A

ProjectReport

on

DESIGN OF PID CONTROLLER FOR DC TO DC CONVERTER TO IMPROVE THE VOLTAGE PROFILE

Submitted in partial fulfilment of the

requirement for the award of the

Degreeof

BACHELOR OF TECHONOLOGY

in

ELECTRICAL ENGINEERING

by

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May, 2020

DECLARATION

We declare that the work presented in this report titled "**Design the PID controller for DC to DC converter to improve the voltage profile**", submitted to the Department of Electrical Electronics and communication Engineering, Galgotias University, Greater Noida, for the Bachelor of Technology in Electrical Engineering is our original work. We have not plagiarized unless cited or the same report has not submitted anywhere for the award of any other degree. We understand that any violation of the above will be cause for disciplinary action by the university against us as per the University rule.

Place:

Date:

Signature of the Student

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Shubham Sharma (1615105021)

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Dhirender chaudhary (1615105008)

School of Electrical, Electronics and Communication Engineering

CERTIFICATE

This is to certify that the project titled **"Design Of PID Controller for DC to DC Converter To Improve The Voltage Profile Quadratic Regulator''**is the bonafide work carried out by Shubham Sharma, Dhirender Chaudhary students, during the academic year 2019-20.We approve this project for submission in partial fulfilment of the requirements for the award of the degree of Bachelor of Technology in Electrical Engineering, Galgotias University.

Mr. D Saravanan
Project Guide(s)

The Project is Satisfactory / Unsatisfactory.

Internal Examiner (s) External Examiner

Approved by

Dean

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ABSTRACT

The several practicals and industrial applications of power electronic based cuk converters are used in hybrid electric vehicles, renewable energy system, electronic voltage regulators, etc, to provide required voltage regulation between the input DC and output DCfor the better result of all these kind of practical applications , it seeks a quick and stable response from a cuk converter along with regulated DC output magnitude. By using of closed loop PID (proportional cum integral cum derivative) controller we control the converter. By using the PID controller the efficiency of the overall converter depends on how well we tuned our PID controller. There are so many methods for tuning the PID controller gain specification and to find the best tuning method is a difficult task. But a method is not generalised for other system it's just best for a given application. Hence for different application there may be different methods of tuning for better result.

So, basically this project is performed on MATLAB software where we can tuned the PID controller by several methods and compare all of them and taken out the best result for the cuk converter control application with the help of time domain performance model and frequency domain stability model.

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GLOSSARY

1.	PID	Proportional integral derivative controller
2.	ZNM	Ziegler Nicholas Method
3.	ZNM 2	Ziegler Nicholas Method 2

1. PROJECT OVERVIEW

1.1.INTRODUCTION

This project is specifically used for renewable power source like solar, wind energy system. In this challenge cuk converter is used because Voltage regulation for DC application device is particularly carried out with the assist of DC/DC converter .The cuk converter is used to nullify the voltage variant produces by the variation in the intensity of sun light and wind flow. Hence cuk converter is best of this application. The L-C circuit is used to compensate the ripple content material in output of the device because due to a few ripple element the output reaction of cuk converter isn't pop out as a constant DC.The main characteristic of cuk converter is to changed the enter voltage to the output voltage with contrary polarity. In this undertaking PID controller is used to improve the output voltage of the machine to get the extra solid and correct result however for this the PID tuning is important so In this assignment numerous conventional PID tuning strategies are computed manually and applied to the PID controller of cuk converter to get smooth transient state and low gain values and less settling time.

1.2 OBJECTIVE OF THIS PROJECT

The main objective of our project is to improve the output volatge profile and minimize the output voltage oscillations of the cuk converter.

1. As we known for voltage regulation for DC application system the use of DC-DC converter is must.

- **Cuk converter** - The cuk converter is mainly used in DC applications as the main function of this converter is to transformthe input voltage to the output voltagewith inverse polarity and due to constant input and output current this converter is more useful for these types of applications.

2. In this project we used the PID controller to enhance the output voltage and to get the more stable result from cuk converter.
3. PID tuning is performed to get more stable result.

- Different types of tuning methods are performed to tune the PID controllers

4. Using MATLAB simulation to compares the final result.

1.2 METHODOLOGY

- Study on different types of converters and its working principle and applications.
- Study on different types of controllers.
- Study on how can PID controllers is to be tuned.
- Study on different types of tuning methods of PID controller.
- Study on MATLAB software.

2. INTRODUCTION TO DC-DC CONVERTER

2.1 DEFINITION

A DC-DC converter is nothing but the electronic devices which helps to change the level of the voltage from one form to another form it may be from high voltage to low voltage or from low to high voltage.

In a DC to DC converter the input DC electricity is enter to an inverter which produces an AC sign (normally a square wave). That sign feeds the number one of a transformer that can step up or down the AC sign. The output side is rectified to produce DC of the specified voltage.

When the output voltage is much less than the input voltage. A switching regulator may be used for efficiency. It consists of a excessive frequency oscillator powered through the DC enter. A regulator allows pulses to circulate a capacitor(s) the load varies. The capacitors output is filtered to supply the DC output.

2.2 BASIC DIAGRAM OF DC-DC CONVERTER

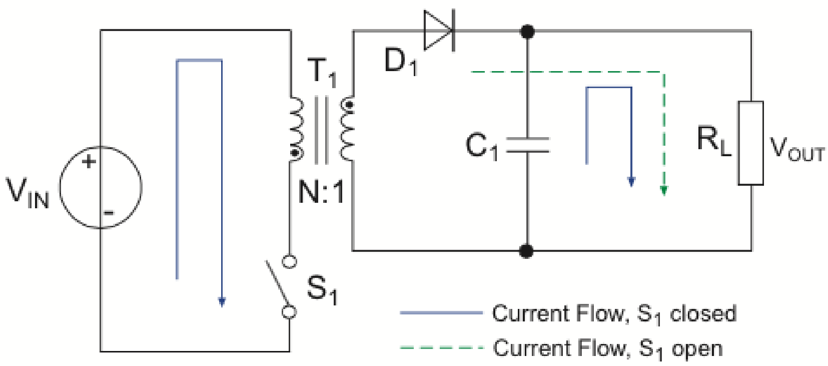

Fig.2.1: DC-DC Converter

2.3 TYPES OF DC-DC CONVERTERS

- Boost converter
- Buck converter
- Buck-Boost converter
- Cuk converter

2.4 BOOST CONVERTER

A Boost converter is a very simple electronic divides which just boost up or step up the value of output voltage from its input (power supply) to its output. (load).

The main components used in the boost converter is generally an inductor a semiconductor switch (MOSFET, IGBT), a capacitor and a diode and a square wave power supply.

CIRCUIT DIAGRAM:

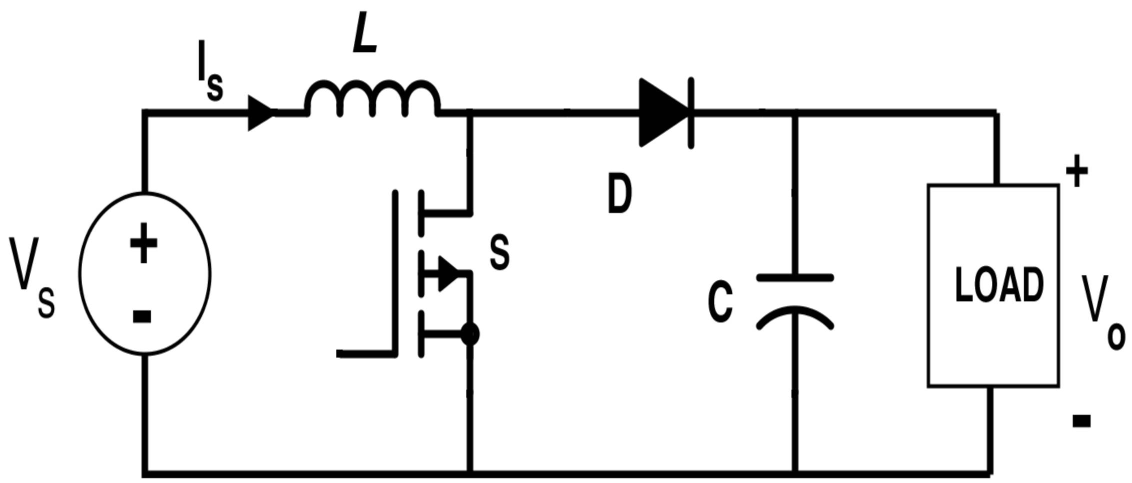

Fig.2.2: Circuit diagram of boost converter

Where, Vs = Power Supply, L = Inductor, S = Switch ,C = Capacitor, Vo = Load ,
D = Diode

APPLICATIONS OF BOOST CONVERTER

Boost converters are used in.

