DESIGN AND DEVELOPMENT OF AN ADJUSTABLE DUAL DC POWER SUPPLY

ARHAM ASHFAQ 2018-EE-167

ADEEL AHMAD 2018-EE-168

MUHAMMAD USMAN 2018-EE-169

SEMICONDUCTOR LAB PROJECT REPORT

SUPERVISOR:DR SYED IRFAN SHAH

December 16, 2019

DECLARATION

I hereby declare that I carried out the work reported in this report in the department of Electrical Engineering,University of Engineering and Technology,Lahore,under the supervision of **Dr.Syed Irfan Shah.**I solemnly declare that to the best of my knowledge,no part of this report has been submitted here or elsewhere in a previous application for award of a degree.All sources of knowledge used have been duly acknowledged.

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ARHAM ASHFAQ

2018-EE-167

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MUHAMMAD USMAN

2018-EE-169

APPROVAL

This is to certify that the project titled “Design and Development of an adjustable DC power supply”carried out by Arham Ashfaq (2018-EE-167),Adeel Ahmad (2018-EE-168) and Muhammad Usman (2018-EE-169) has been read and approved for meeting part of the requirements and regulations governing the award of the Bachelor of Science(Electrical Engineering) of University of Engineering and Technology ,Lahore,Pakistan.

…….. …….

DR SYED IRFAN SHAH DATE

(PROJECT SUPERVISOR)

…….. …….

DR K.M.HASSAN DATE

(CHAIRMAN OF DEPARTMENT)

…….. …….

DR TAHIR IZHAR DATE

(DEAN OF DEPARTMENT)

ACKNOWLEDGEMENT

We would like to express our special thanks of gratitude to my instructor DR SYED IRFAN SHAH who gave us a wonderful opportunity to work on this project which caused us to do a lot of research and we came to know about so many new applications and concepts related to semiconductors.

Secondly, We would also like to thank our parents who's continuous support helped us a lot in finalizing this project within the stated time frame.

THE EXECUTIVE SUMMARY(ABSTRACT)

In this project an adjustable DC dual power supply was developed that has an input voltage of 230VAC/50Hz,output voltage range of 0-30VDC/1.25-30V and maximum output load current of 1.5 A.

.A simulation was made using PROTEUS**,**in which a centre tapped transformer was used that took 230VAC/50Hz input and gave a total of 24 volt output.Next,a PCB layout was made.The prepared PCB layout was transferred to the sheet using toner transfer method.After that 500ml water was boiled in a utensil for about 15 minutes.Small amount of ferric chloride was added to the boiling water.The tweezers were used to move the PCB inside the solution to ensure maximum contact with chemicals.The PCB was removed when all of the copper had washed away.The board was washed with water to remove any excess solution.The scrubber was used to remove the toner.The drill machines in the Project Lab were used to drill holes in the PCB for component placement.All the components were placed and soldered onto the PCB..Drill machine was used to drill holes through the box,to make windows of appropriate dimensions to place the voltmeter,fan,LED ,knobs and switch.The voltage regulators(lm317 and 337) were used for the first time and their importance was highlighted and understanding of their working was developed.It was observed that the real components behave a bit different than the ideal ones,for instance,there is a resistance associated with diodes capacitors and batteries and they might cause simulated and actual results to differ.

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LIST OF ABBREVATIONS AND SYMBOLS USED

V=Voltage.

Vth=Threshold voltage.

VBR=Breakdown voltage.

I=Current.

A=Amperes

R=Resistance

RL=Load resistance

C=Capacitance

F=Farad

n=nano(10^-9)

m=milli(10^-3)

K=kilo(10^3)

f=frequency

Hz=hertz

1. OBJECTIVE

To design and built an adjustable DC dual power supply that has an input voltage of 230VAC/50Hz,output voltage range of 0-30VDC/1.25-30V and maximum output load current of 1.5 A.

