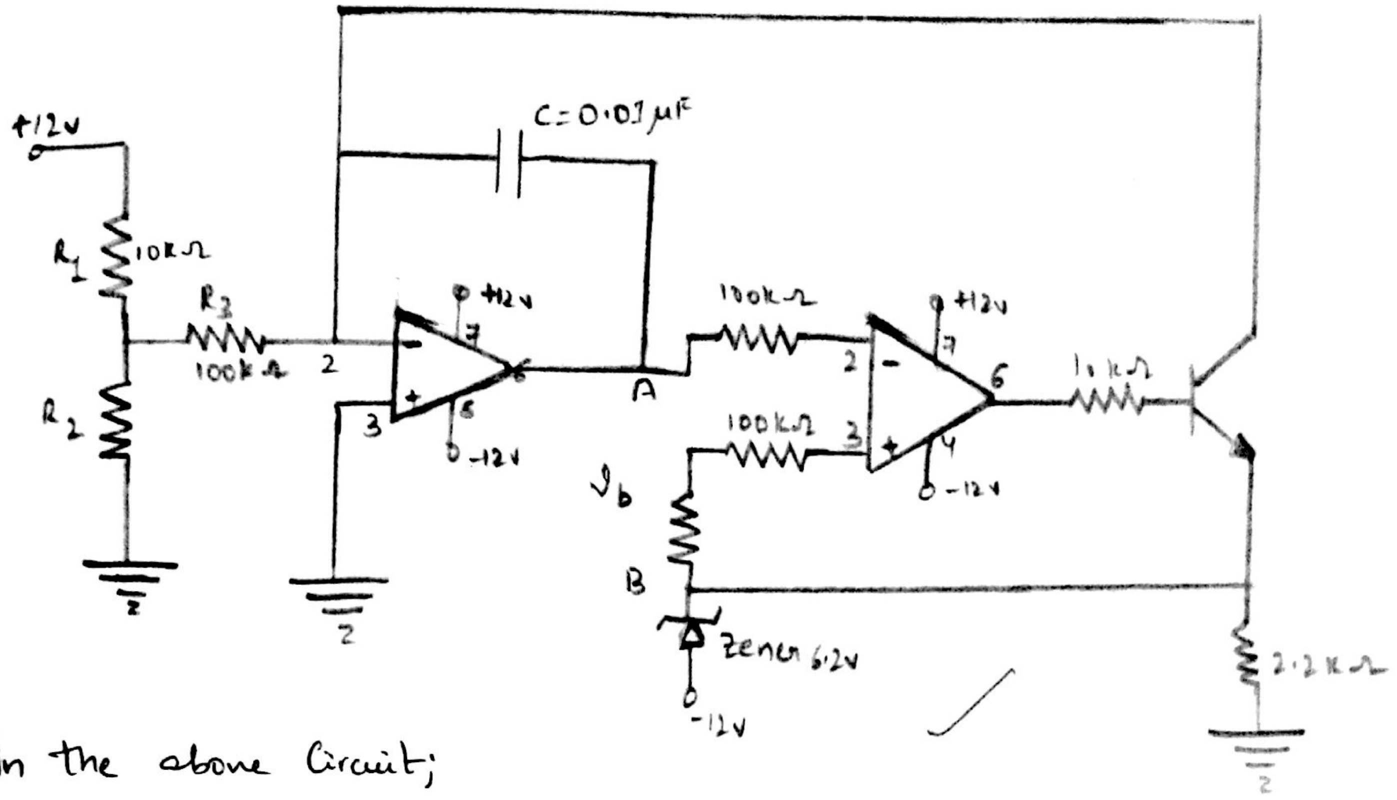
③ [illegible]

Regular Session & GROUP:	Wednesday, Afternoon (L8)
EXPT NO:	EIGHT (8)
DATE OF EXPT:	30/03/2016
STUDENT 1:	K-Y-[illegible] (150107023)
STUDENT 2:	K-[illegible] (150107028)
TABLE NO:	FOURTEEN (14)

PRE-Experimental Readings →



In the above Circuit;

Initially $v_a = 0$

Since $v_c = -12V$ transistor is off and all it gets charged all through R_3 flows through Capacitance "C".