- Automotive applications
- Adaptive control applications
- Used in regenerative braking of DC motors
- DC motor drives
- Power factor correction circuits
- Battery power system

ADVANTAGES OF BOOST CONVERTER

- The main advantage of boost converter is its own working i.e produces the higher value of output voltage as compared to input.
- IT has low operating duty cycle .
- The input current is continuous due to which it is easy to filter the electromagnetic interference.
- Very high efficiency
- Simple design

DISADVANTAGES OF BOOST CONVERTER

- The transient response is slower
- To reduce the ripple voltage as output current is pulsating large output capacitors is required.

2.5 BUCK CONVERTER

A buck converter is nothing but a type of switch mode converter and produces lower output voltage then that of input voltage.

The important components used in this converter is generally an inductor a semiconductor switch (MOSFET, IGBT), a capacitor and a diode and a square wave power supply

CIRCUIT DIAGRAM

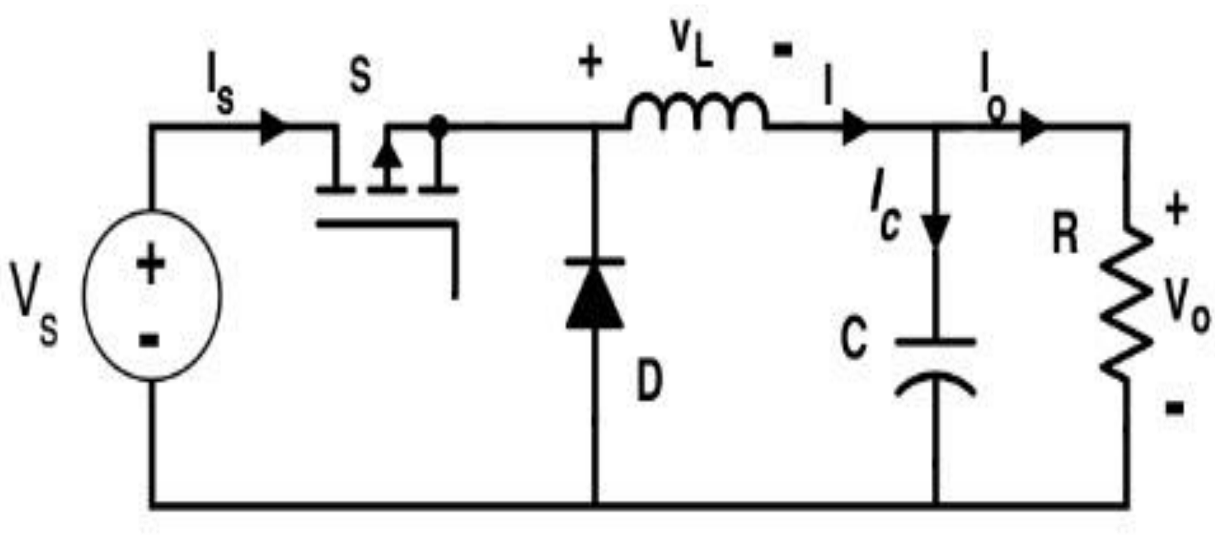

Fig.2.3: Circuit diagram of buck converter

Where, Vs = Power Supply,

L = Inductor

S = Switch

,C = Capacitor,

Vo = Load

D = Diode, Is = input current.

APPLICATIONS OF BUCK CONVERTER

- This converter is used as the point-of-load (POL) and laptops
- Used in battery chargers
- Buck converters is also used in solar chargers
- In audio amplifiers
- In pure sine wave power inverters
- In quad copter
- In brushless motor converter.

ADVANTAGES OF BUCK CONVERTER

- The main advantage of buck converter is its own working i.e to step down the value of output voltage.
- It is cheaper then compared to other converter
- Simple and cheaper design
- It offers systematic solution with smallest external components.

DISADVANTAGES OF BUCK CONVERTER

- Buck converter has slow transient response
- It needs input filter
- High output ripple

2.6 BUCK BOOST CONVERTER

The buck boost converter is a switch mode or DC-DC converter which is basically a combination of both buck as well as boost converter and also work same as buck and boost converter i.e either step-up the output voltage or step-down the output signal as compared to input signal the magnitude of the output voltage is depend on the duty cycle.

CIRCUIT DIAGRAM

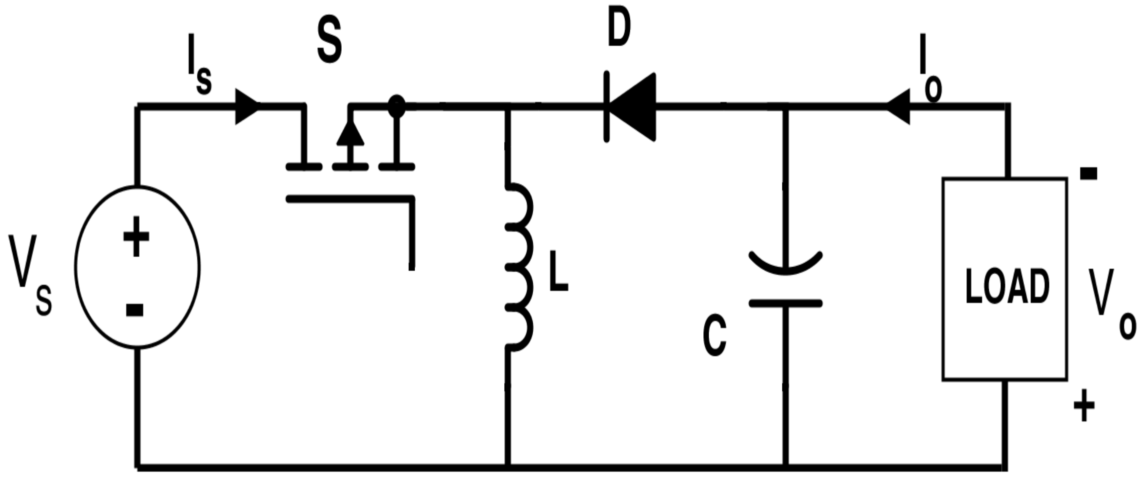

Fig.2.4: Circuit diagram of buck boost converter

Where, Vs = Power Supply, L = Inductor, S = Switch ,C = Capacitor, Vo = Load ,
D = Diode

APPLICATION OF BUCK- BOOST CONVERTER

- Buck-boost converter is used in self regulating power supply
- Works in a power amplifier applications
- Automotive applications
- DC motor drives
- Power factor correction circuits

ADVANTAGES OF BUCK BOOST CONVERTERS

- The main importance of buck boost converter is that it can done both the work either higher-up the voltage or lower-down the output voltage
- Buck boost converter is used in self regulating power supply
- Works in a power amplifier application
- High efficiency
- Simple design and low cost
- Lower operating duty cycle

DISADVANTAGES OF BUCK BOOST CONVERTER

- Due to discontinuous of input current and charging current result in increasement in the size of filters and EMI issues.
- No separation provided in between input to output side which is very reproving (critical) for many applications
- Due to inverted output results in complex sensing and feedback circuits.

