INFORMATION TECHNOLOGY UNIVERSITY

Voltage Regulator Using Operational Amplifier

Semester Project

For

Linear Circuit Analysis

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Introduction

This project is designed to regulate the voltage using a simple circuit with the help of Operational Amplifier. This systems makes it easier to get a specific voltage on output side no matters what input voltages are. It enables the user to use without any worry the output voltage even when you're input voltage is continuously changing.

Functionality

This circuit is very simple, mainly consist of two parts one is the input and other is the output part. Main function hare is performed by the Operational Amplifier.

In a short way, I am going to illustrate its functionality. The input voltages are directly taken from a source and given to a resistor and Zenor diode in series way. As it is simple that Zenor diode always have a fixed voltage in it's across. So, using this property it becomes easy to do next process. That is actually, the reason why I used this diode rather than simple diode.

Next task is to take the voltage across the Zenor diode. These voltage then become the input voltage of Non-inverting amplifier. Or in other words these voltages are given to the Positive input of op-amp. Now, It comes to op-amp as a fixed voltage. As we know that on the non-inverting terminal there is no inversion of signal occur. we just need to have some calculation now.

The information we know until now is that we have fixed voltage as an input in the non-inverting terminal of amplifier and have fixed output from the op-amp. Thus, we just need to have the gain of op-amp

that can generate the required fixed voltage on the output terminal from the given fixed input voltage. With basic calculation based on the components specification this circuit can be easily made.

List of Components

This project uses the following components and devices.

No.	Description	Value	Quantity
1	DC power supply	12-20V	1
2	Op amp	LM358	1
3	Zenor series resistance	According to diode specification	1
4	Input side variable resistance of op-amp	1 kΩ	1
5	Feedback variable resistor	1 kΩ	1
6	Veroboard		1
7	Zenor diode	4.7 or 5.6V	1

Initial testing

Before making the actual circuit we performed some basic tests to check out the basic properties and their nature of work at certain readings. The tests were performed to measure the properties of various components and to make sure that they would be able to work together in a circuit. Here are the components tests result and explanation which were asked.

A) Zenor diode specification

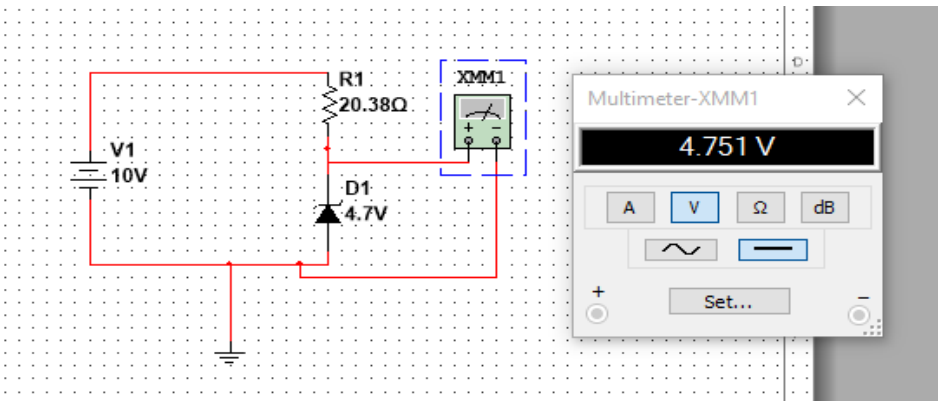
Name =1n5337bg
Test current =260mA

Nominal Value of V =4.7V
Max. Power dissipate. =5W

From these values of Zener diode we can calculate the resistance that is used in series with this resistance.

