}$ H, C = 100 $\times 10^{-6}$ F. Understand the significance of efficiency improvement using switched mode power conversion.



$$\boldsymbol{Buck\ Converter}$$

$$\boldsymbol{Vout = d * Vin}$$



$$\boldsymbol{vout = 109.6}, \quad iout = 4.982, \quad pout = 109.6 * 4.982 = 546.02\ Watts$$

$$vin = 220, \quad iin = 2.601, \quad pin = 220 * 2.601 = 572.22\ Watts$$

$$efficiency = \frac{pout}{pin} * 100 = \frac{546.02}{572.22} * 100 = \boldsymbol{95.42\%}$$

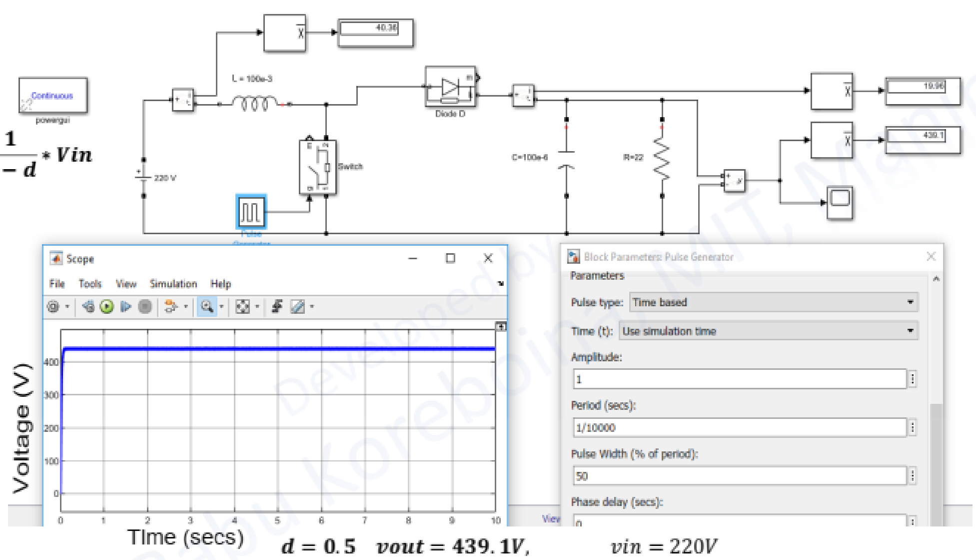
Simulate and Plot efficiency at various output voltages of buck converter.

Problem 3:

Plot the voltage response of a Boost converter across a resistive load of 22 ohm. The source voltage is 220 V and PWM signal has 50% duty cycle and 0.1ms period. Model the circuit with ideal switching devices and L = 100 $\times 10^{-3}$ H, C = 100 $\times 10^{-6}$ F.

$$\boldsymbol{Boost\ Converter}$$

$$\boldsymbol{Vout = \frac{1}{1-d} * Vin}$$



$$\boldsymbol{d = 0.5} \quad \boldsymbol{vout = 439.1V}, \quad vin = 220V$$

Simulate and Plot efficiency at various output voltages of boost converter.

Open-Ended Lab Exercises - 2:

1. Simulate a Buck-Boost Converter with input voltage 150V and output to be variable between 100-200 V. Identify the maximum and minimum duty ratio.
   Converter parameters: 10kHz Switching frequency, L=100mH, C=100µF, Load resistance=22Ω.
   Simulate till 5sec. **[5]**

Experiment III:

Date : __/__/__

Open loop control of Controlled Rectifiers and Voltage Regulators

Aim:

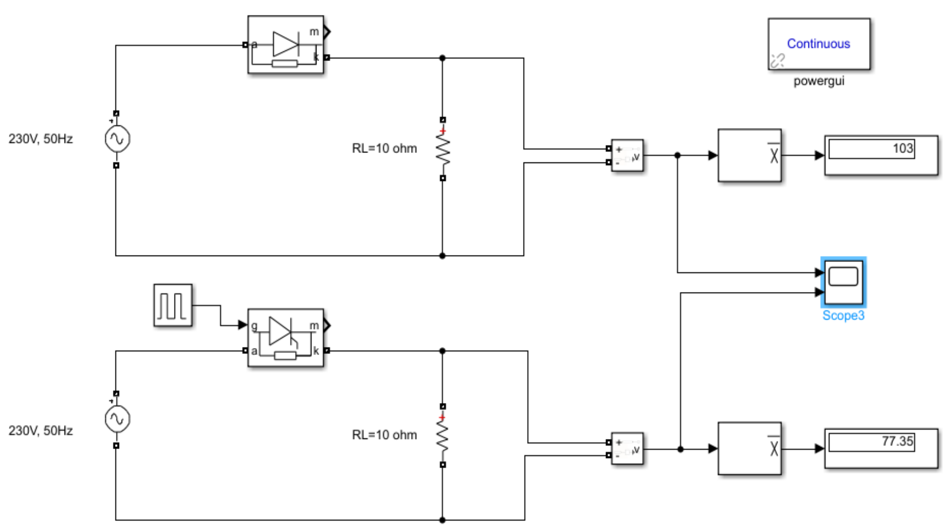
To simulate the open loop control of controlled AC-DC and AC-Converters.

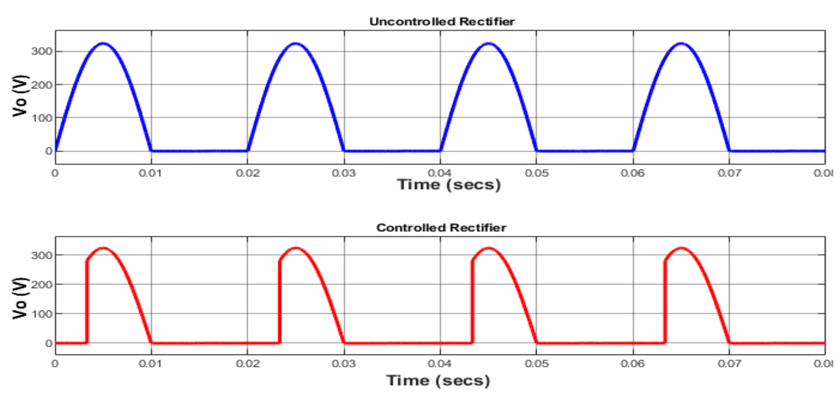
Problem 1:

Understand the concept uncontrolled and controlled half wave rectification.

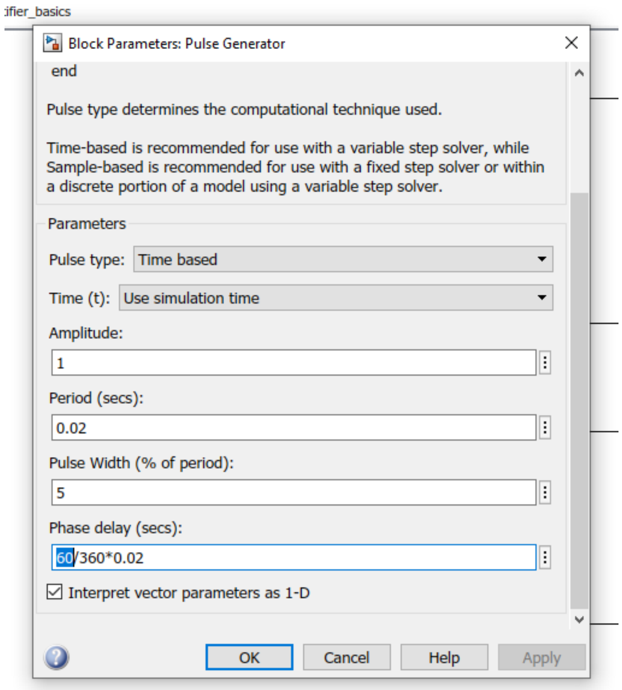
Given Data: 1ph 230V, 50Hz AC supply, Resistive load of 10Ω.

a) Estimate the average output voltage for uncontrolled and controlled half wave rectifier and validate the same through simulation.
b) Calculate the firing angle required to meet the desired average output voltage of 100V and validate the same through simulation.



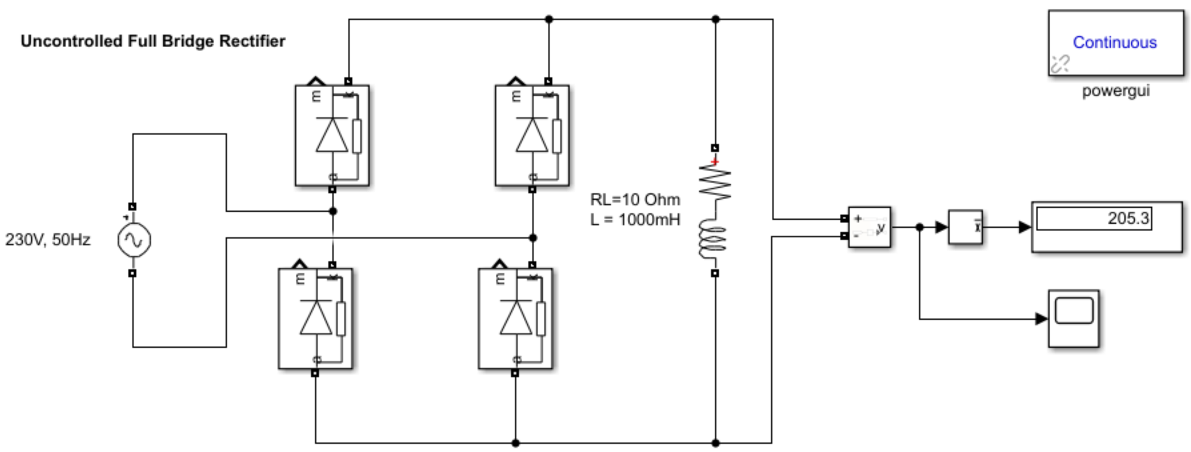


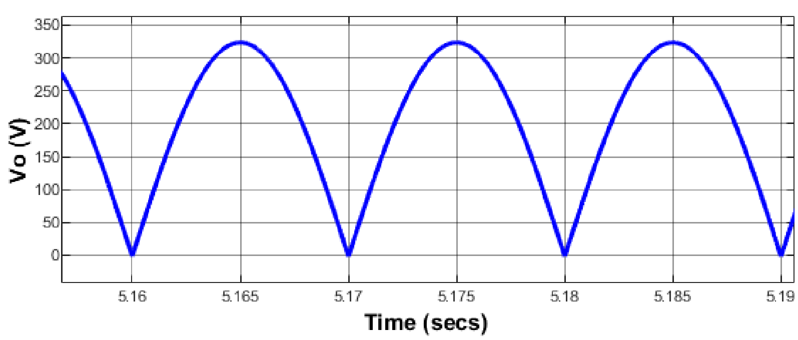
- For firing angle alpha =30 deg
- Output voltage can be controlled by varying alpha.

