Project Report

For the Course

EE-215 Electronic Devices and Circuits

For

B.E. Electrical Engineering

Sr.	Name	CMS ID
1	Ayeza Faisal	517498
2	M. Shahryar Ameer	520657
3	Seemal Rizwan	505272

Degree- Syndicate: 46-A Group Number:
4

Instructor: Dr. Touseef Ali
Lab Engineer: Ma'am Rafia
College of Electrical & Mechanical Engineering (CEME), NUST, Pakistan

Table of Contents

DUAL OUTPUT DC POWER SUPPLY

ABSTRACT:

This report presents the complete design, theoretical analysis, simulation study, and performance evaluation of a dual-output DC power supply. The system produces **one fixed 5V regulated DC output** using a 7805 voltage regulator and **one variable 2–24V regulated output** using an LM317 adjustable regulator. The power supply is fed from a 220V AC mains source and uses a step-down transformer, a full-wave bridge rectifier, and a large smoothing capacitor to convert AC to a stable DC voltage. The regulated outputs were analyzed for voltage stability, ripple performance, load behavior, and power dissipation. The simulation results validate the proper functioning of the design, making it suitable for laboratory use, prototyping, and embedded circuits.

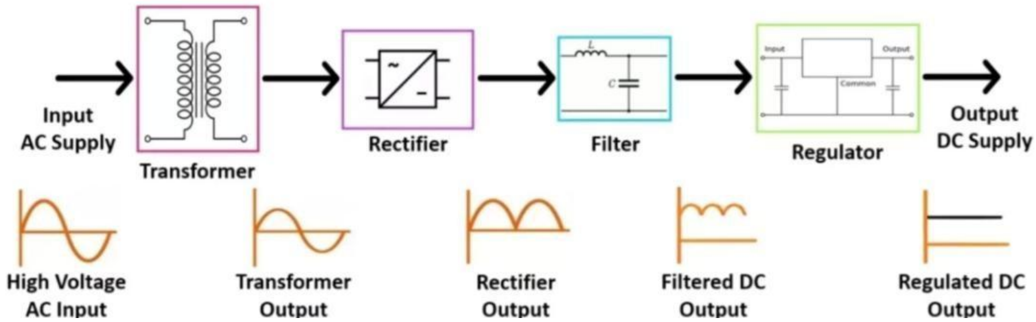
INTRODUCTION:

DC power supplies are essential components in nearly all electronic circuits. From microcontrollers to analog systems, a stable DC supply ensures reliable operation and prevents component damage. This project involves designing a two-channel linear DC power supply that produces:

- **A fixed 5V output (1A)** using the 7805 voltage regulator.
- **A variable 2–24V output (1A)** using the LM317 adjustable regulator. The main objectives are:
- To convert high-voltage AC mains into safe, regulated DC outputs.
- To understand each stage of power supply design including transformer operation, rectification, filtering, and regulation.
- To analyze the performance of LM317 and 7805 under load conditions.
- To investigate ripple voltage, voltage drops, and power dissipation.
- To simulate and interpret output voltages, currents, and waveforms

THEORY:

Power Supply Architecture:



A linear DC power supply consists of the following major stages:

- **AC Step-down Transformer** — reduces 220V AC to approximately 18–24V AC.
- **Full-wave Bridge Rectifier** — converts AC into pulsating DC.
- **Filter Capacitor** — smooths DC and lowers ripple.
- **Voltage Regulators**
- LM317 (variable 2–24V)
- 7805 (fixed 5V)
- **Load Stage** — resistive load or external circuitry.

Each stage is crucial for producing a stable and usable DC supply.

Transformer Theory:

A transformer works on **Faraday's law of electromagnetic induction**, where AC applied at the primary induces AC at the secondary.

Voltage ratio:

$$\frac{V_p}{V_s} = \frac{N_p}{N_s}$$

A step-down transformer is used to reduce 220V AC to around 24V AC.

This is necessary because:

Electronic circuits operate at low DC voltages.

Regulators require higher input voltage than the regulated output.

Isolation from mains improves safety.

