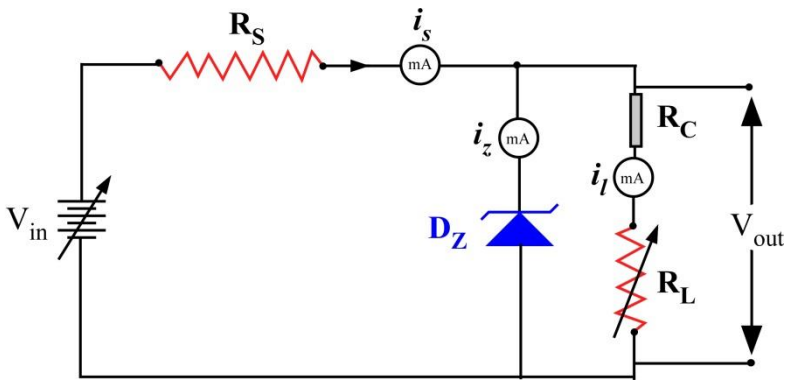
**Aim** : Study of Zener diode as a voltage regulator and use of IC 7805 voltage stabilizer..

**Electronic Parts Required** :

(i) Power supply : ± 15 V
(ii) $R_S = R_C = 2.2$ KΩ = 2 Nos
(iii) Load resistance = $R_L$ = 1.0 kΩ Potentio-meter, 1.0 W
(iv) Zener diode = 1 No with $V_Z$ = 2.7 or 3.9 or 5.1 V
(v) LM7805 IC = 1 No
(vi) Breadboard = 1 No
(vii) Two DT-830D multi-meters for current measurements. One 8007 multimeter with probe for Voltage measurements.
(viii) single stand wires = 6 Nos

## *Part A :* Zener Diode as Voltage Regulators:

**Circuit Diagram :**




A Zener diode of break down voltage $V_z$ is reverse connected to an input voltage source $V_i$ across a load resistance $R_L$ and a series resistor $R_S$. The voltage across the Zener will remain steady at its break down voltage $V_Z$ for all the values of Zener current $\boldsymbol{i}_Z$ as long as the current remains in the breakdown region. In the above circuit, the Zener diode maintains a constant output voltage $V_0 = V_Z$ independent of variations in load resistance $R_L$ or the variation of input voltage $V_i$ ( > $V_Z$) so long as the diode remains in the breakdown region and the input voltage remains within a minimum and maximum voltage.

From the circuit diagram we can write $\mathbf{i}_S = \mathbf{i}_Z + \mathbf{i}_L$

Where, $i_S = \frac{Vi - Vz}{Rs}$, and $i_L = \frac{Vo}{Rl}$

Basically there are two types of regulations such as:

**(i) Line Regulation :**

In line regulation, series resistance, $R_S$ and load resistance, $R_L$ are fixed, only input voltage, $V_{in}$ is varied. Output voltage, $V_0$ remains the same at $V_Z$ and $\boldsymbol{i}_L$ remains constant as long as the input voltage is maintained above a minimum value.

$$\delta \boldsymbol{i}_Z = \delta \boldsymbol{i}_S$$

Thus when load $R_L$ is fixed and input voltage $V_i$ varies then Zener current $\boldsymbol{i}_Z$ and total current $\boldsymbol{i}_S$ change in such to maintain $\boldsymbol{i}_L$ and hence $V_0$ constant. Any change in $V_i$ appears across the series limiting resistance $R_S$.

**Table – I [*Maximum Input voltage should be 20 V*]**

| Sl. No | $\mathbf{R}_L$ (Ohm) | $\mathbf{V}_i$ (Volts) | $\boldsymbol{i}_S$ (mA) | $\boldsymbol{i}_Z$ (mA) | $V_0$ (Volts) |
|---|---|---|---|---|---|
| 1. | 1K or 2.2K | 0 V | | | |
| 2. | **CONSTANT** | - | | | |
| | " | - | | | |
| 20. | " | 20 V | | | |

You can take more than 20 readings if you like to have smooth curve.

**Graph –I**

(*i*) Plot graph between $i_Z$ and $i_S$ to show that $\delta \boldsymbol{i}_Z = \delta \boldsymbol{i}_S$ (Directly proportional)

(*ii*) Plot graph between $V_{in}$ and $V_{out}$ . Find out the breakdown voltage ($V_Z$) of Zener diode.

**(ii) Load Regulation :**

In load regulation, input voltage, $\mathbf{V}_i$ remains constant and the load resistance, $\mathbf{R}_L$ is varied. Output voltage remains same, as long as the load resistance is maintained above a minimum value. Since the voltage $\mathbf{V}_Z$ across the Zener remains constant, $\boldsymbol{i}_S$ is *independent of load*. Hence in this case

$$\delta \boldsymbol{i}_Z = - \delta \boldsymbol{i}_L$$

Thus Zener current changes with change in load current due to change in $\mathbf{R}_L$ but output remains constant at $\mathbf{V}_Z$.

