Uni-Junction Transistor (UJT)

Lecture – 4

TDC PART – I

Paper – I (Group – B)

Chapter - 8

by:

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(8) UJT Application as a Relaxation Oscillator

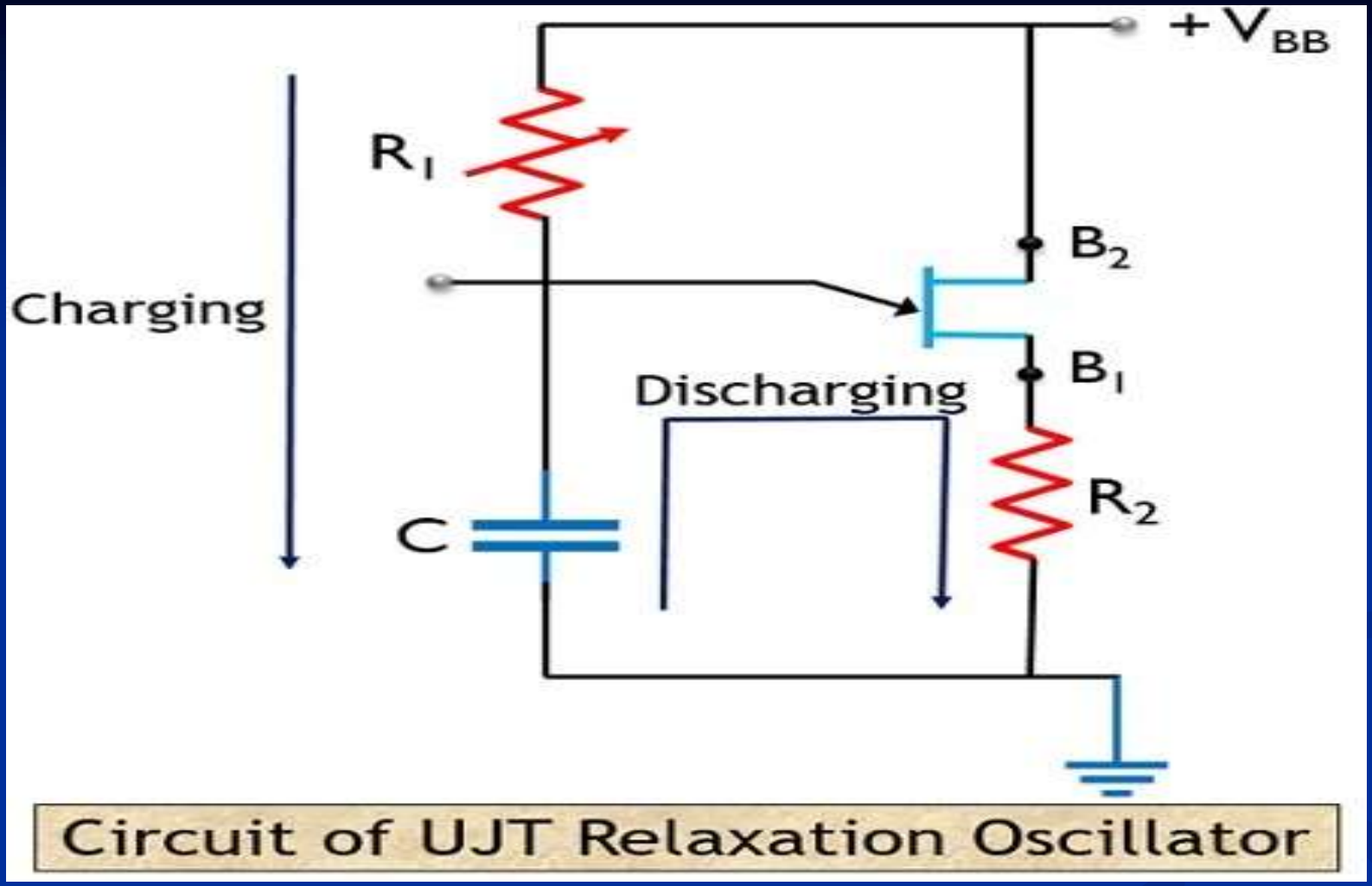
- To generate waveforms **without using any input signal** we use Oscillators. Oscillators are the electronic circuits used to generate waveforms without using any input signal. Waveforms such as sine waves, cosine waves, triangular waves, pulse waves, etc. are generated using an Oscillator circuit. An oscillator is a device that generates a waveform by its own, without any input, though some dc voltage is applied for the device itself to work.