2.7 CUK CONVERTER

- **BASIC INTRODUCTION:**

  The Cuk converter is one of the most important and useful converter for the purpose of voltage regulation for DC application project. These types of converters are used mainly in renewable energy systems like wind energy, solar energy system as a voltage regulators where the input DC voltage is depends on some medium like wind, solar intensity and as we known that these medium intensity regularly changes with a time which causes a regulation in a voltage so to minimise the voltage regulation of the system Cuk converter is used.

- **DEFINITION :**

Cuk converter changes the magnitude of the output voltage in both the form i.e in higher as well as lower form then the magnitude of input voltage. The main function of cuk converter is to transform the input voltage to the output voltage with inverse polarity.

CIRCUIT DIAGRAM OF CUK CONVERTER

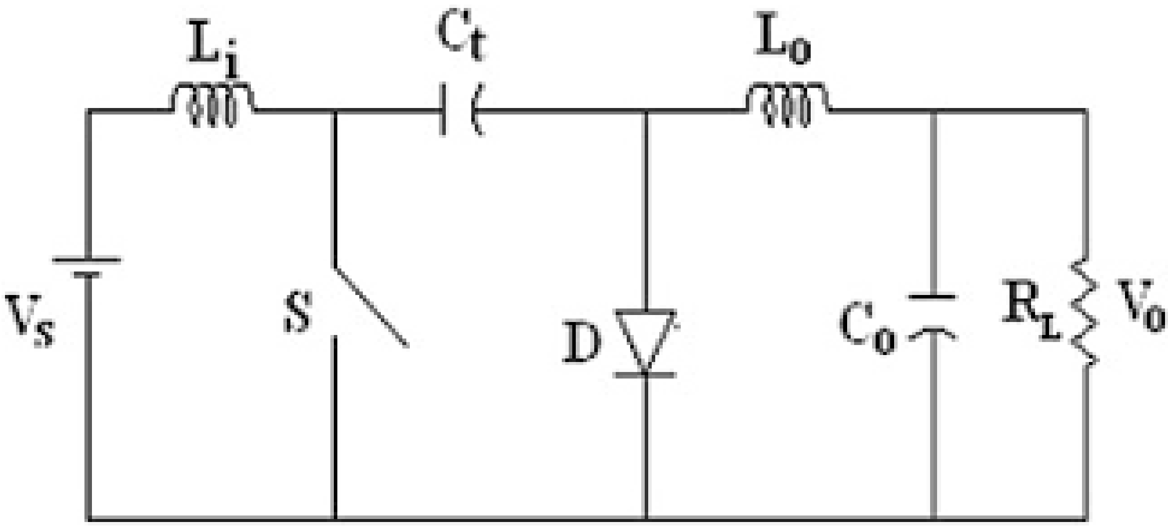

Fig.2.5:Circuit diagram of cuk converter

Where, Vs = Source Voltage, Li = Inductor on source side, Ct = coupling Capacitor, Lo = Inductor on output side, Co = Capacitor on output side, RL = Load Resistance.

2.8 DESCRIPTION OF CUK CONVERTER

- In this converter the power from input part to the output part is transferred through the coupling capacitor (Ct) .If we look at fig 2.5 it shows that the circuit of cuk converter is the mixture of step down converter and step up converter. It consists of four energy storing element i.e two capacitors (Ct,Co), two inductors (Li,Lo) , a switch (S) and a diode(D). If we talking about the working of cuk converter so it operates in two modes first is when switch is on and second one is when switch is off. When sitch is on the diode behaves as a open circuit the voltage stored voltage in coupling capacitor is shifted to the inductor, capacitors and the load at output side. At the time when switch is off diode behaves asclosed circuit at that time the coupling capacitor is charged from the supply which getting from input and from the energy produced by the input inductor.

2.9 **BASICSIMULINK MODEL OF CUK CONVERTER :**

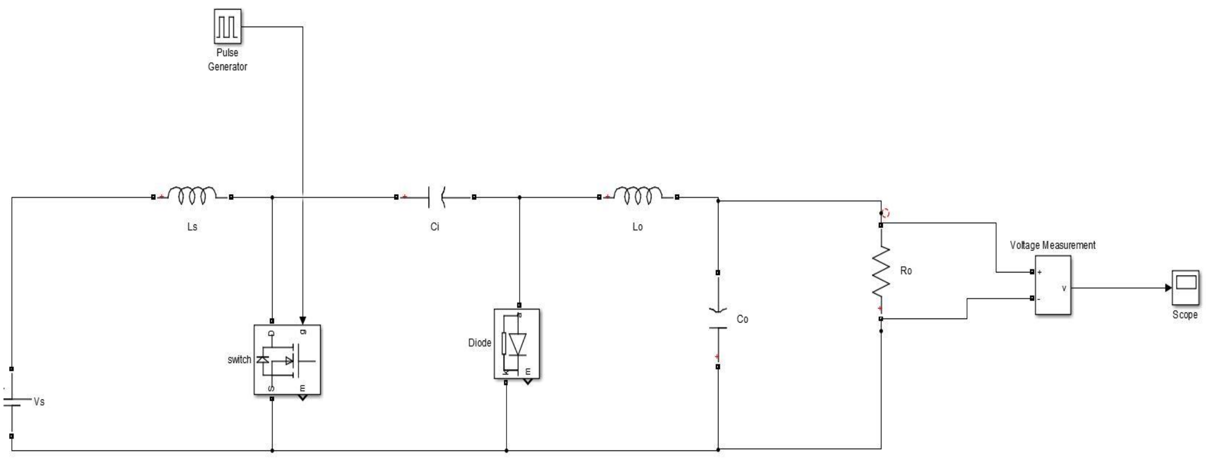

Fig.2.6: SimulinkModel of cuk converter

APPLICATIONS OF CUK CONVERTER

- To make the output voltage as constant source cuk converter is used
- It also used where voltage regulator is required
- In DC drives
- Cuk converters used in hybrid solar, wind energy system as a regulator
- Works as a power amplifier
- Automotive applications

ADVANTAGES OF CUK CONVERTER

- It gives constant supply of output and input current
- The sign of output voltage is reverse of input voltage
- Very high efficiency
- Works as both buck as well as boost converter
- Lower operating duty cycle
- There is no need to have the filter capacitor to reduce the output ripple.

DISADVANTAGES OF CUK CONVERTER

- Complex in design
- The **converter** is difficult to stabilize.

3. INTRODUCTION TO CONTROLLERS

3.1 BASIC INTRODUCTION.

- A basic introduction of controller is that ir is an electronic device which is generally used where automatic systems are installed like in industries where there is a need to regulates the flow of any type of liquids , temperature of material, pressure, level and other industrial process variables. In boilers to maintain the temperature automatically , in water tanks to maintain the water level etc.

DEFINITION:

- A controller is an device used in control system which compares the controlled value(comes from the output through feedback element)shown in fig.3.1 with the desired values (input value) and after the comparison if they found any error in the value then it has a ability to correct the deflection (Error) obtained in the system.

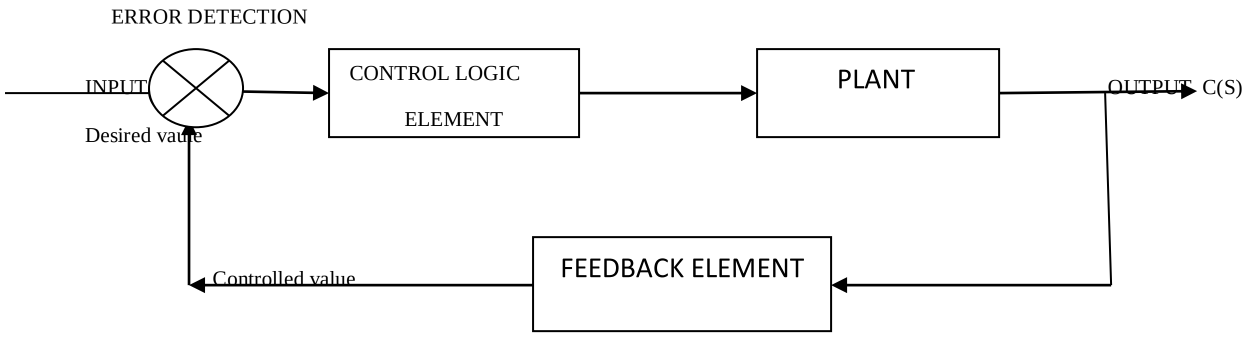

Fig.3.1: Structure of controller

3.2 USES OF CONTROLLERS.

- The main uses of controller are that it helps to increase steady state accuracy by reducing the steady state error.
- Due to increase in steady state accuracy the performance of the controller is also improved.
- Also help to reduce the offset of the control system
- Through controllers we can regulate the maximum overshoot of the system
- The noise signals is also reduced which is obtained by the system
- It makes response faster.

