Ministry of Higher Education
University of Al-Maarif
Medical Instruments Engineering Techniques Department

Power Electronic

For
Students of Third class

Lecture THREE
Unijunction Transistor (UJT)

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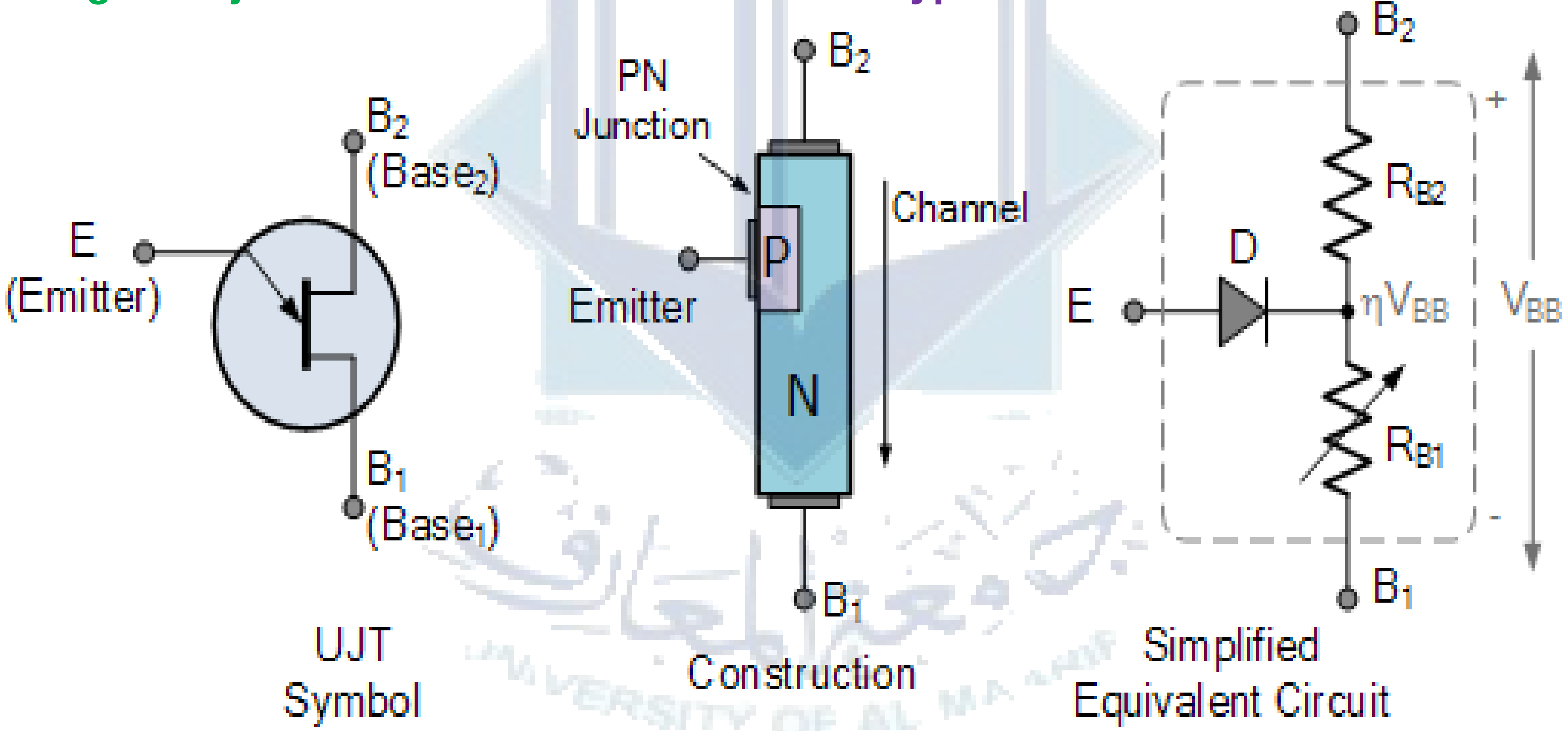
UNIJUNCTION TRANSISTOR (UJT):

- The Uni-junction Transistor (UJT) is a solid-state, **three-terminal device**.
- UJT is constructed using **P-type** and **N-type** semiconductor materials.
- It has a **single PN-junction** formed within the **main N-type** channel.