Initially rate of charging ⇒ $\frac{dq}{dt} = i = \frac{v_i - 0}{R_3}$

$= \frac{4}{100}$ kΩ

$= \underline{\underline{40 \mu A}}.$

(a) From the Circuit;

$v_a = -2200 i,$

& $v_b = 330 i_1 = -5.8$

⇒ $i_1 = 2.29 mA$ & $v_b = -5.0435 V$

v_a goes upto v_b.

Capacitor charges till $v_a = -5.0435V$

So; $(5.0345)(0.01) = (40\mu A)\,t$

$$\Rightarrow t = \frac{5.0435 \times 10^{-3}}{4}$$

$$\therefore \underline{\underline{t = 1.26ms.}}$$

(b) when $v_0 < v_b$; transistor is on set;

$$v_c = -12v$$

No Current flows through C.

$$v_e = 0 = v_b$$

$$I_E(330) = 5.8$$

$$\Rightarrow \underline{\underline{I_E = 17.576mA.}}$$

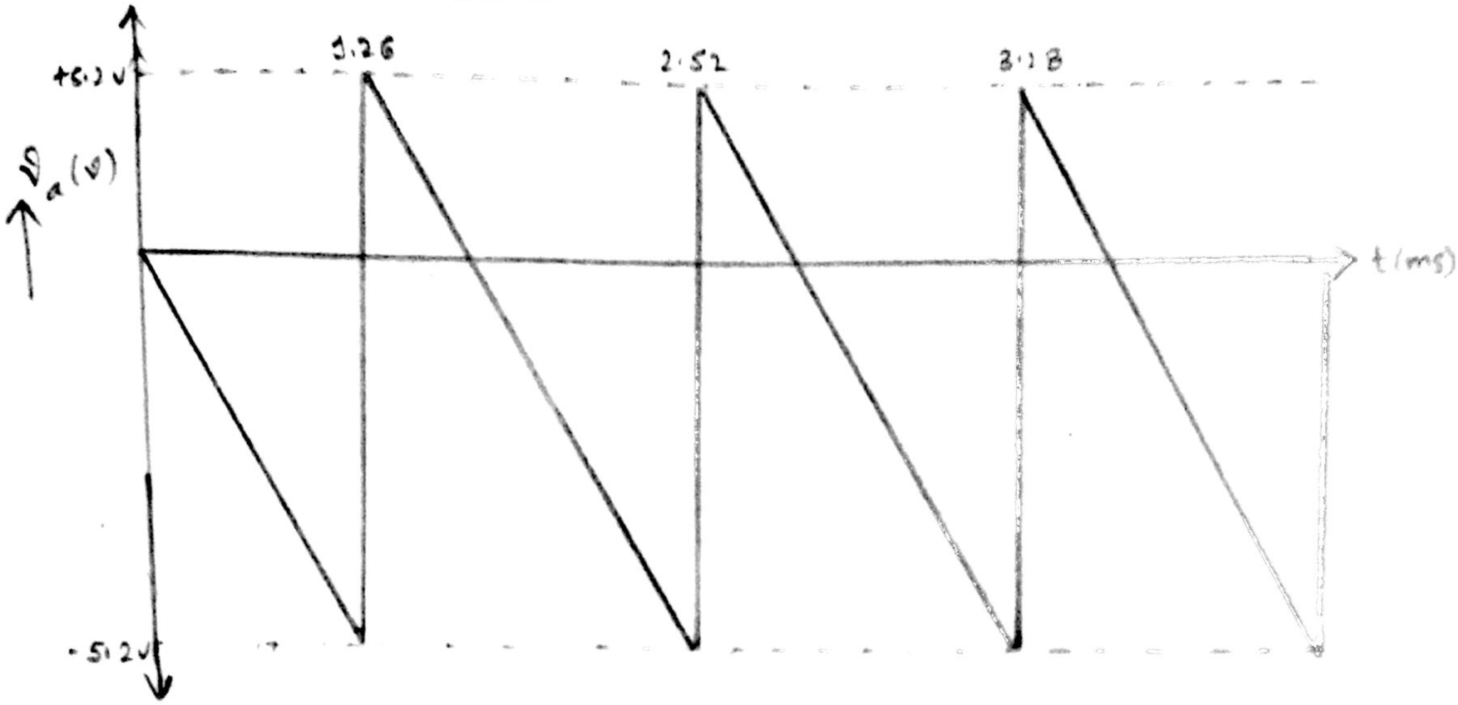
$$\boxed{\therefore I_c = \left(\frac{\beta}{B_H}\right) I_E}$$

