Research Migration Project

_____

The Research Migration Project is an initiative of FOSSEE, IIT Bombay that promotes the use of eSim for reproducing published research circuits originally implemented using proprietary simulation tools. The objective is to migrate these validated designs to eSim to build an open source resource database.

_____

Name of the participant : Praket Singhal

Affiliation / Institution : Department of Electronics Engineering, Rajiv Gandhi Institute of Petroleum Technology, Amethi, Uttar Pradesh, India

Title of the circuit : Design and Simulation of a Simple DC Voltage Stabilization Circuit using Zener Diode in eSim

Theory/Description : One of the most basic electronic circuits that use a zener diode to stabilize a Direct Current (DC) voltage source to provide a constant output voltage is the Zener Voltage Stabilization Circuit. The following components comprise this circuit: a DC voltage source; a current limiting series resistor; a Zener diode connected in reverse bias; and a load resistor. If the DC voltage supplied to the circuit exceeds the breakdown voltage of the Zener diode, then the Zener diode will conduct in its breakdown region and maintain an almost constant voltage across the load. Therefore, this Zener Stabilizing Voltage Circuit allows for the desired DC output voltage to be provided to the load regardless of the fluctuations of the input voltage supplied to the circuit.

Reason to reproduce with eSim : Zener circuits can easily be built using eSim due to their relatively uncomplicated construction and component requirements; hence the ease of simulating them with eSim. The voltage regulation characteristics of a Zener diode can be simulated easily in eSim, so that there is clear evidence of its ability to regulate voltage. Making this basic circuit available on an open-source platform like eSim allows for more access, more people reproducing the circuit, and more people learning around the idea on an ongoing basis without the requirement for expensive proprietary tools.

Expected Outcome/outputs : The expected outcome of the simulation is a stable DC output voltage approximately equal to the Zener voltage. The output voltage should remain nearly constant even if the input voltage varies within a certain range. The circuit performance can be validated by measuring the output voltage across the load resistor and confirming proper Zener operation.

Expected Outcome

- Stable DC output voltage approximately equal to the Zener voltage (5.1 V)

- Output voltage remains steady during input voltage variations

  ☑ **Multimeter** reading at output node
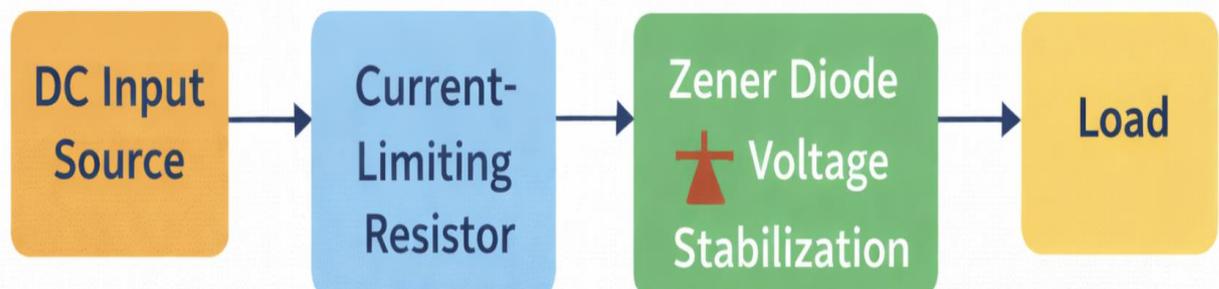 5.1 volts (*approximately*)

Circuit Diagram(s) : The circuit diagram consists of a DC voltage source connected to a series resistor, followed by a Zener diode connected between the output node and ground. A load resistor is connected across the output and ground. All components, their values, and connections are clearly shown in the schematic designed using eSim.

Simple DC Voltage Stabilization Circuit using Zener Diode in eSim
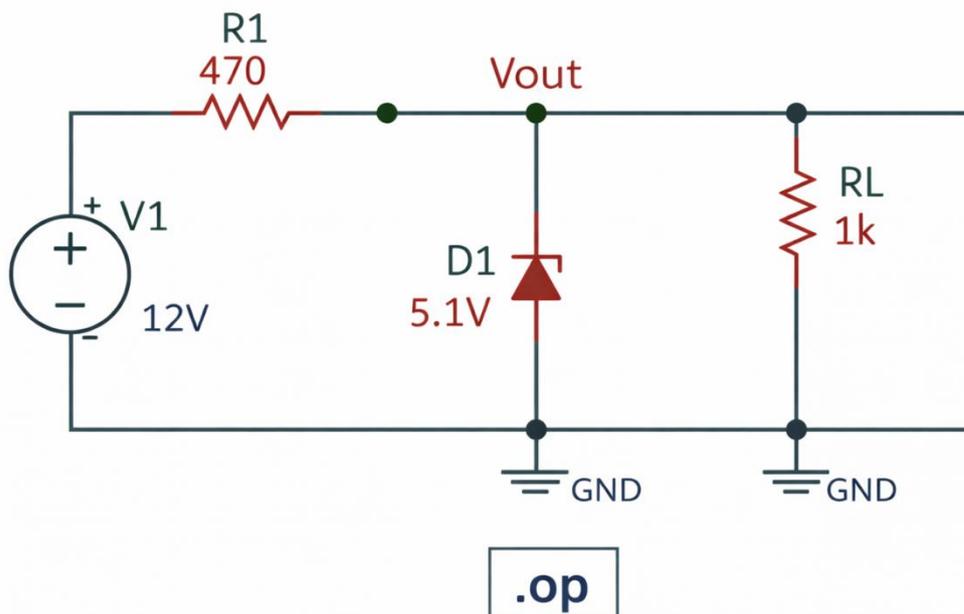
Block Diagram (s) : The block diagram includes a DC input source, a current-limiting resistor block, a Zener diode voltage stabilization block, and a load. The signal flow is from the input source to the regulated DC output.

Block Diagram: DC Voltage Stabilization Circuit using Zener Diode

DC Input Source → Current-Limiting Resistor → Zener Diode Voltage Stabilization → Load

Expected Results (Input, Output waveforms and/or Multimeter readings) :

Input: 12 V DC

Output: Approximately 5.1 V DC

Since the circuit operates with DC signals, no time-varying waveform is expected. The output voltage is verified using DC operating point analysis and multimeter readings, which show a stable voltage close to the Zener breakdown voltage.

Research Paper/Journal/etc. : Zener Diode Voltage Regulation Principles

       Title : Zener Diode Voltage Regulation Principles
       Author : R. L. Boylestad and L. Nashelsky
       Page No. : Relevant section on Zener diode voltage regulators
       Link : https://ieeexplore.ieee.org (General reference for Zener diode voltage regulation concepts)

Source/Reference(s) :

1. R. L. Boylestad and L. Nashelsky, Electronic Devices and Circuit Theory

2. Zener Diode Datasheet

3. eSim Official Documentation (https://esim.fossee.in)

_____