Equivalent circuit of UJT

- With no voltage applied to the (UJT) the **inter base resistance (R_{BB})** is given by:

$$R_{BB} = R_{B1} + R_{B2}$$

- **The voltage across R_{B1} is given by:**

$$V_A = V_{BB} \times \frac{R_{B1}}{R_{B1} + R_{B2}}$$

η

- Here, η is termed as an **intrinsic standoff ratio** and is given by,

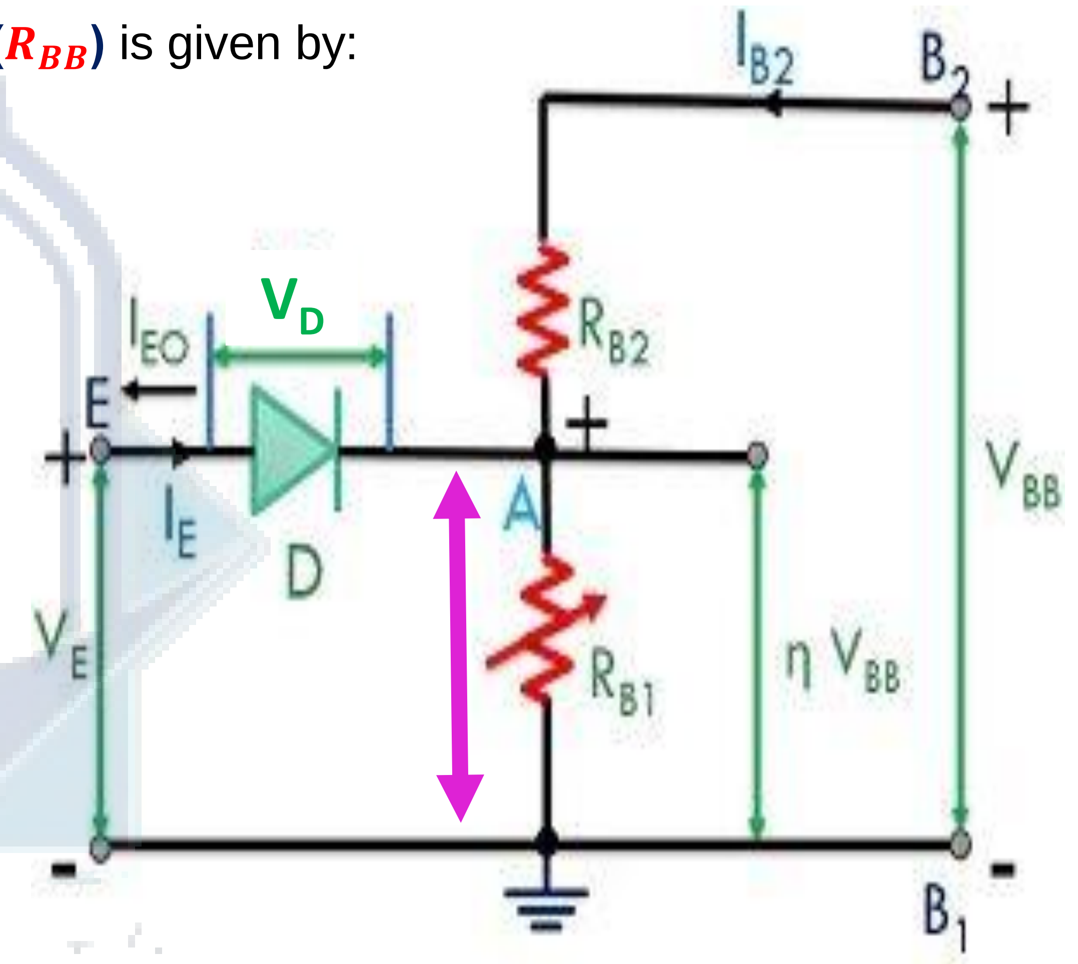
$$\eta = \frac{R_{B1}}{R_{B1} + R_{B2}}$$

where η usually between 0.51 and 0.82

- $V_A = \eta V_{BB}$ *where V_A is called* ***stand off voltage***

- the forward voltage drop across silicon diode $V_D = 0.7\ V$

$V_E = V_D + \eta V_{BB} = V_P$ **Peak point voltage**



When $V_E < \eta V_{BB}$ ∴ PN is reverse biased IE is **negative.**
When $V_E > \eta V_{BB}$ ∴ PN is forward & biased IE is **positive.**