The function which corrects the deviation produced in a system while comparing the controlled value with desired value depending on that function there are three types of controllers and these controllers are known as analog controllers.

3.3 VARIOUS TYPES OF CONTROLLERS

- PI (Proportional Controller)
- IC (Integral controller)
- DC (Derivative controller)

Then we have the mixture of above controllers.

- Proportional derivative controller
- Proportional integral controller
- Proportional integral derivative controller.

3.4 PROPORTIONAL CONTROLLER

- This is a controller in which the actuating signal is to be proportional to the error signal.

✓ **Actuating signal:** This is a signal which compare that how much signal is deviated from output signal to input signal

✓ **Error signal:** Is a difference of feedback signal and reference input .

MATHEMATICAL EXPRESSION OF PROPORTIONAL CONTROLLER

$$\boldsymbol{Ea(t) \alpha E(t)}$$

$$\mathbf{Ea(t) = Kp.E(t)}$$

Here , E(a)= Actuating signal

E(t)= Error signal

Kp= proportional constant.

BASIC STRUCTURE OF PROPORTIONAL CONTROLLER

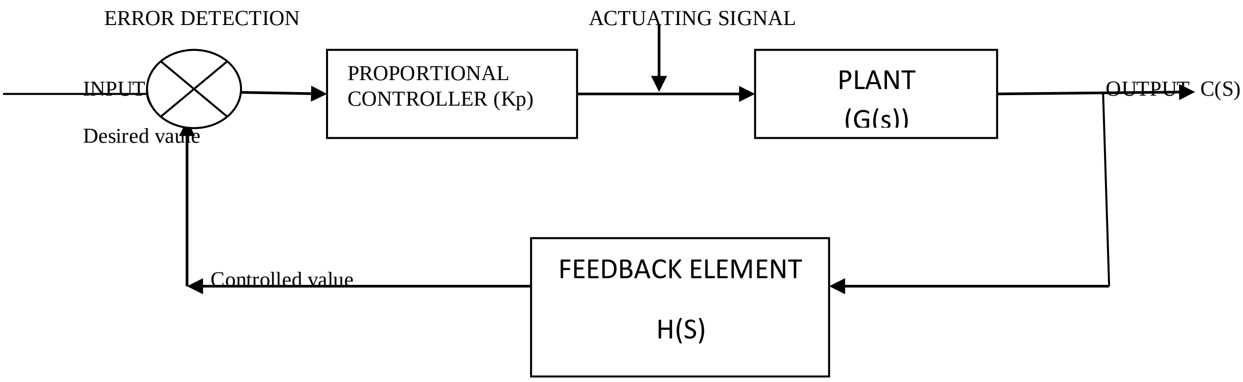

Fig.3.1: Structure of Proportional controller

Where , G(s)= transfer function of a plant

H(s)= feedback value

R(s)= Input signal

C(s)= output signal

USES OF PROPORTIONAL CONTROLLER

- Where error signal is low and need some amplifications.
- It is used where offsets can be tolerated
- Used where load changes are little.

MERITS OF PROPORTIONAL CONTROLLER

- Helps to reduce the steady state error
- By increasing in forward path gain results in making the response of the system faster
- makes system more stable

DEMERITS OF PROPORTIONAL CONTROLLER

- We get some offset in the system because of the presence of these controllers
- It improve the maximum overshoot of the system

3.5 DERIVATIVE CONTROLLER

The derivative controller is a controller in which the actuating signal is equal to the derivative of the error signals.

MATHEMATICAL EXPRESSION FOR DERIVATIVE CONTROLLER.

$$Ea(t) = \frac{d}{dt}.E(t)$$

BASIC STRUCTURE OF DERIVATIVE CONTROLLER

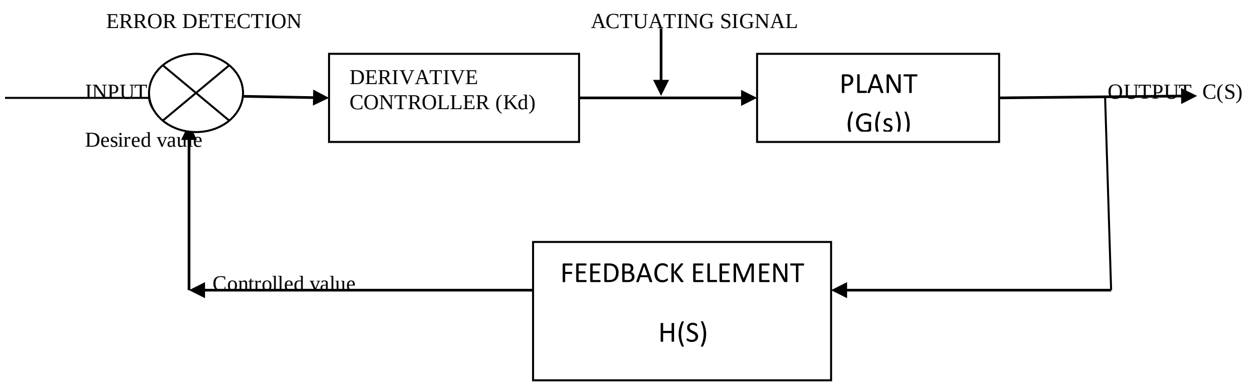

Fig.3.1: Structure of Derivative controller

MERITS OF DERIVATIVE CONTROLLER

- The main merit is that it increases transient response of the system.
- It improve the stability of the system
- Decrease the value of overshoot

DEMERITS OF DERIVATIVE CONTROLLER

- The major demerit of this controller is that it never uses alone because it compensate the output fast when there is a sudden change in the system
- Cannot improve the steady state error.
- Noise signals can be increased
- It produces saturation effects

3.6 INTEGRAL CONTROLLER

- In integral signal the actuating signal is the integral of the error signal.

.

MATHEMATICAL EXPRESION

$$Ea(t) = \int E(t)dt$$

$$\boxed{Ea(t) = Ki\int E(t)dt}$$

BASIC STRUCTURE OF INTEGRAL CONTROLLER

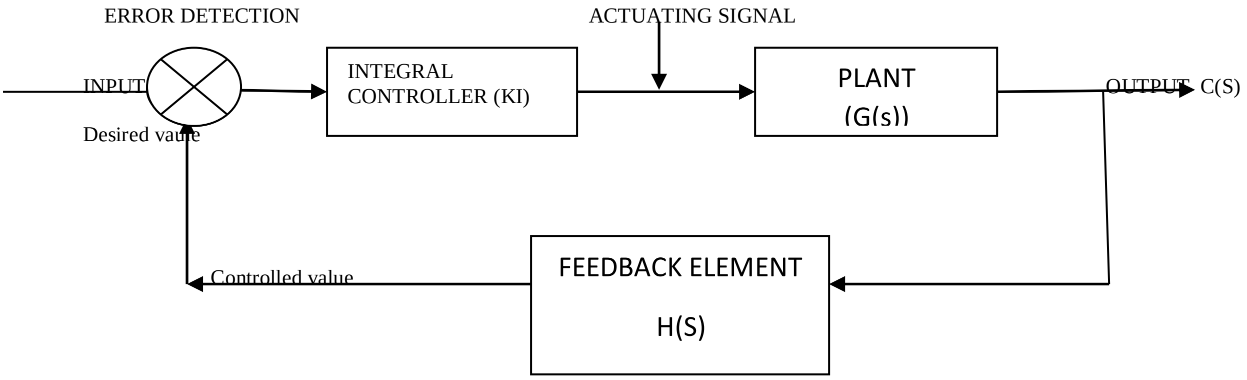

Fig.3.1: Structure ofIntegral controller

MERITS OF INTEGRAL CONTROLLER

- This controller has a ability to return the controlled variable back to the exact set point following a disturbance
- Also known as reset controller

DEMERITS OF INTEGRAL CONTROLLER

- It responded slowly towards the produced error
- Make the system un stable.