Total voltage = 10V
Zener Voltages = 4.7V
Resistance = ?
Current I = 260mA

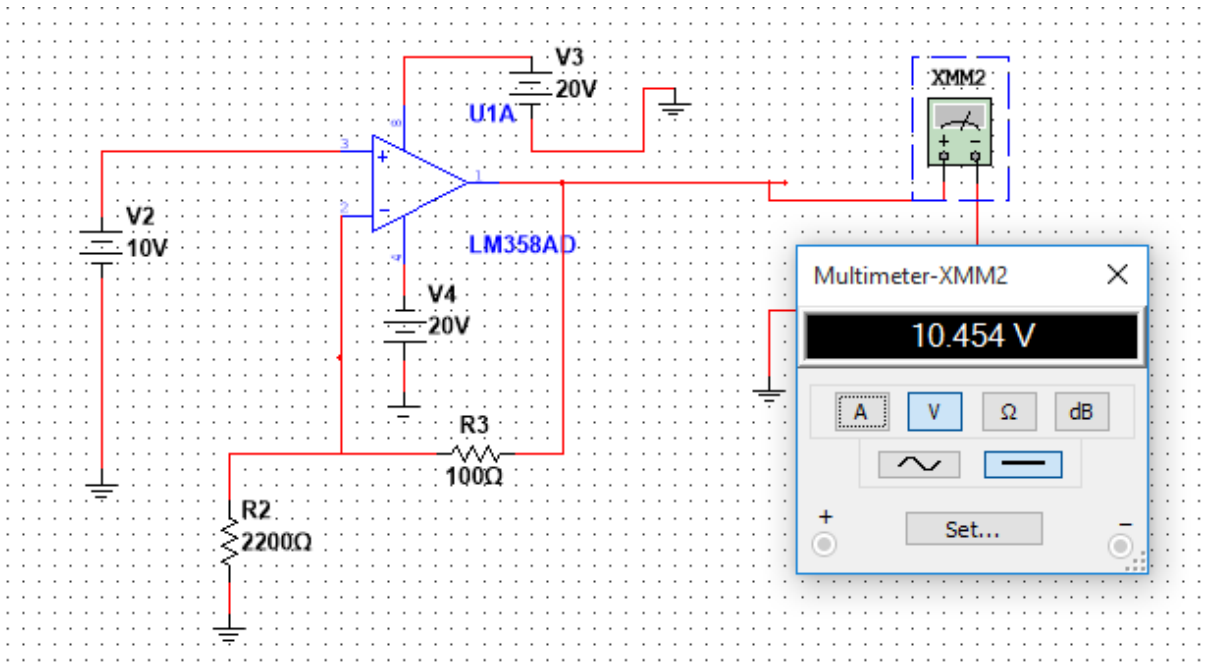
Thus resistance is equals to **20.38 Ohms** (using OHM's law).
With this resistance in series with zener diode the value of voltage across diode is equals to **4.751V** (Fig.1)



B) Non-inverting amplifier with gane 1

Rf = 2.2K
Rs =100ohm
Vin =10V
Vout = ?
Gain = 1

By using the gain formula for non-inverting amplifier we have set the values of feedback (Rf) value and input side resistance. From the calculation with this value the Gain will be precisely equals **to 1.04545** Now, Vin is set to be 5V and Vout is taken out which is equals to roughly
10.454V (Fig,2)



This value can also be measured by using the formula for Vout.

C) A variable resistor have three terminals. If I say the left one L And the right one R. The voltages are applied at terminals L and R is ground. When the knob is moved in direction of L terminal the voltage goes on increasing. When terminal knob is moved toward R terminal the voltage value decreae.The knob is referred as third terminal (central terminal).

Final Testing and Circuit Implementation

After doing all the calculations and making a draft circuit we finally made a real circuit on Vero board using the same components. Main components were Op-amp and TL-431 IC.

The input range is from 8 to 20 volts. These voltages directly goes into TL-431 with an appropriate resistance. I used mean of higher and lower values and used 500 ohm (0.5K) resistance. Output voltages from TL-431 is exactly 2.5V then next step is to amplify these 2.5 voltages to 5V as our requirments. I used LM-358 Op-amp with

adjusting its gain as 2. This is done by keeping the feedback resistance and source resistance same.
This can be verified by formula also. After placing these components I solder them out and made final circuit. When I done I have made different readings with different input voltages to check the accuracy of my circuit.
The values are given in table below.

Input voltages	V across TL-431	Output V of Op-amp
8V	2.5004	5.0456
10V	2.5023	5.0586
14 V	2.5104	5.0568
18V	2.5200	5.0902