UJT OFF: When $I_E < I_P$
UJT ON : When $I_E > I_P$

Ex 1:

The intrinsic stand - off ration for a (UJT) is determined to be (**0.6**) if the **inter - base resistance** is 10 KΩ What are the value of R_{B1} and R_{B2}

Sol:

$R_{BB} = R_{B1} + R_{B2} = 10\ K\Omega$, $\eta = 0.6$

$$\eta = \frac{R_{B1}}{R_{B1} + R_{B2}}$$

$$0.6 = \frac{R_{B1}}{10K\Omega}$$

$$R_{B1} = 6\ K\Omega$$

$$R_{B1} + R_{B2} = 10\ K\Omega$$

$6\ K\Omega + R_{B2} = 10\ K\Omega$ ⇒ $R_{B2} = 10\ K\Omega - 6\ K\Omega$ ⇒ $R_{B2} = 4\ K\Omega$

Home work(1)

A (UJT) has 10 V between the bases. if the intrinsic stand -off ration is (0.65) find the value of stand off voltage. What will be the peak -point voltage. if the forward voltage drop in the p-n junction is 0.7 v

Characteristics of Unijunction transistor

- The characteristic curve of the UJT shows the **relationship** between **emitter voltage (V_E)** and **emitter current (I_E).**

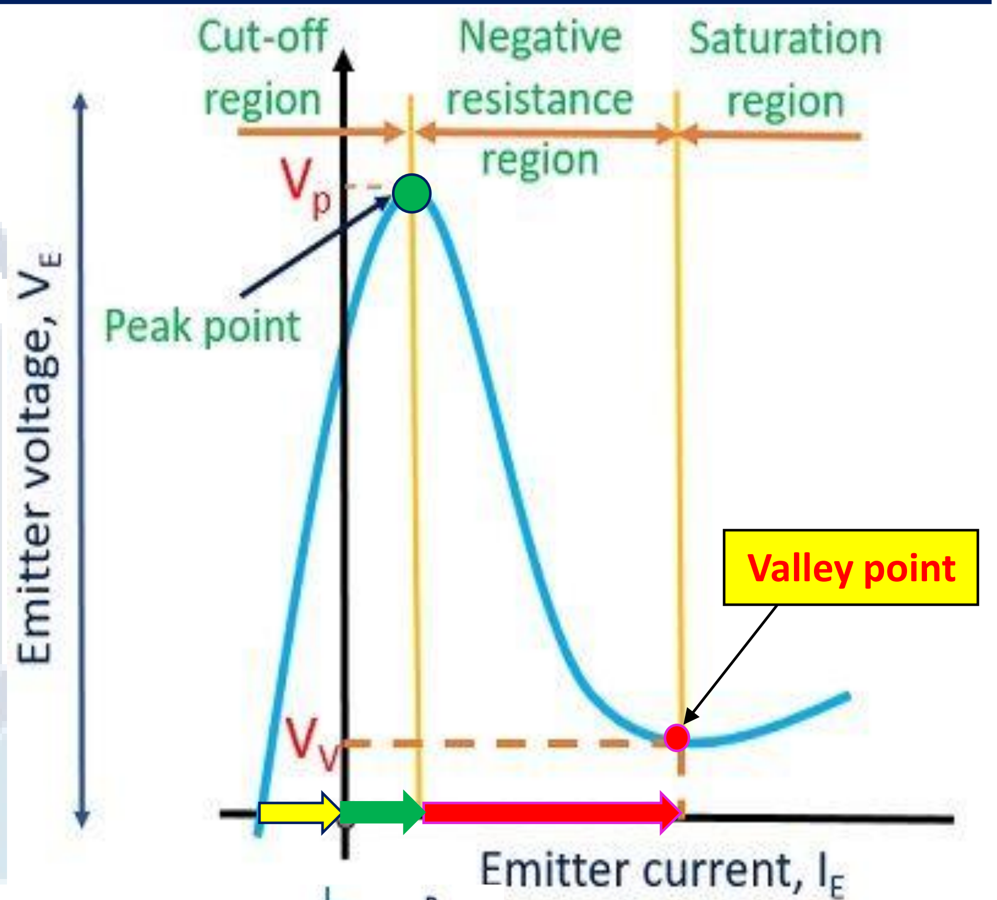
- In the cut-off region, the emitter current (I_E) **remains below** the leakage current (I_{Eo}).