2. THEORY

2.1 PN JUNCTION DIODE

PN junction diode is one of the fundamental elements in electronics that only allows current in forward bias mode i.e when the anode of the diode is at higher potential than the cathode of the diode. In this type of diode, we dope one side of a semiconductor piece with an acceptor impurity and another side with a donor impurity. A PN junction diode is a two-terminal electronics element, which can be classified as either ‘step graded’ or ‘linear graded’.

In a step graded PN junction diode, the concentration of dopants both, in the N side and the P side are uniform up to the junction. But in a linearly graded junction, the doping concentration varies almost linearly with the distance from the junction. When we do not apply any voltage across the PN diode, free electrons will diffuse through the junction to P side and holes will diffuse through the junction to N side and they combine with each other.

Thus the acceptor atoms in the p-side near the junction edge and donor atoms in n-side near junction edge become negative and positive ions respectively. The existence of negative ions in the p-type side along the junction and positive ions in the n-type side along the junction edge creates an electric field. The electric filed opposes further diffusion of free electrons from the n-type side and holes from the p-type side of the PN junction diode. We call this region across the junction where the uncovered charges (ions) exist, as depletion region.

If, we apply forward bias voltage to the p-n junction diode. That means if the positive side of the battery is connected to the p-side, then the depletion regions width decreases and carriers (holes and free electrons) flow across the junction. If we apply a reverse bias voltage to the diode, the depletion width increases and no charge can flow across the junction

The figure1 shows the current-voltage characteristic of a PN junction diode.

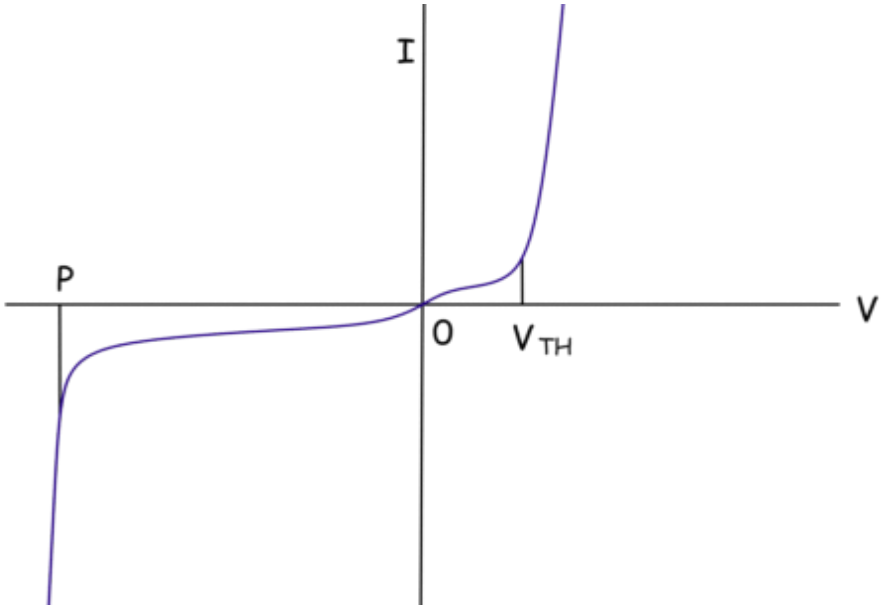


FIGURE 1:I-V CHARACTERISTICS OF SILICON DIODE

When, V is positive the junction is forward biased, and when V is negative, the junction is reverse biased. When V is negative and less than V_{TH}, the current is minimal. But when V exceeds V_{TH}, the current suddenly becomes very high. The voltage V_{TH} is known as the threshold or cut in voltage. For Silicon diode V_{TH} = 0.7 V. At a reverse voltage corresponding to the point P, there is abrupt increment in reverse current. This portion of the characteristics is known as breakdown region.