3.7 PROPORTIONAL INTEGRAL DERIVATIVE CONTROLLER.

(PID CONTROLLER)

3.7.1 Basic introduction:

4 **A** PID controller is acombination of all the three analog controllers i.e proportional (P) cum integral (I) cum derivative (D) controller. Basically this controller is used in industrial control application to regulates the temperature, flow of liquids, speed of the system and other variable work. PID controller is one of the best controller and also one og the best choice of control engineer, because it is very understandable and because it is quite effective. One of the best quality of PID controller is that is saves the previous reading of the system (through integration) and then accordingly develop the desired future behavior of the system (through differentiation).

CLOSED LOOP STRUCTURE OF PID CONTROLLER.

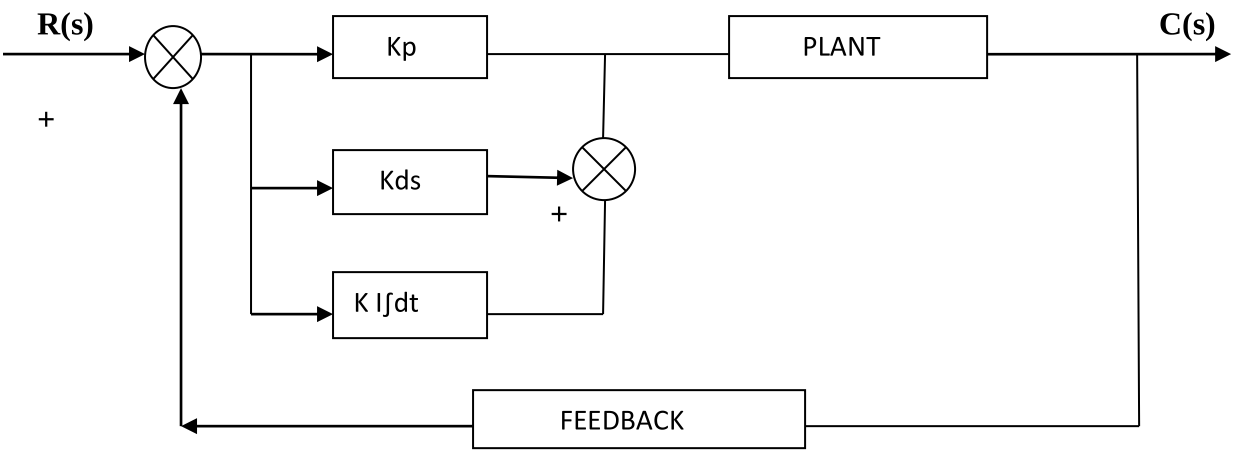

Fig.3.5: Closed loop structure of PID

Where,

3 Kp = Proportional constant

4 Kds = Derivative constant

5 Ki = Integral constant

MATHEMATICAL EXPRESSION

$$\left[\boldsymbol{Eo(t) = Kp.e(t) + Ki\int e(t)dt + Kd.\frac{de(t)}{dt}} \right]$$

The overall Transfer functions is:

$$\frac{C(s)}{R(s)} = \frac{\left(Kp+Kds+\frac{Ki}{S}\right)(Wn^2)}{S(S+2Swn)} \ldots\ldots$$

$$\frac{C(s)}{R(s)} = \frac{(S^2.Kd + S.kp + Ki)Wn^2}{S^2(S + 2Swn)}$$

Where Eo= Actuating signal .

USES OF PID CONTROLLER

- In robotic arm movement
- In temperature controller in boilers,coldstorage houses
- Speed control.

ADVANTAGES OFPID CONTROLLER

- No offset problems
- High stability
- High accuracy
- High speed response

➢ **WORKING OF HEATER FURNACE WITH PID CONTROLLER.**

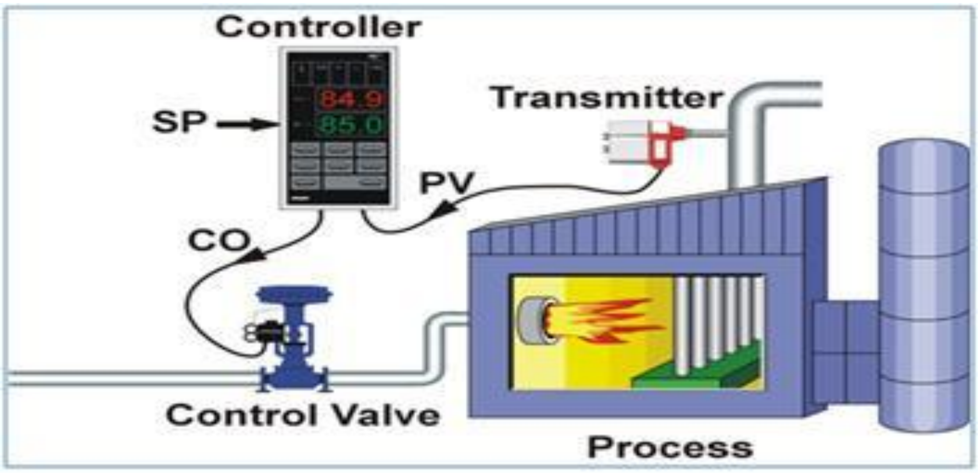

Fig.3.6:PID controller in furnace system

- **With the** help of controller we can set the required temperature set
- The situation of control valve is set by the output of controller (CO)
- When the process is run the PID compare the PV and SP value and find out the error

  Between these two signal

- **By** analyzing that error controller set the position of valve at right place so that we can get the required output which we want
- If there is a variation in temperature the controller changes the position of valve respectively

3.8 Tuning method of PID

There are various method for tuning of PID controller given below :

1) Ziegler Nicholas method 1
2) Ziegler Nicholas method 2
3) Cohen coon method
4) Wang jan chan method

In this project we use Ziegler Nicholas method 1 and Ziegler Nicholas method 2 for tuned the PID controller

- Every tuning method has its own way of calculating gain values

For Ziegler Nicholas method 1

$$k_p = 0.6K_c$$

$$K_i = 2\frac{K_p}{P_c}$$

$$K_d = K_p\frac{P_c}{8}$$

For Ziegler Nicholas method 2

$K_p = 0.6K_c$, Reduce Ki and Kd to zero

4. MODELLING AND ANALYSIS

Modelling of cuk converter is little bit different from other converter because its configuration is changing according to change in switch operation .During switch On condition voltage and current equation can be obtained using KVL and KCL Laws which are represented below.The voltage across the inductor at source is given by