- Basically there are two types of electronic oscillators- the **Linear oscillators** and the **Relaxation Oscillators**. The **Linear oscillators** are used to generate the **sinusoidal waveforms** whereas the **relaxation oscillators** are used for generating the **non-sinusoidal waveforms**. A Relaxation Oscillator is basically a non-linear oscillator that has the ability to generate a non-sinusoidal periodic waveform at its output, such as triangular wave, square wave etc. These are also known as non-sinusoidal waveform generators. Relaxation oscillator consists of a feedback loop with a switching device such as a Transistor (BJT), Op-Amp, and UJT etc. that repetitively charges and discharges the **capacitor** through a **resistor** until it reaches the threshold value. In UJT Relaxation Oscillator, UJT is used as the switching device which charges and discharges the capacitor through a **resistor.** Here, the period of the oscillator depends on the time constant of the capacitor and Resistor.

UJT Relaxation Oscillator Construction

- In UJT Relaxation Oscillator the **Emitter E** of UJT is connected with a **Resistor R1** and **Capacitor C** as shown in **Fig (9)** below. The **external DC supply voltage** given to the circuit is **V_{BB}** and it is connected to the **UJT** terminal **B_2** and also connected to the **Emitter E** through **Resistor R1.** The **base B_1 terminal** is connected with a **resistor R2**. The **R_1C time constant** determines the timings of the output waveform of the relaxation oscillator. The **fig (9)** shows how to use a **UJT** as a relaxation oscillator.

- Here we can clearly see that the **relaxation oscillator** circuit is composed with a uni-junction transistor (UJT) and a **capacitor C** which gets charged through **resistor R1** and gets discharged through **resistor R2.**



- **Fig (9)** Shown a Uni-junction transistor relaxation oscillator circuit diagram.

UJT Relaxation Oscillator Working

- Let initially, the voltage across the **capacitor C** is zero.

$$V_C = 0 \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

- The UJT is in **OFF** condition. The resistor R_1 provides a path for the **capacitor C** to charge through Resistor R using applied supply voltage (V_{BB}).

- The **capacitor C** charges according to the voltage

$$V = V_0 \left[1 - e \left(- t / R_1 C \right) \right] \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

- The **capacitor C** present in the circuit usually starts charging through **resistor R1** and continues to charge until the maximum voltage **V_{BB}**. At the time of charging of the **capacitor C**, the voltage present across the capacitor shows an exponential increase until a **peak voltage** is achieved. This **peak voltage** is indicated as **V_P**.

- Once the capacitor voltage reaches **V_P**, the **UJT** present in the circuit gets **ON** and as the **UJT turns ON**, the capacitor now starts discharging through the **resistor R2** present in the circuit. So, the discharging current flowing through the **resistor R2** generates a voltage spike.

- This process continues and the voltage across the **capacitor C** a Non- Sinusoidal waveform is observed which shown in **Fig (10)** indicated on a graph. The **Fig (10)** in next slide represents the voltage waveforms across the **capacitor C** and **resistor R_2.**

- If the **capacitor C** is charged to the **voltage V_P** in time **T**, we can write,

$$V_P = V_{BB} [\, 1 - e\, (-\, t \,/\, R_1 C\,)\,] \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (3)$$

$$\eta = 1 - e\,(-\, t \,/\, R_1 C\,) \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (4)$$

$$T = R_1 C \ln [\, (1 \,/\, 1 - \eta\,)\,] \quad \ldots\ldots\ldots\ldots\ldots\ldots (5)$$

