KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY

PROJECT REPORT

Department: Electronics and Communications Engineering

Course No.: ECE 2200

Course Title: Electronic Circuits Design Laboratory

Topic: DC Power Supply

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Submitted To:	**Submitted By:**
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Objectives:

1. To implement a DC power supply.
2. To provide the feature to DC power supply.
3. To observe the output of DC power supply.
4. To observe the functionality
5. To find maximum load current and efficiency of the DC power Supply.

Introduction:

A DC power supply is a fundamental component in almost every electronic system, providing the required power to operate various devices and circuits. Unlike alternating current, which constantly changes direction, direct current flows in a single direction, making it ideal for powering most electronic devices. Whether for laboratory testing, powering embedded systems, or driving low-voltage circuits, a reliable DC power supply is crucial for ensuring the proper functioning of electronic devices.

This project aims to design and construct a versatile DC power supply capable of providing a stable and adjustable output voltage and current. The goal is to develop a power supply that can deliver a range of voltages with adjustable output, ensuring that it can be used for various applications, from powering small electronic components to more demanding projects that require precise voltage and current regulation.

The power supply will incorporate features such as over-voltage protection, under-voltage protection, and voltage and current adjustability, ensuring that it meets the needs of different electronics and minimizes the risk of damage to sensitive components. The design process will include key stages, such as transforming the AC voltage to DC, regulating the output, and providing protection mechanisms to safeguard both the power supply and the devices being powered.

In this report, we will discuss the components used, results, contribution, complexity, budget and the steps involved in building a working prototype of this. The project will highlight essential concepts in power electronics, including rectification, voltage regulation, and current limiting, providing an in-depth understanding of the principles behind modern power supply design.

Theory:

DC Power Supply:

A DC power supply converts AC power from a standard outlet into a stable DC power source. This regulated direct current is then used to power a device, module or component. DC power supplies come in varying levels of input and output voltage, output current and power rating. We can generally choose between a constant voltage model or a constant current model. In constant voltage models, voltage remains constant at that level even if changes occur in the load. In constant current models, current remains constant at that level even if changes occur in the load. Input voltages are more commonly standardized over an available range, although it is also possible to specify just one power level. Output voltages are commonly offered for specific DC values of 5, 12, 24, or 48 volts.

As covered in the previous chapter, a DC power supply can be derived from an AC line. Most electrical and electronic circuits need a constant DC voltage source, regardless of input variations. While DC batteries can serve as an input, they are costly and require periodic replacement. Therefore, it is essential to first convert an AC input into a DC voltage source and then regulate it for consistent performance. This conversion process involves four major steps and is often illustrated by a diagram known as the Regulated DC Power Supply Block Diagram.

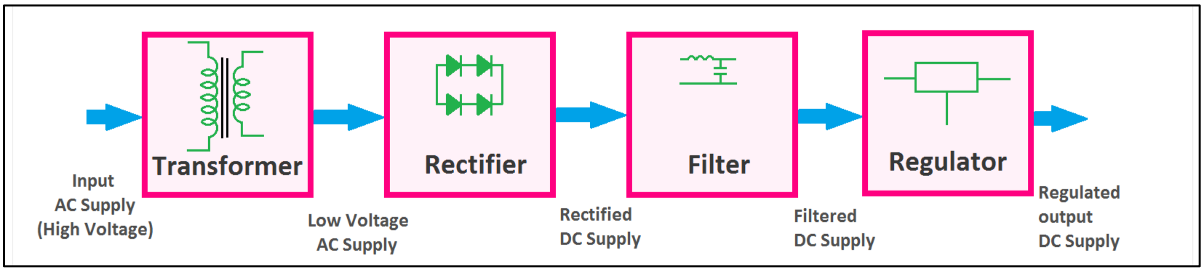


Fig 1: DC Power Supply Block Diagram.