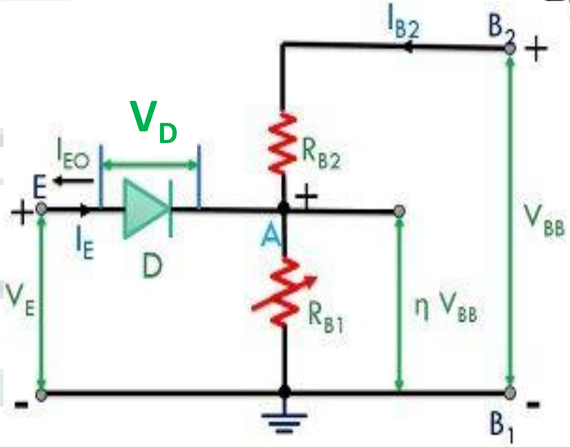
- Conduction begins when the emitter voltage (V_E) reaches the peak voltage (V_P).

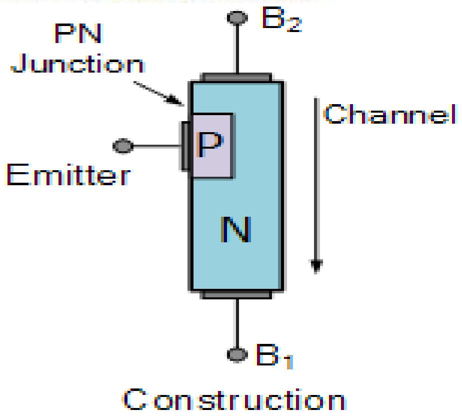
- After the peak voltage, as the emitter current (I_E) increases, the resistance of R_{B1} decreases.

- This decrease in R_{B1} demonstrates **negative resistance** in the negative resistance region.

- Once the **valley point** is reached, the device enters the **saturation region**, where further increases in emitter current (I_E) occur with little change in voltage.







Applications of UJT

- UJT is mainly used as a trigger for SCRs and Triacs in AC power control.

- It's used in gate pulse generation, timing circuits, and trigger generators.

- UJT applications include sawtooth generators, oscillators and phase control.

- The simplest UJT circuit is the Relaxation Oscillator, producing non-sinusoidal waveforms.

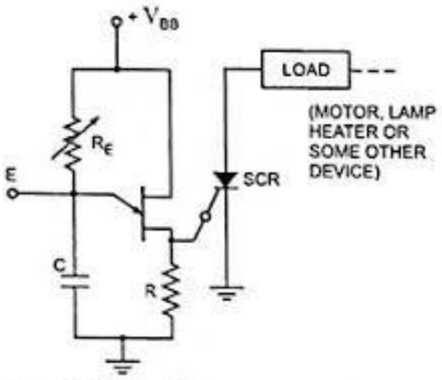


Fig. 26.91 *UJT Triggering of An SCR*

Relaxation Oscillator

- A UJT relaxation oscillator is a simple circuit that generates **non-sinusoidal** waveforms (usually **sawtooth** or **pulse**).
- It works by **charging a capacitor** through a resistor. When the capacitor voltage reaches a certain threshold, the UJT turns on,