- Above equation gives the **time period** of the **Relaxation Oscillator.**

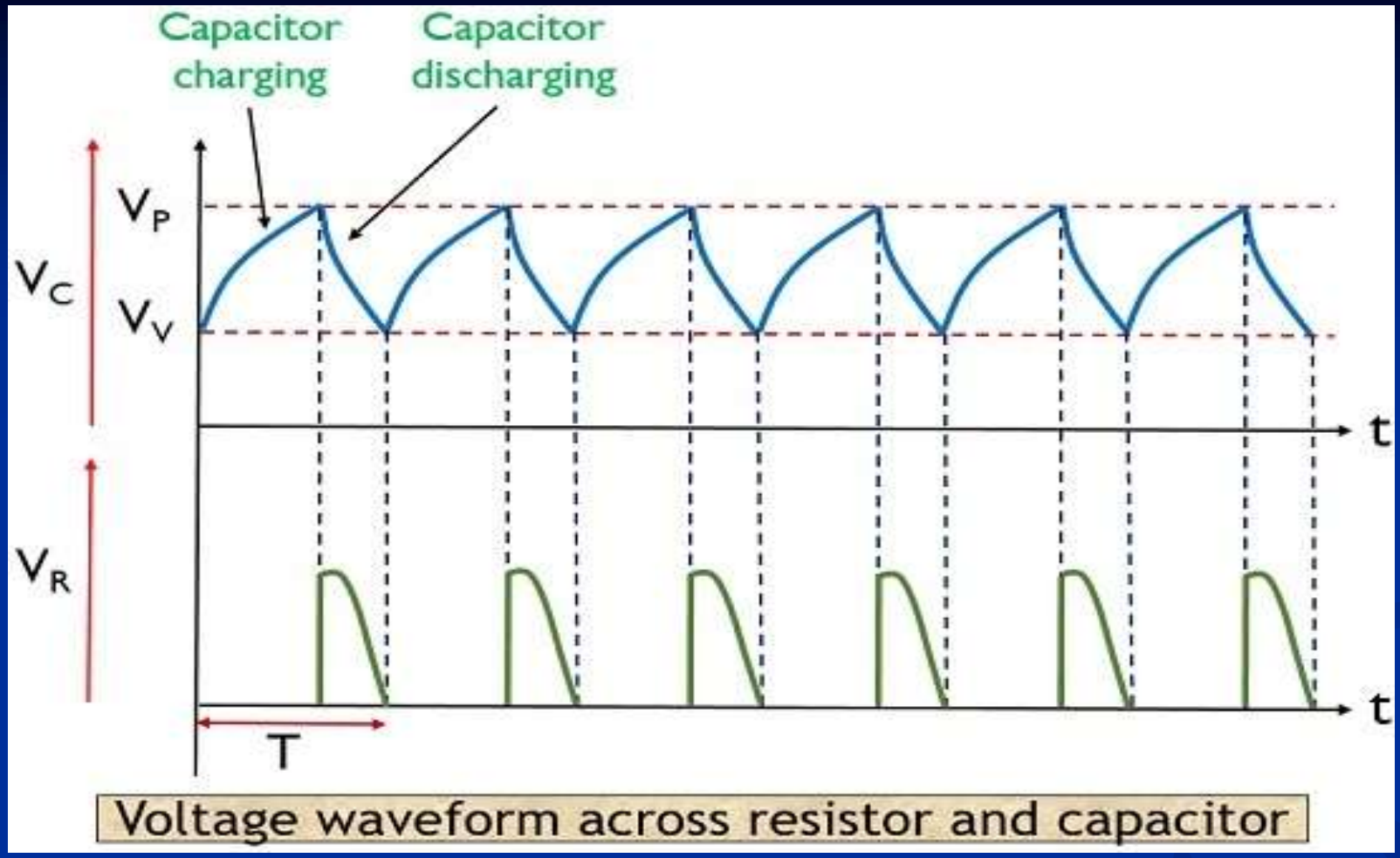
- For calculating the **Oscillating Frequency** of the **UJT Relaxation Oscillator, we** can use the following formula,

$$f = 1 / T \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (6)$$

Putting the value of T from equation (5) to equation (6) we get,

$$f = 1 / R_1 C \ln [(1 / 1 - \eta)] \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (7)$$

- At the time of the capacitor discharging the voltage across it drops to **Vv**. This is the V**alley voltage** indicated **as VV**. Thereby **cutting off the UJT device**. Once the **cut off state** is reached, the **capacitor C** again starts charging thereby causing the repetitive cycle to take place. This **repetitive cycle** of **charging** and **discharging** of the **capacitor C** produces **Sawtooth waveform** across capacitor.



- **Fig. (10)** Shown relaxation oscillator output Voltage waveforms across **capacitor C** and **resistor R2**.

- So, the **charge** and **discharge** of capacitor produces the sweep waveform as shown in **Fig (10)** above. The **charging** time produces **increasing sweep** and the **discharging** time produces **decreasing sweep**. The repetition of this cycle forms a continuous sweep output waveform.

- It is to be noted here that when UJT is off, the **output voltage** will be **0**. As at this particular interval the applied voltage charges the **capacitor C** hence output voltage will be zero. As the output is a **non-sinusoidal waveform** and **due** to this **relaxing state** of the oscillator hence this circuit is said to be working as a **Relaxation Oscillator.**

Chapter End