NEW HORIZON
COLLEGE OF ENGINEERING
New Horizon Knowledge Park, Ring Road, Marathalli
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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

20EEL68 - MINI PROJECT

Report on

Variable Bench Power Supply with Monitoring and Display

Submitted by:

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Under the Guidance of
Dr. Vinoth Kumar K

Dissertation submitted in partial fulfillment of the requirements for the award of the degree of
BACHELOR OF ENGINEERING
in
ELECTRICAL AND ELECTRONICS ENGINEERING

VISVESVARAYA TECHNOLOGICAL UNIVERSITY
"Jnana Sangama", Belgaum – 590018, Karnataka, India

2020-2021

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Certified that the mini project work entitled "Variable Bench Power Supply with Monitoring and Display" carried out by Md Sagar Khan (1NH18EE727) Lokare Ashwini Balasaheb(1NH18EE725), and Vivek Ranjan (1NH18EE069 are bonafide students of New Horizon College of Engineering submitted the report in completion of project at Department of Electrical and Electronics Engineering, New Horizon College of Engineering during the Academic Year 2020-2021.

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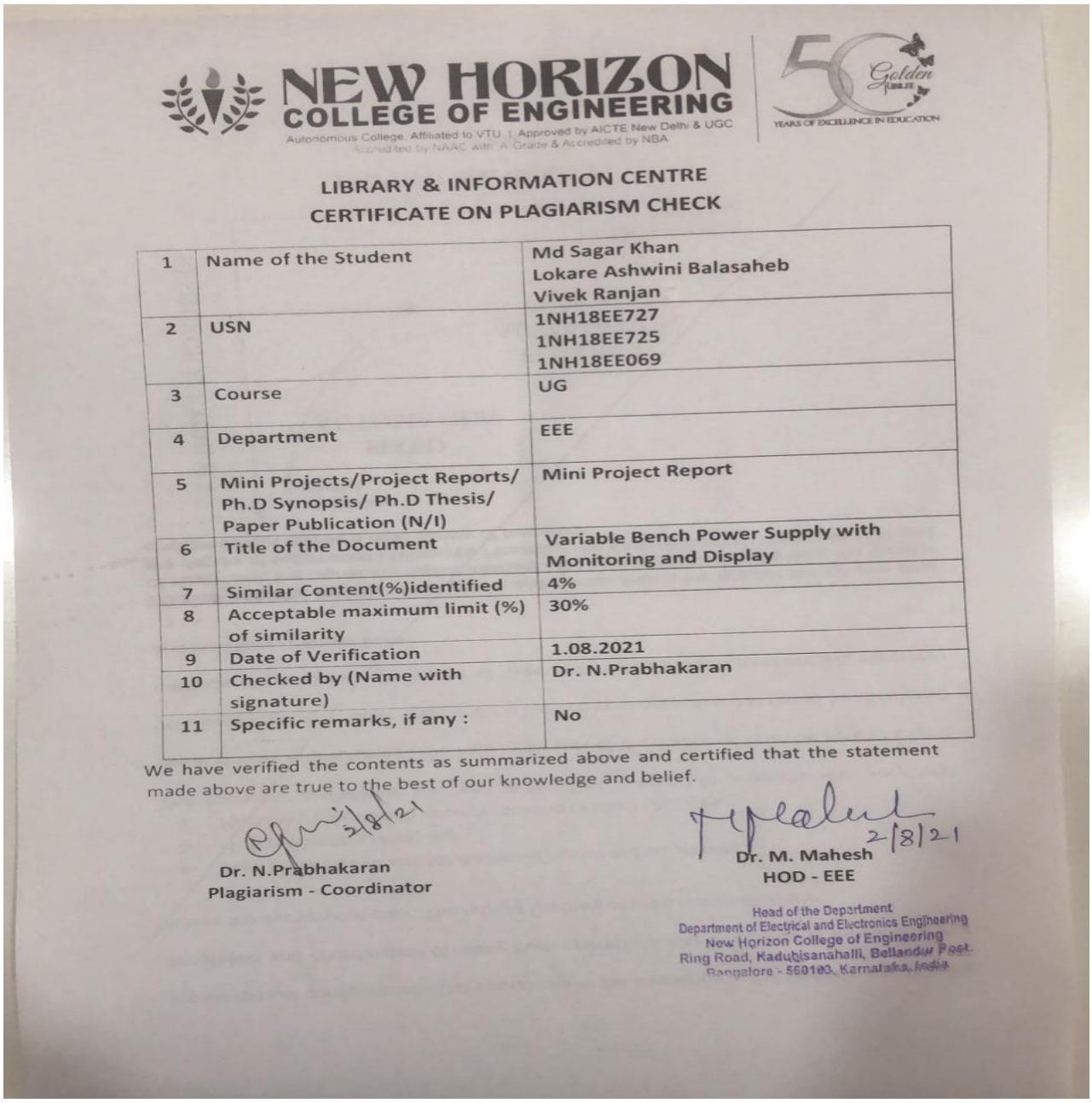

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6	Title of the Document	Variable Bench Power Supply with Monitoring and Display
7	Similar Content(%)identified	4%
8	Acceptable maximum limit (%) of similarity	30%
9	Date of Verification	1.08.2021
10	Checked by (Name with signature)	Dr. N.Prabhakaran
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ABSTRACT

If we look around us in daily life we are using several electronic gadgets. And obviously those do not run without any energy. So basically we need to charge them in other words. Suppose someone using in his/her life a mobile phone, a laptop, an electric cycle & DC bulbs for study purpose & so on. Obviously he/she will use different charger or power supplies. But being an electrical engineer I feel that no need of different power supplies, We can do it with a single power supply which can be varied & can be used for different aspects. But obviously this is not something that I and my team are thinking for the first time in world. There are many genius who have already thought about and discovered and implemented too. That is a fact that what we think about is already have been created by someone meanwhile. But there is something called innovation, which is nothing but to find out a upgraded and advanced way of the solution which is already available. So, as simple as that we have also done our project differently from other people and also have reduced the overall cost of the project into much lesser extent.

ACKNOWLEDGEMENT

With immense pleasure and deep sense of gratitude, we wish to express sincere thanks to our supervisor **Dr. Vinoth Kumar K**, Associate Professor, Department of Electrical and Electronics Engineering, New Horizon College of Engineering, without his motivation and continuous encouragement, this mini project would not have been successfully completed.