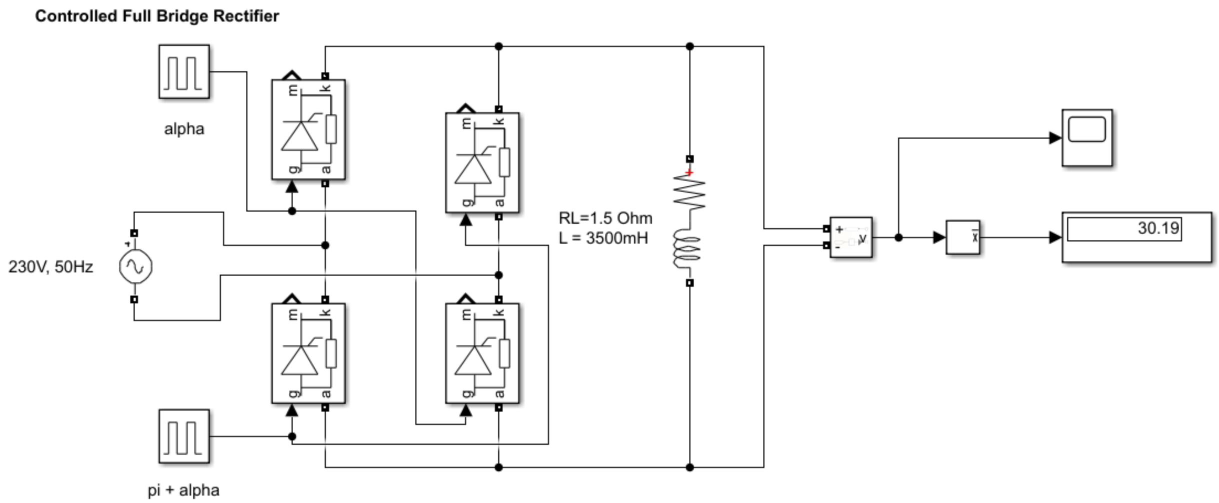


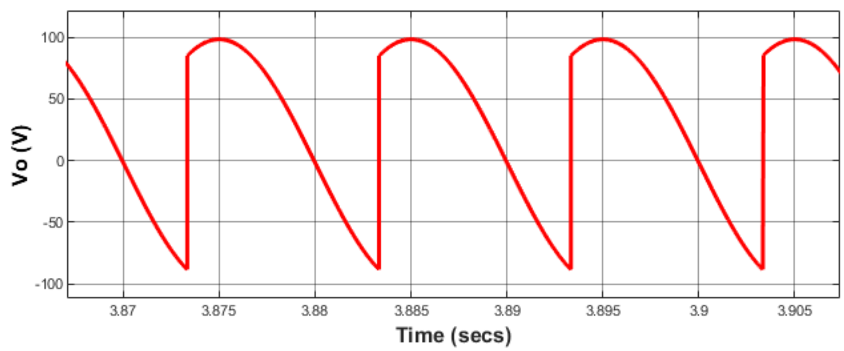
Problem 2:

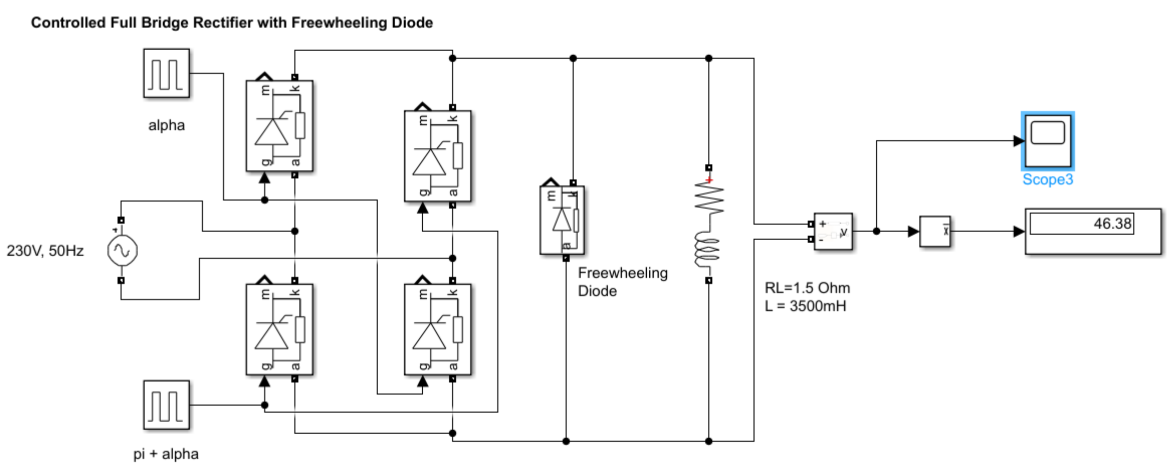
Simulate the concept of full wave bridge controlled and uncontrolled rectifiers.

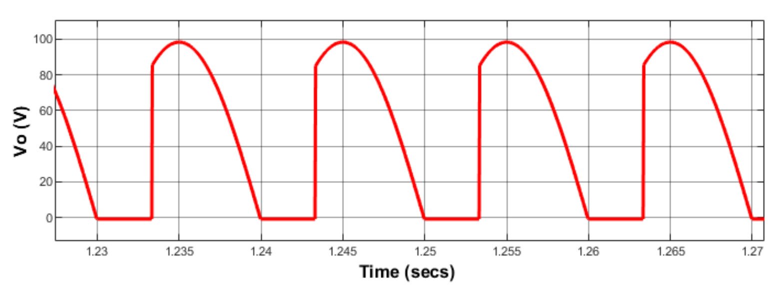





Controlled Full Bridge Rectifier
alpha
230V, 50Hz
RL=1.5 Ohm
L = 3500mH
30.19
pi + alpha

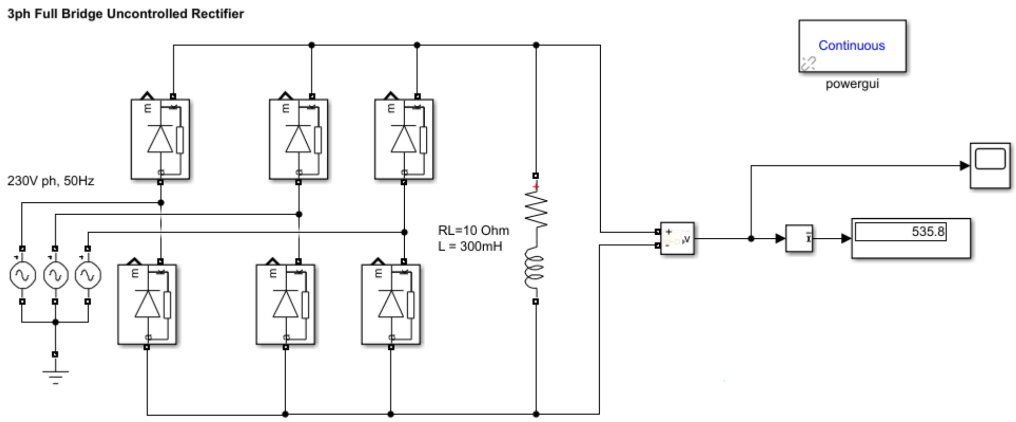

Vo (V)
Time (secs)

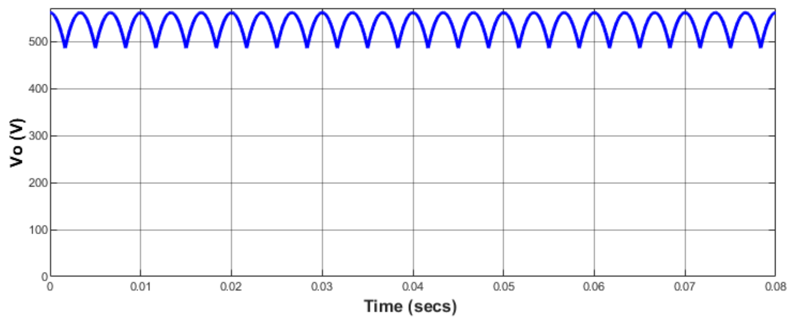

Controlled Full Bridge Rectifier with Freewheeling Diode
alpha
230V, 50Hz
Freewheeling
Diode
RL=1.5 Ohm
L = 3500mH
Scope3
46.38
pi + alpha

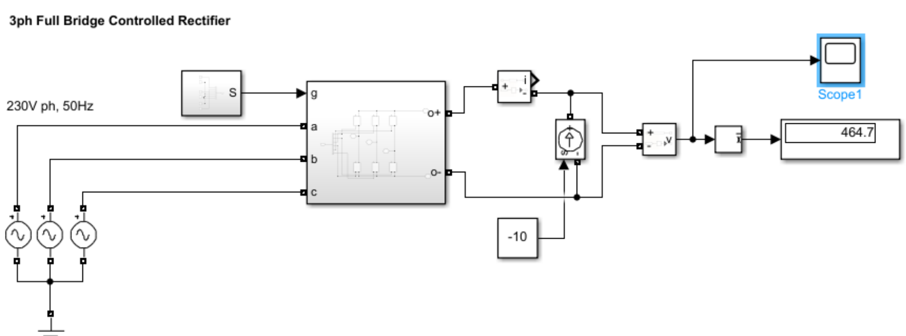

Vo (V)
Time (secs)

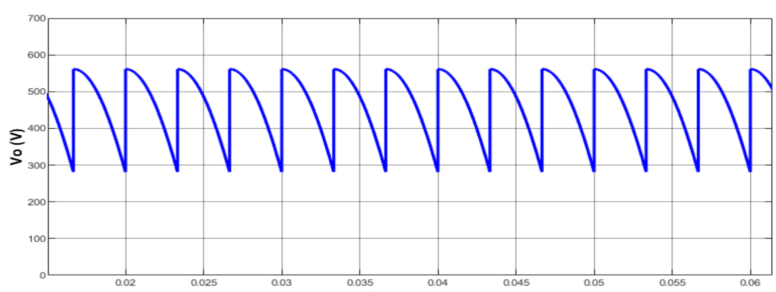
Problem 2:

Simulate the concept of 3ph full wave bridge controlled and uncontrolled rectifiers





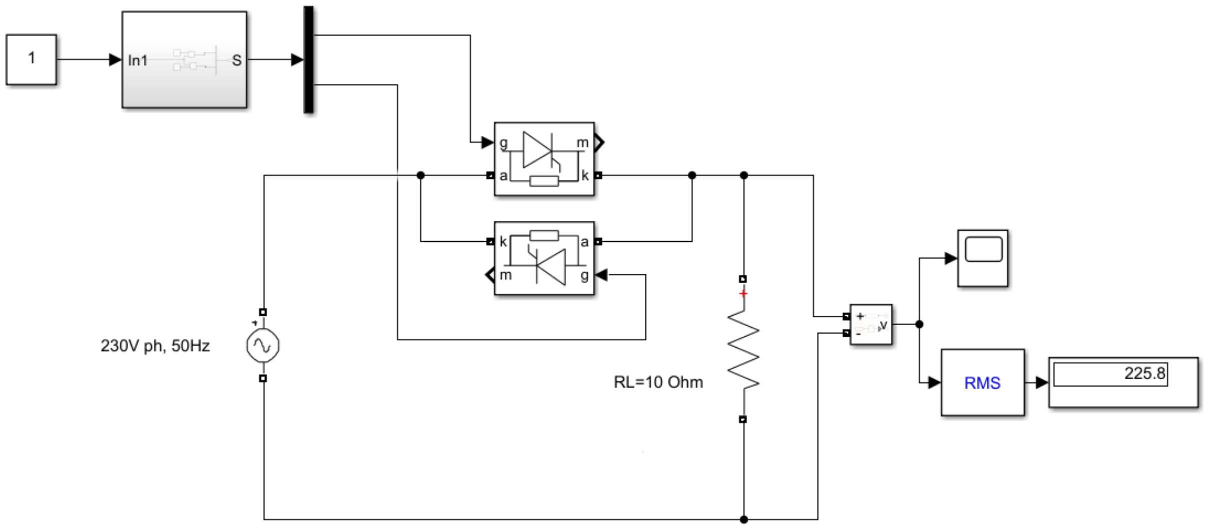


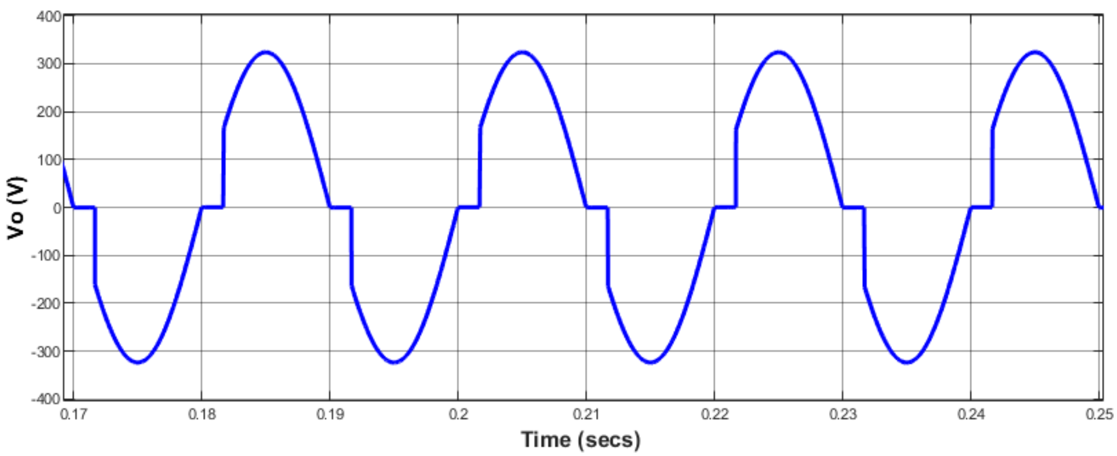


- Vary the firing angle between 0 and 180 deg and observe the output voltage.

