Basic Electrical and Electronics Engineering Lab (BEEE102P)

EXPERIMENT 6

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Experiment No 6.

LINE AND LOAD REGULATION USING ZENER DIODE

BEEE102P
Basic Electrical and Electronics Engineering Lab
List of Experiments

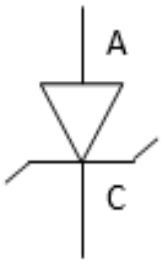
S.No	Experiment Title
Cycle-1 Software Experiments	
1	Verification of Mesh current analysis and node voltage analysis using ORCAD/Capture CIS
2	Verification of Thevenin's theorem using ORCAD/Capture CIS
3	Verification of Maximum power transfer theorem using ORCAD/Capture CIS
4	Verification of Resonance phenomenon in a series RLC circuit using ORCAD/Capture CIS using AC Parametric Sweep Analysis
5	Design of single-phase half-wave and full wave rectifier
Cycle-II Hardware Experiments	
6	Verification of Kirchhoff's current law/ Thevenins theorem
7	Wiring circuit for Single lamp and Fan with regulator/ Staircase wiring circuit layout of multi storage building
8	Design of half adder circuit using logic gates
9	Measurement of energy using single phase energy meter
10	Design of regulated power supply using Zener diode

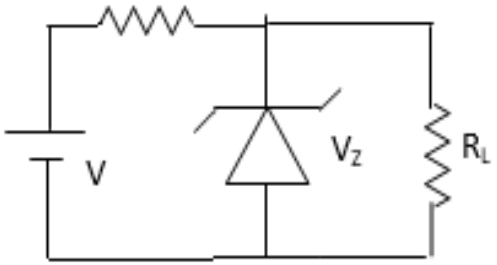
Zener diode

- When reverse voltage reaches breakdown voltage in a PN diode, the current through the junction and power dissipated at the junction will be high.
- Such an operation is destructive and the diode gets damaged.
- However, diodes can be designed with adequate power dissipation capability to operate in the breakdown region.
- One such diode is **Zener diode** which is heavily doped than the ordinary diode.