$$V_C = \eta V_{BB} + V_D = V_P$$

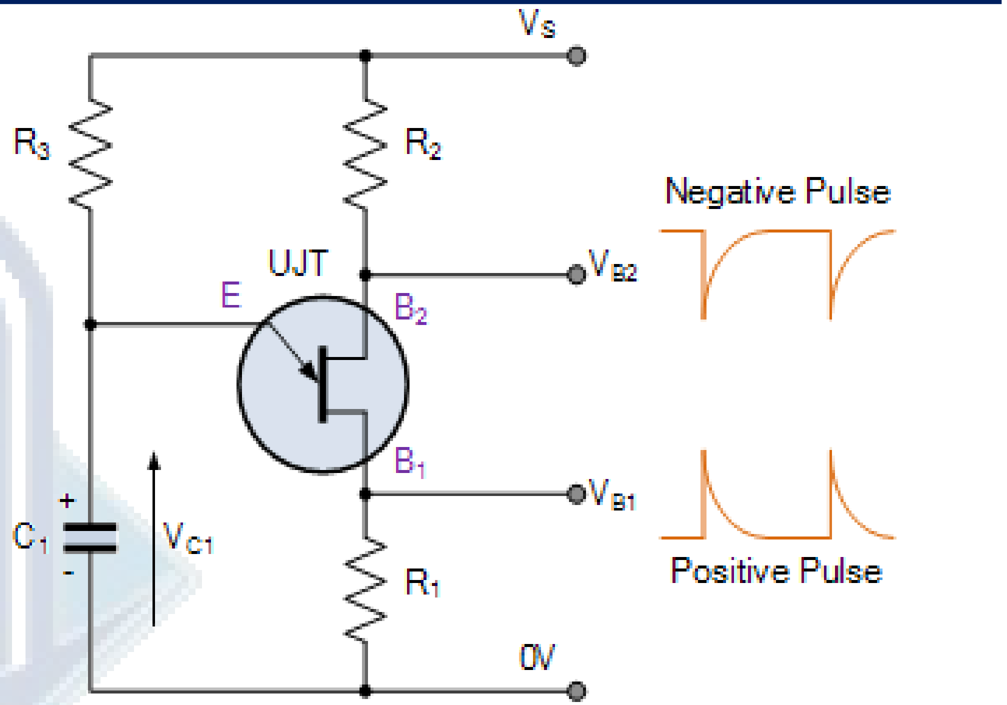
- **discharging** the capacitor rapidly and creating a sharp pulse.

$$V_C = V_{BB}\left(e^{-\frac{t}{R_3 C}}\right)$$

Discharge at certain time

$$V_C = V_{BB}\left(1 - e^{-\frac{t}{R_3 C}}\right)$$

charge at certain time



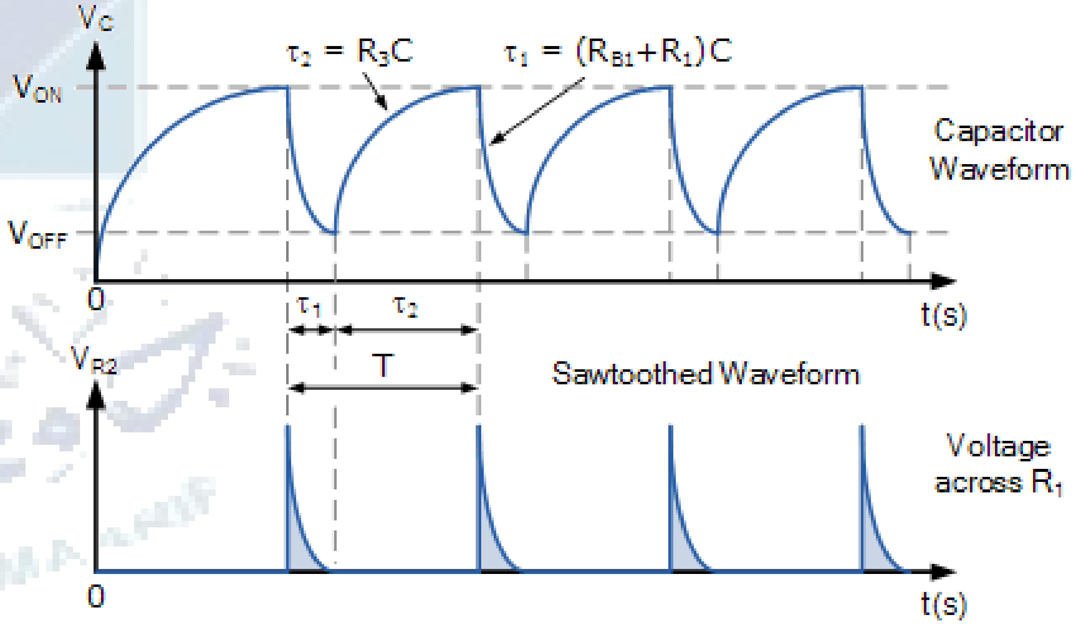
- This process repeats, producing an **oscillating** output.
- The frequency of oscillation is controlled by the **resistor** and **capacitor values** **(Time Constant).**