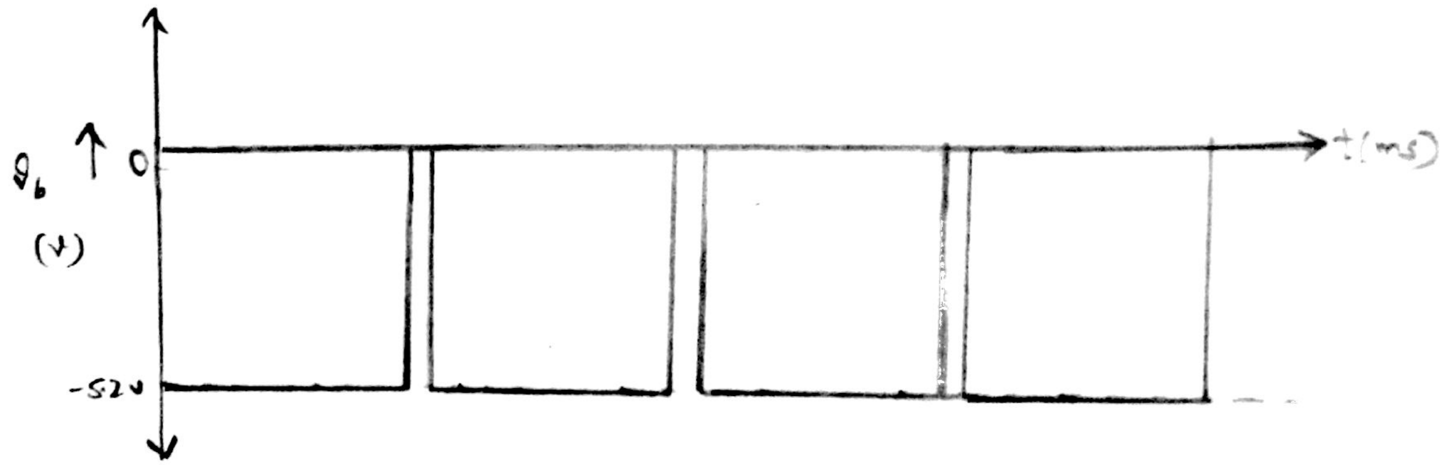
Time for discharging $(t) = \dfrac{5.0435 \times (0.01\mu F)}{17.131\,ms}$