We grateful to the Chairman of New Horizon Educational Institution, **Dr. Mohan Manghnani** for motivating us to carry out research in the NHCE and for providing with infrastructural facilities and many other resources needed for our project work.

We would also be thankful to our principal **Dr. Manjunatha** of NHCE for providing all the required facilities in completion of this project.

We express my sincere thanks to **Dr. M. Mahesh,** HoD, Department of Electrical and Electronics Engineering, New Horizon College of Engineering for his kind words of support and encouragement.

We wish to extend my profound sense of gratitude to my parents for all the sacrifices they made during our project and providing us with moral support and encouragement whenever required.

Date:
Place: Bengaluru

DECLARATION

We **MD SAGAR KHAN – 1NH18EE727, LOKARE ASHWINI BALASAHEB - 1NH18EE725 and VIVEK RANJAN - 1NH18EE069,** students of New Horizon College of Engineering hereby declare that, this project phase-I work entitled "**Variable Bench Power Supply with Monitoring and Display**" is an original and bonafide work carried out at New Horizon College of Engineering in partial fulfillment of Bachelor of Engineering in Electrical and Electronics Engineering of Visvesvaraya Technological University, Belgaum.

We also declare that, to the best of our knowledge and belief, the work reported here in does not form part of any other thesis or dissertation on the basis of which a degree or award was conferred on an earlier occasion by any student.

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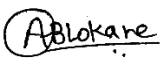
LOKARE ASHWINI BALASAHEB	**1NH18EE725**	
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TABLE OF CONTENTS

CHAPTER NO.	CHAPTER NAME	SUB-CHAPTER NAME	PAGE NUMBER
1	**INTRODUCTION**	-	**10**
2	**AIM**	-	**11**
3	**COMPONENTS**	COMPONENTS REQUIRED	**12**
		Step down transformer	**13**
		1N4004 Diode	**14**
		Capacitor	**14-15**
		LM317 Voltage Regulator	**15-16**
		BD139 Transistor	**16**
		2N3055 Transistors	**16-17**
		Digital Voltmeter and Ammeter	**17**
		5k, 10k Pots	**17-18**
		Resistor	**18-19**
		Switch	**19**
		DC Motor	**19-20**
		Breadboard	**20-21**
		Probs	**21**
		Knobs	**21**
		Connecting Wires	**21-22**
		Wooden Box (used as container for the circuitry)	**22**
4	**BLOCK DIAGRAM**	-	**22-23**
5	**CIRCUIT**	CIRCUIT DIAGRAM	**23-24**
		CIRCUIT DESCRIPTION	**24-25**
6	**WORKING PROCEDURE**	-	**25-26**
7	**SIMULATION DIAGRAM**	-	**27-28**
8	**RESULT & APPLICATION**	RESULT	**28-29**
		APPLICATION	**29**
9	**CONCLUSION**	-	**30**

LIST OF TABLES

TABLE NO.	DESCRIPTION	PAGE NUMBER
1	Connection of pins between LM317 Voltage Regulator to BD139 transistor and other part of circuit model	**24-25**
2	Connection of pins between LM317 and 2N3055 transistors and other circuit parts	**25**

LIST OF FIGURES

FIGURE NO.	DESCRIPTION	PAGE NUMBER
1	STEP DOWN TRANSFORMER	13
2	1N4004 DIODE	14
3	CAPACITOR	15
4	LM317 VOLTAGE REGULATOR	16
5	BD139 TRANSISTOR	16
6	2N3055 TRANSISTOR	17
7	DIGITAL VOLT AMP METER	17
8	RESISTOR POT	18
9	RESISTOR	19
10	SWITCH	19
11	DC MOTOR	20
12	BREADBOARD	21
13	CONNECTING WIRES	22
14	BLOCK DIAGRAM	23
15	CIRCUIT DIAGRAM	24
16	SIMULATION CIRCUIT	27
17	VOLTAGE & CURRENT WAVEFORMS	29

CHAPTER 1

INTRODUCTION:

This mini project includes a variable bench power supply which is basically used to provide various range of power supply or we can say a variable power supply for various types of loads with various types of voltage rating, current rating or we can say different types of power rating.

In this project we have used AC power supply only for the shake of giving a AC supply to the module. We are not varying the AC power supply. But we are not using directly DC batteries also. So if we have to control DC power supply then we know that we need to convert AC to DC.

For the above purpose a bridge rectifier circuit with proper filtering capacitance is used so that we are eliminating the cost of battery to be purchased.

We know that a 36V or 48V battery will come at a cost of around INR 1k to 2k. So, the cost of battery itself making the project expensive.

Comparing to available variable power supply models in market this extra cost of battery is negligible. As the products available in market are at cost of around 7k-10k INR.

Even being this much lesser amount at cost we are still removing the battery cost also by making use of the studies we had in our subjects. So, we know the diodes don't cost high. It comes around at cost of INR 5-10 per pieces & so the filtering capacitors.

So in overall we have reduced the cost of our variable power supply model at very lesser amount comparing to other already available devices.

CHAPTER 2

Aim:

The main objective of this mini project is to design a Variable Bench Power Supply model which consists of Variable Power means Adjustable Voltage & Adjustable Current and also to display the Voltage reading & Display Current reading.

For example if the voltage is adjusted to 10V or current is adjusted to 1.5Amps then as usual the digital voltmeter and ammeter shows the reading 10V and 1.5Amps.

CHAPTER 3

COMPONENTS REQUIRED

1. Step down transformer
2. 1N4004 Diode
3. Capacitor
4. LM317 Voltage Regulator
5. BD139 Transistor
6. 2N3055 Transistors
7. Digital Voltmeter and Ammeter
8. 5k, 10k Pots
9. Resistor
10. Switch
11. DC Motor
12. Breadboard
13. Probs
14. Knobs
15. Connecting Wires
16. Wooden Box (used as container for the circuitry)

3.1 Step-down Transformer

A transformer is a static electrical device which works on mutual induction. It is basically an AC to AC converter. Using transformers we can increase the level of input power or decrease the level of input power.

Based on which it is classified into following types:

A. Step up transformer
B. Step down transformer

Again based on structures transformers are classified into shell type and core type transformers.

So step down transformer is an electrical device which can decrease the level of input voltage for example if input is 230V AC then it can be stepped down below 230V AC i.e 200V AC, 24V AC, 12V AC etc.

All the transformers consists of primary winding and secondary winding. The winding ratio is the factor based on which the device is designed to convert for desired range.