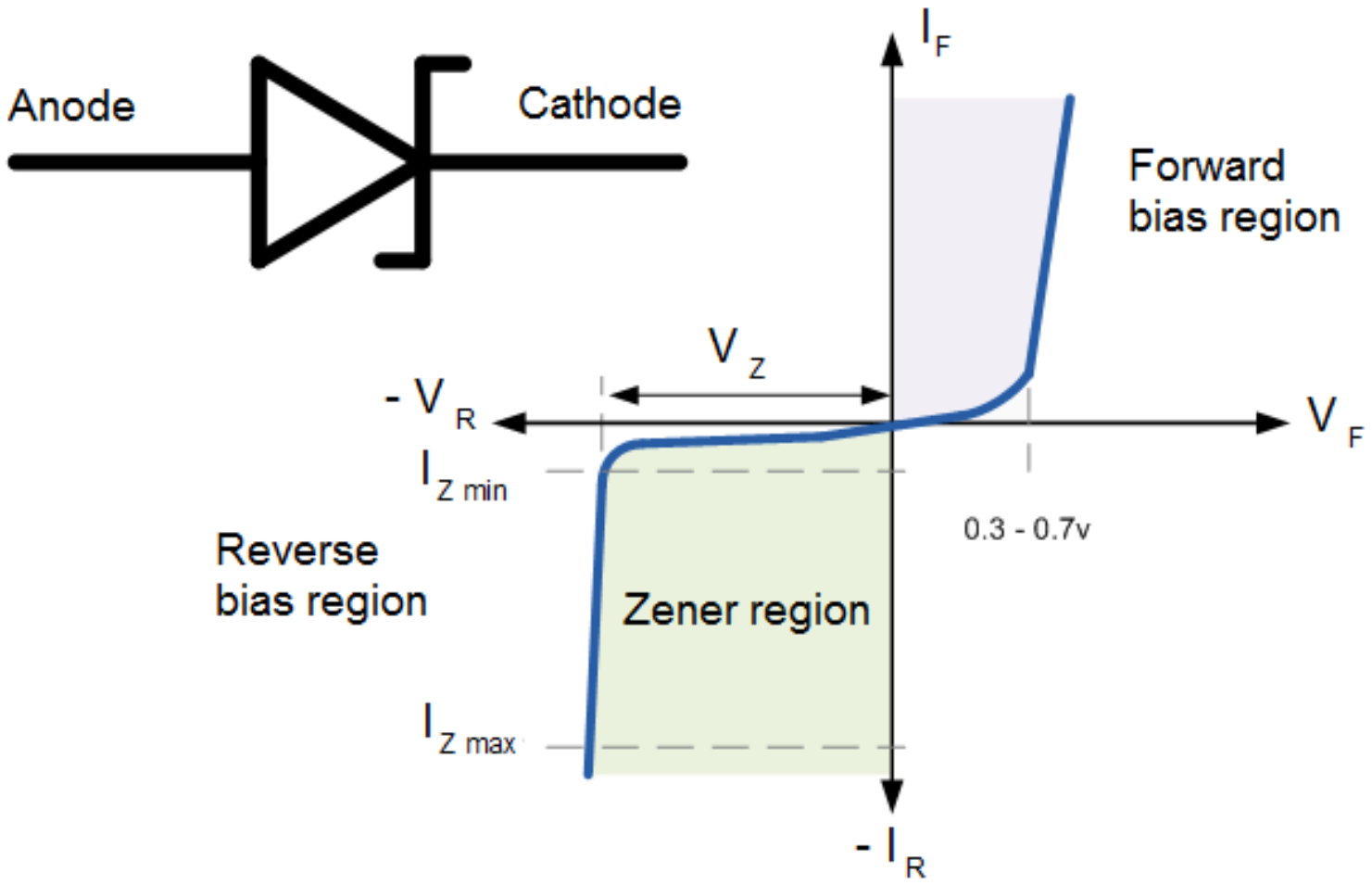
Zener diode

- A Zener diode is a silicon PN junction semiconductor device which is operated in its reverse breakdown region.
- Zener diodes are available having Zener potentials of 1.8 to 200 V with power ratings from 1/4 to 50 W.
- Because of its higher temperature and current capability, silicon is usually preferred in the manufacture of Zener diodes.


A
C


V
V_Z
R_L

Forward Current
$+I_F$
Reverse Breakdown Voltage
-V
+V
Reverse Bias
Forward Bias
"Zener" Breakdown or Avalanche Region e.g. 7.5v
0.7v
Constant Voltage
Reverse Current
$-I_Z$


Anode
Cathode
I F
Forward bias region
V Z
- V R
V F
I Z min
0.3 - 0.7v
Reverse bias region
Zener region
I Z max
- I R

- The forward bias condition is same as the ordinary PN diode, but Under reverse bias condition, breakdown of the junction occurs and the breakdown voltage depends upon the amount of doping.

- If the diode is heavily doped, depletion layer will be thin and consequently breakdown occurs at lower reverse voltage, besides the breakdown voltage being sharp.

- Thus the breakdown voltage can be selected with the amount of doping. When the reverse bias field across the junction is sufficiently high, it may exert a strong force on bound electrons to tear them out from a covalent bond.

- Thus a large number of electron – hole pairs will be generated through a direct rupture of the covalent bond thereby resulting in large reverse current at the breakdown voltage.

- Though Zener breakdown occurs for lower breakdown voltage and avalanche breakdown occurs for higher breakdown voltage, such diodes are normally called Zener diode

- Application

- From the zener diode characteristics, under the reverse bias condition, the voltage across the diode remains almost constant although the current through the diode increases.

- Thus the voltage across the zener diode serves as a reference voltage. Hence the diode can be used as a voltage regulator.

