BUCK CONVERTER

End Semester Project Report

Project Scenario : 4

EE-371 LINEAR CONTROL SYSTEMS

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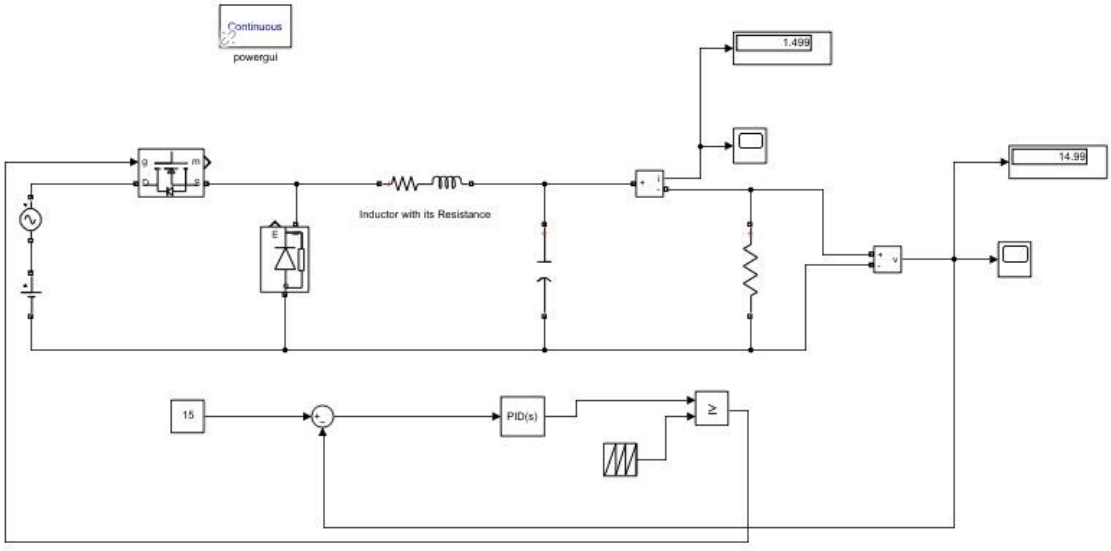
Preface:

This project is about Buck Converter is the basic switched-mode power supply topology. Buck converter is a DC-DC converter which will step down a higher voltage to a lower voltage level, that means output voltage magnitude is less than the input voltage magnitude. The Buck Converter produces voltage ranging from the input voltage to down to Zero voltage. It is widely used throughout the industry to convert higher DC input voltage into lower DC output voltage. A buck converter is a step-down DC to DC converter. For a DC–DC converter, input and output voltages are both DC. It uses a power semiconductor device as a switch to turn on and off the DC supply to the load. The switching action can be implemented by a BJT, a MOSFET, or an IGBT.

Given Design Specifications:

Input Voltage (V_i)	110 ±10 V
Output Voltage(V_o)	15 V
Load Current (I_R)	1 to 5 A
Ripple voltage	± 2%
Inductor's resistance R_L	0.1 Ω
Transistor R_{on}	0.01 Ω
% OS	≤ 20%

Simulink Circuit:



Transfer Function:

$$H(s) = \frac{\frac{1}{LC}}{s^2+\left(\frac{R_L}{L}+\frac{1}{RC}\right)s+\frac{\frac{R_L}{R}+1}{LC}}$$

$$\text{PID Controller } G(s) = P + \frac{I}{s} + \frac{DN}{1+\frac{N}{s}}$$

So, Overall Transfer Function;

$$T(s) = \frac{\frac{\frac{1}{LC}}{s^2+\left(\frac{R_L}{L}+\frac{1}{RC}\right)s+\frac{\frac{R_L}{R}+1}{LC}}}{1+\left[\frac{\frac{1}{LC}}{s^2+\left(\frac{R_L}{L}+\frac{1}{RC}\right)s+\frac{\frac{R_L}{R}+1}{LC}}\right]\left[P + \frac{I}{s} + \frac{DN}{1+\frac{N}{s}}\right]}$$