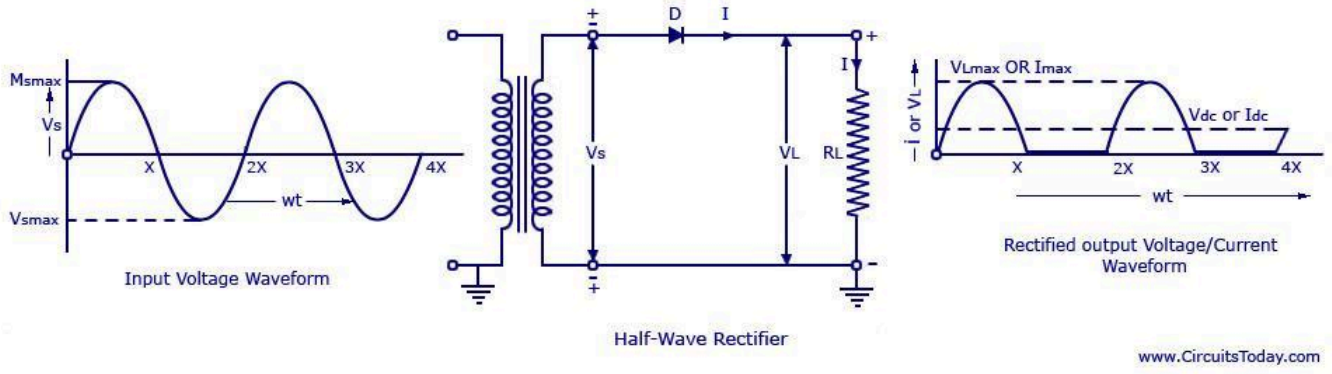
2.2 DIODE TO CONVERT AC TO DC

2.2.1 HALF WAVE RECTIFICATION

The ac voltage across the secondary winding as shown in figure 2 changes polarities after every half cycle of the input wave. During the positive half-cycles of the input ac voltage i.e. when the upper end of the secondary winding is positive w.r.t. its lower end, the diode is forward biased and therefore conducts current. If the forward resistance of the diode is assumed to be zero (in practice, however, a small resistance exists) the input voltage during the positive half-cycles is directly applied to the load resistance RL, making its upper-end positive w.r.t. its lower end. The waveforms of the output current and output voltage are of the same shape as that of the input ac voltage.

During the negative half cycles of the input ac voltage i.e. when the lower end of the secondary winding is positive w.r.t. its upper end, the diode is reverse biased and so does not conduct. Thus during the negative half cycles of the input ac voltage, the current through and the voltage across the load remains zero. The reverse current, being very small in magnitude, is neglected. Thus for the negative half cycles, no power is delivered to the load.

Thus the output voltage (VL) developed across load resistance RL is a series of positive half cycles of alternating voltage, with intervening very small constant negative voltage levels, It is obvious from the figure 2 that the output is not a steady dc, but only a pulsating dc wave.



FGURE 2:HALF WAVE RECTIFIER

2.2.2 FULL WAVE RECTIFICATION

The full wave rectifier circuit, as shown in figure 3 ,consists of two power diodes connected to a single load resistance (R_L) with each diode taking it in turn to supply current to the load. When point A of the transformer is positive with respect to point C, diode D_1 conducts in the forward direction as indicated by the arrows.

When point B is positive (in the negative half of the cycle) with respect to point C, diode D_2 conducts in the forward direction and the current flowing through resistor R is in the same direction for both half-cycles.