Problem 3:

Simulate the concept of AC-AC Voltage regulator.





Open-Ended Lab Exercises - 3:

1. Simulate a full wave diode rectifier with 230V rms input AC supply connected to a resistive load of R=32.5Ω.

b) Plot the output voltage across Resistive Load.

c) Observe the output voltage if a 4700μF capacitor is connected across the resistive load.

[5]

Experiment IV:

Date : __/__/__

Closed loop control of DC-DC Converters: Buck and Boost Converters

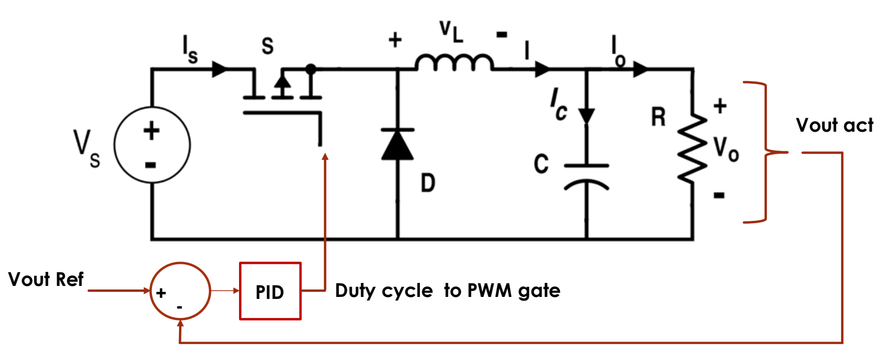
Aim:

To simulate the closed loop Buck and Boost converters using **Simscape**

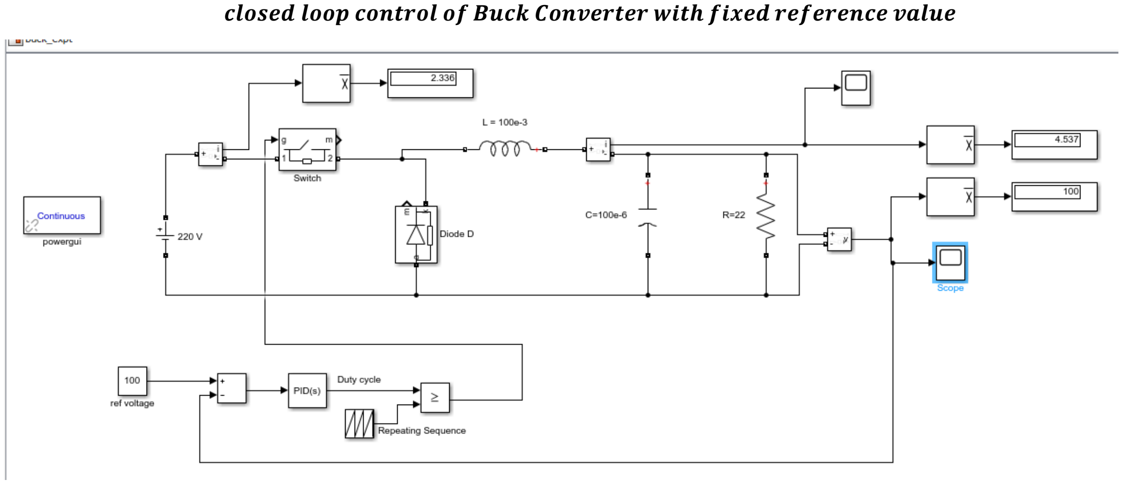
Problem 1:

Plot the voltage response of a closed loop Buck converter across a resistive load of 22 ohm. The source voltage is 220 V and PWM duty cycle is generated using PID controller block. Model the circuit with ideal switching devices and L = 100 $\times 10^{-3}$ H, C = 100 $\times 10^{-6}$ F and switching frequency 10KHz. Understand the significance of closed operation with fixed and step change in reference points.

Closed loop DC-DC buck Converter



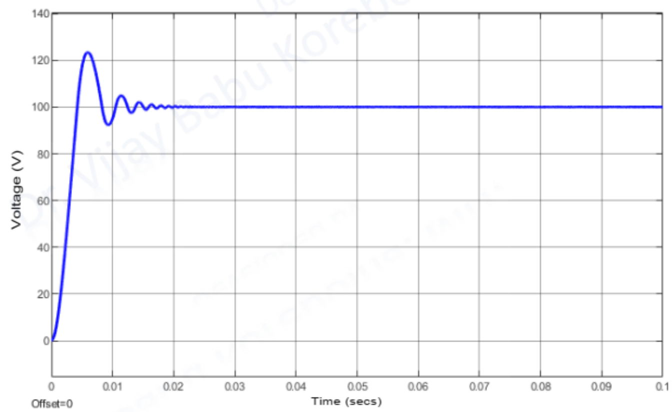
$closed\ loop\ control\ of\ Buck\ Converter\ with\ fixed\ reference\ value$



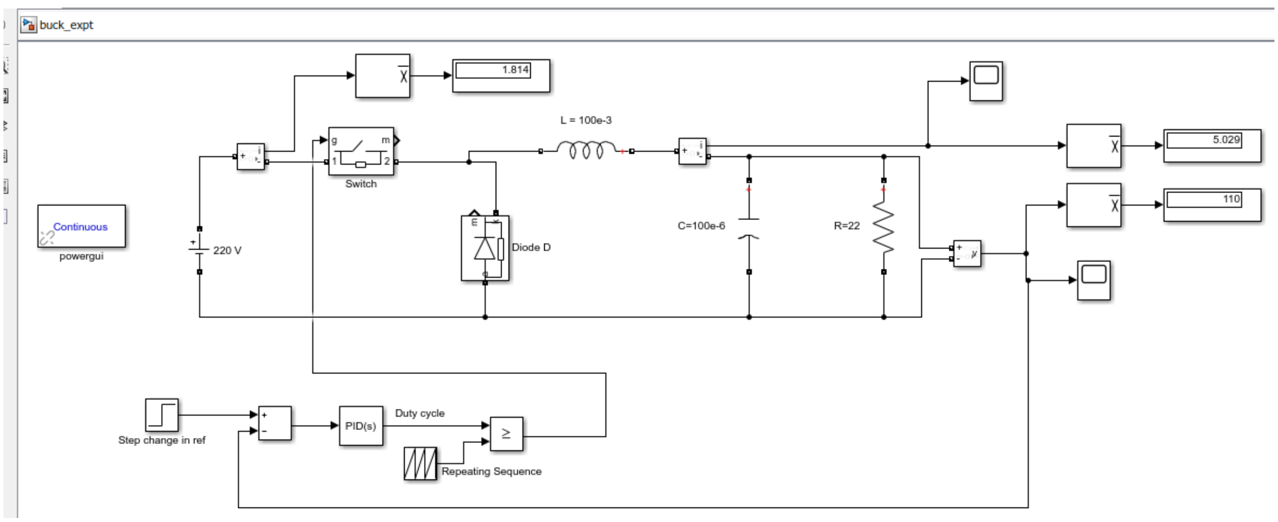
$Vout\ reference = 100\ V, \quad vin = 220V \quad actual\ vout = 100V$

$kp = 100, \quad ki = 10$

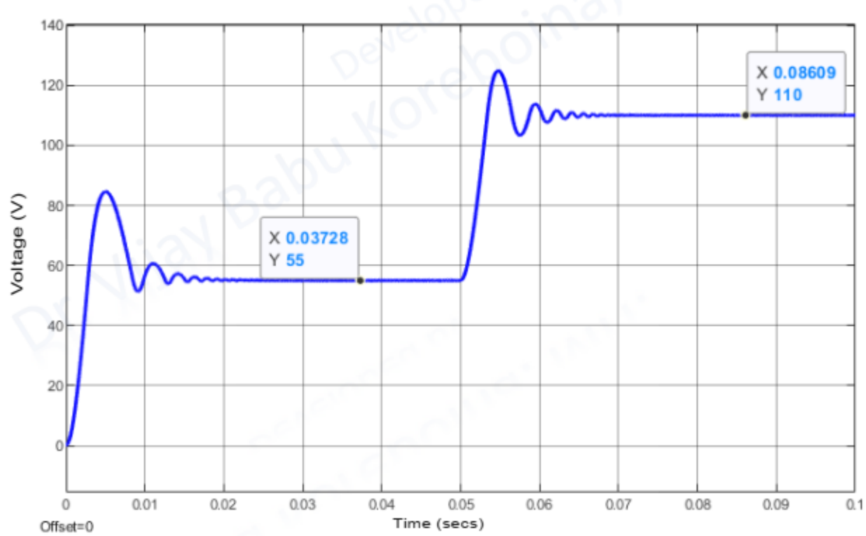
$students\ are\ advised\ to\ work\ with\ proportional\ control\ until\ steady\ error\ exists$
$and\ then\ apply\ integral\ control\ gain\ to\ the\ effect\ in\ steady\ state\ error$



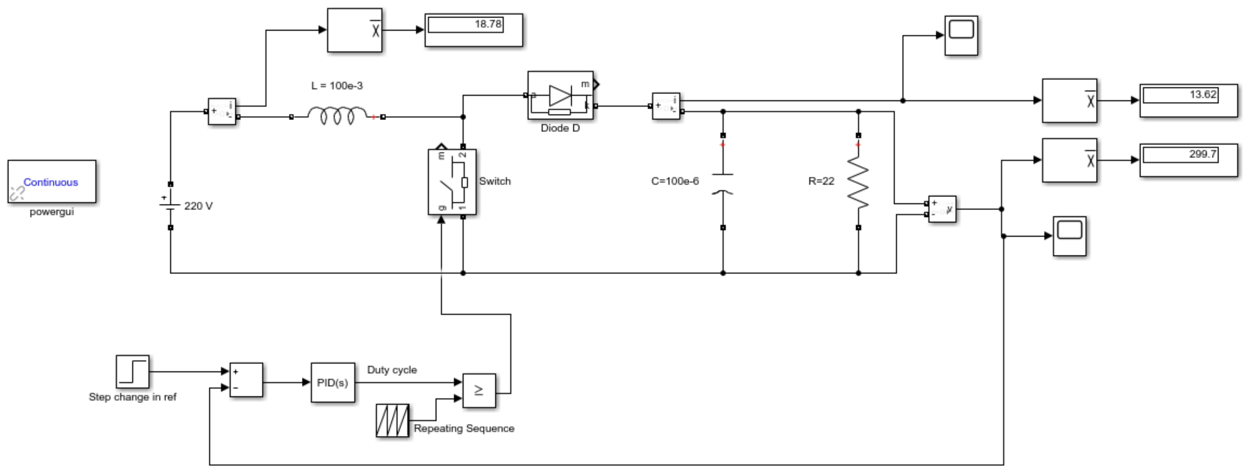
closed loop control of Buck Converter with step change in reference value



Step change in reference from 55V to 110V, at time 0.5sec, actual vout = 55 and 100V

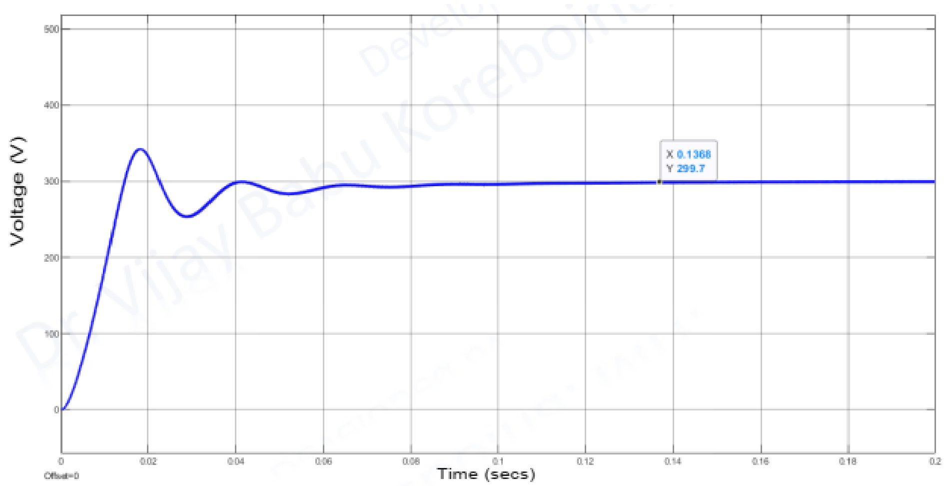


$$\textit{closed loop control of Boost Converter with fixed reference value}$$



$$Vout\ reference = 300\ V, \quad Vin = 220V \quad actual\ vout = 299.7\ V$$

$$kp = 0.0017, \quad ki = 0.08$$



Open-Ended Lab Exercises - 4:

1. Describe open and closed loop control system and discuss when to select open loop and closed loop operation. Give some examples for open loop and closed loop systems.
2. Identify and discuss applications of PID Controller in Industry.
3. Discuss on advanced controllers used in Industries.
4. Describe the effects of each controllers in PID.
5. Recognize the disadvantages of PID controller and their mitigations.