$$v_i = L_i \frac{di_L}{dt}$$

By applying KVL in loop 2 in Figure.4.1 we get the equation

$$\boldsymbol{v_i - v_{Co} = L_o \frac{di_{Lo}}{dt}}$$

Current passes through interlinking capacitor is given by

$$i_{Li} = C_i \frac{dv_{Li}}{dt}$$

Apply KCL for loop 3 in Figure 4.1we get

$$i_{Lo} - \frac{v_{Co}}{R_L} = C_o \frac{dv_{Co}}{dt}$$

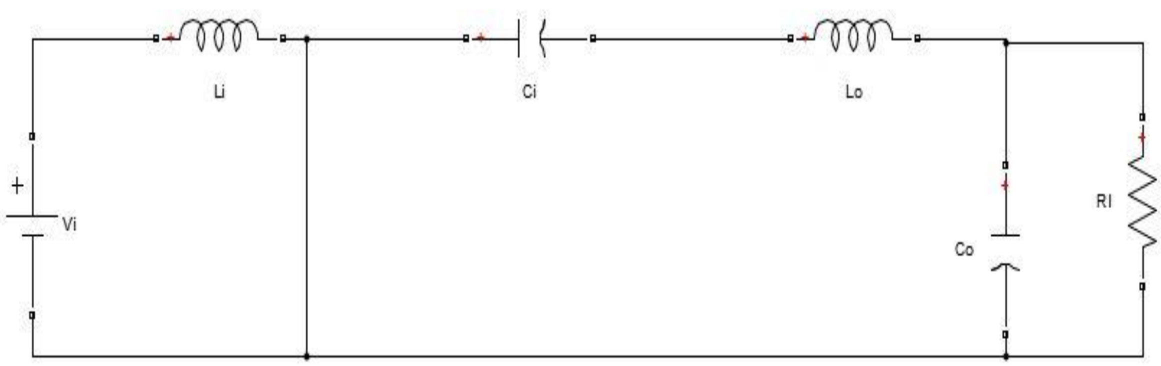

Figure 4.1 circuit diagram of cuk converter (switch on)

Equations during switch off condition are given below

By applying KVL in loop 1 in figure 4.2 we get

$$v_i - v_{Ci} = L_i \frac{di_{Li}}{dt}$$

Voltage across output inductor is given by

$$v_{Co} = -L_o \frac{di_{L_o}}{dt}$$

Current passes through interlinking capacitor is given by

$$i_{L_i} = C_i \frac{dv_{L_i}}{dt}$$

Applying KCL for loop 3 in figure 4.2 we get

$$i_{L_o} - \frac{v_{C_o}}{R_l} = C_o \frac{dv_{C_o}}{dt}$$

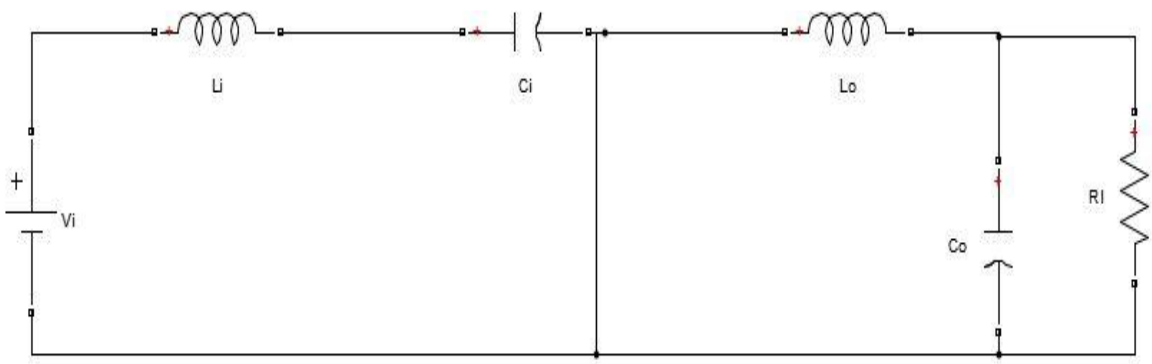

Figure 4.2 circuit diagram of cuk converter (switch off)

With the help of those current and voltage equation we can define steady state space model for the system

At switch on condition

$$X = A_1X + B_1U$$

$$\begin{bmatrix} i_{Li} \\ i_{Lo} \\ i_{Cl} \\ i_{Co} \end{bmatrix} = \begin{bmatrix} 0 & 0 & \left(\frac{-1}{L_s}\right) & 0 \\ 0 & 0 & 0 & \left(\frac{-1}{L_o}\right) \\ \left(\frac{-1}{C_l}\right) & 0 & 0 & 0 \\ 0 & \left(\frac{1}{C_o}\right) & 0 & \left(\frac{-1}{RC_o}\right) \end{bmatrix} \begin{bmatrix} i_{Li} \\ i_{Lo} \\ v_{Ci} \\ v_{Co} \end{bmatrix} + \begin{bmatrix} \left(\frac{1}{L_i}\right) \\ 0 \\ 0 \\ 0 \end{bmatrix} [v_i]$$

$$\begin{bmatrix} i_{Li} \\ i_{Lo} \\ i_{Cl} \\ i_{Co} \end{bmatrix} = \begin{bmatrix} 0 & 0 & 0 & 0 \\ 0 & 0 & \left(\frac{1}{L_o}\right) & \left(\frac{-1}{L_o}\right) \\ 0 & \left(\frac{-1}{C_l}\right) & 0 & 0 \\ 0 & \left(\frac{1}{C_o}\right) & 0 & \left(\frac{-1}{R_L C_o}\right) \end{bmatrix} \begin{bmatrix} i_{Li} \\ i_{Lo} \\ v_{Ci} \\ v_{Co} \end{bmatrix} + \begin{bmatrix} \left(\frac{1}{L_i}\right) \\ 0 \\ 0 \\ 0 \end{bmatrix} [v_i]$$

$$\begin{bmatrix} i_{Li} \\ i_{Lo} \\ i_{Cl} \\ i_{Co} \end{bmatrix} = \begin{bmatrix} 0 & 0 & \left(\frac{-1}{L_s}\right) & 0 \\ 0 & 0 & 0 & \left(\frac{-1}{L_o}\right) \\ \left(\frac{-1}{C_l}\right) & 0 & 0 & 0 \\ 0 & \left(\frac{1}{C_o}\right) & 0 & \left(\frac{-1}{RC_o}\right) \end{bmatrix} \begin{bmatrix} i_{Li} \\ i_{Lo} \\ v_{Ci} \\ v_{Co} \end{bmatrix} + \begin{bmatrix} \left(\frac{1}{L_i}\right) \\ 0 \\ 0 \\ 0 \end{bmatrix} [v_i]$$

$$\begin{bmatrix} v_o \\ i_s \end{bmatrix} = \begin{bmatrix} 0 & 0 & 0 & 1 \\ 1 & 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} i_{Li} \\ i_{Lo} \\ i_{Cl} \\ i_{Co} \end{bmatrix}$$

At switch off condition $X = A_2X + B_2U$

Output equation $Y = CX + DU$

So the system equation for cuk converter is given by

$$\frac{v_o}{v_s} = \frac{1.561 \times 10^{16}}{s^4 + 40070s^3 + 5.509 \times 10^9 s^2 + 2.083 \times 10^{12} s + 1.041 \times 10^{16}}$$

Above equation is the transfer function of the system which we used in matlab for tuning the PID Controller

4.1 MODEL OF CUK CONVERTER WITH PID CONTROLLER

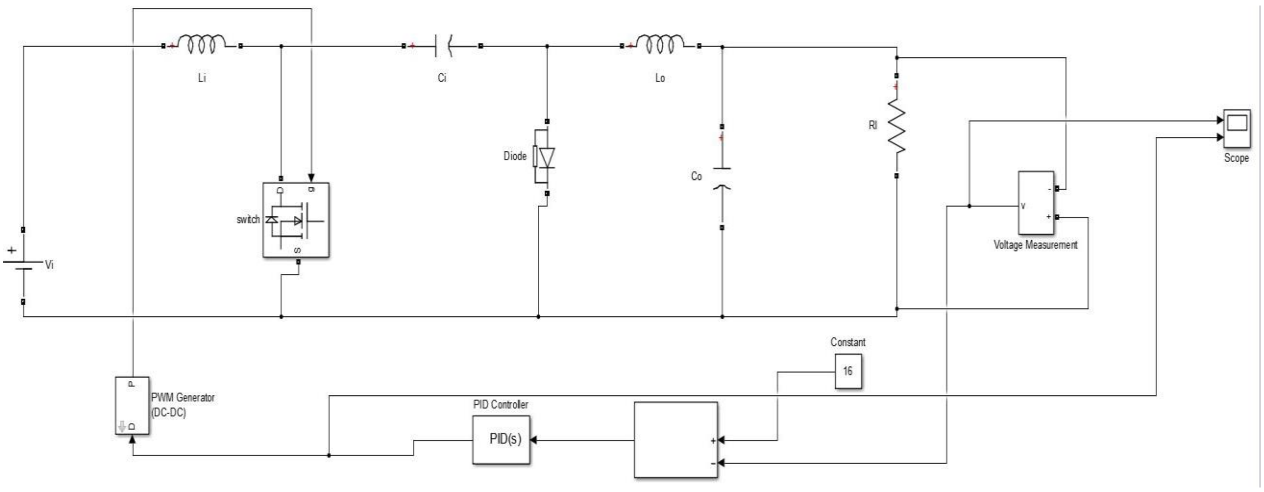

Figure 4.3 cuk converter with pid controller

- This diagram is only for given input values to the controller and for the output values of the converter