**Table – II** (without $R_C$) : $R_C$ = A current limiting constant resistor **[***Maximum Input voltage should be 15 V* **]**

| Sl. No | $\mathbf{V}_i$ (Volts) | $\mathbf{R}_L$ (Ohm) | $\boldsymbol{i}_L$ (mA) | $\boldsymbol{i}_Z$ (mA) | $V_0$ (Volts) |
|---|---|---|---|---|---|
| 1. | 15 V | 0 Ω | | | |
| 2. | **CONSTANT** | - | | | |
| | " | - | | | |
| 20. | " | 1K Ω | | | |

You can take more than 20 readings if you like to have smooth curve.

**Graph –II**

(*i*) Plot graph between $I_Z$ and $I_L$ to show that $\delta\mathbf{I}_Z = -\delta\mathbf{I}_L$ (Inversely proportional)

(ii) Plot graph between $V_{out}$ and $R_L$ . Find out the breakdown voltage ($V_{out} = V_Z$) of Zener diode.

**Table – III** (with $R_C$ = 2.2 K Ω) : $R_C$ = A current limiting constant resistor

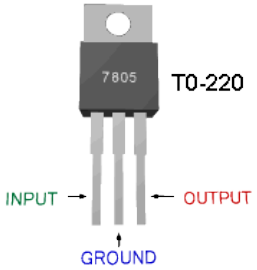
| Sl. No | $\mathbf{V}_i$ (Volts) | $\mathbf{R}_L$ (Ohm) | $\boldsymbol{i}_L$ (mA) | $\boldsymbol{i}_Z$ (mA) | $V_0$ (Volts) |
|---|---|---|---|---|---|
| 1. | " | | | | |
| 2. | **CONSTANT** | | | | |
| | " | | | | |
| 20. | " | | | | |

**Graph –III**

(*i*) Plot graph between $I_Z$ and $I_L$ to show that $\delta\mathbf{I}_Z = -\delta\mathbf{I}_L$ (Inversely proportional)

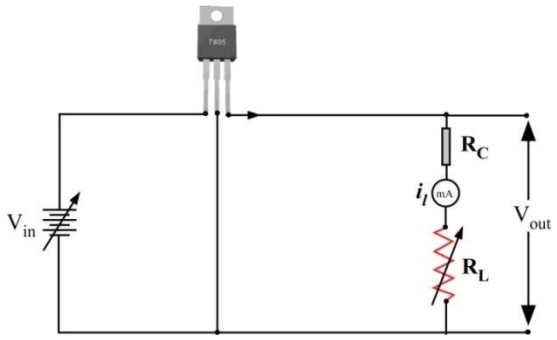
(ii) Plot graph between $V_{out}$ and $R_L$ in the presence of $R_C$. Find out the breakdown voltage ($V_{out} = V_Z$) of Zener diode which was not possible in Table II because Load $R_L$ draw more current.

## ***Part B :*** **Voltage Regulator IC 7805:**




For LM7805 the minimum input voltage is 7.2 V and maximum input voltage is 35 V to get a stable 5.0 V output voltage. The maximum current the load can draw is about 1 Amp.

**Circuit Diagram :**




**(i) Line Regulation :**

In line regulation, output constant current limiting series resistance, $R_C$ and load resistance, $R_L$ are fixed, only input voltage, $V_{in}$ is varied. Output voltage, $V_0$ remains the same at $V_Z$ and $i_L$ remains constant as long as the input voltage is maintained above a minimum value.

**Table – I [** *Maximum Input voltage should be 20 V* **]**

| Sl. No | $R_C + R_L$ (Ohm) | $V_i$ (Volts) | $i_l$ (mA) | $V_0$ (Volts) |
|---|---|---|---|---|
| 1. | 2.2 K | 0 | | |
| 2. | **CONSTANT** | - | | |
| | " | - | | |
| 20. | " | 20 | | |

You can take more than 20 readings if you like to have smooth curve.

**Graph –I**

(*i*) Plot graph between $V_{in}$ and $V_{out}$. Find $V_{min}$ input voltage for which $V_{out}$ is constant to 5 V.

**(ii) Load Regulation :**

In load regulation, input voltage, $V_i$ remains constant and the load resistance, $R_L$ is varied. Output voltage remains same irrespective of load.

**Table – II [** *Maximum Input voltage should be 15 V, $R_C$ = 2.2 KΩ* **]**

| Sl. No | $V_i$ (Volts) | $R_L$ (Ohm) | $i_l$ (mA) | $V_0$ (Volts) |
|---|---|---|---|---|
| 1. | 15 V | 0 Ω | | |
| 2. | **CONSTANT** | - | | |
| | " | - | | |
| 20. | " | 1K Ω | | |

You can take more than 20 readings if you like to have smooth curve.

**Graph –II**

(*i*) Plot graph between $V_{out}$ and $R_L$.

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