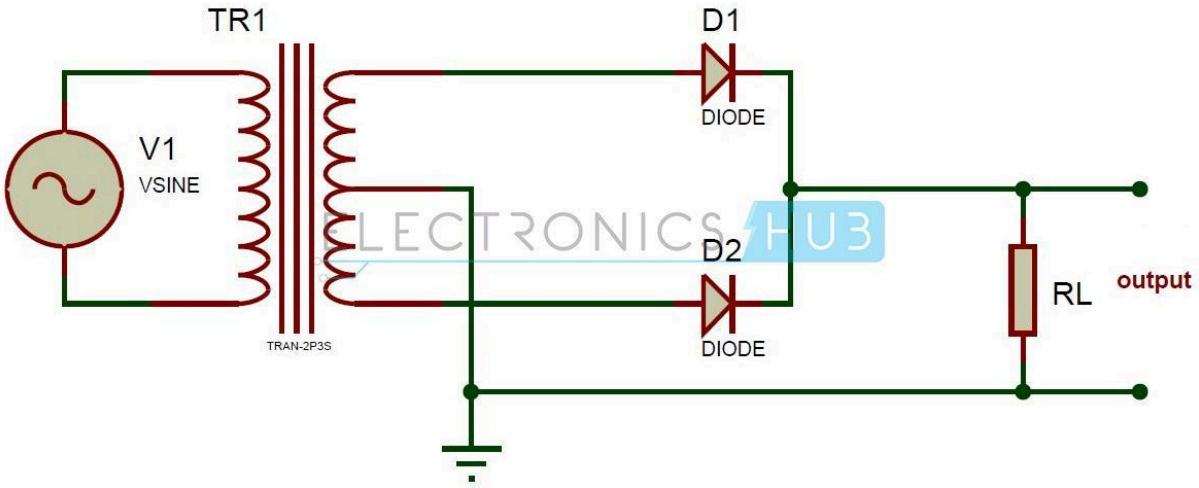


FIGURE 3:FULL WAVE RECTIFIER CIRCUIT

2.2.3 BRIDGE RECTIFICATION

When input AC signal is applied across the bridge rectifier, during the positive half cycle diodes D1 and D3 as shown in Figure 4 are forward biased and allows electric current while the diodes D2 and D4 are reverse biased and blocks electric current. On the other hand, during the negative half cycle diodes D2 and D4 are forward biased and allows electric current while diodes D1 and D3 are reverse biased and blocks electric current.

During the positive half cycle, the terminal A becomes positive while the terminal B becomes negative. This causes the diodes D1 and D3 forward biased and at the same time, it causes the diodes D2 and D4 reverse biased.

During the negative half cycle, the terminal B becomes positive while the terminal A becomes negative. This causes the diodes D2 and D4 forward biased and at the same time, it causes the diodes D1 and D3 reverse biased.