For example 2:1 winding ratio transformer can step down the 200V AC supply to 100V AC supply. 4:1 winding ratio transformer can step down the 100V AC supply to 25V AC supply etc.

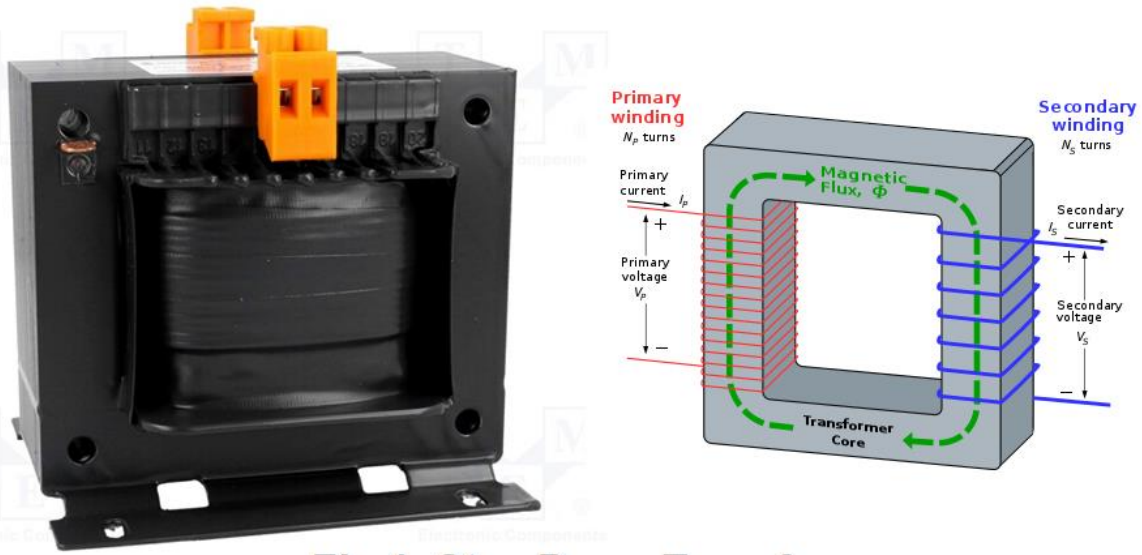


Fig 1: Step Down Transformer

3.2 1N4004 Diode

Diode is a semicondcutor device with 2 terminals (anode and cathode). I allows the current to flow only in one direction. Thus it is called unilateral elctronic device.

There are several types of diode available in market but for this project we are using 1N4004 which is a rectifier diode as the maximum current carrying capacity of 1N4004 is 1Amperes with the withstanding peak capacity of 30Amperes.

In this project the rectifier diode 1N4004 is used to build the bridge rectifier circuit which is used to convert the AC to pulsating DC. Here in this project it is connected after the step down transformer and then it is given to filtering capacitor and then to LM317 voltage regulator and 2N3055 transistor.

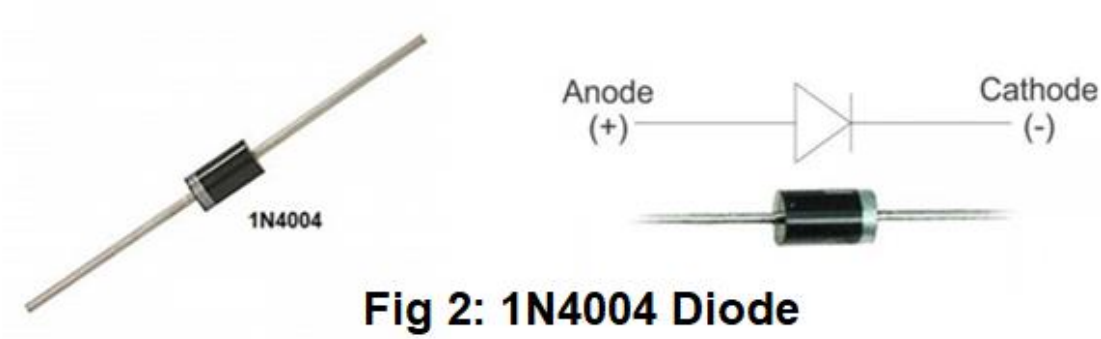


Fig 2: 1N4004 Diode

3.3 Capacitor

A capacitor is an electrical component storing electrical energy. The property possessed by it is known as capacitance. In this project we have used 0.1 micro farad and 1 nano farad and 150 pico farad capacitors.

Capacitor is linear and bilateral device. Capacitor follows Ohm's law, so it is a linear device. Current in capacitor can flow through both the sides or directions of a capacitor, hence for it is a bilateral device.

Capacitor has two terminals and current can flow through any of these terminals. The measure of the capacitor is capacitance and the unit is 'Farad'.

In the market there are several capacitors available with variety of types (ceramic and electrolyte etc.) and of different capacitance values.

Here in this project we have used both ceramic and electrolyte capacitors. One 4700uF capacitor and one 0.1uF capacitor.

4700uF capacitor is used as filtering capacitor which is connected next to bridge rectifier circuit in order to convert pulsating DC to filtered or smoothen DC.

0.1uF capacitor is connected next to LM317 voltage regulator in order to provide a balanced output supply of LM317 to BD139 transistor.

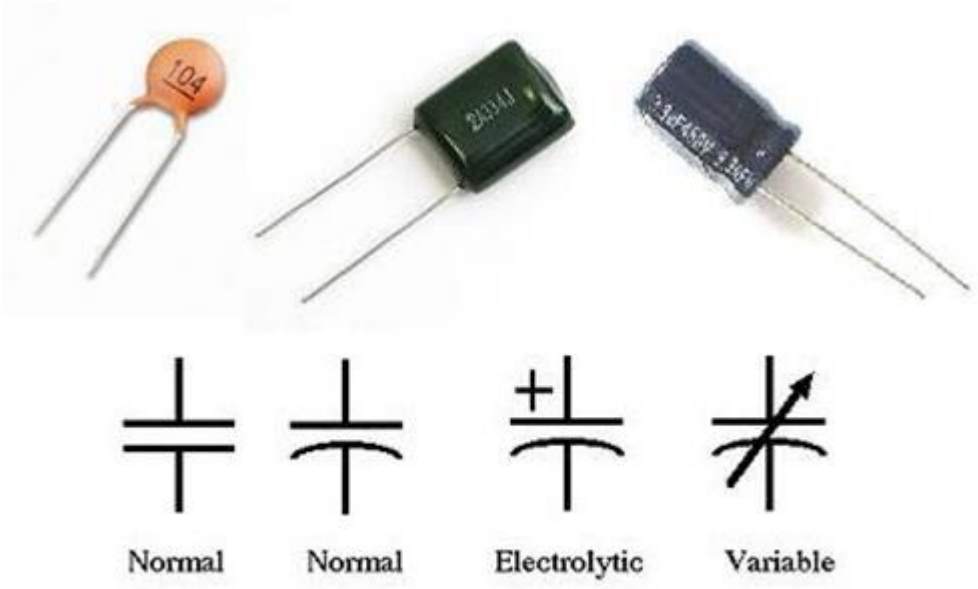


Fig 3: Capacitor

3.4 LM317 Voltage Regulator

LM317 is a voltage regulator which is having a maximum output capacity of 37V DC and maximum input it can have 47V DC.