Zener Diode Voltage regulation:

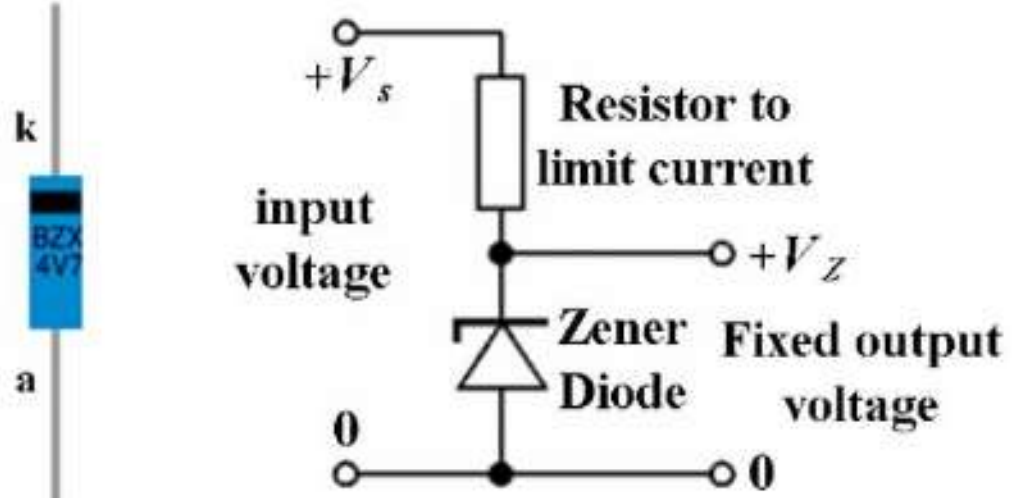
- Line regulation
- Load Regulation

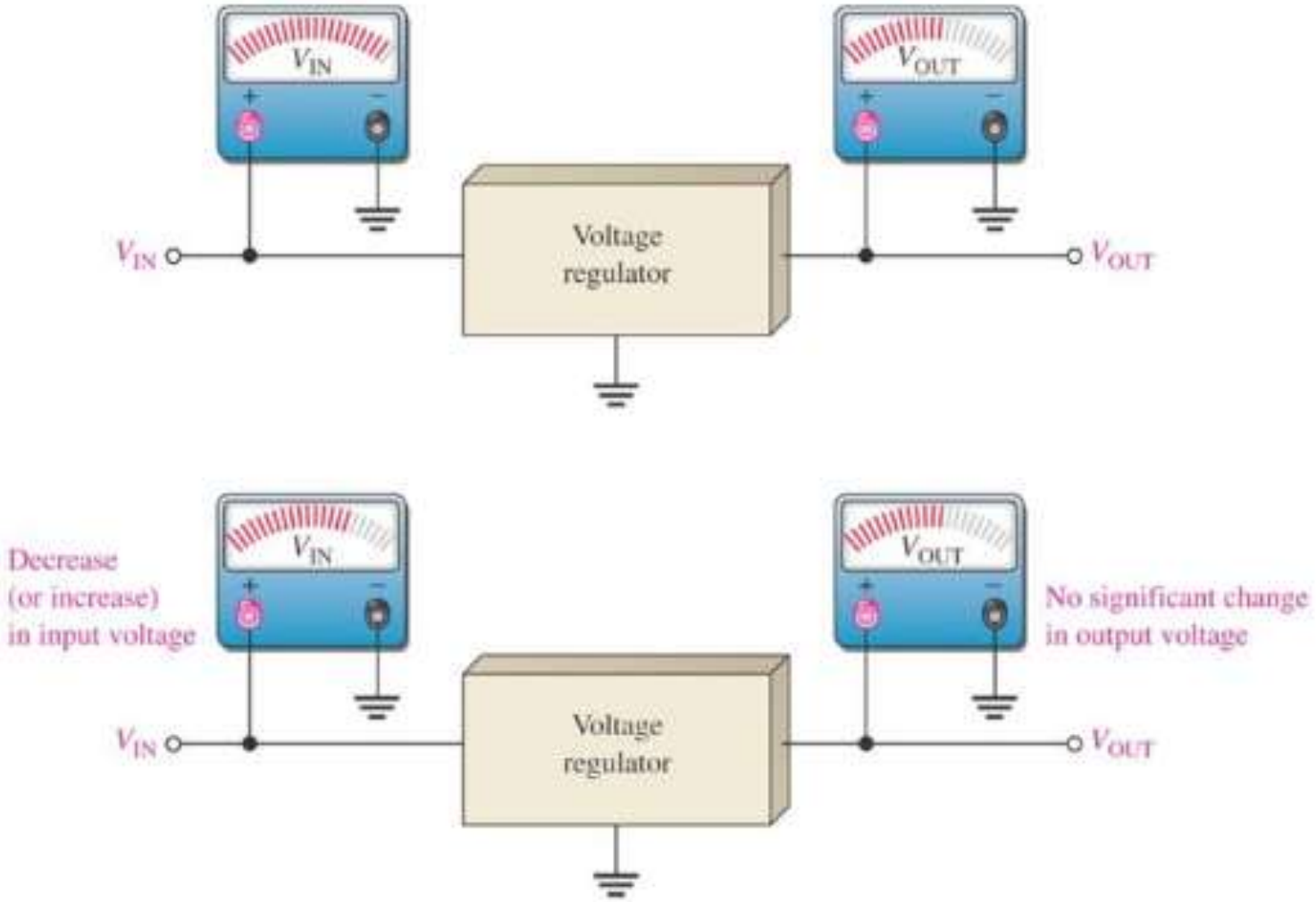
- The purpose of **line regulation** is to maintain a nearly constant output voltage when the **input voltage** varies.
- The purpose of **load regulation** is to maintain a nearly constant output voltage when the **load** varies

