AC-DC CONVERTER

1-CONCEPTS AND SPECIFICATIONS

1.1 Project Objectives
We do this project to improve our understanding of the construction processes followed during the realization of the design and we also specifically learn AC to DC converters. In addition we also improve our preparation of project.

1.2 Project Goals
By doing this project we are now ready for the construction that is realization of other projects and we are now have a technical experience on the realization of the software design and also experience on the software design of the projects.

1.3 Project Responsibilities
In this project we are responsible to give the project on time and not to cheat during the steps of the project. We are also responsible for not to waste the materials used in the labs and also protect our selves against acid, base and ultraviolet light.

1.4 Preliminary Specifications
Input voltage 220VAC ±10%
Output voltage 1,5...12 VDC continuously adjustable
Output current 1A (maximum)
Output ripple < 0.1Vpp
Load regulation better than 1%
Line regulation better than 1%

2-CIRCUIT DESCRIPTION
The block diagram of the circuit:

![Block Diagram](image.png)

Figure 1-Block Diagram
DESIGN

Transformer:
Transformer is used to step up or step down the voltage for our purpose. In this project we use transformer as a step down transformer since our input voltage is the mains voltage that is 220V AC and we want the output to be much smaller than this mains voltage.

\[ P_1 = P_2 \text{ (Ideal Transformer)} \]
\[ P_1 > P_2 \text{ (Real Transformer)} \]

For the ideal
\[ \frac{V_1}{V_2} = \frac{N_1}{N_2} \]
\[ \frac{I_1}{I_2} = \frac{N_2}{N_1} \]
\[ R_1 = V_1/I_1 = N_2^2 \cdot V_2/I_2 = N_2^2 \cdot R_2 \]

Figure 2- Transformer Circuit

Rectifier:
Rectifier circuit is used to convert the AC input to DC input. Although it converts AC to DC the DC output of the rectifier is not smooth as we want. There are ripples in the DC output of the rectifier circuit.

We construct a full wave rectifier for our purpose and use a capacitor to smooth the output voltage of the fullwave rectifier. We use four diodes to construct the fullwave rectifier and use capacitor additionally for the construction of the rectifier part of our design.
Figure 3 – Rectifier Circuit

**Voltage stabilizer:**

Voltage stabilizer is used to smooth the DC output of the rectifier part of our circuit. That is to say there are ripples in our DC output of the rectifier circuit and voltage stabilizer stabilize as name implies this DC output to smooth DC output.

We construct the voltage stabilizer part by using three capacitor a LM317+two diodes+one resistors as shown in figure below.

Figure 4 - Voltage Stabilizer

**3-SIMULATION RESULTS**

Transformer:

Transformer takes the mains AC input and steps down it as shown in the graph following pages.

Rectifier:

Rectifier takes the AC output of the step down transformer and converts it to DC output with ripples as shown in the graph following pages.

Voltage stabilizer:
Voltage stabilizer takes the output of the rectifier’s DC output with ripples and smooths the DC voltage with no ripples.

4. TEST & MEASUREMENT RESULTS

4.1 Output voltage
\[ V_{\text{omin}} = 1.26 \text{V (No load)} \]
\[ V_{\text{omin}} = 0.5 \text{V for } I_L = 1 \text{A (V}_{\text{Rpp}} < 0.1 \text{V)} \]
Set to \( V_o = 5 \text{V (No load)} \)
\[ V_o = 4.6 \text{V for } I_L = 1 \text{A (V}_{\text{Rpp}} < 0.1 \text{V)} \]
Set to \( V_o = 12 \text{V (No load)} \)
\[ V_o = 11.4 \text{V for } I_L = 1 \text{A (V}_{\text{R}} < 0.1 \text{Vpp)} \]
\[ V_{\text{omax}} = 15.3 \text{V (No load)} \]
\[ V_{\text{omax}} = 13.1 \text{V for } I_L = 1 \text{A (V}_{\text{R}} < 0.1 \text{Vpp)} \]
Not: if ripple voltage is higher than 0.1Vpp at 1A, than use the maximum current which gives less than 0.1Vpp ripple voltage.

4.2 Ripple Voltage
\[ V_R = 9 \text{mV V}_{\text{pp}} (V_o=5V, I_L=1A) \]
\[ V_R = 11 \text{mV V}_{\text{pp}} (V_o=12V, I_L=1A) \]

4.3 Line Regulation
Set \( V_o = 10 \text{V for } V_{\text{in}} = 220\text{VAC} \)
\[ V_o = 10 \text{V for } V_{\text{in}} = 198\text{VAC (220V-10\%)} \]
\[ \Delta V = 0 \text{V} \]
Line Regulation = \( (\Delta V/V_o)/(0.10)\cdot100 \% = 0 \% \)

4.4 Load Regulation
Set \( V_o = 10 \text{V for } I_L = 0 \text{A} \)
\[ V_o = 9.86 \text{V for } I_L = 1 \text{A} \]
\[ \Delta V = 0.14 \text{V} \]
Load Regulation = \( (\Delta V/V_o)\cdot100 \% = 1.4 \% \)

Note: If you can not get \( I=1\text{A} \), use \( I_{\text{max}} \) which you can get, instead of 1A.
**FINAL TECHNICAL SPECIFICATIONS**

Input voltage 220VAC ±10%

Output voltage 1.26-15.3 VDC continuously adjustable

Output current ..... A (maximum)

Output ripple < 0.009Vpp

Load regulation 1.4 %

Line regulation 0%

Dimensions 186×119×80mm

Weight ≅1.5 kg

5-DISCUSSION

We find the results of our test are expected compared to the simulation results. I think we practice our specific knowledge on AC to DC converters by doing this project and we also pratice our design using software programs and further our construction of the hardware by the help of the software.

6- Appendix A: COMPLETE SCHEMATIC DIAGRAM

Complete circuit diagram is shown below:

![The Schematic diagram of the circuit](image)

Bill of materials are listed below:

7- Appendix B: BILL OF MATERIALS

<table>
<thead>
<tr>
<th>Component</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transformer</td>
<td>4,250.000 TL</td>
</tr>
<tr>
<td>1N4001 Diode (6)</td>
<td>150.000TL</td>
</tr>
<tr>
<td>Positive 20 Spray (Photosensitive)</td>
<td>18,500.000 TL</td>
</tr>
<tr>
<td>Electrolytic Capacitor 4700µF - 25V</td>
<td>600,000 TL</td>
</tr>
</tbody>
</table>
Electrolytic Capacitor 10µF - 25V (2) 400.000TL
Capacitor 100nF 100.000TL
PCB board 500.000TL
LM317T IC 450.000TL
Resistor 470 150.000TL
Solder (1m) 350.000TL
Heat Sink 350.000TL
Connection cable soft 1m 650.000TL
Female banana plug (2) 400.000TL
ON/OFF Switch 800.000TL
Potentiometer 5k 850.000TL
Fuse 250.000TL
Fuse plug 250.000TL
Power cable with plug 220V mains 450.000TL
Box 3.500.000TL
Knob 200.000TL

8-Appendix C: PCB
Figure 6 – Bottom view of PCB

Figure 7 – Component placement on PCB (Top view)

9-Appendix D: BOX
Figure 8- Picture of the Power Supply

Figure 9- Mechanical drawings of the box
Figure 10- Placement of the components in the box