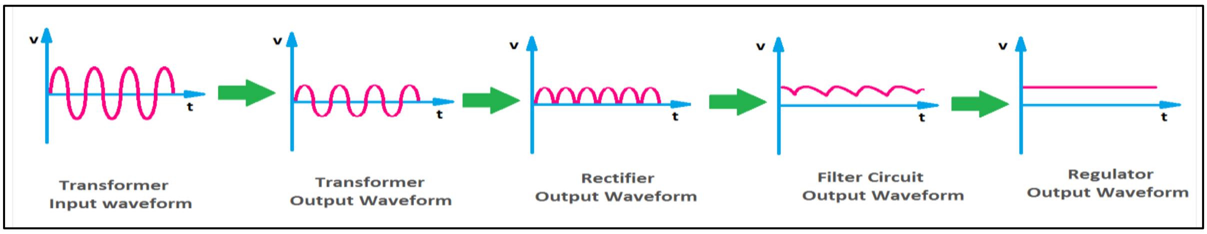


Fig 2: Waveforms at every stage of DC power supply.

From the diagram we see that a DC power supply involves the terms like Transformer, Rectifier, Filter, Voltage regulator. Let's discuss the terms functionality:

Transformer: It mainly transforms voltage from lower to higher or from higher to lower voltage. There are two types of transformers. One is step up transformer which increases the input. Another is step down transformer which decreases high AC voltage to a lower level and provides isolation between the input and the rest of the power supply. So, For the Dc power supply general requirements is fulfilled by step down transformer.

Rectifier: A rectifier is an electronic device that converts an alternating current into a direct current by using one or more P-N junction diodes. A diode behaves as a one-way valve that allows current to flow in a single direction. This process is known as rectification. The selection of dc power supply depends on the load attached to the power supply. However, for greater Dc output voltage and efficiency purposes, mostly bridge rectifiers are used.

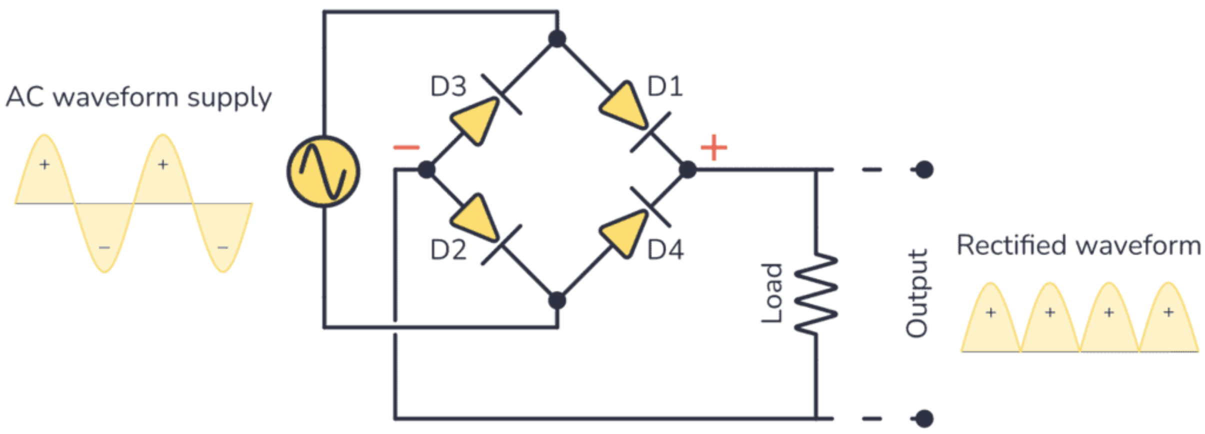


Fig 3: Full wave - bridge rectifier.

Filter: The function of this part of the circuit is the removal of ripples or AC contents from the output voltage supplied through the rectifier. Practically, no filter can be ripple free like Dc battery or which can provide output voltage devoid of any Ac contents. However, through a careful selection of a filter and increasing the number of its sections, ripple values found in the output of a rectifier circuit can be minimized substantially, so that the power supply operates in an excellent manner.