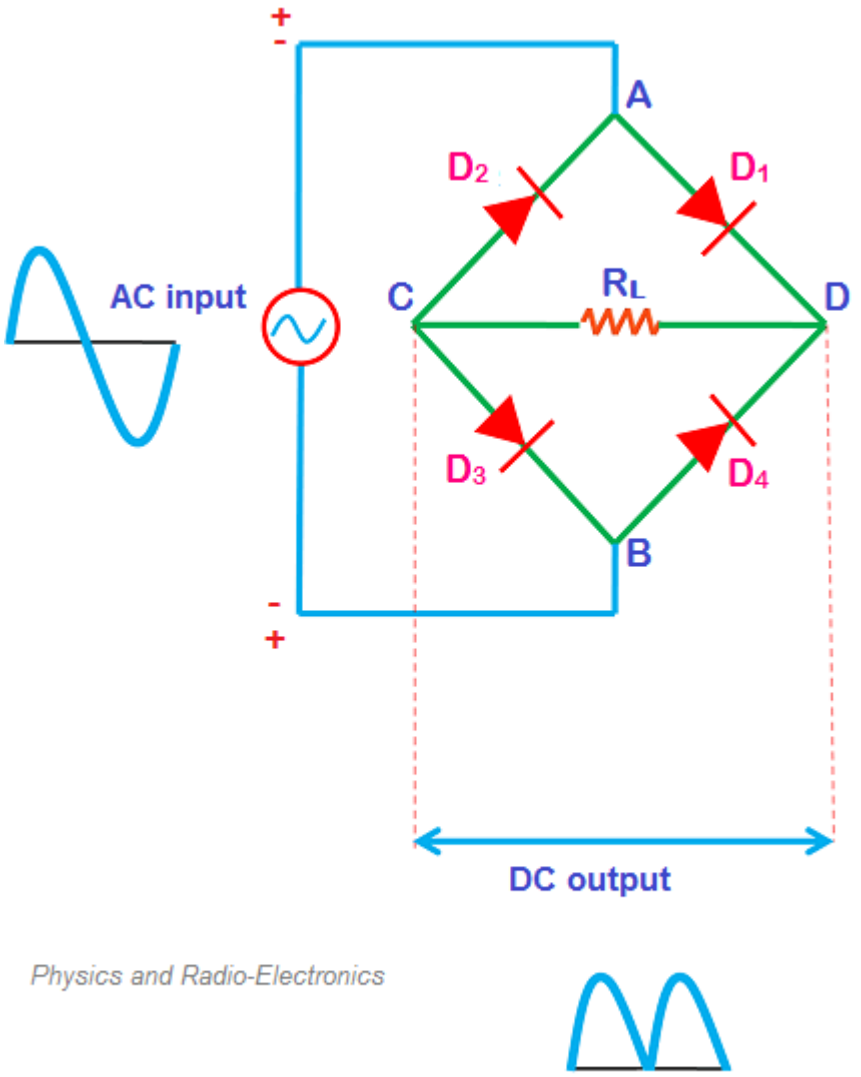


FIGURE 4:BRIDGE RECTIFIER

3. PROCEDURE

1.A rough schematic with the manually calculated values of capacitance,resistance,voltage and current was made on paper.

2.A simulation was made using **PROTEUS,**in which a centre tapped transformer was used that took 230VAC/50Hz input and gave a total of 24 volt output.

3.The simulation was run and the required results were verified.If the results did not meet the reqirements of the project,new values of resistors and capacitors were used to get the desired output.

4.Next,a PCB layout was made using **ALTIUM DESIGNER.**

5.The prepared PCB layout was transferred to the sheet using toner transfer method.

6.After that 500ml water was boiled in a utensil for about 15 minutes.

7.Small amount of ferric chloride was added to the boiling water.

8.The boiling was stopped and water was allowed to cool down a bit.

9.The PCB board was placed inside ferric chloride solution with the help of tweezers.

10.The tweezers were used to move the PCB inside the solution to ensure maximum contact with chemicals.

11.The PCB was removed when all of the copper had washed away.

12.The board was washed with water to remove any excess solution.

13.The scrubber was used to remove the toner.

14.The drill machines in the Project Lab were used to drill holes in the PCB for component placement.

15.All the components were placed and soldered onto the PCB.

16.Next,a reasonable sketch of the Box in which circuit was to be placed was made on paper,clearly indicating the positions of transformer,fan,switch,LEDs and voltmeters.

17.Drill machine was used to drill holes through the box,to make windows of appropriate dimensions to place the voltmeter,fan,LED ,knobs and switch.