Pin 1 & 2 are used for output voltage control with proper circuitry. Pin 3 is the input pin for LM317.

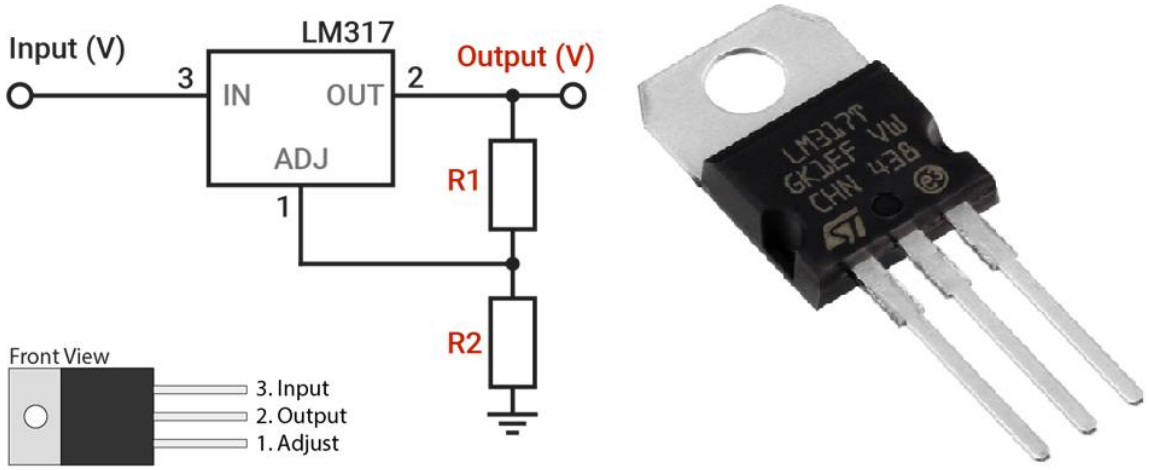


Fig 4: LM317 Voltage Regulator

3.5 BD139 Transistor

BD139 is a NPN transistor which is a power amplifier. Here in this project it is used in order to control the current range.

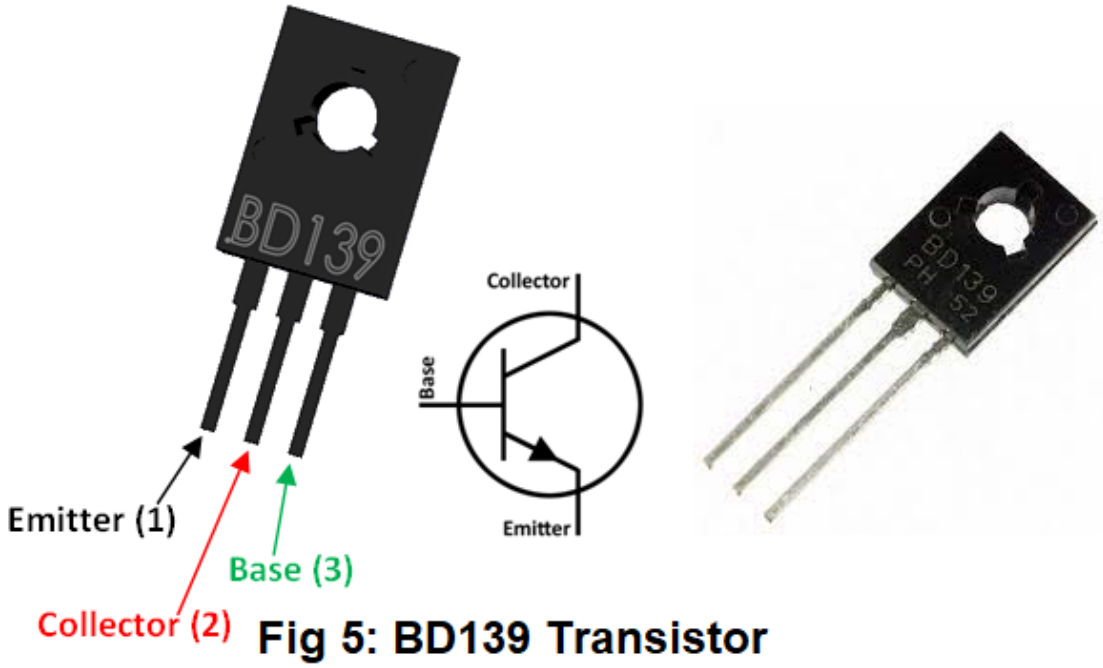


Fig 5: BD139 Transistor

3.6 2N3055 Transistor

2N3055 is a NPN transistor with high current gain. Here it is used along with BD139 to provide the variable current range.

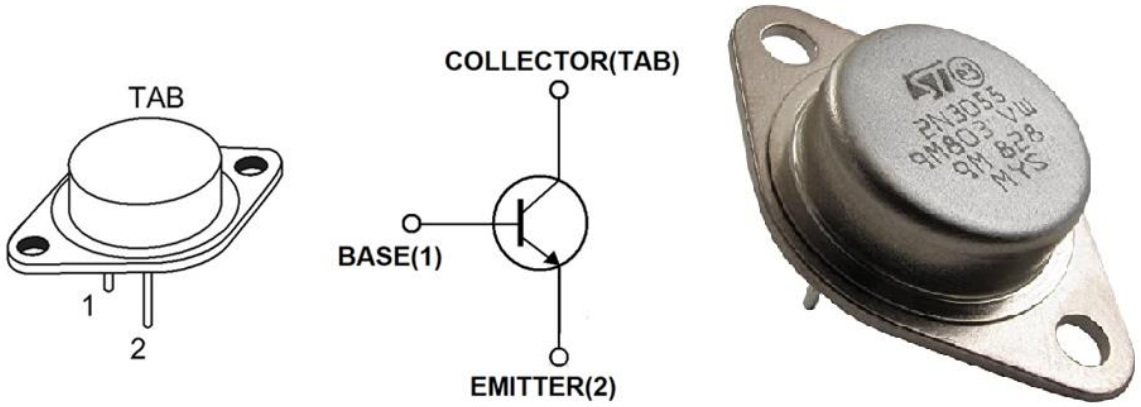


Fig 6: 2N3055 Transistor

3.7 Digital Voltmeter and Ammeter

Digital Voltmeter and Ammeter is a single device which is used to display the current and voltage reading on its screen.