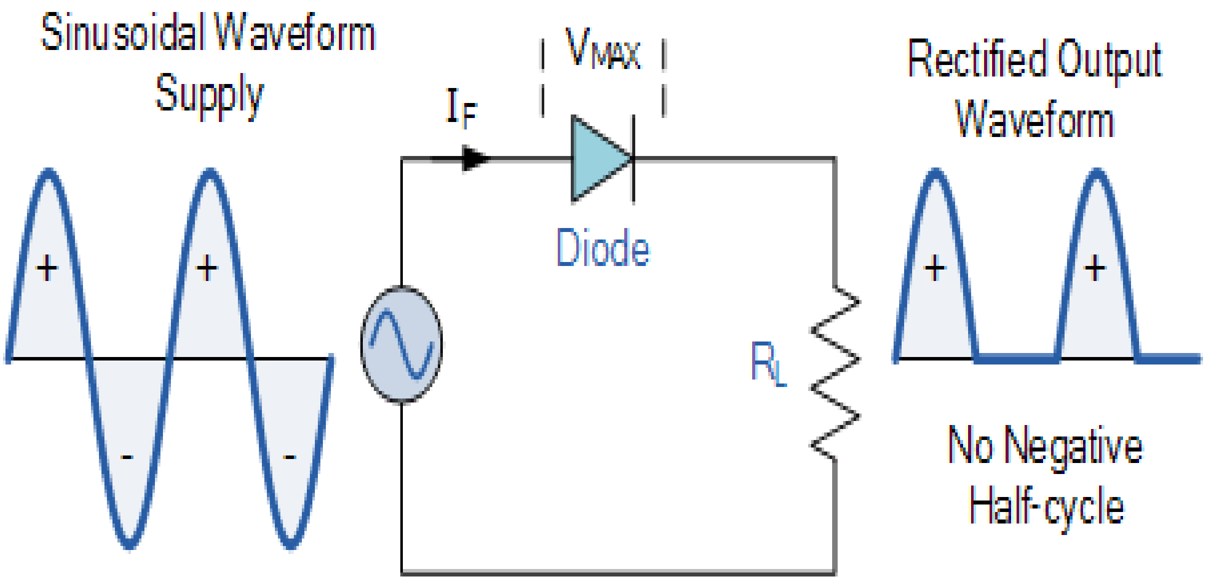


Fig 4: Filter Circuit.

Voltage regulator: Voltage regulator, any electrical or electronic device that maintains the voltage of a power source within acceptable limits. The basic function of a voltage regulator is to keep the terminal voltages of a DC supply always constant, irrespective of any changes in load or AC input voltages received by the transformer.

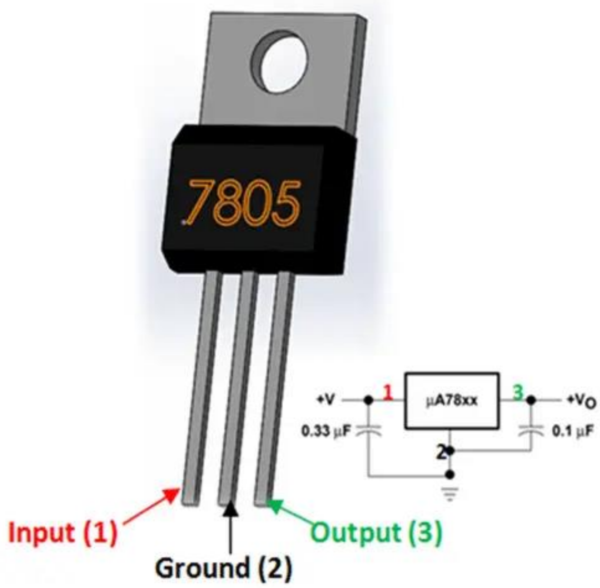


Fig 5: Voltage regulator pin diagram.