Experiment V:

Date : __/__/__

Control of DC Motor using Buck Converter

Aim:

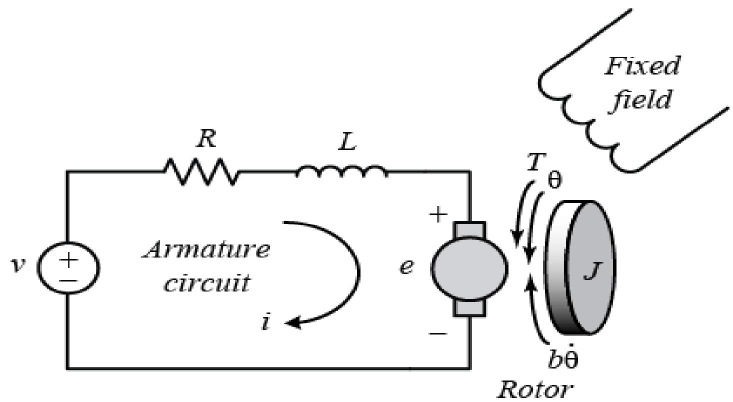
To model an armature controlled DC motor from first principles of modelling. Also simulate and analyze the motor performance as per specifications in SIMULINK.

Problem 1:

A Dc armature controlled motor with the following parameters: R = 2 Ω, L =1.1mH and K_b = 1.26 V/rad/sec, K_t = 1.26 N.m/Amp, with rotor parameters of J = 0.05kg-m^2 **, B = 0 Nm/rad/sec** with no load is directly started from a dc supply voltage of 220V. Plot the motor starting speed response and the time taken to reach 157.07 rad/sec (1500 rpm).

Observe the effect of friction with B=0.001

Circuit Description:



System equations:

i. Voltage equation, $V(t) = Ri(t) + L\frac{di(t)}{dt} + e_b(t)$

ii. Torque equation, $T_m(t) = J\frac{d\omega_m(t)}{dt} + B\omega_m(t) + T_l(t);$

iii. Electromagnetic Torque , $T_m(t) = \frac{e_b(t)}{\omega_m(t)}\, i(t) \;=\; K_t * i(t)$

iv. Induced Emf , $e_b(t) = K_b\,\omega_m(t)$

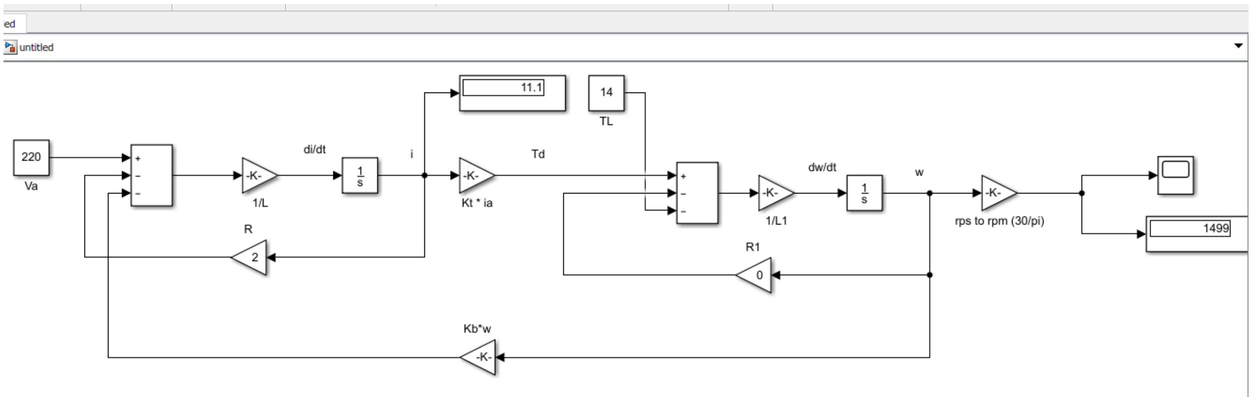
Rearranging the system equations

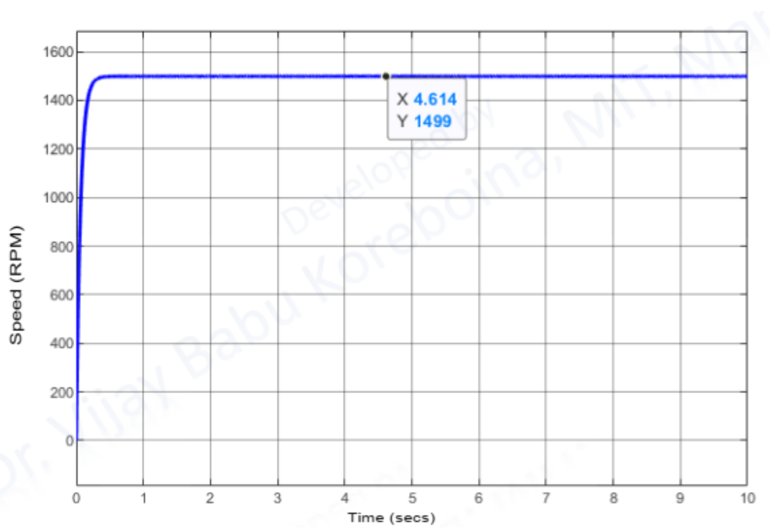
$$\frac{d\omega_m(t)}{dt} = \frac{1}{J}\left[T_m(t) - \left(B\omega_m(t) + T_l(t)\right)\right]$$

$$\frac{di(t)}{dt} = \frac{1}{L}\left[V(t) - Ri(t) - e_b(t)\right]$$

Solution

SIMULINK Diagram:

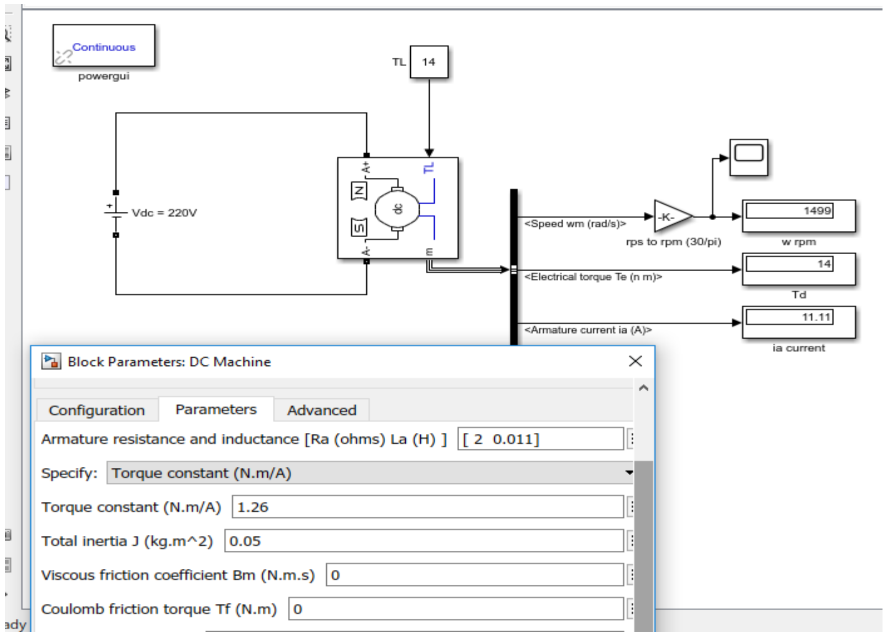


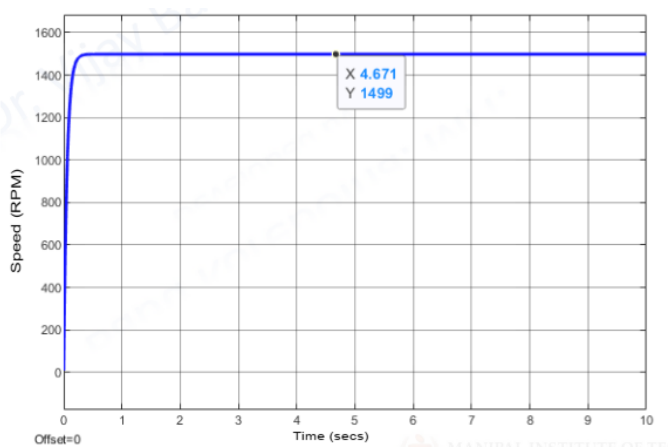


Problem 2:

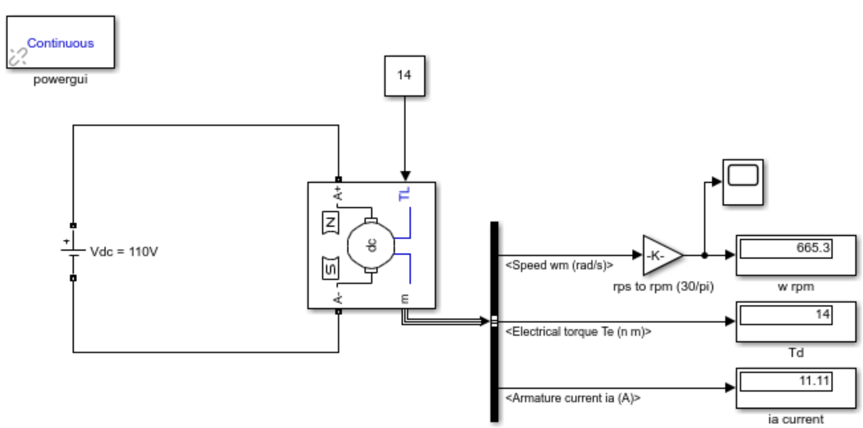
A Dc armature controlled motor with the following parameters: R = 2 Ω, L =1.1mH and K_b = 1.26 V/rad/sec, K_t = 1.26 N.m/Amp, with rotor parameters of J = 0.05kg-m^2 , B = 0 Nm/rad/sec with no load is directly started from a dc supply voltage of 220V and is given rated field current. Plot the motor starting speed response and the time taken to reach 157.07 rad/sec (1500 rpm) using simscpe.