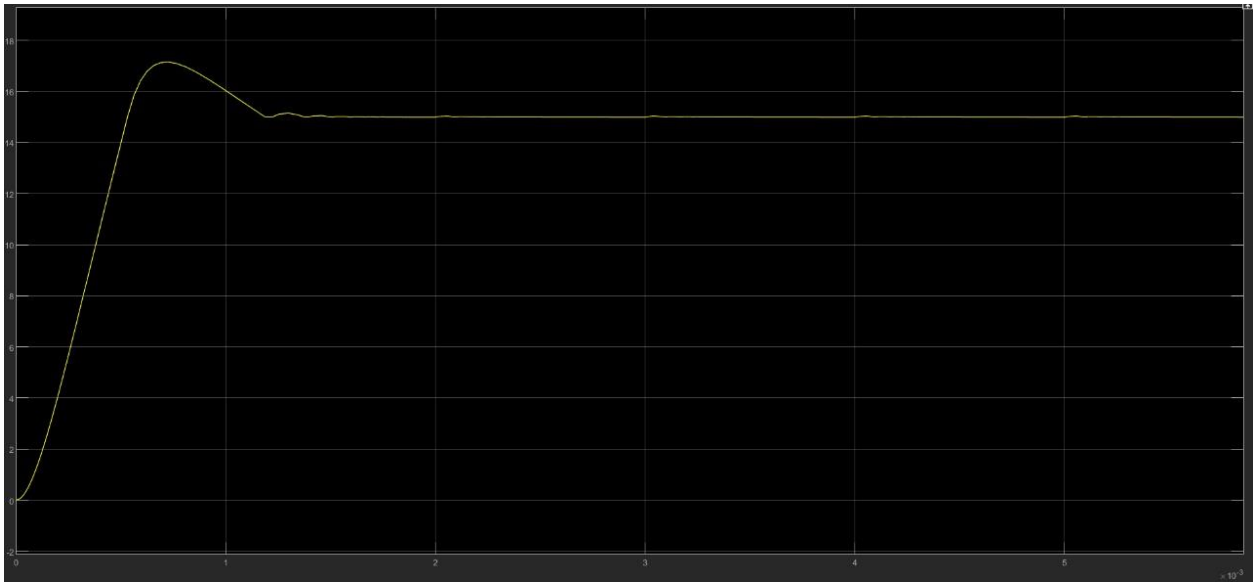
$$T(s) = \frac{sR}{s^3+s^2(R_LRC+L)+s(R_L+RP)+RI}$$

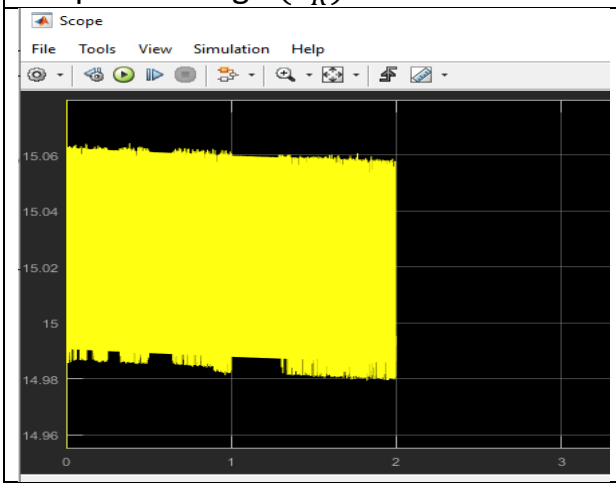
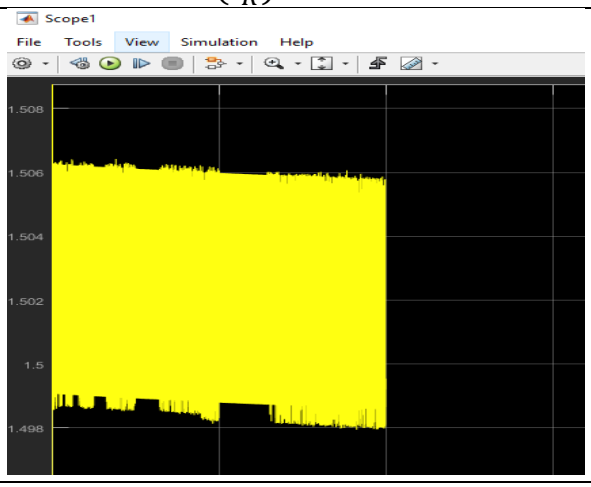
By putting values,

$$T(s) = \frac{10s}{(3e-6)s^3+s^2(0.030001)+s(1010.1)+200}$$

Results:

V_o Plot at R=10 Ω:

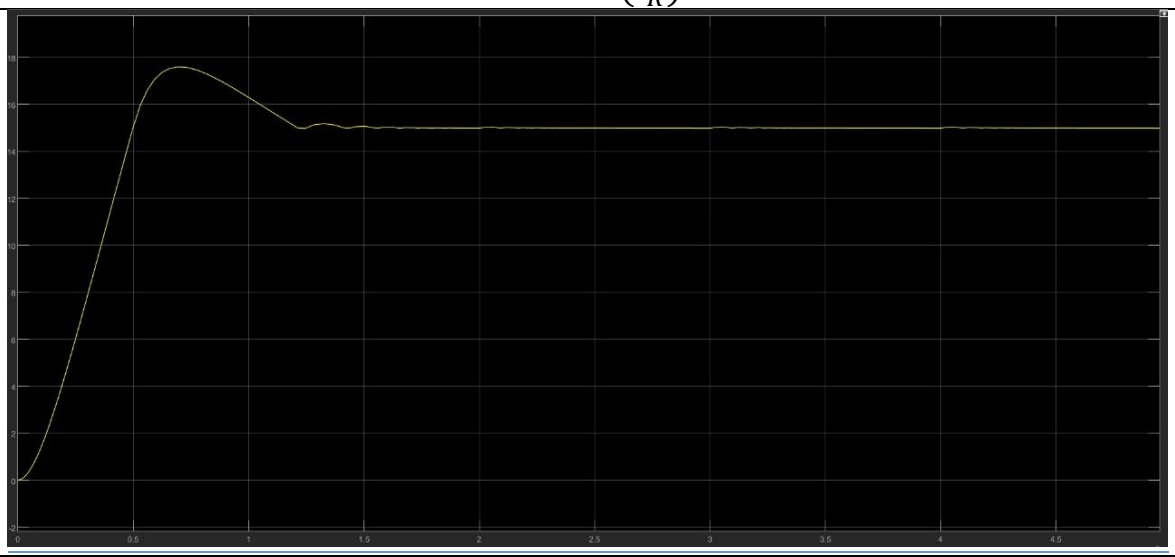
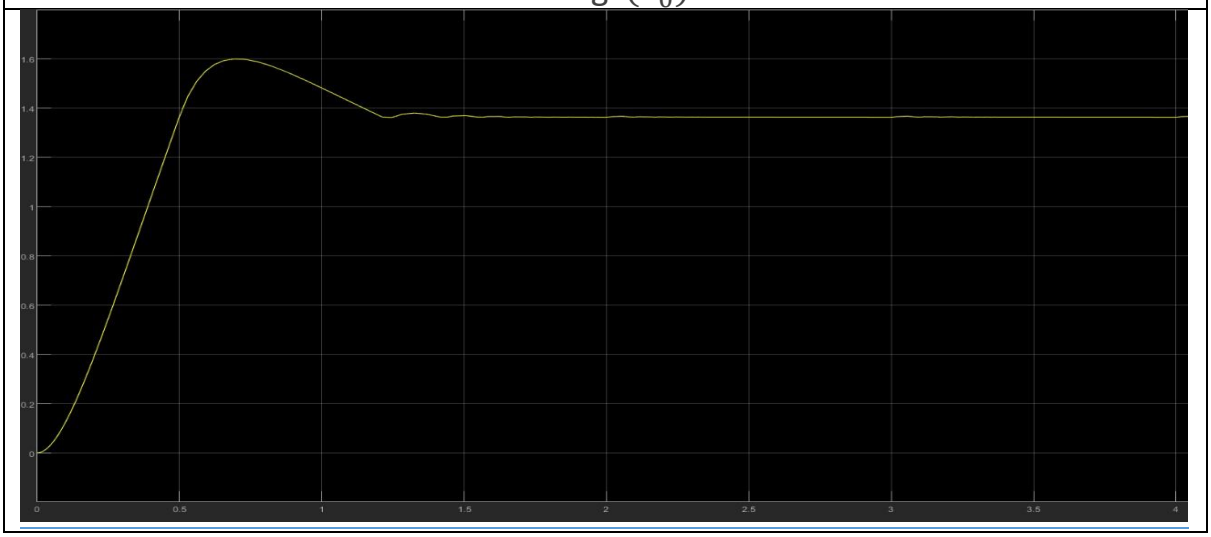


Output Voltage (V_R)	Load Current (I_R)
	

Overshoot :14.6 ≤ 20 % which is acceptable according to our design specs.