Relay:

Relays are the switches that aim at closing and opening the circuits electronically as well as electromechanically. It controls the opening and closing of the circuit contacts of an electronic circuit. When the relay contact is open (NO), the relay isn't energized with the open contact. However, if it is closed (NC), the relay isn't energized given the closed contact. However, when energy (electricity or charge) is supplied, the states are prone to change.

Relays are normally used in the control panels, manufacturing, and building automation to control the power along with switching the smaller current values in a control circuit. However, the supply of amplifying effect can help control the large amperes and voltages because if low voltage is applied to the relay coil, a large voltage can be switched by the contacts.

If preventive relays are being used, they can detect overcurrent, overload, undercurrent, and reverse current to ensure the protection of electronic equipment.

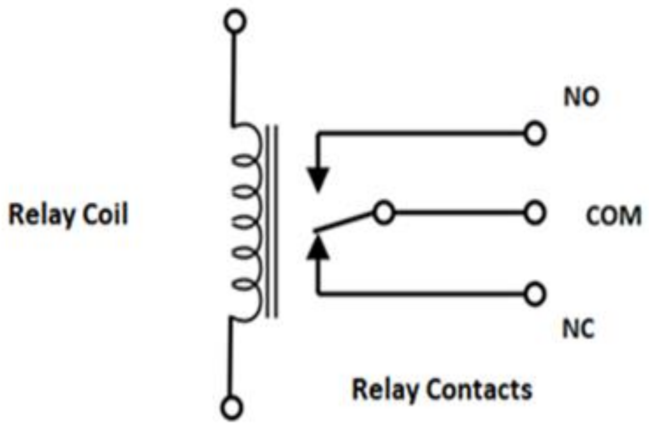


Fig 6: Relay connection.

Relay consists of a coil, which receives an electric signal and converts it to a mechanical action and contacts that open and close the electric circuit.

When different mechanical parts are connected on the basis of the electromagnet, a contact connection is established.

Short circuit protection:

Short circuit protection is a safety feature implemented in many power supplies to protect against the potentially damaging effects of short circuits. A short circuit occurs when an electrical current travels along an unintended path, such as a direct connection between the positive and negative terminals of a power supply. This can cause a surge of current to flow through the circuit, which can damage components and potentially cause a fire or other safety hazards. To prevent such incidents, most power supplies are equipped with short circuit protection circuitry that detects a short circuit and shuts down the power supply to prevent damage to the circuitry or any connected components. Short circuit protection circuits typically work by monitoring the output voltage and current of the power supply. If the output current exceeds a certain threshold, indicating a short circuit, the short circuit protection circuitry will quickly shut down the power supply to prevent further damage. Some power supplies may also have other protective features, such as over-voltage protection, over-current protection, and over-temperature protection, which can protect against other types of potentially damaging conditions. However, short circuit protection is one of the most important safety features in a power supply, as it can prevent potentially dangerous situations from occurring.