Observe the effect of friction with B=0.001



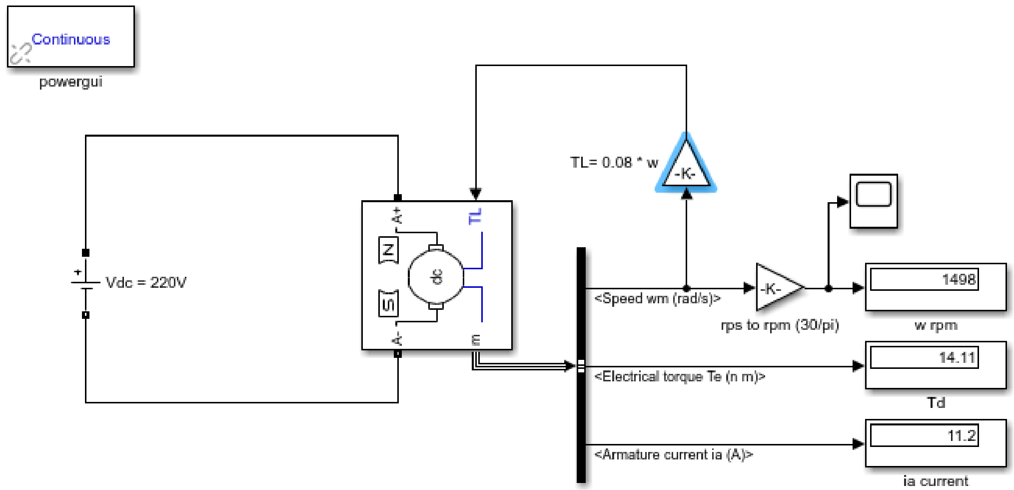


Armature voltage = 110V, speed response = 665.3 rpm



Problem 3:

A Dc armature controlled motor with the following parameters: R = 2Ω, L =0.011H and K_b = K_t 1.26V/rad/sec, with rotor parameters of J = 0.0167 kg-m^2 , B = 0 Nm/rad/sec with a load torque is proportional to the speed of rotation, $T_L = 0.08\ \omega$. Its armature is connected to a dc supply voltage of 220V and is given rated field current. Find speed of motor.



Open-Ended Lab Exercises - 5:

1. A DC armature controlled motor with the following parameters: R = 2Ω, L =0.011H and K_b = K_t 1.26V/rad/sec, with rotor parameters of J = 0.05 kg-m^2 , B = 0 Nm/rad/sec with a FAN load with coefficient 5.67e-4. Calculate the Torque at 750rpm and simulate the same by vary voltage to get 750rpm output.
2. For the same above system, if the input voltage is 100V, what is the speed and torque of the output FAN load.

Lab VI:

Date : __ /__ /__

Closed loop Speed Control of DC Motor using buck converter

Aim:

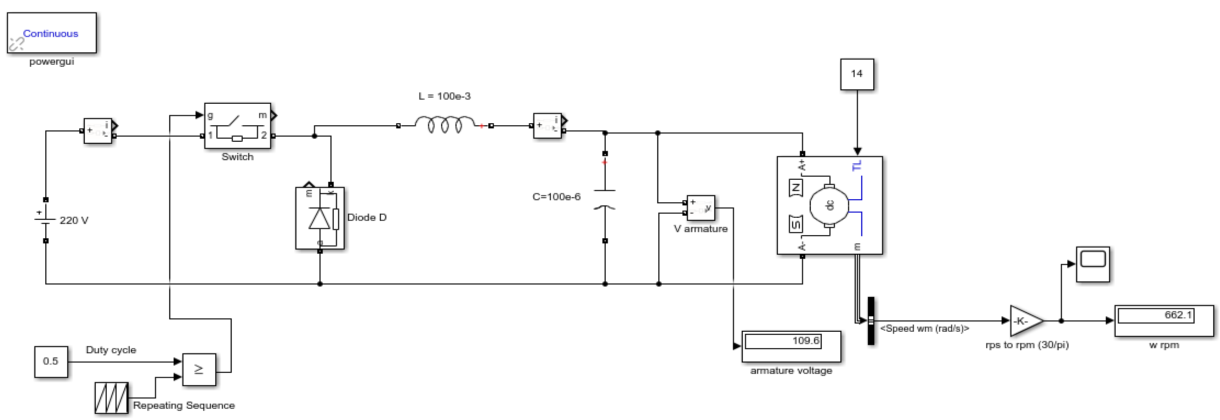
To model armature voltage speed control of DC motor using buck converter.

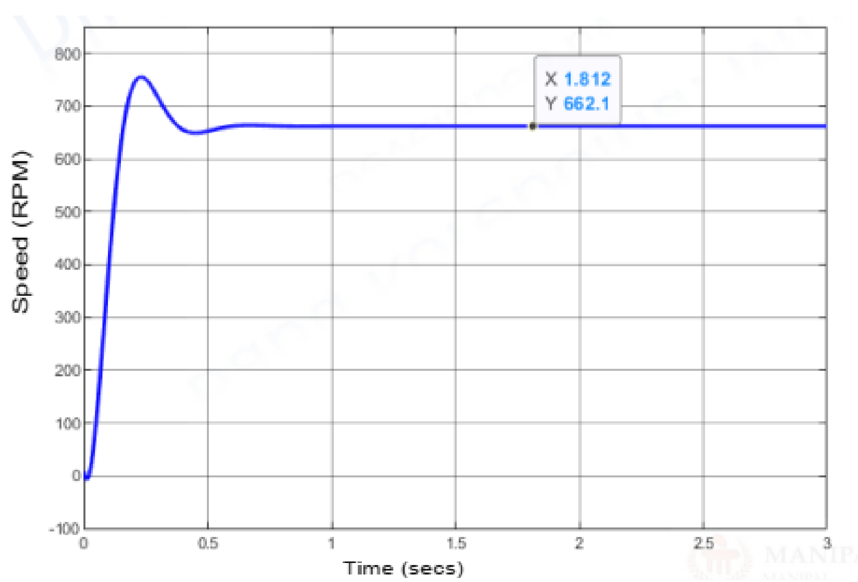
Problem 1:

A Dc armature controlled motor with the following parameters: R = 2 Ω, L =1.1mH and K_b = 1.26 V/rad/sec, K_t = 1.26 N.m/Amp, with rotor parameters of J = 0.05kg-m^2 **, B = 0 Nm/rad/sec** with no load is directly started from a dc supply voltage of 220V. Plot the motor starting speed response and the time taken to reach 157.07 rad/sec (1500 rpm).

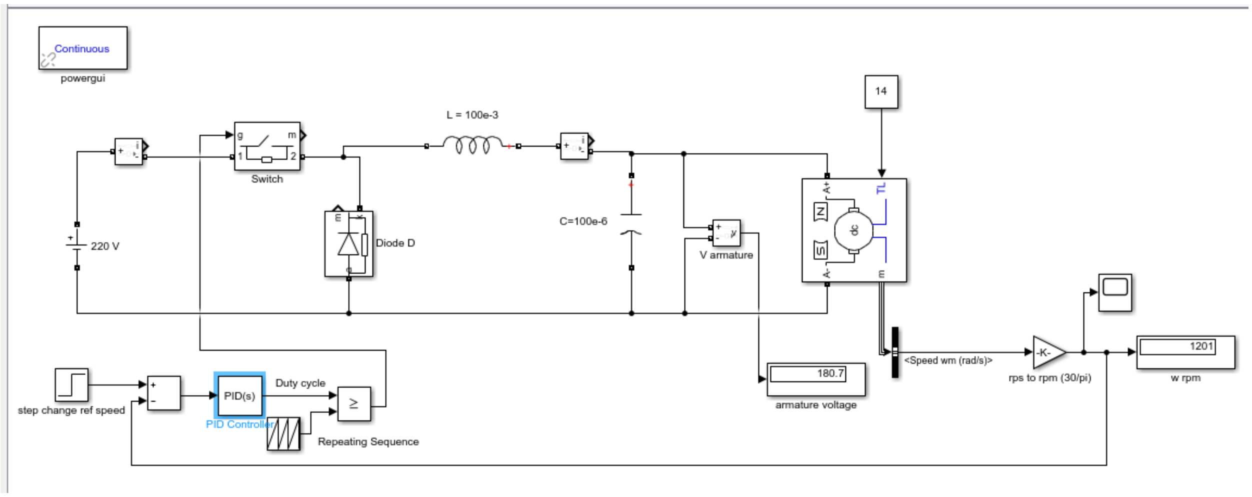
Control the speed of DC motor using armature voltage control through buck converter.

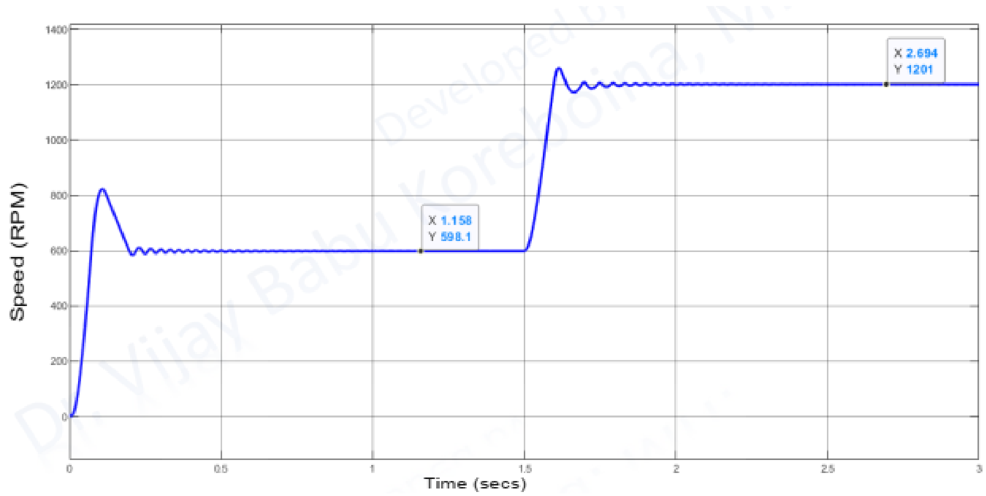
Circuit Description:



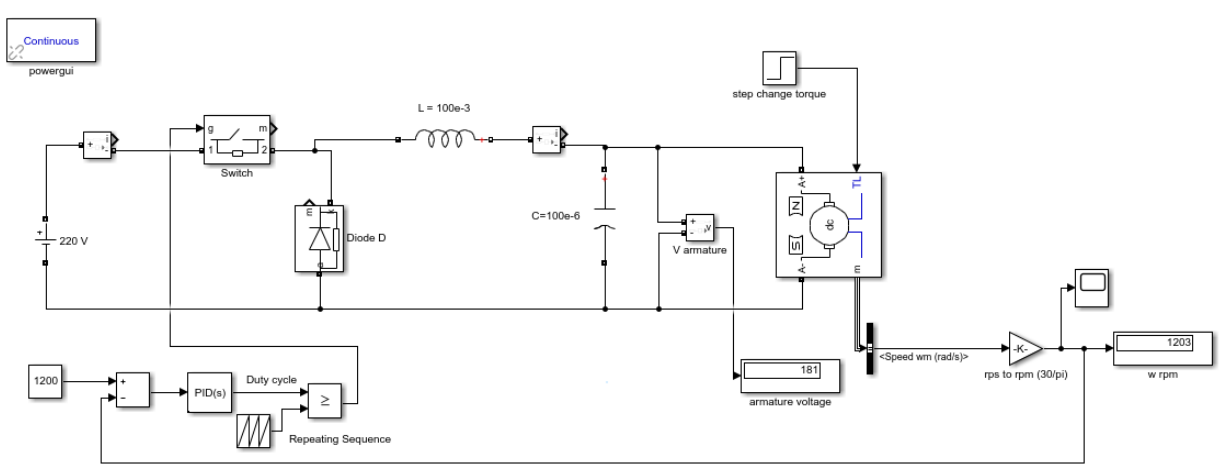


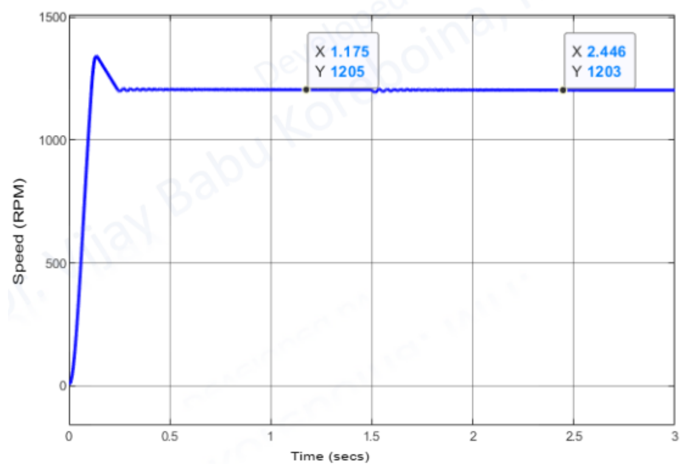
Closed loop speed control: kp=0.1 ki=0.02, step change in input reference 600 rpm to 1200 rpm





Closed loop speed control: kp=0.1 ki=0.02, step change in load from 7Nm to 14Nm for constant speed of 1200 rpm.