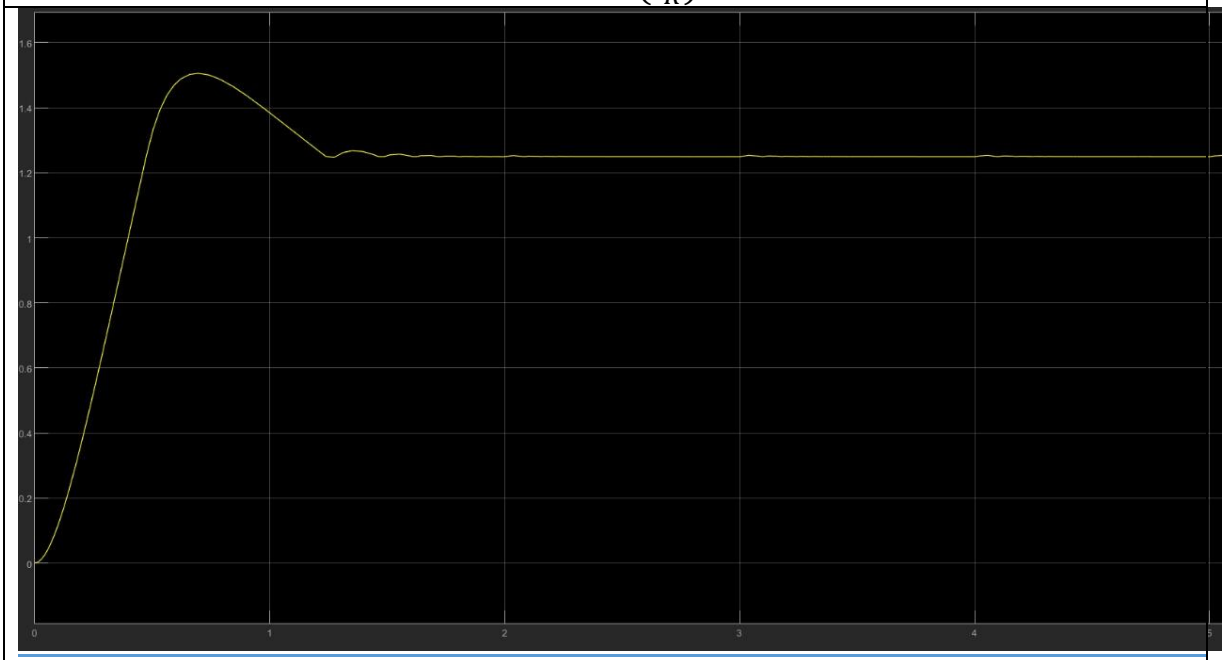
Ripple Voltage: 0.4 % ± 2% which is acceptable according to our design specs.

At load 11 Ω :

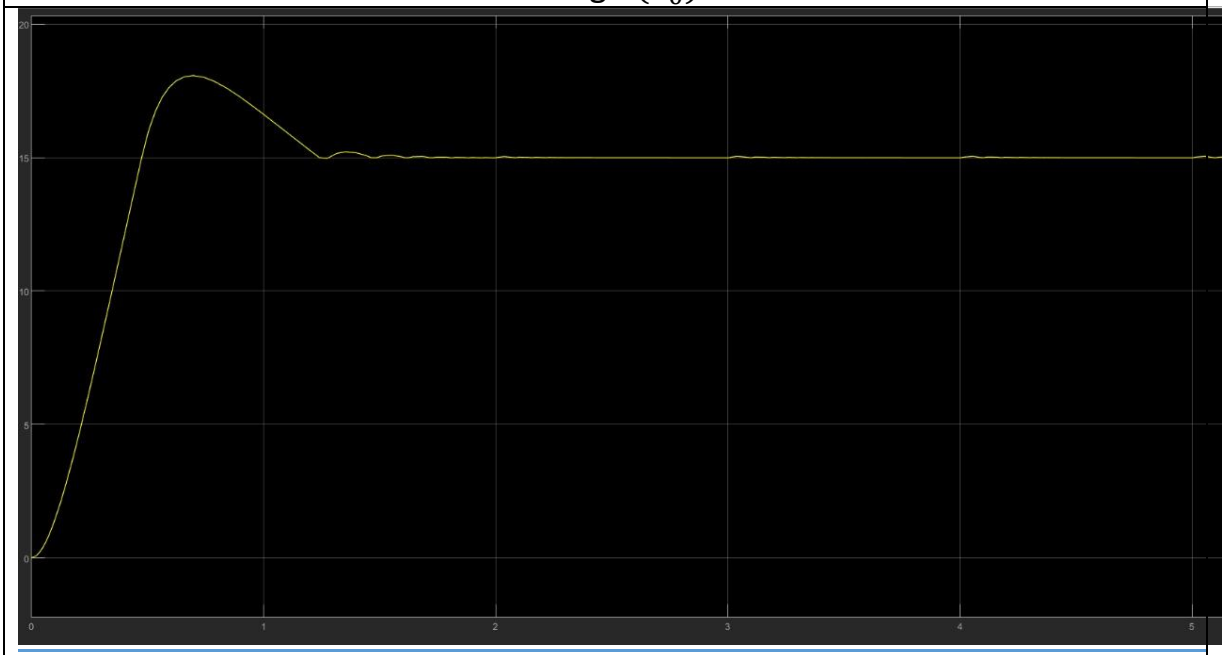
Current (I_R)