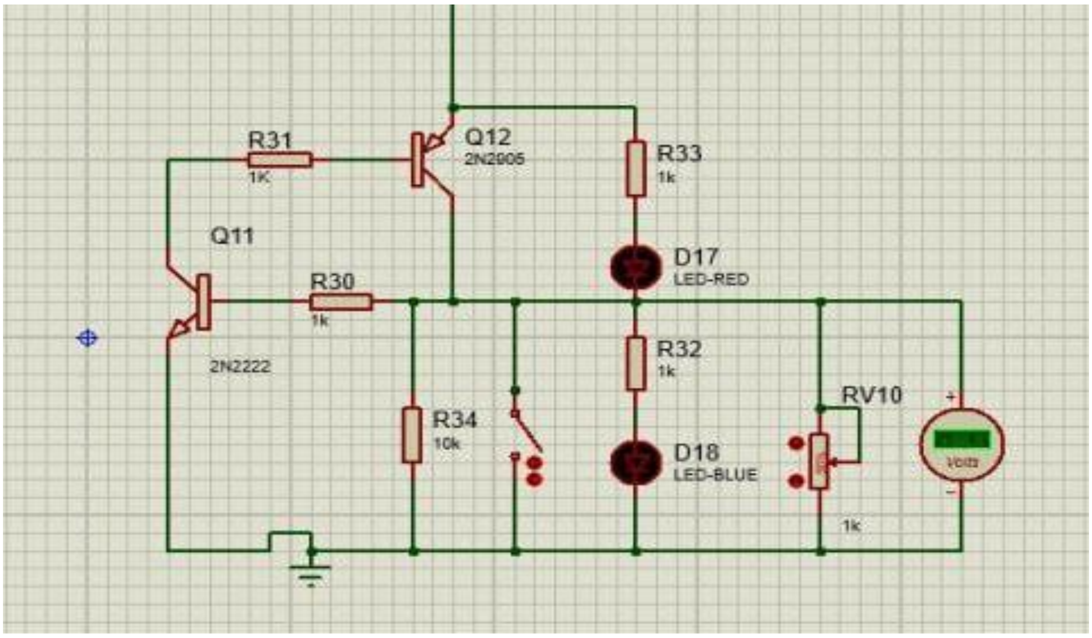


Fig 7: Short circuit protection circuit.

Under and Over Voltage Protection:

This voltage protection circuit is designed to develop a low-voltage and high-voltage tripping mechanism to protect a load from any damage. In many of the homes and industries fluctuations in AC mains supply take place frequently. Electronic devices get easily damaged due to fluctuations. To overcome this problem, we can implement a tripping mechanism of under / overvoltage protection circuit to protect the loads from the undue damage.