A 22V AC secondary produces approximately:

$$V_{peak} = V_{rms} \times \sqrt{2} = 24 \times 1.414 = 33.9V$$

This is consistent with the **33.9V DC** seen in simulation.

Full-Wave Bridge Rectifier Theory:

The rectifier converts AC into pulsating DC using 4 diodes.

Advantages of full-wave rectification include:
Higher average output voltage
Lower ripple
Smaller filter capacitor requirement Peak rectified voltage:

$$V_{DC} \approx V_{peak} - 2V_{diode}$$

Assuming 0.7V drop per diode:

$$V_{DC} = 34 - 1.4 = 32.6V$$ This

forms the raw DC supply for the regulators.

Smoothing Capacitor (Filter Stage):

A large electrolytic capacitor (1000µF) reduces ripple by charging to the peak voltage and discharging between cycles.

Ripple voltage formula:

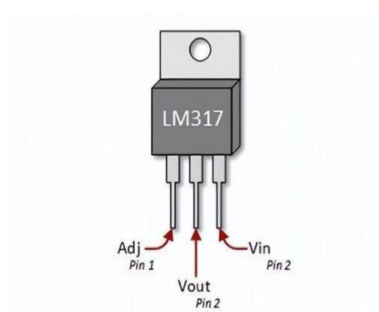
$$V_r = \frac{I_{load}}{fC}$$

Where:
$f = 100\ Hz$(full-wave ripple frequency), $C = 1000\mu F$
At 1A load:

$$V_r \approx 10I$$

Which is 10V for 1A.
This small ripple is acceptable for linear regulators.

LM317 Adjustable Regulator Theory:



The Range of LM 317 is 1.25 – 37V.
For a minimum of 2V we attached 220Ω resistor for limiting the voltage.
The LM317 provides an output voltage set by resistors R1 and R2 using:

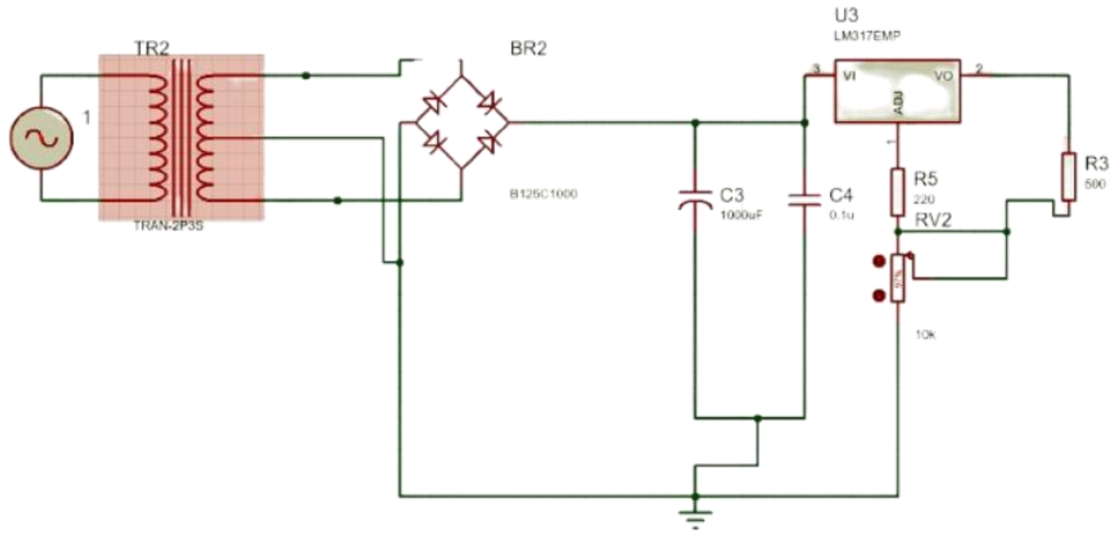
$$V_{out} = 1.25(1 + \frac{R_2}{R_1})$$

In the provided schematic:

$R_1 = 500\Omega$, $R_2 = 10k\Omega$ potentiometer + 220Ω Thus maximum output is approx.:

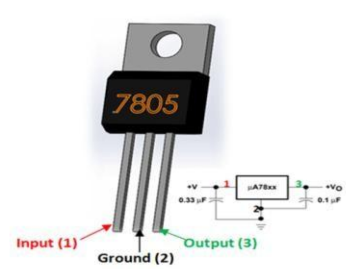
$$V_{out,max} \approx 1.25(1 + \frac{10000}{500}) \approx 26.25\,V$$

Power Supply Design (2-24V):



LM317 Key Features:

Output range: 1.25V to 37V
Current up to 1.5A
Short-circuit protection
Thermal shutdown
Requires dropout of **3V**
(i.e. $V_{in} \geq V_{out} + 3V$)

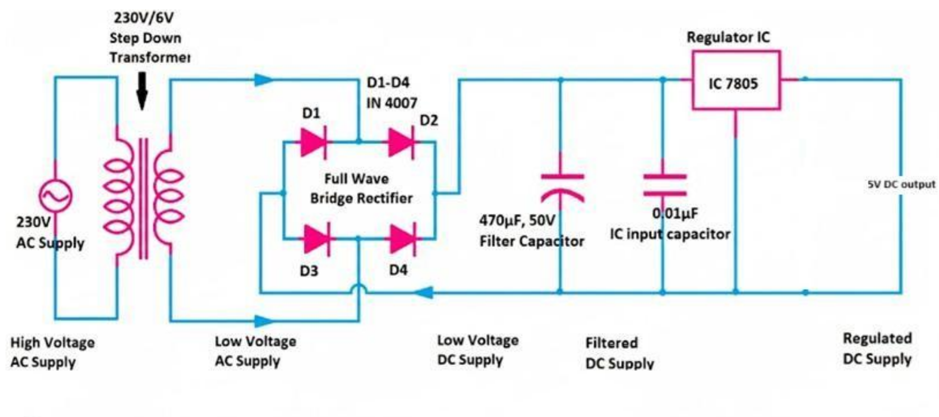


7805 Fixed Regulator Theory*:*

The 7805 regulator provides a stable 5V output.

It uses an internal reference and pass transistor to maintain a fixed voltage.

Power Supply Circuit Design (5V DC):



Power Dissipation:

$$P = (V_{in} - V_{out}) \times I$$ If

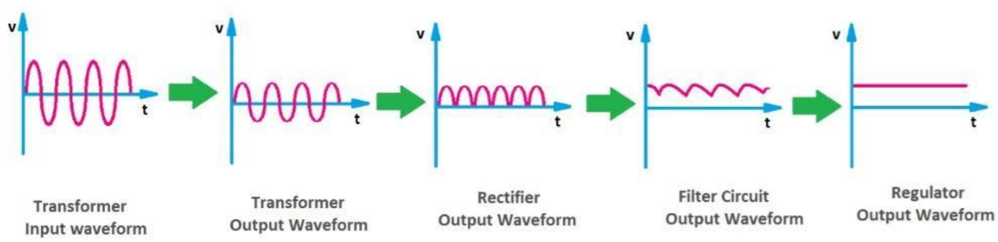
input is ~30V:

$$P = (30 - 5) \times 1 = 25W$$

This is significant → requires **large heatsink**.