➢ For simulation another diagram is used which is shown below

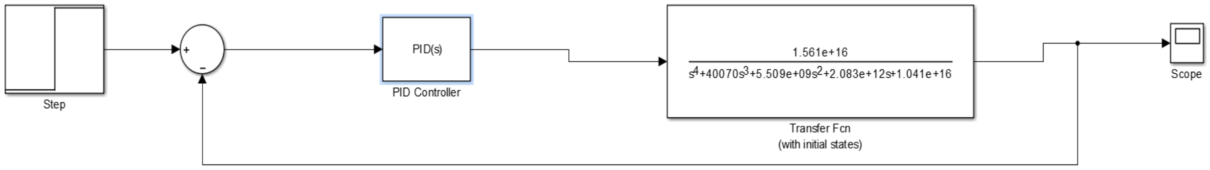

Figure 4.4 simulink model

The model consist of summation block step input for calculating error and pid controller for Control the action and a scope to show the output

4.2 PARAMETER OF CUK CONVERTER WITH PID (FIGURE 4.3) USED ARE:

Vi	12v
Vo	18v
R	8.1
Li	432 microhenry
Lo	649 microhenry
Ci	17.8 microfaraday
Co	3.08microfaraday
D	0.6

Table No. 4.1 Parameters of cuk conveter with PID

5 SIMULATION AND RESULT

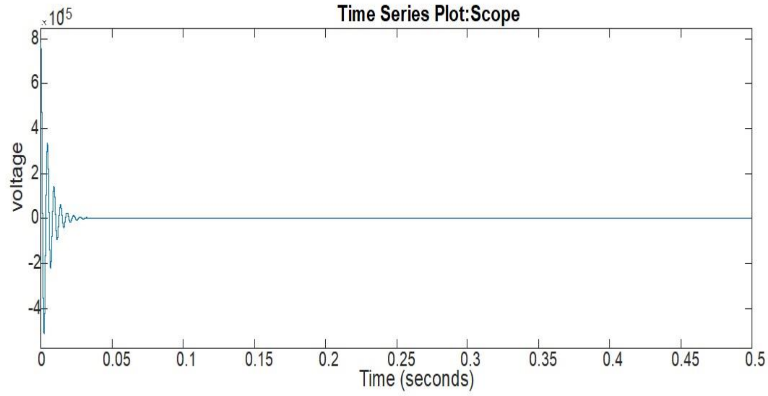

Figure 5.1 output of cuk converter with pid

5.1 TIME DOMAIN ANALYSIS

Any system can be represented with reference to function of time is called time domain analysis .The below figure are the output of pid controller after performing simulation in matlab .Usually the output of the system can be represented in two states transient state and steady state . The steady state time depends upon the input of the system where as transient state time depends on the poles of the system .