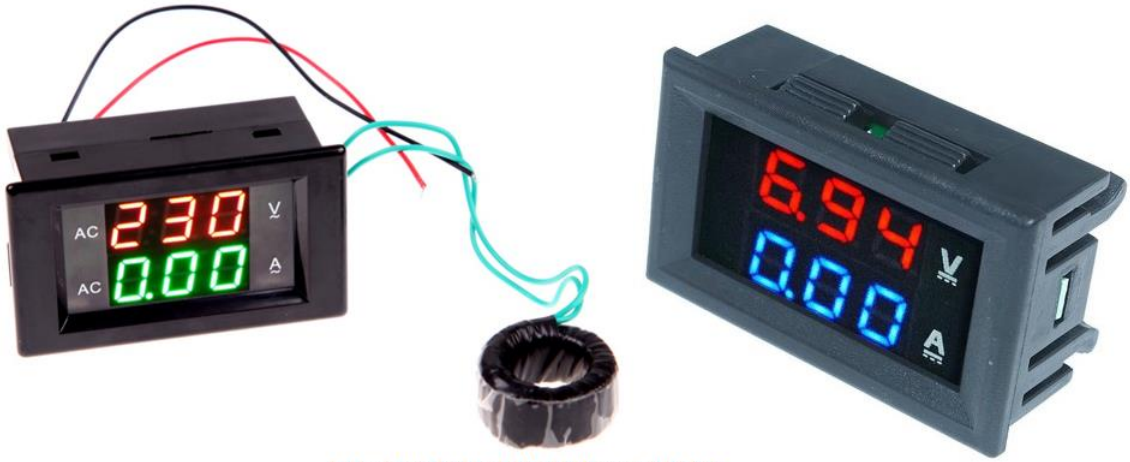
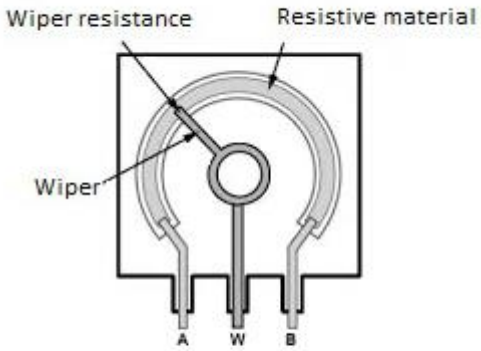


Fig 7: Digital Volt Amp Meter

3.8 5k, 10k pots

These pots are basically variable resistance devices. 5k pot is used along with LM317 in order to vary the voltage range and 10k pot is used along with BD139 in order to vary the current range. These pots are provided with knobs covered on it.

Image of a Potentiometer



Internal structure of a Pot

Fig 8: Resistor Pot

3.9 Resistor

A resistor is a passive two terminal component which opposes the flow of current. It's opposing property is called as resistance. The unit is ohm for resistance. The current I in amperes flowing through a resistor of resistance R is given by

$$I = \frac{V}{R}$$

The power consumption in watts by a resistor is given by

$$P = I^2 \times R = I \times V = V^2 / R$$

Resistance is also given by

$$R = \rho \times \frac{l}{A}$$

Resistance in other words can be defined as the very opposing nature of a conductor to oppose the current flow. It is proportional to the voltage difference in two points of a conductor and inversely proportional to the current flowing in the conductor. It is obtained by ohms law.

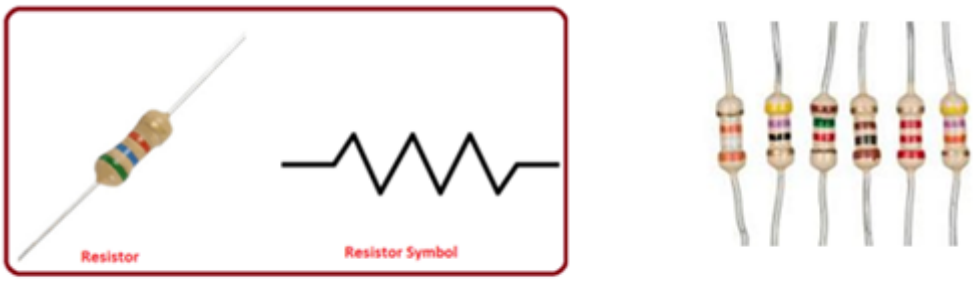


Fig 9: Resistor

3.10 Switch

A switch is an electrical component which can make a circuit open or closed. The power switch operates normal 'On/Off' operation by means of changing the position of the switch.

There are several types of switches available in the market like power switches, push button switches, dpdt, dpst, tpst & tpdt switches etc.

Fig 10: Switch

3.11 DC Motor

In this project a 36V DC motor is used at output port in order to check the proper working of variable power supply.