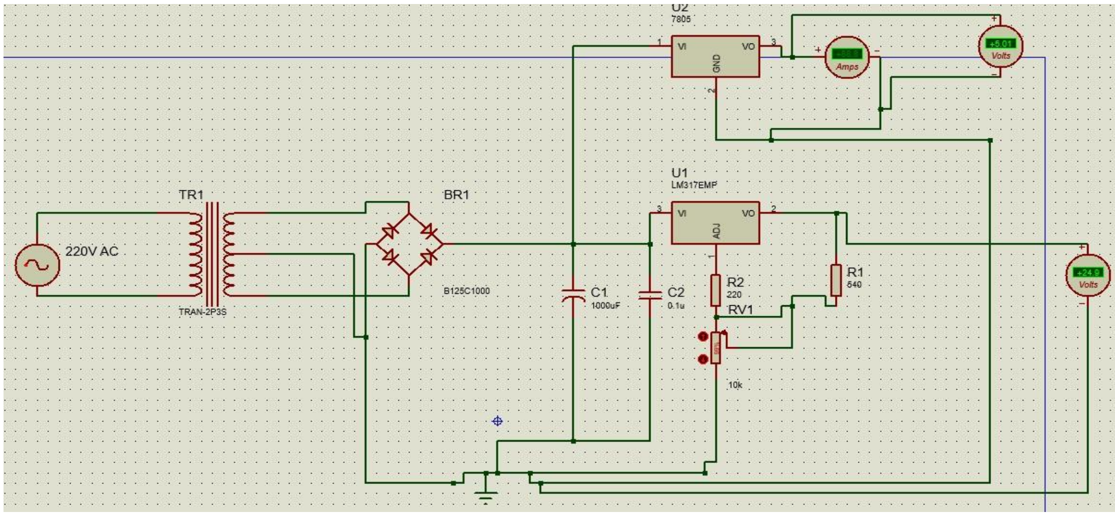
METHODOLOGY:

Circuit schematic was modeled exactly as provided.
Transformer configured to deliver approx. 22V AC.
Bridge rectifier for converting AC to DC and 4700µF capacitor connected for smoothing.
LM317 wired with resistors R1 and RV1 for adjustable output.
7805 connected with load resistor R4.



Output voltages measured using Proteus simulation probes.
Load current calculated using Ohm's Law.

SIMULATION RESULTS:



<u>Rectified DC Voltage:</u>

Measured: 24.4V DC
Expected: ~24VDC
This confirms correct rectification and filtering. ***LM317***
Output:

Measured: 24V
Load current: 0.99A
Matches: Maximum adjustable setting.

7805 Output:

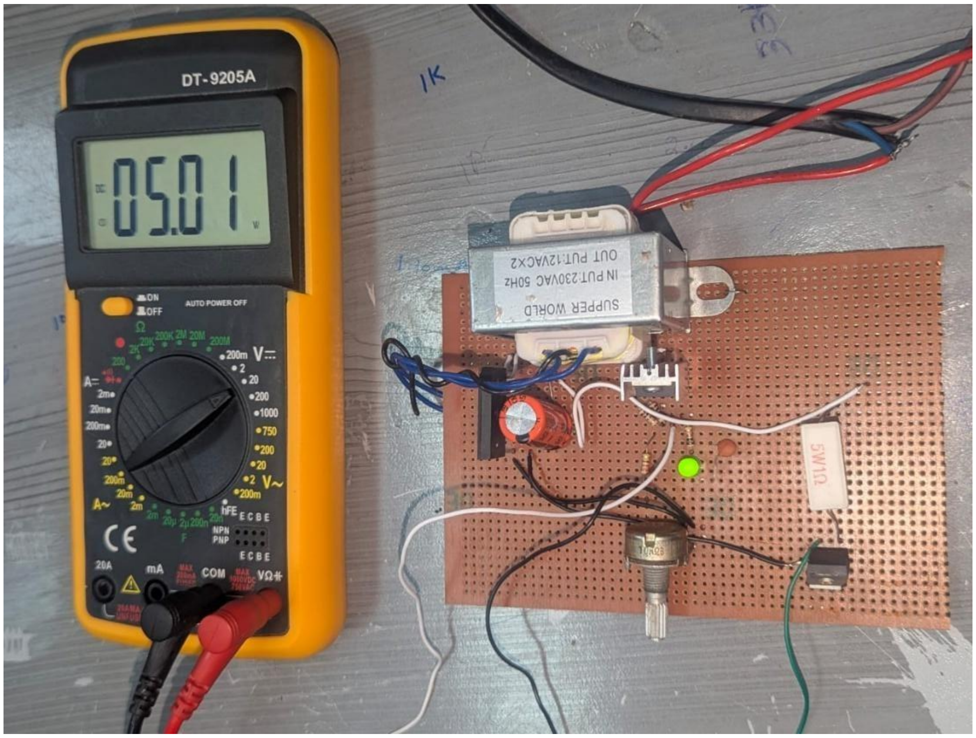
Measured: 4.93V Load
current: 0.95A
Within ±5% tolerance.