4. SCHEMATIC,PCB LAYOUT:

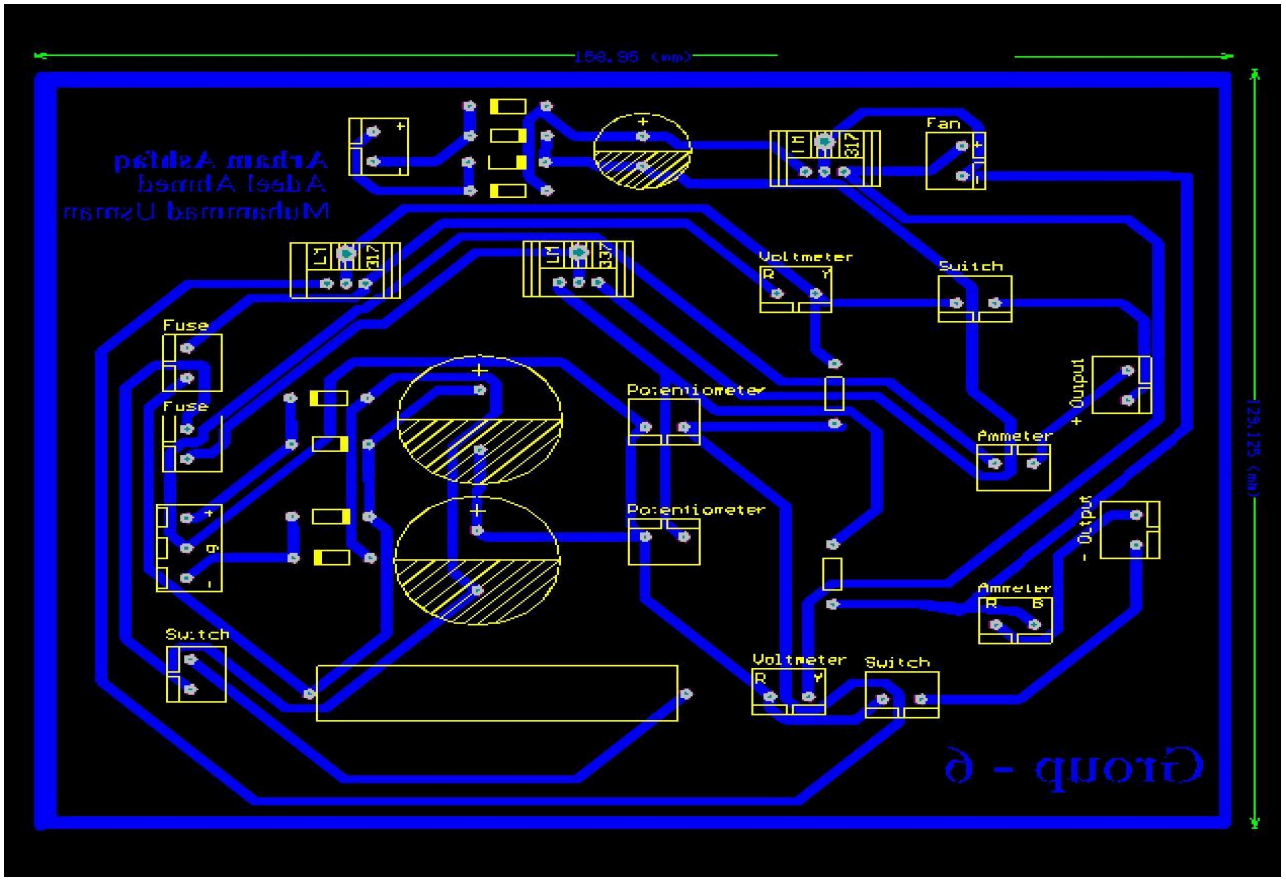


FIGURE 5:PCB LAYOUT

5. TESTING

Figure 6: Testing on 19V and 1A current

6. COST

5.1 COST CALCULATION

6.1.1 LIST OF EXPENDITURES

1. Price of components.
2. Price of single layer Fibre PCB.
3. Cost of fuel to travel to hall road and back to university.
4. Cost of uber if bike was not available.
5. Cost of food if students stayed at university to completed the project after lecture timings.

5.1.2 BILL OF MATERIALS

NAME	QUANTITY	PRICE(PKR)	REFERRENCE
Transformer	1	500	
1n4007 Diode	5	50	
Potentiometers	5	50	
Ceramic Resistor	3	150	
Switches	2	20	
Heat shrinks	5	20	
Fuses	4	20	
12V DC Fan	1	100	
Single-layer Fiber Glass PCB	1	750	
Soldering Iron	1	240	
Soldering Wire	1	200	

TABLE 1:BILL OF MATERIALS

TOTAL: 2100 PKR

6. LEARNINGS

For the first time during the electrical engineering degree,group members went to purchase and use a transformer in a project.The voltage regulators(lm317 and 337) were used for the first time and their importance was highlighted and understanding of their working was developed.It was observed that the real components behave a bit different than the ideal ones,for instance,there is a resistance associated with diodes capacitors and batteries and they might cause simulated and actual results to differ.

7. CONCLUSION

The aim of the project was to develop and design a dual DC power Supply.The voltage regulators were used at the end of the rectifier circuit with capacitor filters,to regulate and smoothen the ripple. It was observed that there was a difference between the actual and simulation results.It was concluded that the difference was due to the real behaviour of components.Thus,for future projects,students must first make a trial circuit on breadboard for testing,before making a PCB.The power supply developed and designed in the project can be used yo supply DC voltage to various circuits,and if modified a bit,can also be used as a mobile phone battery charger,