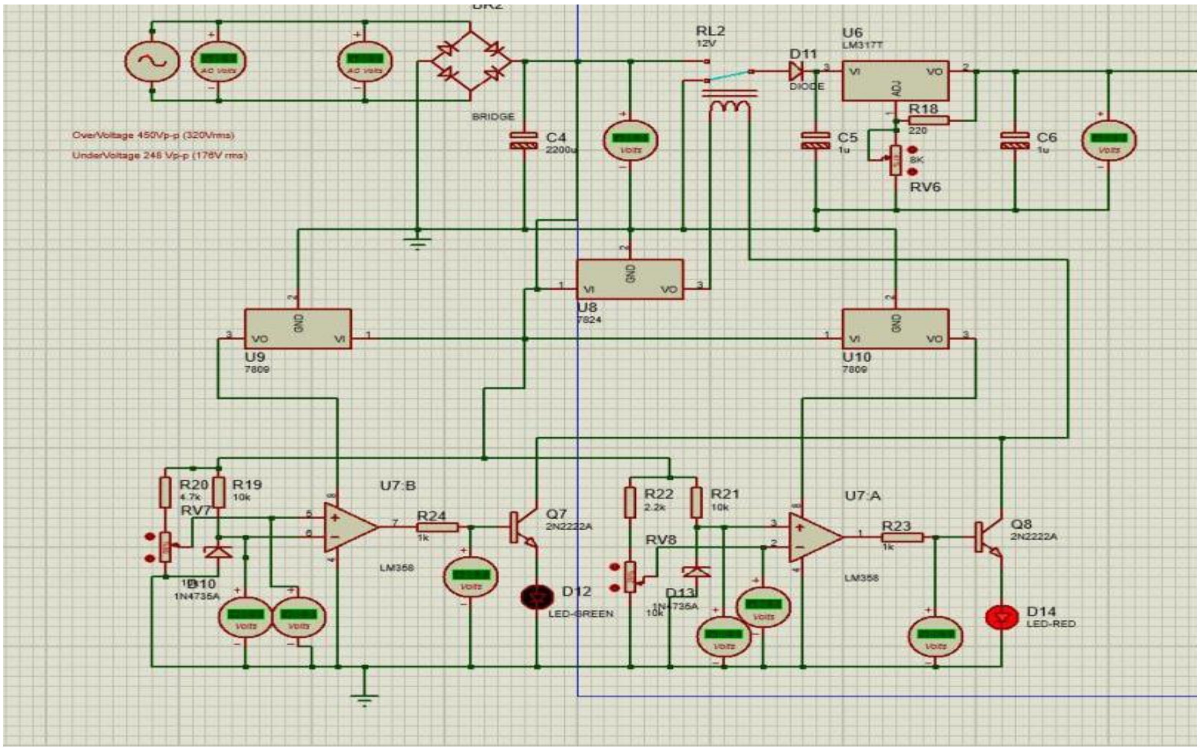


Fig 8: Under and Over voltage protection circuit.

Important features:

1. Short circuit protection.
2. Under voltage protection.
3. Over voltage protection.
4. Provide 0 to 13 regulated Dc voltage.
5. Short circuit indication.
6. Auto switching on over voltage and under voltage.
7. Great efficiency.

Apparatus:

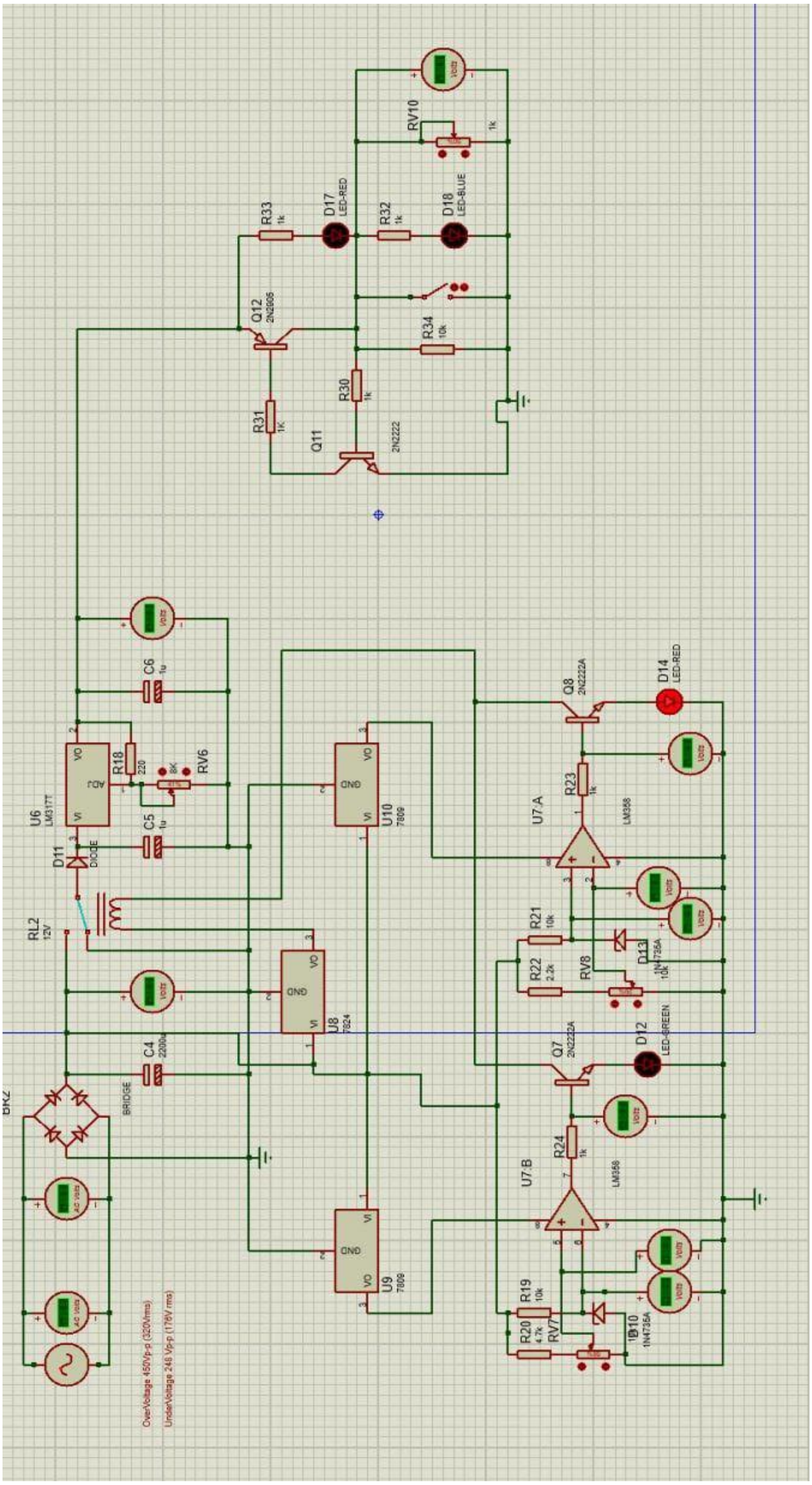
Table-1: List of required apparatus: -

Serial No	Components	Quantity	Price (per piece)
1.	Transformer	1	290/-
2.	Diode	5	1.7/-
3.	Zener Diode	2	2/-
4.	Capacitor	3	2/-(1uF), 7.5/-(2200uF), 3.3/- (0.1uF)
5.	Resistor	16	2/-
6.	Operational Amplifier	2	20/-
7.	Adjustable Regulator IC (LM317T)	1	22/-
8.	Regulator IC	2	15/-
9.	Variable Resistor	1	20/-
10.	Transistor	4	4/-
11.	Relay	1	20/-
13.	LED	4	2/-
14.	Switch	1	5/-
15.	PCB implementation	1	300/-
TOTAL		809/-	

Working procedure:

In this project we provided a DC power supply with some special features. Those features have provided more attractive to project. We knew about the basics and theory. And according to these we provided our project. We build a schematic diagram on software to check our knowledge and thoughts on DC power supply making and after checking these We started to build in Breadboard with required apparatus for practical checking and then we moved on commercial way (PCB implementation). And finally, we checked our result with the simulating result and hardware implementing result.

Circuit Diagram:



Result Analysis:

Let's discuss the results into breaking points for better understanding.

1. At first the step-down transformer converts high AC voltages into low AC voltages(30Vmax).
2. The output voltages varied from 0 to 13v for every testing.
3. Under voltage circuit works till 180 AC volt and Over voltages circuit works till 240 AC volt. The range is 60 AC volt, where the power supply could perform.
4. Efficiency of the DC voltage supply was approximately 88% in simulation, 82% in hardware implementation, 80% in PCB implementation under ideal conditions, with minimal energy losses.
5. The system was stable down to a minimum load of 10 mA, maintaining output voltage within an acceptable range.
6. The voltage regulation module consistently provided a stable output with only minor deviations under load changes.
7. Short circuit protection circuits, under voltage protection circuit and Over voltage protection circuit performed perfectly. Every protection circuit was stable.
8. The indication for every protection circuit was perfectly worked

Budget analysis:

According to the assumed budget list, the actual budget cost is in larger amount. It occurs due to practical equipment. Sometimes the equipment was a waste of money because of the defect in equipment, sometimes due to low quality equipment, it was burned. Sometimes the equipment wasn't giving an actual rating. Due to these reasons the budget wasn't actual. But if we avoid wasting equipment then the budget will be approximately close to our actual budget. And our project is low cost. Many of the tools required for this project, such as a soldering iron, is one-time purchases that can be used for future projects. Therefore, the initial cost is high but amortized over time if used for additional work. External lab testing and calibration can be costly, but they ensure that the power supply operates within safe and efficient parameters. For less critical projects, this expense can be avoided or reduced by using in-house equipment. While materials and labor make up the bulk of the cost, the investment in quality testing and reliable tools ensures the power supply operates efficiently and safely. By planning for equipment reuse and utilizing cost-saving measures, the budget can be optimized without sacrificing performance or safety.