Ripple:

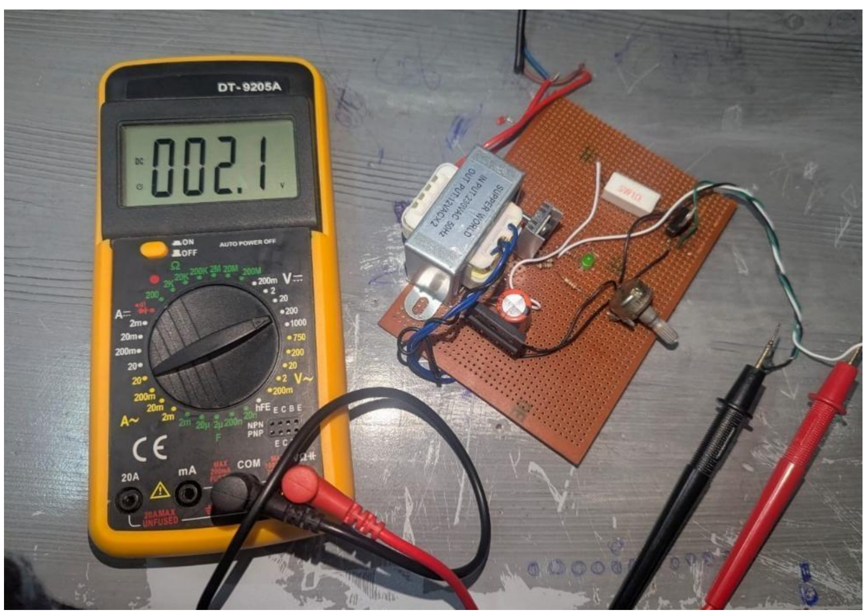
Minimal ripple was observed due to the large filter capacitor.

<u>HARDWARE:</u>

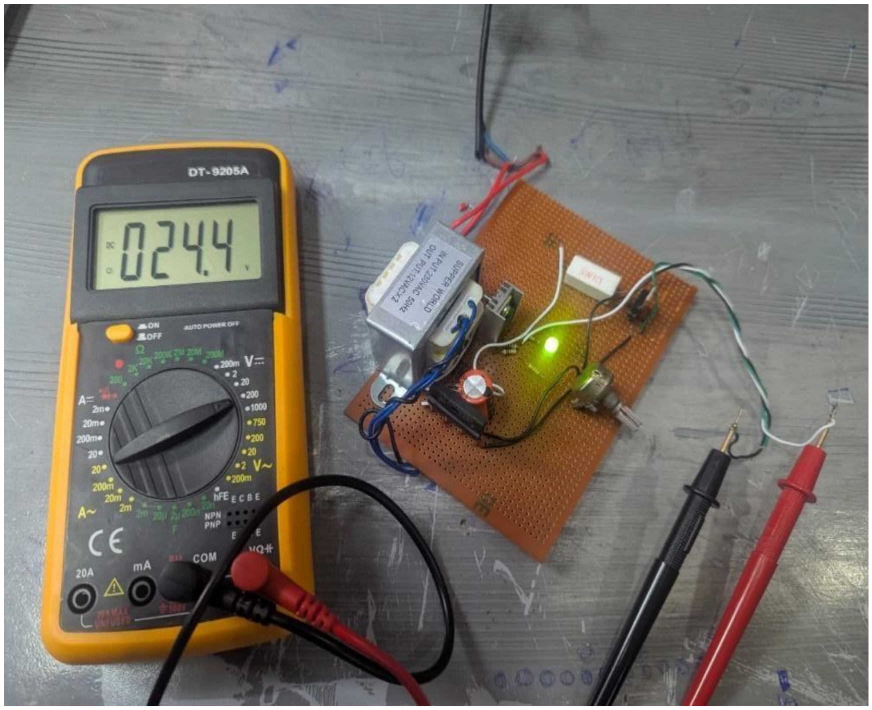
<u>5V (DC/Fixed Voltage):</u>



2-24V (Variable Potential):