Voltage(V_0)


At load 12 Ω:

Current (I_R)



Voltage (V_0)



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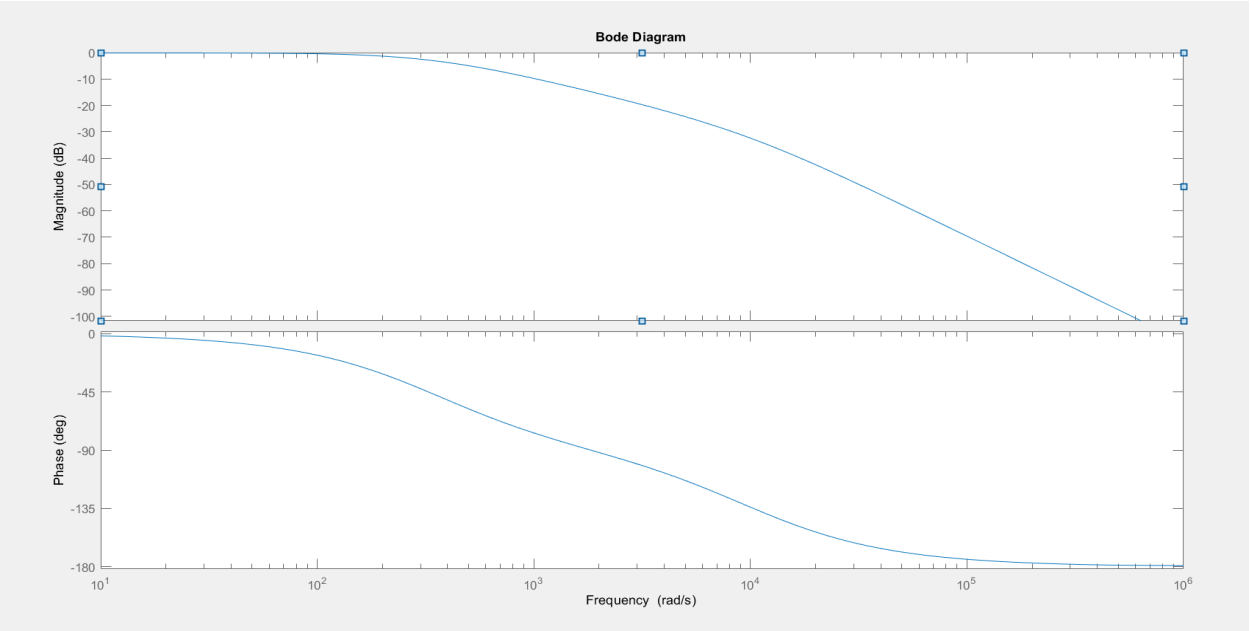
Bode plot without feedback:



Cost of Implementation:

- Diode Rs.60
- P-channel Mosfet(IRF9540) Rs.100
- PID CONTROLLER Rs.2860
- (Inductor,resisor,capacitor) Rs.100
- Comparators Rs.60
- Connecting Wires Rs 50
- TOTAL COST: Rs 3130 (approx.)

Conclusion:

From the simulation results it is found that in case of the buck converters, the desired output voltages can be obtained by selecting proper values of inductor, capacitor and switching frequency. At each stage, targets were set to acquire the necessary skills to meet the criteria of the project and design the circuits for implementation into the software and hardware simulation. This project gives the opportunity to study new skills and raise valuable knowledge in circuit designing and problem solving skills which has greatly enriched knowledge and understanding through the erudition route which may help one in for the further progression.