Complexity faced:

We have faced some problems during this project session which caused we don't get the proper output. But after solving this we were success to complete the project. These are: -

1. Zero adjustment was not at the output.
2. Over voltage protection and under voltage protection were not working together.
3. Relay was not switching.
4. Loose connection in bread board.
5. Low quality equipment was disturbing to get the proper result.
6. Components in the voltage regulation and protection modules generated heat, affecting overall efficiency and stability.
7. Performance in simulations did not perfectly align with hardware testing results.
8. Due to PCB space, Fitting all components on a compact PCB was a great challenge.
9. Dealing with noise

Designing a DC power supply can be both rewarding and challenging. The complexity arises from multiple factors, including component selection. It was good approach is to start with a simple design, then progressively add features like protection circuit and voltage regulation. We have gained a better understand the intricacies of power supply design and how to manage these complexities effectively.

Contribution:

Table-2: Summary of team contribution

Team Member Name	Key contribution
Nazmul Islam Nayem (2109013)	Overall Project Planning, Communication, Under and Over-voltage Circuit Design and Simulation, Hardware Implementation of over and under-voltage circuit Project testing and debugging, PCB Design, Soldering and Inspection, Safety Testing.
Muntasir Billah Nakeeb (2109016)	Voltage Regulator Circuit Design and Simulation, Resource Allocation, Safety Testing, Hardware Implementation of short circuit, Documentation, PCB Design, Project testing and debugging Soldering and Inspection, Project Presentation.
Rukaiya Alam Nidra (2109019)	Overall Project Planning, Communication, Team Coordination, Short Circuit Design and Simulation, Hardware Implementation of short circuit, Project testing and debugging, Developed and maintained the project schedule, Safety Testing, Technical Documentation.

Discussion:

In this project, we successfully designed and built a versatile DC power supply capable of delivering a stable and adjustable output voltage. Through careful selection and integration of components, we were able to implement key features such as voltage regulation, current limiting, and over-voltage and under-voltage protection, ensuring the power supply's reliability and safety during operation.

The design process included several key stages:

- AC to DC Conversion: A transformer was used to step down AC voltage, followed by rectification to convert it into DC. A filter capacitor was employed to smooth the output.
- Voltage Regulation: A linear voltage regulator was chosen to provide stable, adjustable voltage. While it worked well, it exhibited inefficiencies due to heat dissipation, leading to the consideration of more efficient switching regulators for future improvements.
- Protection Mechanisms: The design included basic protection features, such as over-voltage, under-voltage protection and short circuit protection.

The design process highlighted important concepts in power electronics, including AC to DC conversion, linear and switching voltage regulation, and the importance of protection circuits for both the power supply and the powered devices. By using a combination of transformers, rectifiers, voltage regulators, and filters, we were able to achieve a well-regulated and efficient DC output, making the power supply suitable for a wide range of applications in electronics. While the project was successful, it also revealed areas for potential improvement, such as increasing the efficiency of the power supply with the use of advanced switching regulators or expanding its capabilities to handle higher currents or voltages. Future iterations of the project could focus on enhancing these features and adding more precise control over the output parameters.

Overall, this DC power supply provides a reliable and cost-effective solution for powering electronic circuits, and it offers valuable insights into the design and operation of power supplies in general. The knowledge gained from this project lays a strong foundation for further exploration and development of more advanced power electronics systems.

Conclusion:

This project provided valuable practical experience in designing a DC power supply, emphasizing the importance of voltage regulation and safety features. The challenges faced during the design process, such as efficiency concerns and the complexity of protection features and relay switching, were addressed and provided valuable lessons for future iterations. By refining the design with more efficient components, advanced protection systems, and enhanced user interfaces, this power supply can be adapted to meet a broader range of applications in both hobbyist and professional settings.

Reference:

1.
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