(a) 2V(Minimum)



(b) 24V(Maximum)

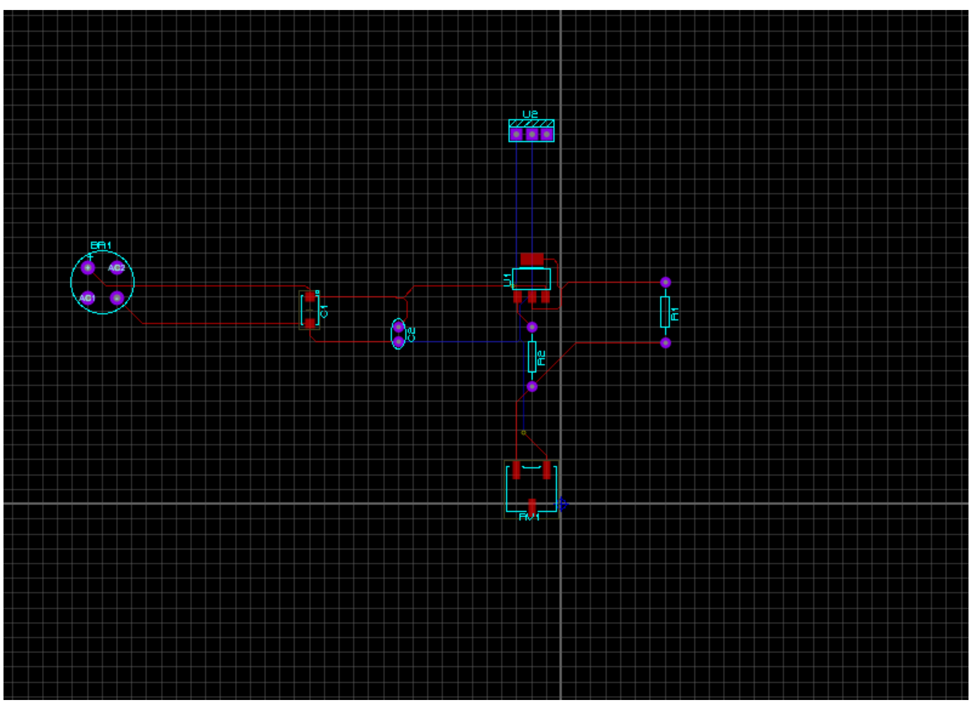
FURTHER EXPLANATION:

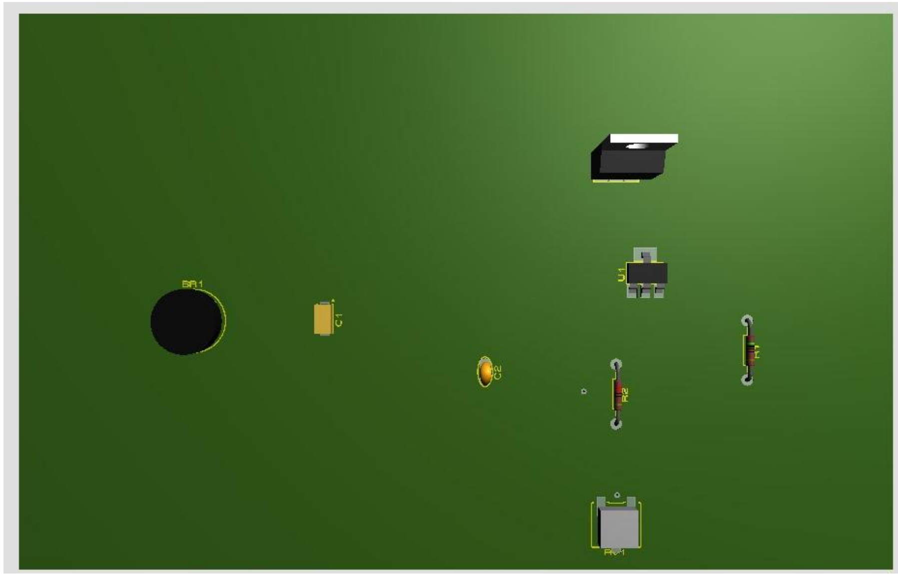
The transformer provides adequate AC voltage for both regulators.
The rectified and filtered DC level matches theoretical peak voltage.
LM317 performs correctly across its expected voltage range.
The 7805 maintains near-constant output despite heavy load.
High heat dissipation is expected in real hardware; simulation does not show thermal shutdown but real circuits require heatsinks.
The load resistors draw close to the regulator’s rated current, validating performance at nearmaximum load.
Ripple voltage remains low, demonstrating correct capacitor sizing.