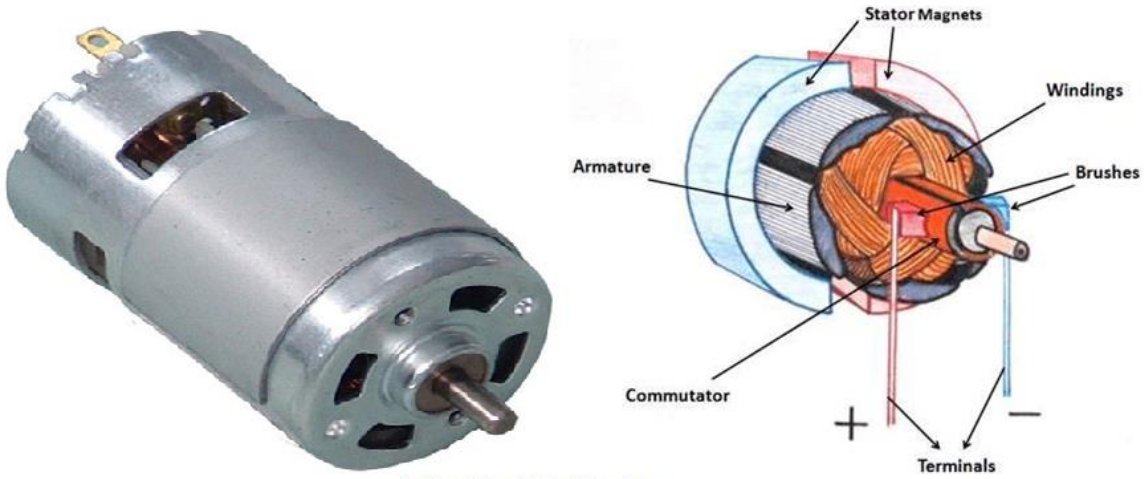


Fig 11: DC Motor

3.12 Breadboard

It is a device for testing the circuit designs. There is no need of soldering in it as done in case of pcb's.

Breadboard is an electrical equipment which serves as a base for many circuit designs instead of using PCBs and other complex equipments.

Breadboard is used for testing many circuit designs before they can be implemented for PCBs.

The breadbord consists of several holes in it with electric conductor metal plate below.

The components required for a particular circuit design is attached through the holes of the breadboard.

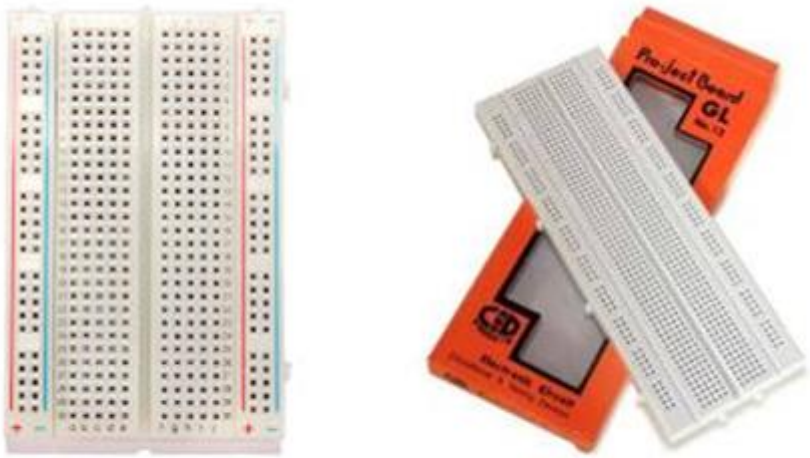


Fig 12: Breadboard

3.13 Probs

Probs are a basically type of wire. Here 2 probs are used at output port in order to connect the loads.

3.14 Knobs

Knobs are used on 5k and 10k pot in order to smooth physical handling of adjustment of the pots.

3.15 Connecting Wires

These are used to connect various components in the circuit building .In our project we have used male to male jumper wires as connecting wires.

The wires are basically are the metal rods which allows the current flow through it. Wires are of various types depending upon the applications such as:

1. Single Strand Wires
2. Multi Strand Wires

3. Jumper Wires

Here we have used some single strand and some jumper wires. Jumper wires are basically connectors. It can be male-male, male-female, female-female connectors.

Fig 13: Connecting Wires

3.16 Wooden Box

A wooden box is used as a container for the whole circuitry. This gives a standard look to the power supply model.

CHAPTER 4

Block Diagram

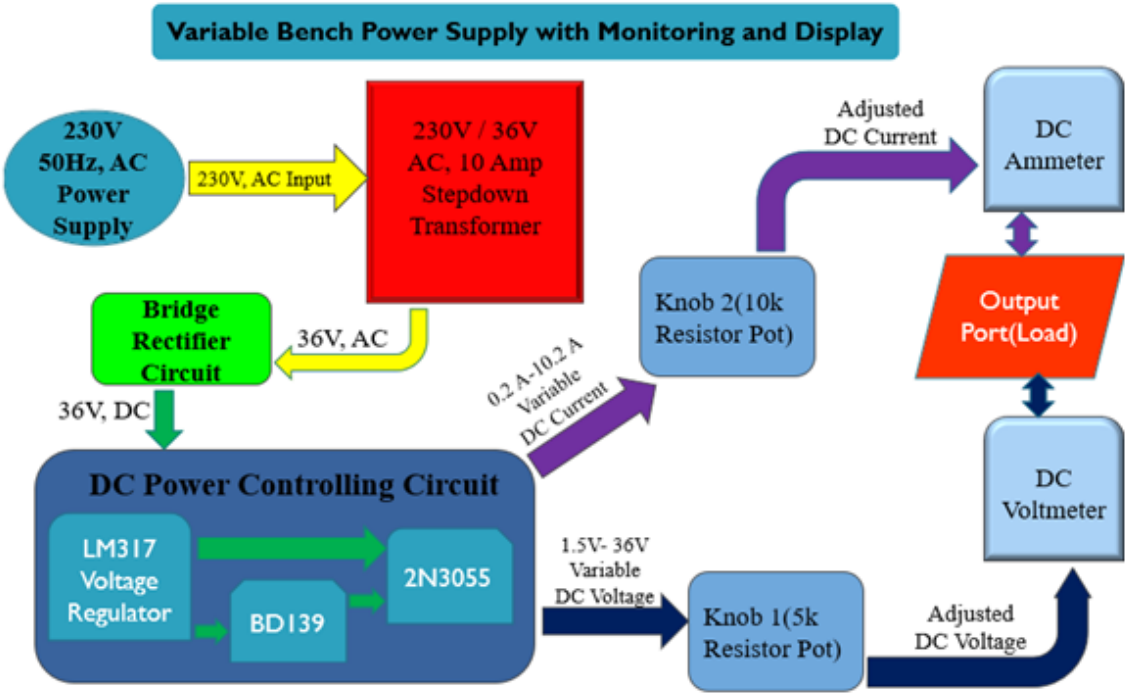


Fig 14: Block Diagram

We have a 230V,50HZ AC supply, then stepdown transformer, bridge rectifier circuit then we have the dc power controlling which consists of LM317, BD139, 2N3055

And two pots used as knobs are given to this block in order to control the voltage & current which you can see can be displayed in voltmeter & ammeter respectively