Theory:

Regulator - Zener diode regulator

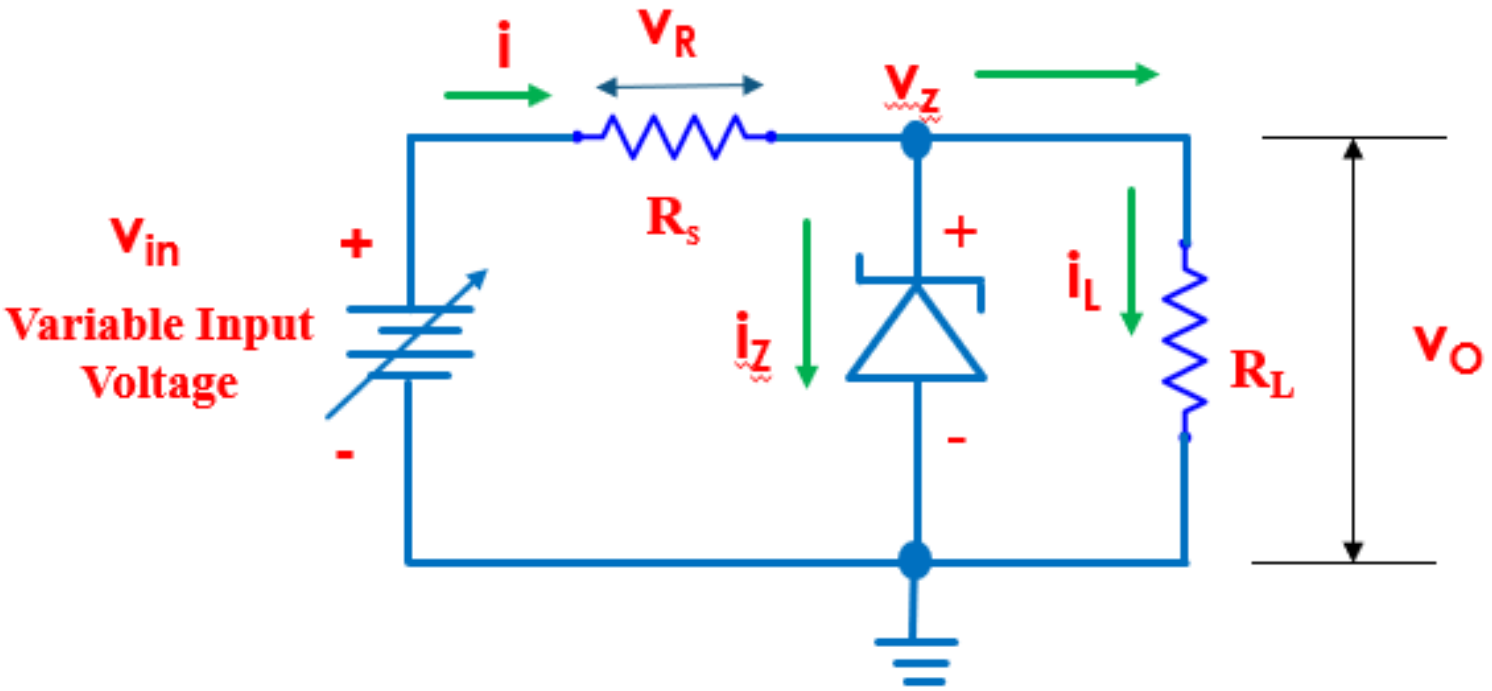
- For low current power supplies - a simple voltage regulator can be made with a resistor and a zener diode connected in reverse.
- Zener diodes are rated by their breakdown voltage V_z and maximum power P_z (typically 400mW or 1.3W)