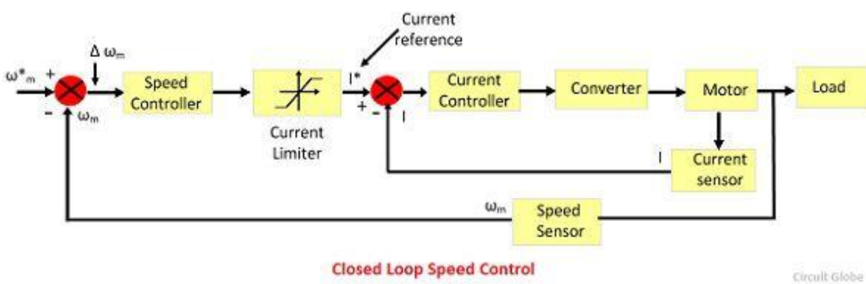
Problem 2:

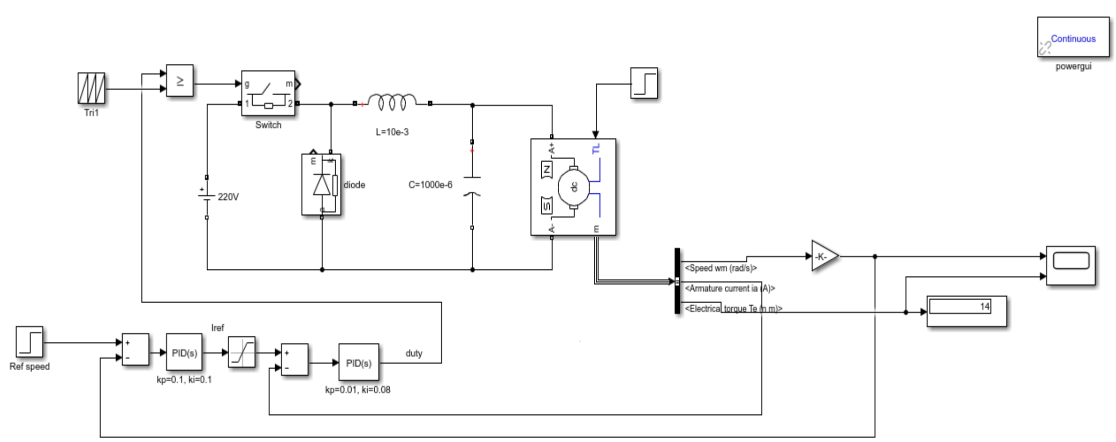
To model and simulate the DC motor with closed loop speed control with current controller using Simscape. A Dc armature controlled motor with the following parameters: R = 1.1 Ω, L =0.003H and K_b = 1.2 V/rad/sec, K_t = 1.2 N.m/Amp, with rotor parameters of J = 0.05kg-m^2 , B = 0.001 Nm/rad/sec. Develop the model and find the speed response with step change in speed and step change in load.

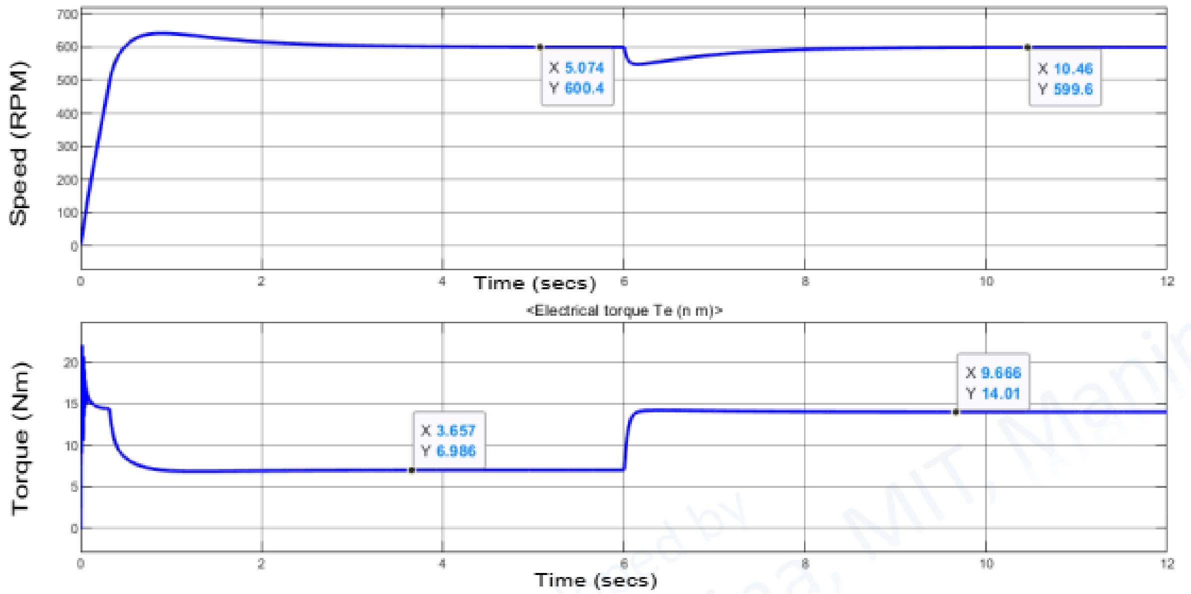
Given:

Speed controller gains: kp=0.1, ki=0.1

Current controller gains: kp=0.01, ki=0.08







Open-Ended Lab Exercises - 5:

1. A DC armature controlled motor with the following parameters: R = 2Ω, L =0.011H and $K_b = K_t$ 1.26V/rad/sec, with rotor parameters of J = 0.05 kg-m^2 , B = 0 Nm/rad/sec with a FAN load with coefficient 5.67e-4. Calculate the Torque at 750rpm and 1200rpm and simulate the closed loop speed control of Motor with 750rpm for 5 secs and 1200rpm in next 5 secs.

Date : __/__/__

Lab VII:

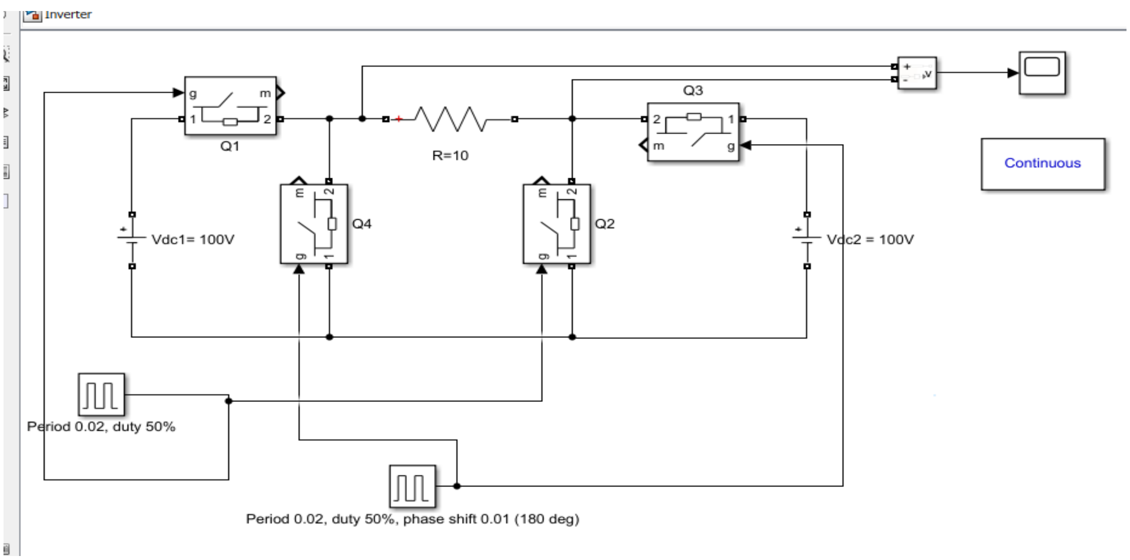
Control of AC Induction Motor using 3ph Inverter

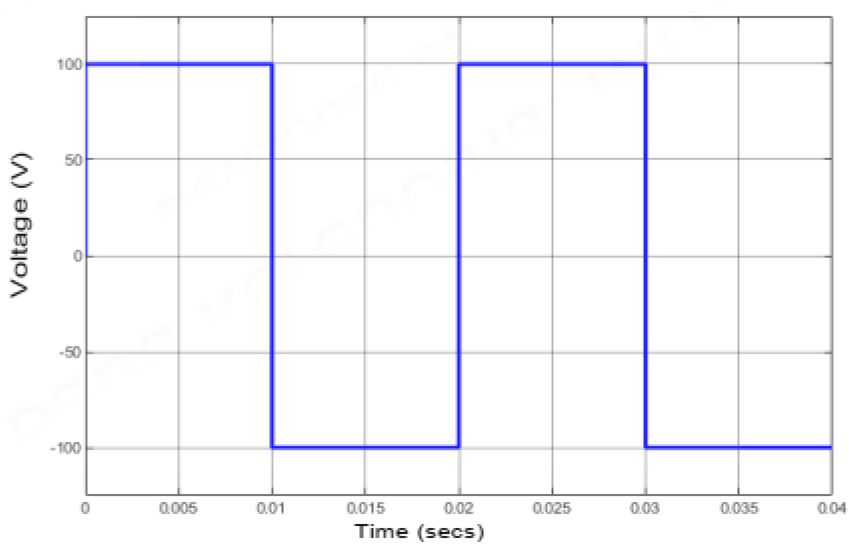
Aim:

To familiarize with DC-AC converters and SPWM technique.

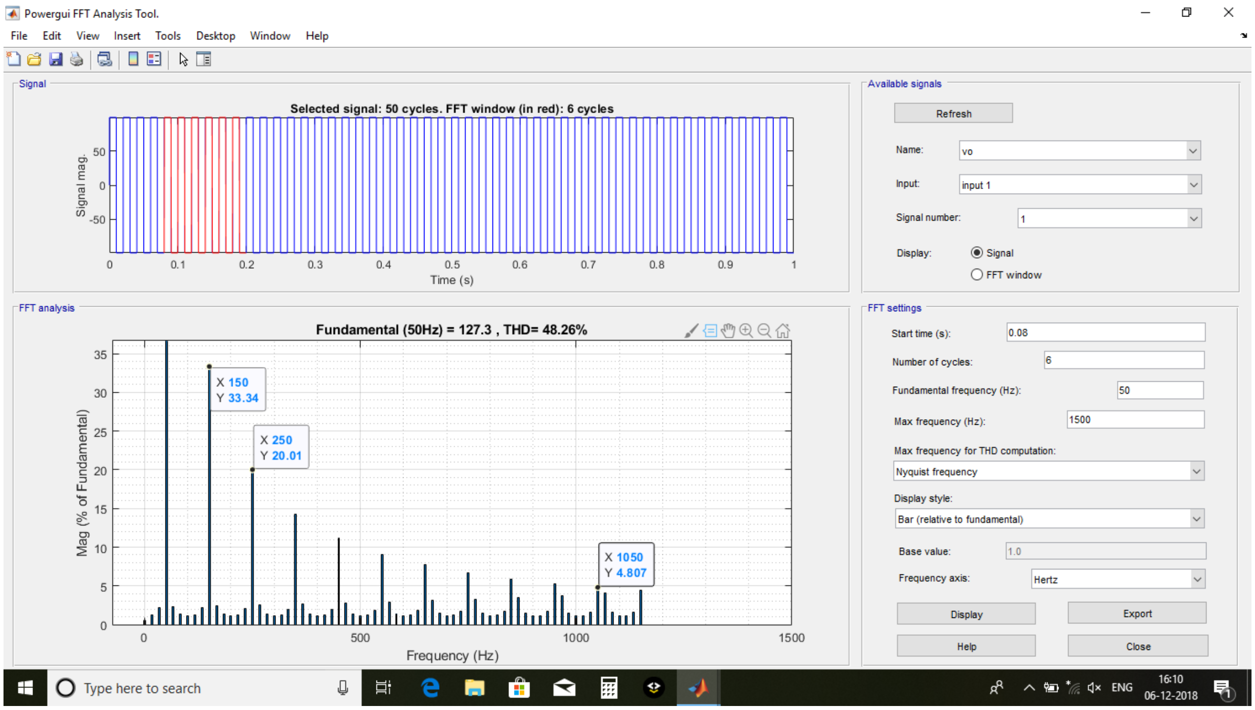
Problem 1:

To develop an single phase DC-AC inverter with DC voltage as 100 V and resistive load R=10 ohm. Observe the output Voltage to be AC form with 50Hz (0.02 sec). Observe the FFT analysis window of output voltage which depicts lower order harmonics (Which are hard to filter)
Generate 100 Hz (0.01 sec) AC signal by adjusting pulse generators period.