CHAPTER 5

5.1 Circuit diagram

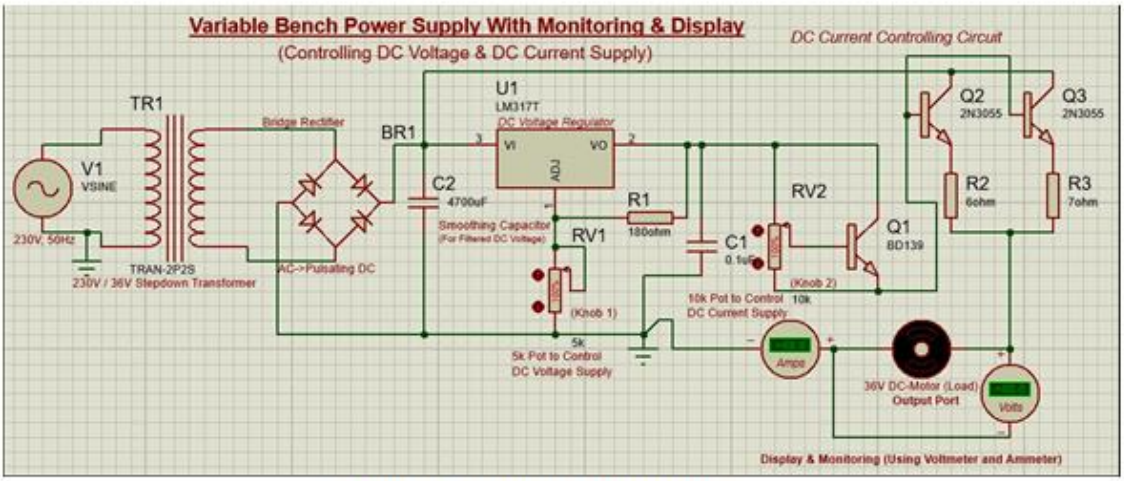


Fig 15: Circuit Diagram

5.2 Circuit description

The 230V,50HZ AC supply which is given to the stepped down transformer of rated current 10Amps, which will convert 230V AC to 36V AC

Next we have the full wave bridge rectifier which will convert it to pulsating DC and this 4700uF capacitor will smoothen it. the filtered voltage is given to LM317,2N3055 where in LM317 using proper circuitry of output pin 2 and adjust pin 1 it is designed to provided to max 36V Dc voltage, which can be varied using 5k resistor pot,RV1

Now using BD139 & 2N3055 proper circuitry we are able to achieve maximum current of 10.2Amps, which can be varied using 10k resistor pot,Rv2 and this is shown in the output port where we can connect the loads.

Following chart describes the connection of pins between LM317 Voltage Regulator to BD139 transistor and other part of circuit model:

LM317 Voltage Regulator	BD139 & other parts
Pin 2	0.1 uF capacitor, Collector of BD139
Pin 1	5k pot (RV1) and hence ground

Pin 1 & 2 Combination	180ohms resistor (R1)

TABLE 1

Following chart describes the connection of pins between LM317 and 2N3055 transistors and other circuit parts:

LM317 voltage regulator	2N3055 and other circuit parts
Pin 3	Collectors of 2N3055 transistors in parallel, also output of DC 36V from bridge rectifier circuit is connected to PIN 3 or input pin of LM317 voltage regulator.

TABLE 2

So this are the technical specifications: Here, First 230V, 50 Hz AC supply is step down to 36V AC using step down transformer with 10A current rating.

36V AC supply using bridge rectifier circuit converted to 36V pulsating DC which is filtered through 4700uF capacitor.

This 36V filtered DC is given to LM317 voltage regulator, BD139 & 2N3055 in order to achieve adjustable DC power supply (DC voltage and current supply).

Using 5k resistor pot connected to LM317, 1.5V-36V DC voltage is achieved.

Using 10k resistor pot connected to BD139, 0.2A-10.2A Dc current is achieved.

CHAPTER 6

Working Procedure

All the working procedure is given below in steps with necessary mathematical calculation.

- Bridge rectifier

Output Voltage After 4700uF Capacitor=36V DC, Vin for LM317 and 2N3055 Collector Connection

- LM317

  Vin=36, Vout=(1.03-R1/RV1)=Vcc for BD139

- BD139 & 2N3055- Darlington & parallel connection of BJTs [hfe1,hfe2,hfe3 respectively]

  Vcc=35.784 V=Vce, RV2=10k(max), R2=6ohms, R3=7 ohms, Req=6+7=13ohms

  Vee=Vcc*(1/hfev)*RV1, Ie=((hfec*RV2*RV1*Vee), hfev=hfe1*hfe2=71*70=4970,

  hfec=((R2/hfev^2)+(R3/hfe2^3))=5.74*10^-9 [hfe1 for BD139 & hfe2,hfe3 for 2N3055 respectively]

  hfe1=71, hfe2=70, hfe3=70

First, 230V, 50 Hz AC supply is step down to 36V AC using step down transformer with 10A current rating.

36V AC supply using bridge rectifier circuit converted to 36V pulsating DC which is filtered through 4700uF capacitor.

This 36V filtered DC is given to LM317 voltage regulator, BD139 & 2N3055 in order to achieve adjustable DC power supply (DC voltage and current supply).

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Using 10k resistor pot connected to BD139, 0.2A-10.2A Dc current is achieved.