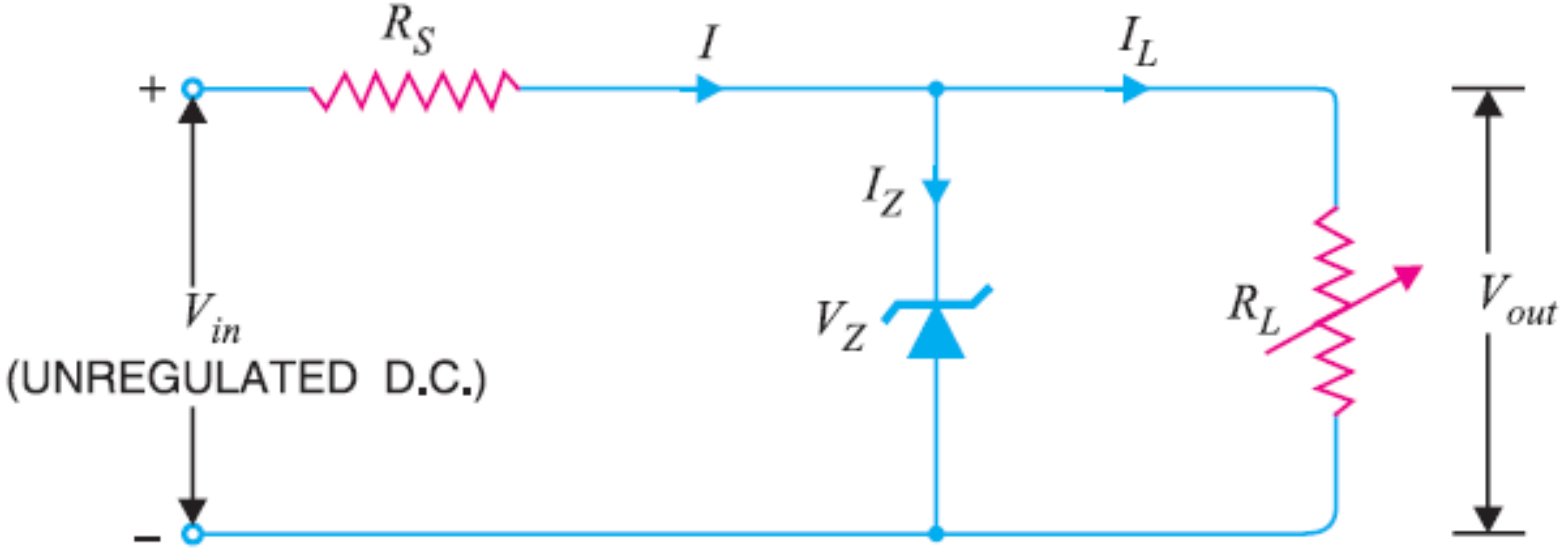
Line regulation: A change in input (line) voltage does not significantly affect the output voltage of a regulator (within certain limits)

- **Line regulation:** Maintaining output voltage constant while the input voltage is changing



$$I = I_L + I_Z$$

- **Load regulation:** Maintaining output voltage constant while the load resistance is varying.