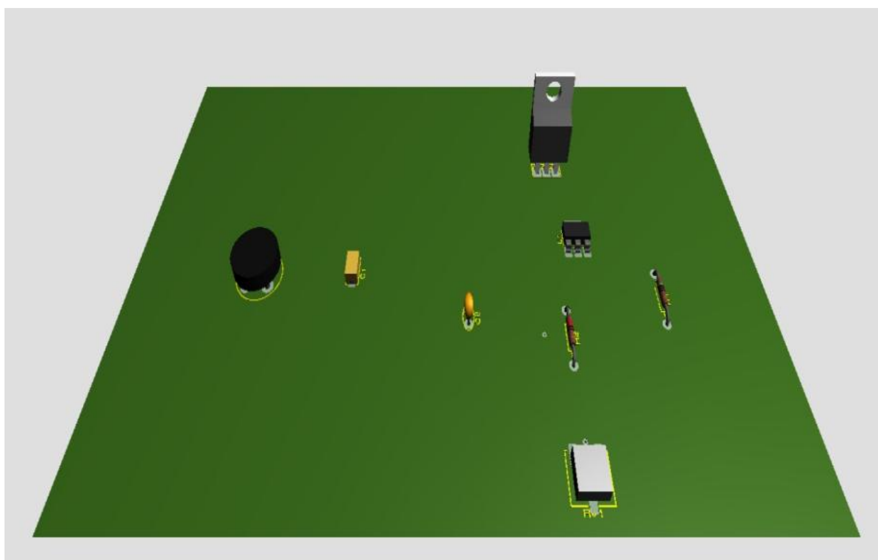
BILL OF MATERIAL(BOM):

COMPONENTS	QUANTITY	PRICE
Transformer (1A ,24V)	1	350
Bridge Rectifier	2	140
breadboard	1	250
Veroboard	1	250
Resistors/Capacitors	6	100
Power Resistor	1	130
LM317 Voltage regulator	2	100
7805 Voltage Regulator	2	50
Soldering Iron and wire kit	1	800
Total		**2170**

PCB LAYOUT:







TROUBLESHOOTING ERRORS:

- Check transformer output if there is no voltage.
- Verify bridge rectifier orientation (+, –, AC, AC).
- Replace filter capacitor if ripple is too high.
- Ensure capacitor polarity is correct.
- Reduce load if output voltage drops.

- Check LM317 pin connections (Adj, Out, In).
- Replace or reconnect potentiometer if LM317 is not adjusting.
- Add heatsink if regulators overheat.
- Ensure 7805 input is above 7V.
- Check for loose ground connections.
- Inspect resistors R1, R2, R3, R4 for open circuits.
- Confirm wiring continuity between regulator and output terminals.
- Replace bridge rectifier if heating excessively.
- Tighten or re-solder loose wires.
- Reduce input voltage if heat dissipation is too high.

CONCLUSION:

The dual-output DC power supply successfully converts 220V AC into two regulated DC outputs:
Variable 2–24V (LM317)
Fixed 5V (7805)
All theoretical values closely match simulation results. The design offers reliability and stability suitable for laboratory applications and general electronics use.

REFERENCES:

LM317 Datasheet
7805 Voltage Regulator Datasheet
Boylestad, R. *Electronic Devices and Circuit Theory*
Floyd, T. *Electronic Fundamentals*
Sedra & Smith, *Microelectronic Circuits*