$$\tau = R_3 C$$

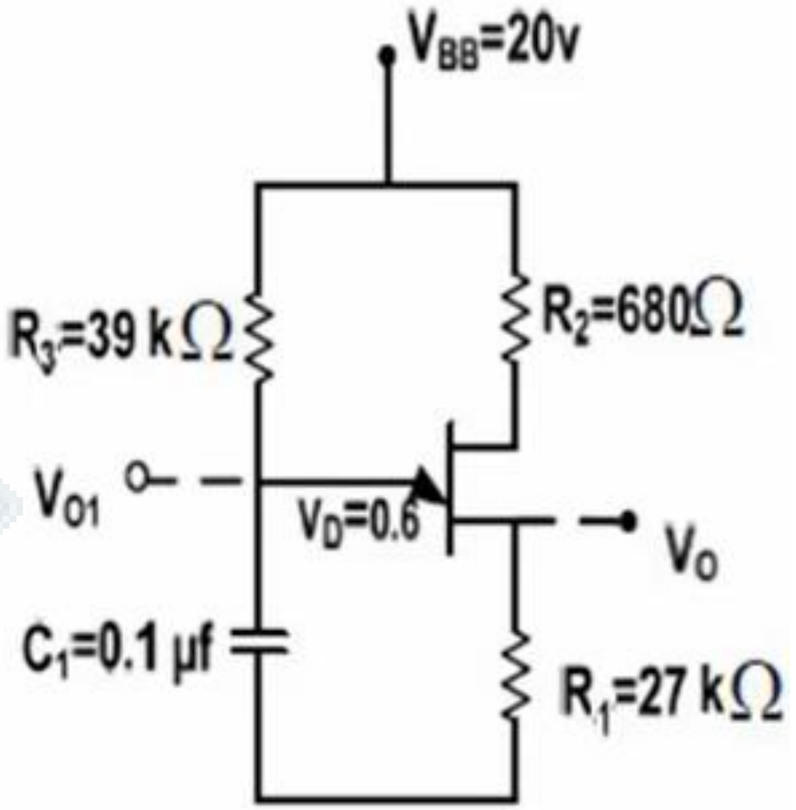
$$T = R_3 C \ln\left(\frac{1}{1-\eta}\right)$$

$$F = \frac{1}{T}$$

F: *the frequency* (HZ)



Ex 2: For the circuit Shown find T, F, V_o, using η = 0.5



Sol:

i

$$T = R_3 C ln\left(\frac{1}{1-\eta}\right)$$

$$T = 39k\Omega \times 0.1\mu f \times ln\left(\frac{1}{1-0.5}\right)$$

$$T = 2.7\ ms$$

ii

$$F = \frac{1}{T}$$

$$F = \frac{1}{2.7ms}$$

$$F = 370\ HZ$$

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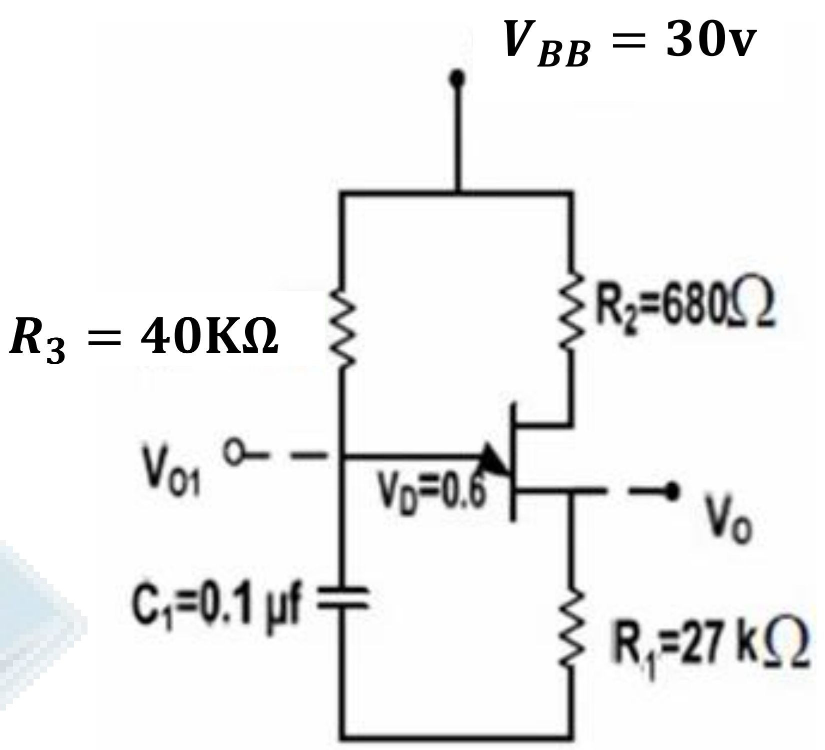
$$V_o = \eta V_{BB} + V_D$$

$$V_o = 0.5 \times 20 + 0.6$$

$$V_o = 10.6\ V$$

Home work(2)

For the circuit Shown find T, f, Vo, using η = 0.6



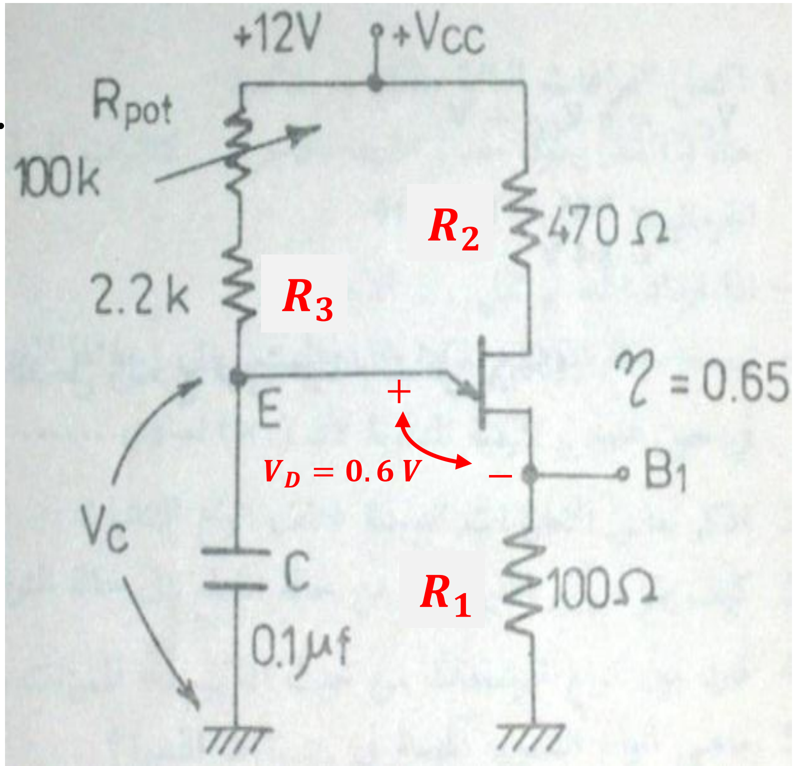
H.W (3)

Sol:

Using the UJT to construct an oscillator as shown below, calculate:

1- Minimum & Maximum frequency of pulses which can be generated.

2- Maximum capacitor voltage.



$$T = (R_3 + R_{pot})C\ln\left(\frac{1}{1-\eta}\right)$$

Minimum frequency

When $R_{pot} = 0\Omega$

Maximum frequency

When $R_{pot} = 2.2\ K\Omega$

Complete the solution

Answers:

1- 93.2 Hz , 4.33 kHz

2- 8.4 V

Home work(4)

The data sheet for a 2N2646 Unijunction transistor gives the intrinsic stand-off ratio as 0.65. If a 100nF capacitor is used to generate the timing pulses, calculate the timing resistor required to produce an oscillation frequency of 100Hz.