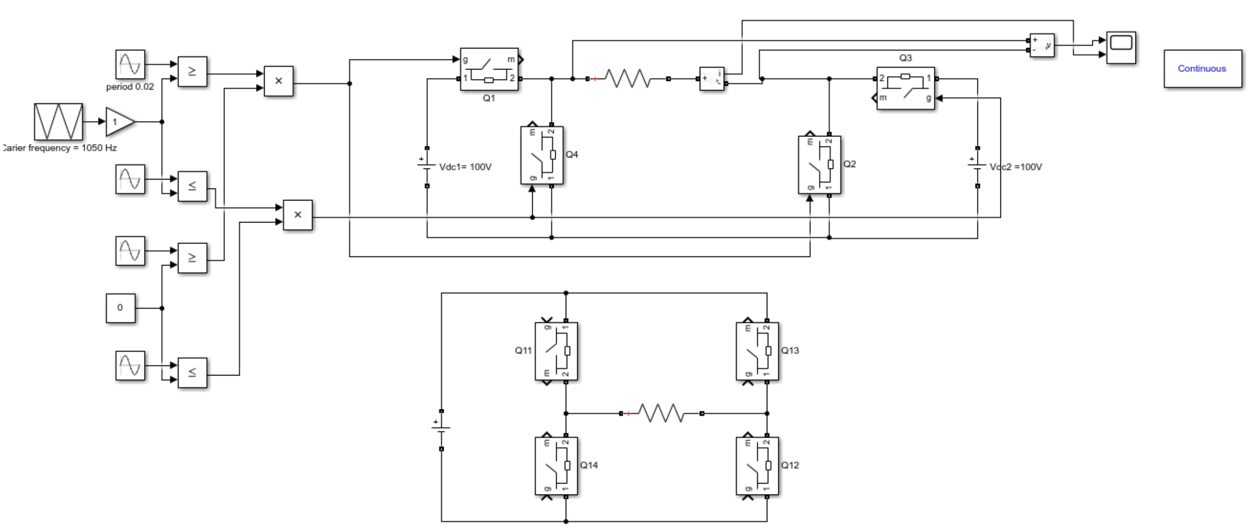


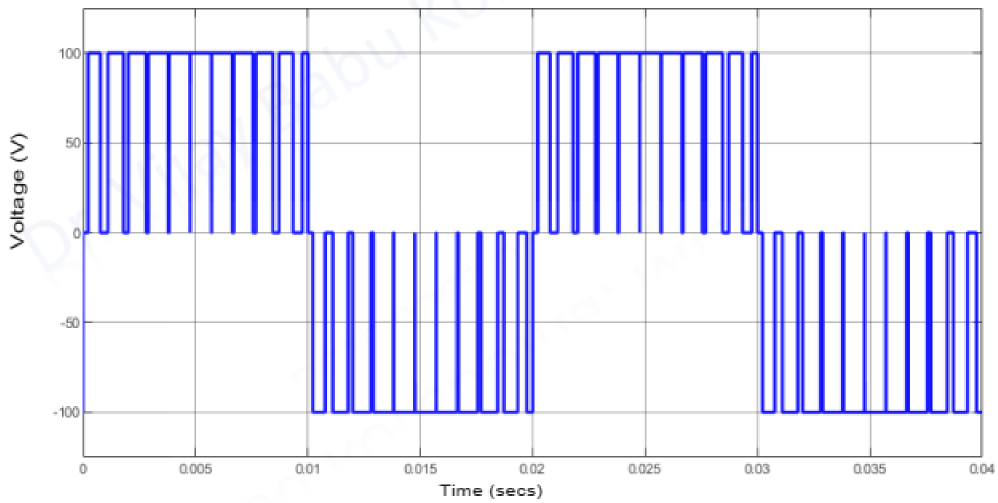
FFT window of output voltage with single pulse PWM mode:

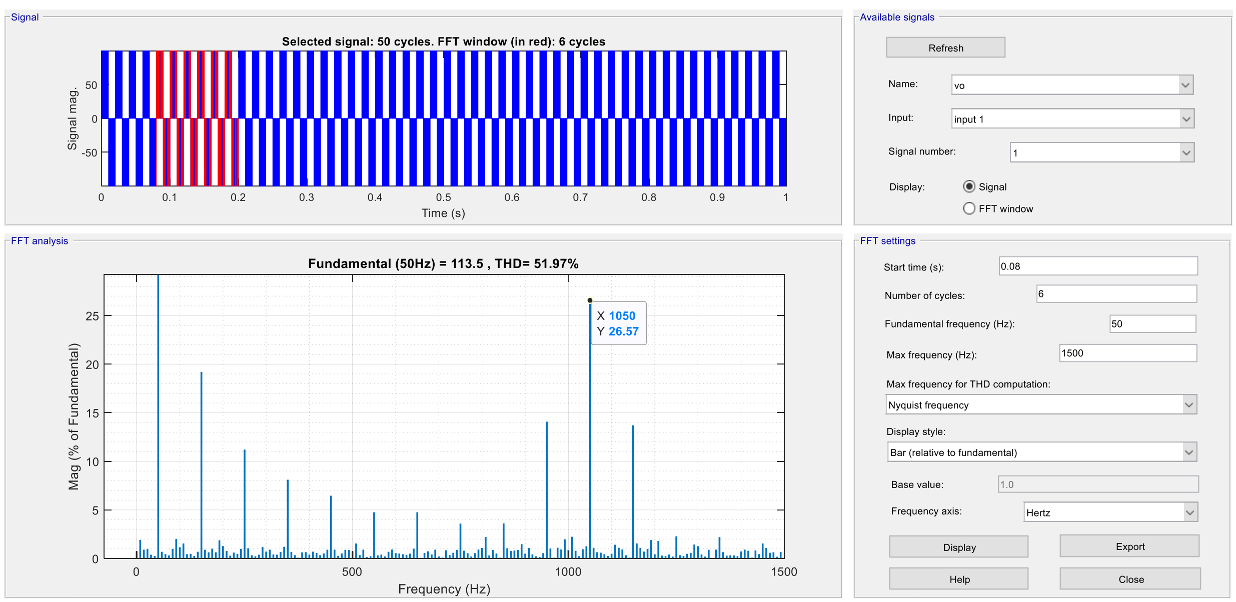


Problem 2:

To develop an single phase DC-AC inverter with DC voltage as 100 V and resistive load R=10 ohm using sine-PWM technique. Observe the output Voltage to be AC form with 50Hz (0.02 sec). The carrier frequency of triangular wave can be 1050 Hz. Observe the FFT analysis window of output voltage which depicts lower order harmonics (Which are hard to filter)