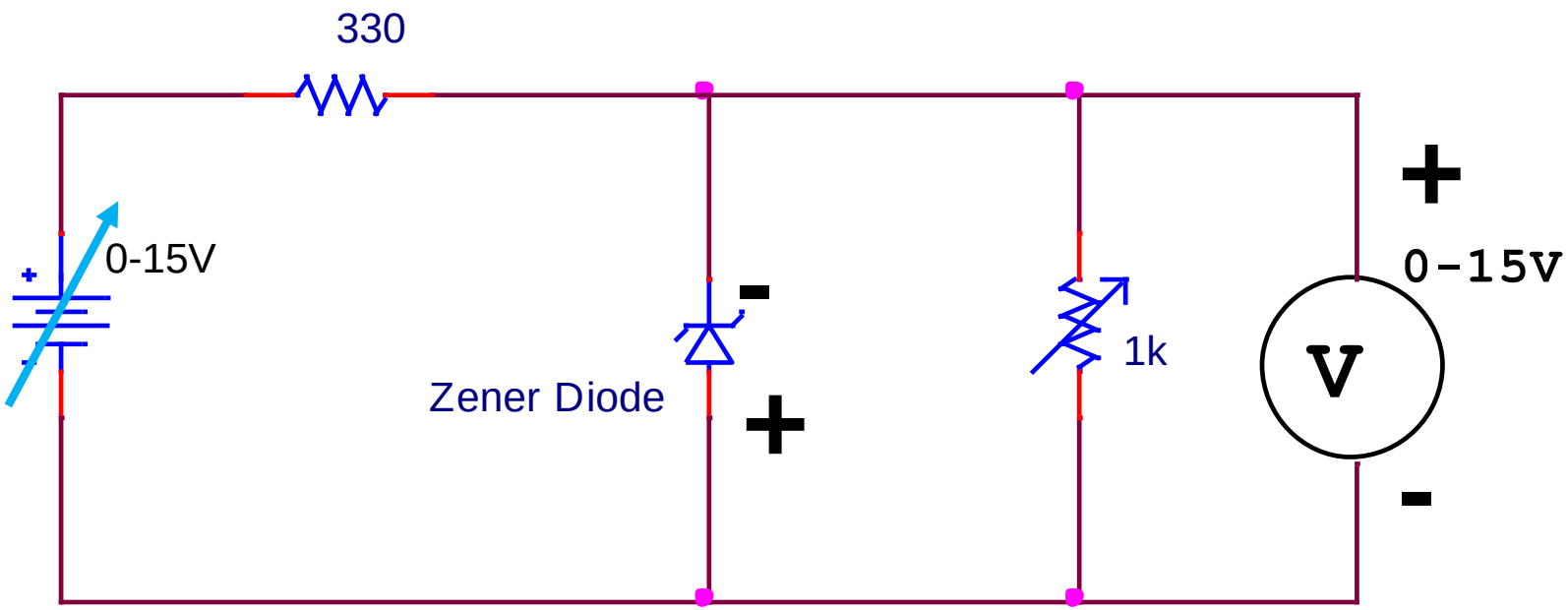
$$I = I_L + I_Z$$

Apparatus/Tool required:

S. No.	Name of the apparatus	Range / Type	Quantity
1	Zener diode	-	1 No.
2	RPS	0 – 30 V	1 No.
3	Ammeter	0 – 10 A	2 No.
4	Voltmeter	0 – 30 V	2 No.
5	Resistor	330 Ω	1 No.
6	Resistor	1 kΩ	1 No.
7	Breadboard	-	1 No.
8	Wires	-	Few

Circuit Diagram:

Connect Zener in reverse bias i.e. Anode to negative of power supply



Cathode= negative

Anode= Positive

Manual Calculations:

Line Regulation: Load Resistor = 1000Ω

Sl.No	Input DC Voltage (Vi) in Volts	Output DC Voltage (V_L) in Volts
1	2	
2	4	
3	6	
4	8	
5	10	

Load Regulation: Input d.c. voltage = 10V

Sl.No	Load Resistance in ohms	Output DC Voltage (V_L) in Volts
1	1000	
2	2200	
3	4700	
4	5600	
5	15000	