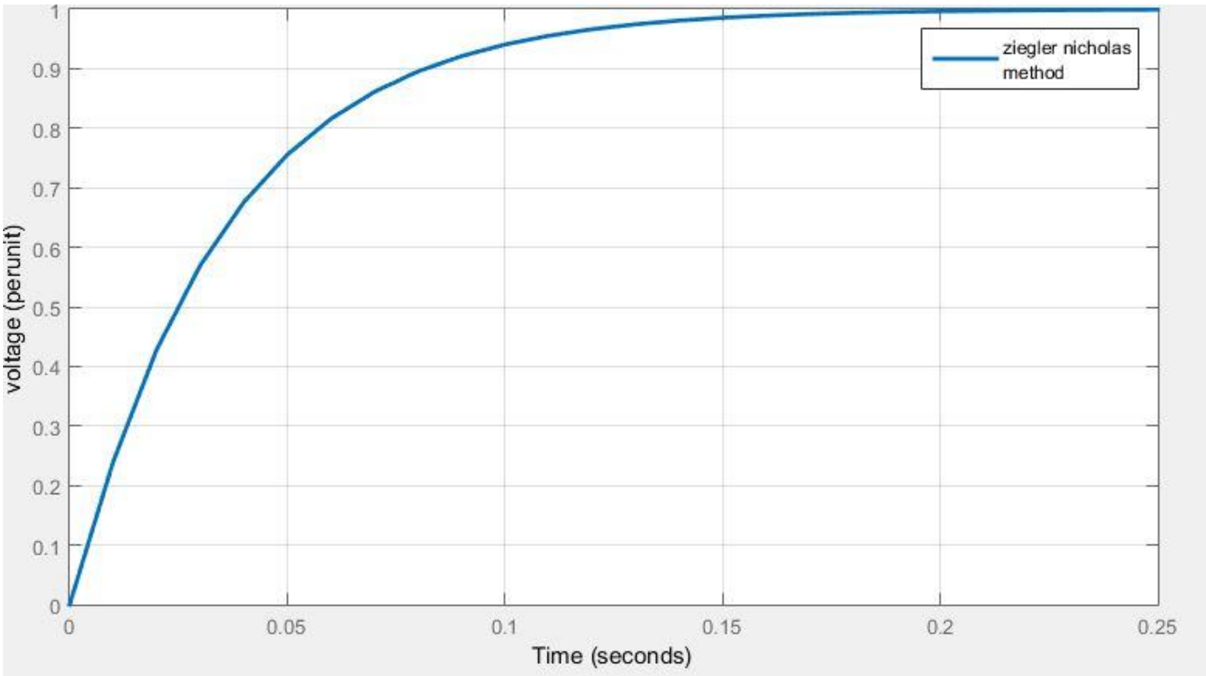

Figure 5.2 output response of ziegler nicholas method

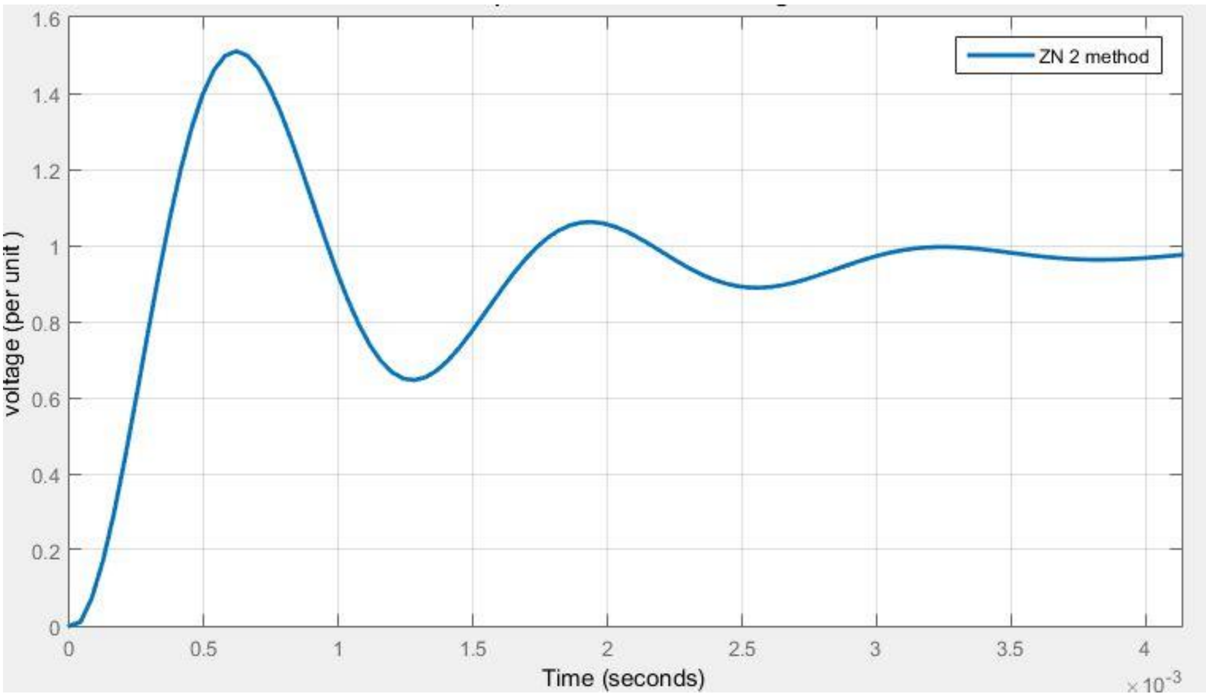

Figure 5.3 output response of ziegler nicholas method 2

5.2FREQUENCY DOMAIN ANALYSIS

Analyzing the transient state and steady state response in term of frequency and phase called frequency domain analysis .This method is known as bode plot .there is a criteria for telling the system is stable or not by using phase margin and gain margin values .The system which are having high phase margin value then the gain margin are considered as stable system

Below figure are the result of simulation in the matlab software

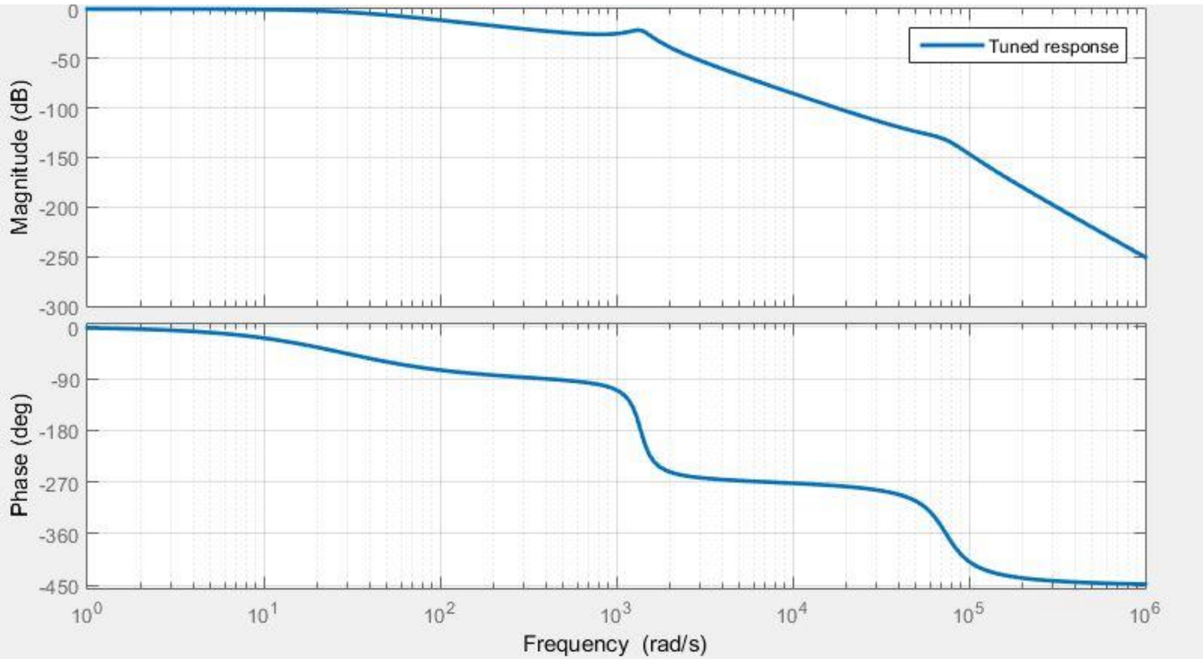

Figure 5.4 stability response for ziegler nicholas method 1

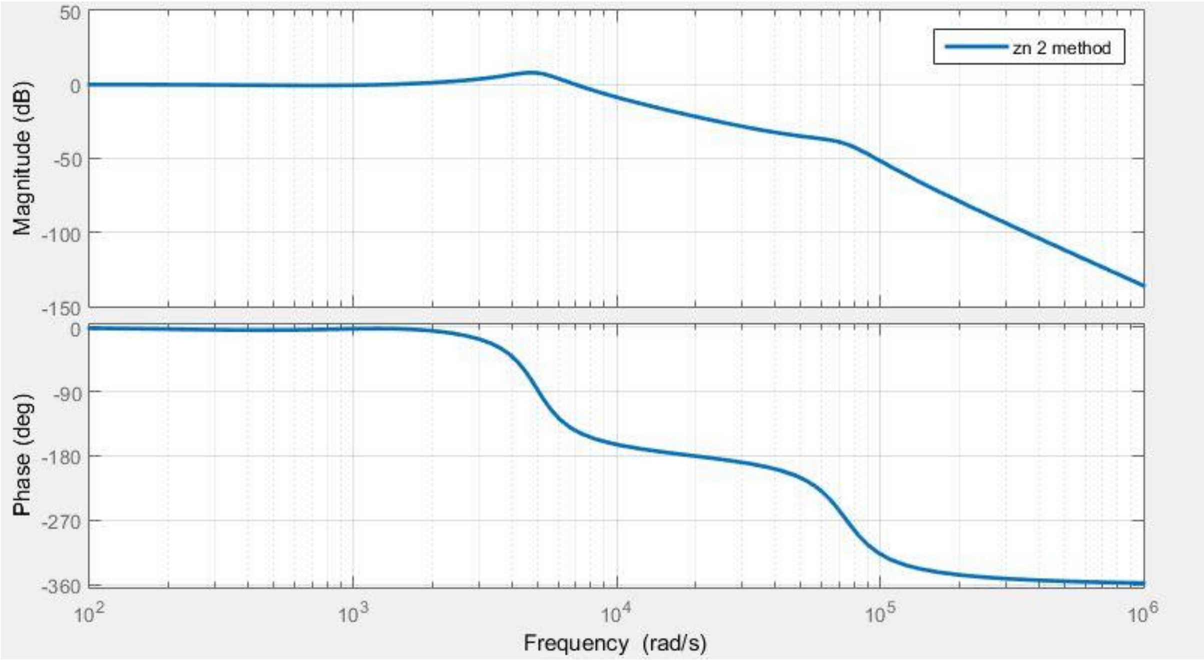

Figure 5.5 stability response for ziegler nicholas method 2

Method name	Kp	Ki	Kd
Ziegler Nicholas	0.0011563	0.000577995	0.00057839
Ziegler Nicholas 2	3.994	2307	0.001283

TABLE 5.1.PID gain values

Method name	Gain margin in (dB)	Phase margin (in degree)
Ziegler Nicholas	41.3	51.4
Ziegler Nicholas 2	23	22.2

TABLE 5.2 Phase margin values and gain margin values

6.CONCLUSION

Here two PID tuning method are compared in time and frequency domain responses So that we can design the best controller for cuk converter .By comparing the simulation Result of these two method we can find out that ZNM method gives the best response in Comparison to ZNM 2 .Also ZNM take more response time but overall values are the best Such as it has more PM value then the GM which gives the stable system in comparison to ZNM 2 .so it can be concluded that ZNM is best method for designing a controller for CUK Converter.

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