CHAPTER 7

Simulation Diagram

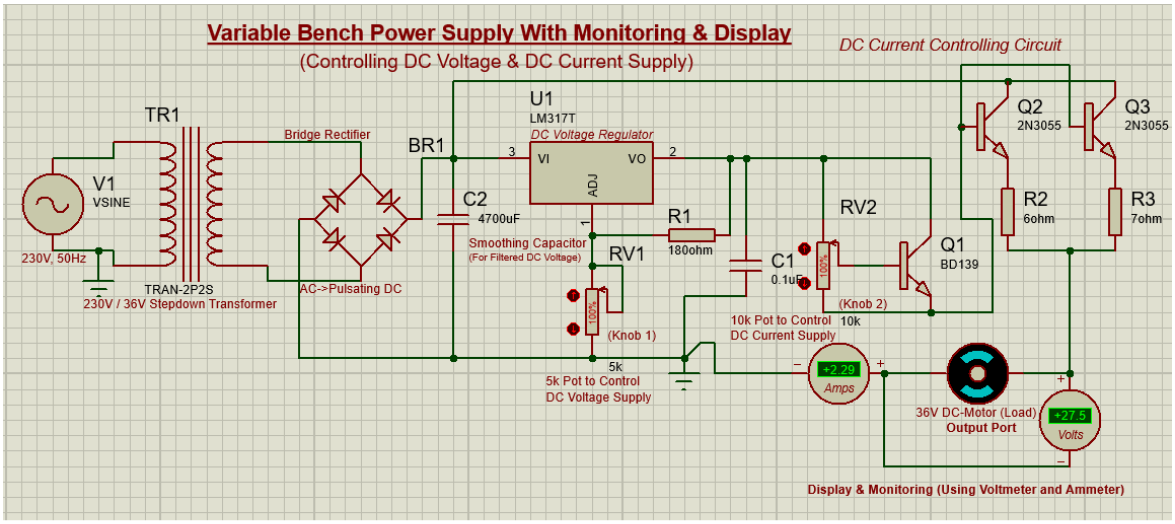

Fig 16- Simulation Circuit

For simulation we have gone through 3 testcases as following:

The 1st case that is to find out it's maximum open circuit output voltage & maximum short circuit output current. We know that in open circuit voltage is maximum & current is zero & the vice versa in reverse case

So adjusting Rv1 we are able to vary the voltage & now if I vary Rv2 that is used for varying current, has no effect on voltage variation. So, the variable output voltage is achieved and we can see maximum open circuit output voltage is 36V

Now for current we have to short circuit the output port, now voltage reading shows zero due to short circuit path now varrying rv2 that is 10k pot or knob 2 we are able to achieve current up to 10.2 Amps.

For case 2 we used a 220ohm rheostat at the output port here it is named as RV3, varying the rheostat to maximum means resistance is maximum so voltage is near to 36V

& current is near to while when resistance is minimum ,voltage is near to 1V and current is near to 10Amps.

For case 3 we used a 36V dc motor at the output port. Effect of voltage & current change using knob 1 &2. As the current increases speed of motor also increased and as currents decreases speed of motor also decreased.

and the waveforms of input & output voltage & current are achieved and are discussed in details in results.

CHAPTER 8

8.1 RESULT

36V DC is input for LM317 IC, BD139 & 2N3055.

RV1=5K and RV2=10K resistor pots are adjusted to minimum.

Output port is open circuited.

Circuit is simulated, adjusting RV1 varies the voltage, adjusting RV2 doesn't make any changes in voltage.

Maximum Open Circuit Voltage, V(oc)= 36V, current=0A (as open circuit)

Simulation is stopped, output port is short circuited, Circuit is simulated.

Adjusting RV2(while RV1 is max) current reading varies.

Maximum Short Circuit Current, I(sc)= 10.2A, voltage=0V(as short circuit)

So this was the **1st case**

Now coming to the **2nd case**

Now a rheostat, RV3 of 220 ohm is connected at output port as load.

RV1=5k(Max) and RV2=10k(Max)

RV3=220ohm(Max), Output: Voltage- 34.6V, Current- 0.16A

RV3=Minimum, Output: Voltage- 0.99 V, Current- 9.94A

Now coming to the **3rd case**

Connecting a 36V DC motor at output port the speed of motor is increased & decreased by adjusting RV1 & RV2.

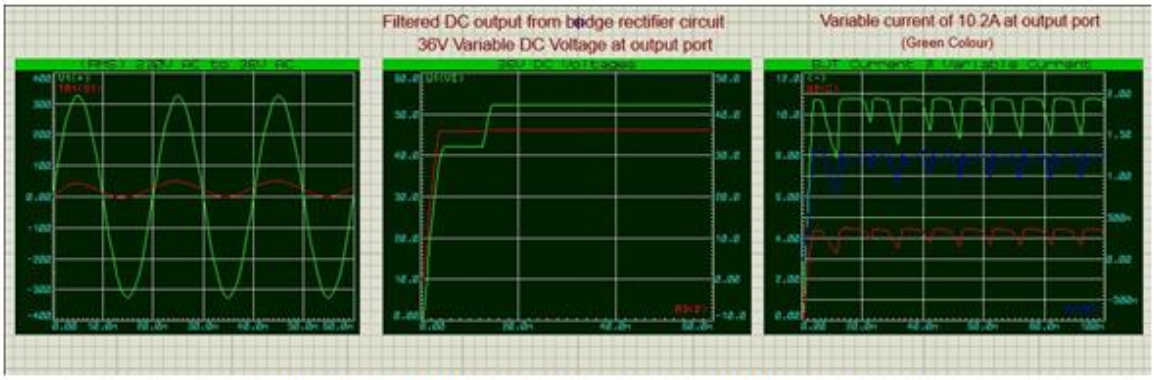

Fig 17: Voltage & Current Waveforms

The graphs it is as per the function of the circuit,the 230V AC to 36V AC conversion here it is the peak voltage so reading shows 325 instead of 230 which is rms value, in 2nd graph red waveform is 36v variable output dc voltage & in graph 3 green color waveform is variable 10.2Apms current.

8.2 Application

The whole system can be used for

1. DC Motors of different ratings.
2. DC Fans
3. DC Bulbs
4. DC battery charging
5. Other DC equipment of different voltage ranges etc.

Chapter 9

Conclusion

- The circuit design simulation was working properly we were able to achieve variable dc power supply which can be used for Used for various loads
- It is Cost effective as the components used are not so costly
- From the waveform we could see that it was Converting AC to DC properly
- A range of DC power supply up to 36Volts, 10 Amperes we are able to achieve which Can be used for 3V, 9V, 12V, 24V, 36V DC loads of different current rating

REFERENCES

I. **Modeling an Intelligent Variable Power Supply Device** Shoewu, O. and Makanjuola, N.T., Department of Electronic and Computer Engineering, Lagos State University, Epe Campus, Lagos, Nigeria. *Corresponding author: Shoewu

II. **Design and Development of an Intelligent Variable Power Supply Device.** O. Shoewu 1, O.M. Olaniyi 2, and O.M. Ogunleye 11 ,Department of Electronic and Computer Engineering, Lagos State University,Epe Campus, Lagos, Nigeria. **2,** Department of Electrical and Electronics Engineering, Bells University of, Technology,Ota, Ogun State, Nigeria

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IV. https://www.electronicshub.org/

V. https://www.electronicsforu.com/

VI. https://www.researchgate.net/

VII. http://www.ijareeie.com/

VIII. http://www.arpapress.com/

IX. https://www.academia.edu/