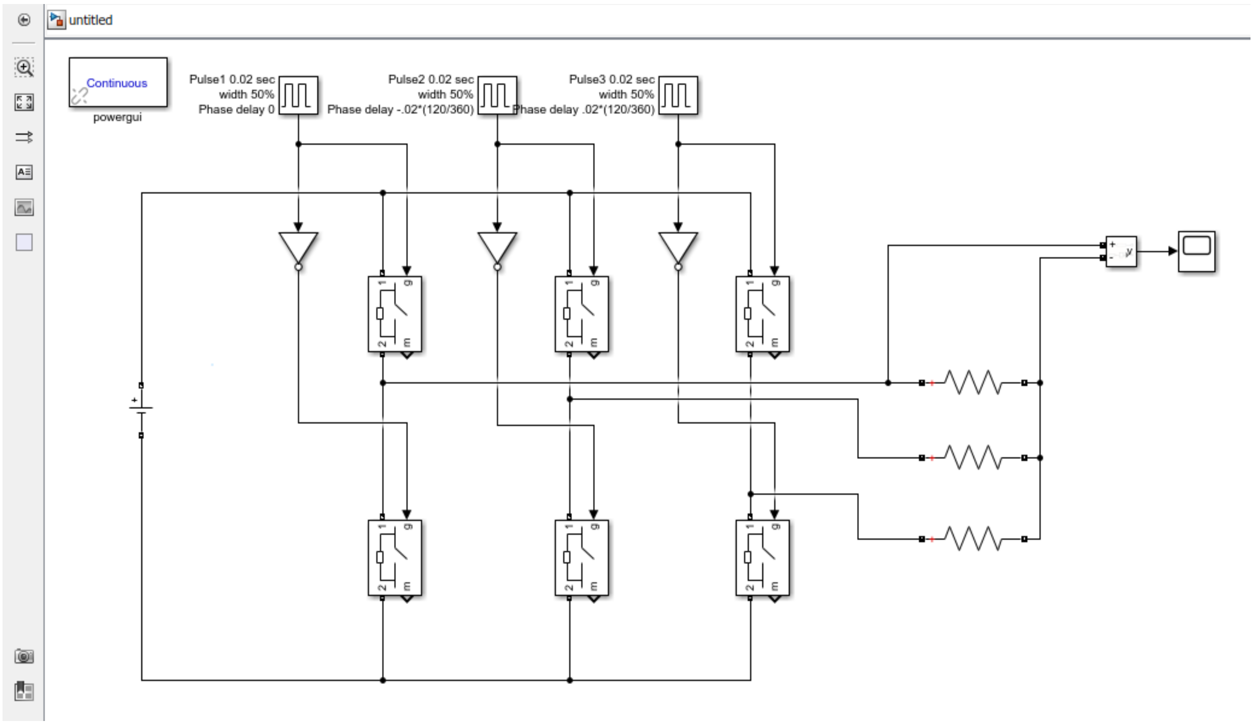


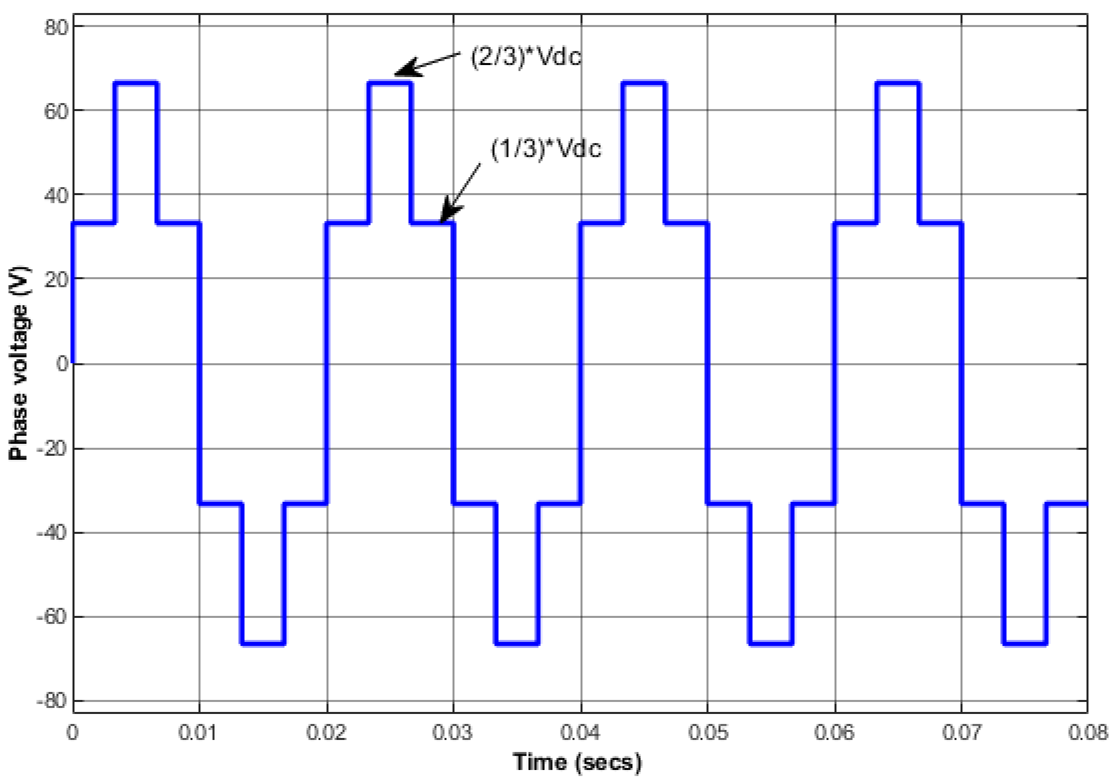




Major portion of harmonics are shifted to carrier frequency (1050 Hz) which is higher frequency than fundamental frequency and is easy to filter out with small value of fliters.

Three phase Inverter: 180 deg conduction mode





Lab VIII:

Date : __ /__ /__

Familiarization of PLC based Drive control

Aim:

To familiarize PLC based drive control and loading drive parameters to enable PLC logic programming. Also, to code the encoder to assist linear motion.

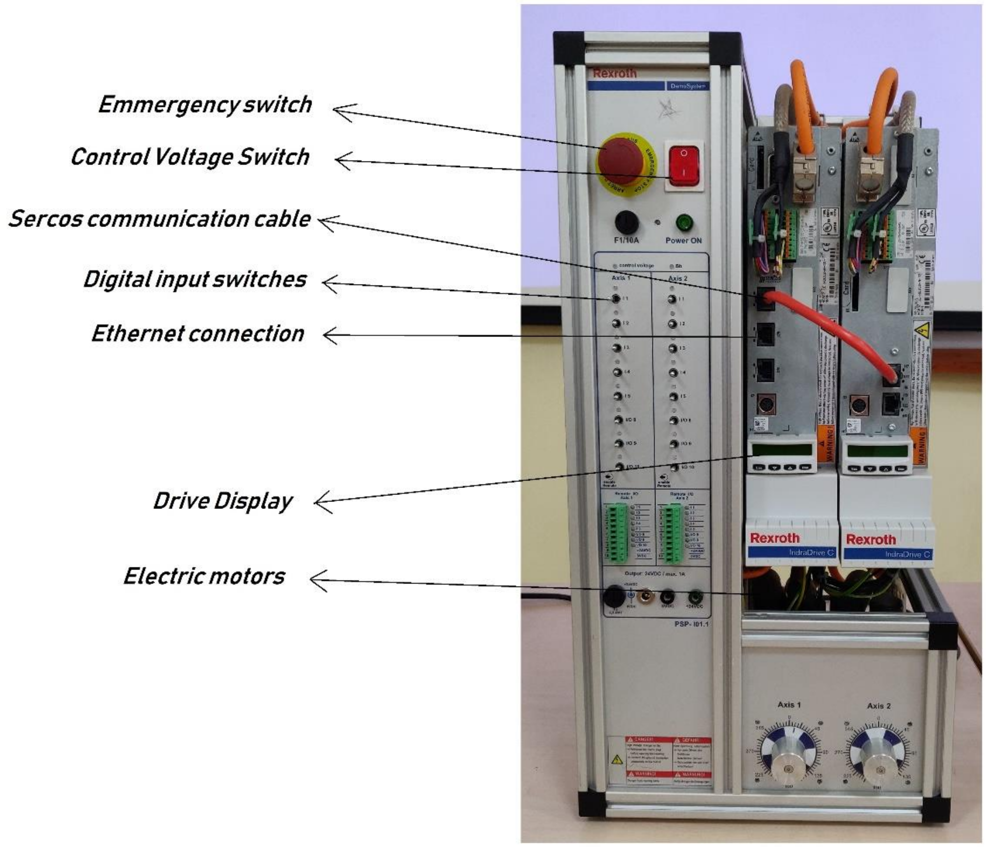


Fig : Rexroth Plc based Drive Control

Steps for initializing drive

1) Turn on the control voltage switch
2) Release the emergency safety button.
3) In few seconds, press power on button.

You have just activated the control voltages/currents. The single phase supply has been converted to dc and then converted to 3 phase ac supply using the power converters in the drive and ready to be supplied to your motors which are 3 phase ac servo synchronous motors.

4) Check for drive display – **BB** shows healthy connection with power supply ready.
5) If display shows RL/F2704 – press escape
6) Click on power switch on the panel- Drive status changes to AB.

Steps for parameterizing the drive to the PLC.

1) Connect the drive to Ethernet port '**X26**'.
2) Check the IP address of Ethernet X26 port on Drive Display of hardware.
3) Correct you PC IP address starting from 192.168.1.6 onwards.
4) Open "Indraworks Engineering", Project → Scan for devices.
5) Add "Indraworks Ethernet" → Next
6) Set IP address range 192.168.1.1 to 192.168.1.5→Finish
7) HCS02.1 will be detected and added (which is axis 1)
8) Axis 1 Default- "Enter Parameterisation Mode"

Steps for enabling master –slave configuration.

9) Sercos check cross communication drive active and MLD in CCD master. Add slave address 2.
10) Update slave drive parameters.
11) MLD – Configuration check "PLC has permanent control over drive."
12) Local I/o – I/O X31/X32
    a. 1-2 is drive enable power supply don't alter
    b. 3 ,4,5,6,7 configure as input ports – P-0-1390 : PLC input word at %IB0 . ***X*** *varies from 0 to 4*

Steps for setting up the drive measuring units and gears .

13) Axis1-measuring units-scaling units- rotary/linear.
14) Axis1-measuring units-scaling units -Gears – 1:1
15) Exit parameterization mode. Enable operational Mode. Check for drive status "AB/AH"

Steps for programing the drive

16) Logic PLC_PRG
17) MC_Power – enable drive/ provide holding torque.
18) MC-stop - Stop with deceleration mentioned
19) MC_moveVelocity – CW direction with defined speed/acc/Dec.

Exercise A.

Write a program the drive to move the motor in CW direction with speed of 1000 rpm.

Exercise B.

Write a program the drive to move the motor in CCW direction with speed of 1000 rpm.

Exercise C

Write a program the drive to move the motor in forward direction to a position of 10mm.

Exercise D.

Write a program the drive to move the motor in backward direction to 50 mm distance.

Procedure

PLC logic

Part B: Master Slave

Master and Slave operation of Drives

Aim:

To familiarize PLC based drive control and master –slave configuration and programming.

Exercise I

Write a program to drive the master in CW direction with a speed of 2000 rpm. Also start the slave connected to drive in CCW direction with a speed of 1000 rpm exactly after 60 sec of master operation. Stop the master after 5 minutes of its operation and the slave after 7 minutes of its operation.

Exercise II

A picker head is placed about 15 cm above the conveyor belt (conveyor1). When the product comes beneath the picker the sensor S1 turns on signaling the picker to pick up the thing. Then the task of the picker head is to place the product on the second conveyor belt placed at a height of 10 cm and distance of 250 cm from the conveyor 1 within a period of 2 min after S1 goes on. Until unless picker head has not reached initial position (sensed by sensor S2), S1 has to stay OFF. As long as next product comes in conveyor1 the picker head stays in rest position. Add a manual emergency stop to the entire process without disabling the drives

Procedure

PLC logic

Lab IX :

Date : __ /__ /__

Familiarization of HMI Module

Aim:

To program a PLC based HMI module to add and subtract two numbers.

Procedure

1. Open IndraWorks Engineering
2. Open a new project
3. From the right hand pane under Drives and Control open the IndraLogic folder. Drag and drop the IndraLogic L20 DP under the new project created in step 2.
4. Select Target as FWA-CML20*-IL-04VRS-D0-0003 and Firmware release as FWC-ILsL20-RUN-04v27.01-NN
5. Create a new communication parameter and give the local address as 192.168.1.20 for the PLC.
6. Write the PLC program using ladder logic for the given experiment.
7. Go to the Project tab in the upper pane and click on options. Click on Symbol configuration. Click on configure symbol file button. Check all the boxes in the pop up box.
8. Rebuild the project and check if the symbol file has been created successfully.
9. Create the HMI screen using the following steps:
10. Click on Visualization tab on the right hand pane. Drag and drop the VCP/VCH mode onto the new project created.
11. Select device name as VCP11(TFT) which appears in the pop up. Click on VI composer software from the left hand pane.
12. In VI Composer, under the communication tab, click on BRC-symbolic. Click on Edit in the Communication parameters.
13. Select Ethernet in the transport layer protocol and add 192.168.1.20 as the IP address of control.
14. Give the connection a name and link the variables created in the symbol file to this connection name.
15. Create the HMI screen by going to Languages→First language→Screens→Main screen. Create the screen according to the question provided.
16. Compile the program and download it onto the HMI given the IP address of 192.168.1.11.

PLC logic

HMI Screens

Part B:

Date : __ /__ /__

HMI coding for Star Delta startup

Aim:

To program a PLC based HMI module for the following:

In order to avoid high starting currents, three-phase asynchronous motors are firstly switched in a star connection and then, after a time delay, switched over into a delta connection. By activating the S1 pushbutton “Start”, the star contactor K2 and the main contactor K1 are activated. The star contactor K2 is deactivated after a time delay of 5 s and simultaneously, the delta contactor K3 are activated. Now, the motor is running in nominal operation. By activating the S2 pushbutton “Stop” or the motor protection switch F2, the control is immediately set into the idle state. You have to note in the program preparation that the main contactor K1 may only be activated if contactor K2 has been activated. It must moreover be ensured that the star contactor K2 and the delta contactor K3 are never activated simultaneously. The respective switching states of the contactors are to be queried via S4 and S5. By means of the message contacts S4 and S5, the control is transmitted the current switching state.

PLC logic

HMI Screens

Scheme:

Internal: 60 Marks

1. **Every student will be graded out of 10 for the each simulation lab experiments and their exercise. (10*7 = 70).**
2. **Every student will be graded out of 5 for the each practical conducted and record of results. (5*4 = 20)**
3. **Mini Project of 30 Marks.**
4. **On successful completion of the 11 exercises and Mini Project, the total marks out of 120 shall be scaled down to 60 to be graded as the Internal mark of the exam.**

External: 40 Marks

1. **One Minor and One Major Question**
2. **End Sem evaluation is carried out for write up, conduction and results.**

Assignment/Exercises

Drives, Controls and Modelling Lab (MTE 3161, 2018 New Curriculum)

Effect of P, PI, PD, PD Controls on a given second order plant

$$G(s) = \frac{1}{s^2 + 10 * s + 20}$$

Control of 3ph Induction Motor using 3ph Inverter

PLC based Real time Motor Control (using single axis)

1. **For various change in speeds in rotary mode.**
2. **For various distances travelled in linear mode**

PLC based Real time Motor Control (multi axis using master slave)

1. **For various change in speeds in rotary mode.**
2. **For various distances travelled in linear mode.**

Developing HMI based simple calculator application.

Developing HMI based ATM application.