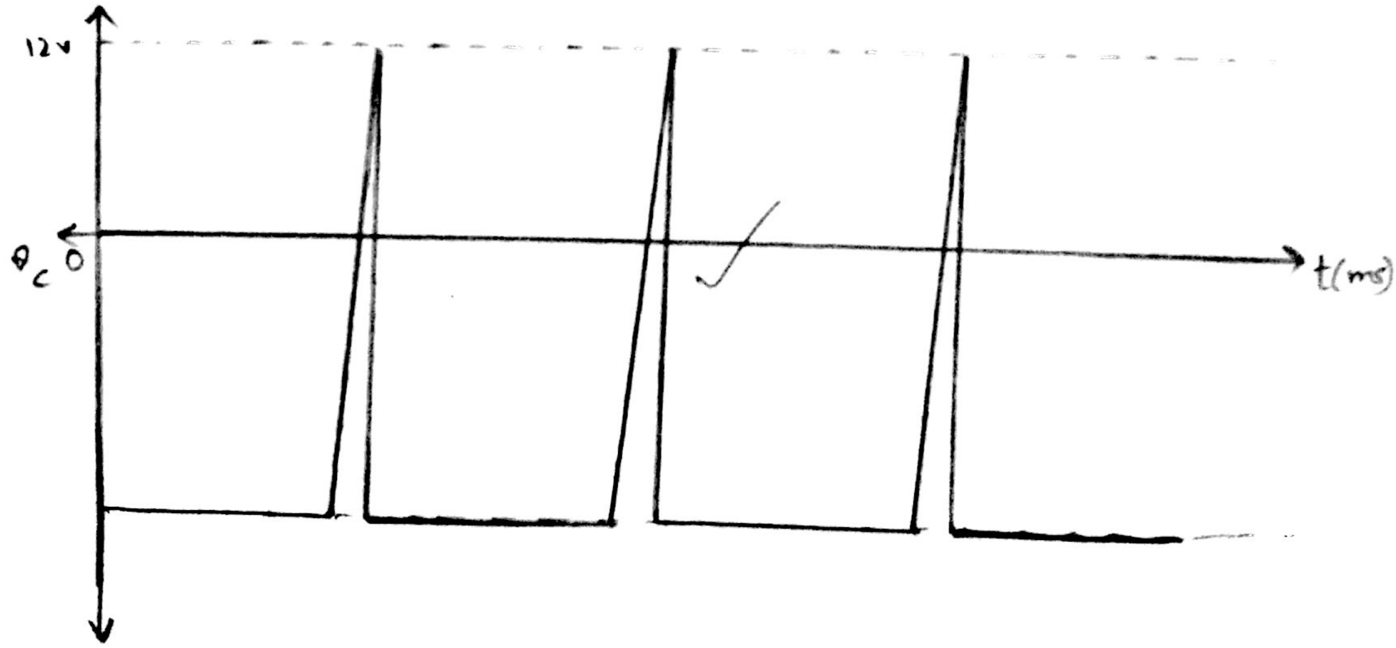
$$= \underline{\underline{2.92ms.}}$$

$$= \underline{\underline{2.92\mu s.}}$$

OBSERVATIONS :-

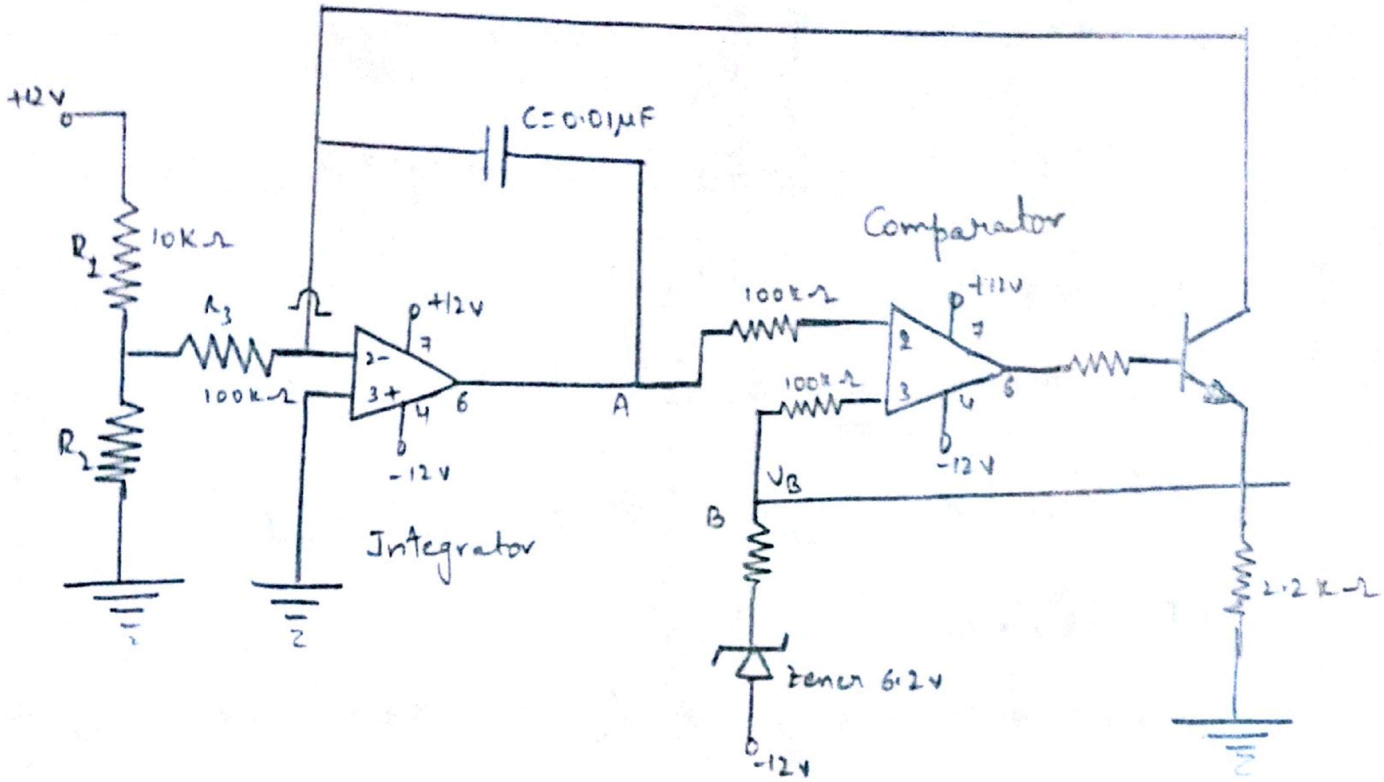






ective → Designing a voltage to frequency Converter.

Circuit diagram →



Working → 1) Initially Capacitor "c" gets charged at a Constant rate of $[V_i/R_3]$ amp. The Output voltage V_a at pt "A" drops linearly till $V_a \geq V_b$ (voltage at pt B). approx (V_b x −0.5v)

2) The Comparator output V_c is at approx −12v when V_a > −5v and the transistor is in off state.

3) The −vely Increasing V_a becomes less than −5v, the Comparator output goes to approx +12v. The transistor gets on & hence emmitter volt of transistor is at Zero voltage. The transistor is Insaturated state. The Capacitor starts discharging slowly. until V_c > 0. The Comparator output V_c becomes −12v & it is off. This process repeats.

OBSERVATIONS →

2<a> For $R_1 = 10 k\Omega$ and;

a) $R_2 = 1 k\Omega$;

$V_a = 4.8 \times 2 = 9.6 V$ & $V_b = -2.6 \times 2 = -5.2 V$

Time period = 10.4 ms & frequency = 96.15 Hz.

b) $R_2 = 2.2 k\Omega$;

$V_a = 4.6 \times 2 = 9.2 V$ & $V_b = -2.6 \times 2 = -5.2 V$

Time period = 5.2 ms & frequency = 192 Hz

c) $R_2 = 3.9 k\Omega$;

$V_a = 4.6 \times 2 = 9.2 V$ & $V_b = -2.6 \times 2 = -5.2 V$

Time period = 3.6 ms & frequency = 277 Hz.

d) $R_2 = 5.6 k\Omega$;

$V_a = 4.6 \times 2 = 9.2 V$ & $V_b = -2.6 \times 2 = -5.2 V$

Time period = 2.8 ms & frequency = 357 Hz

S.No	Resistance ($k\Omega$)	Frequency ($f = 1/T$) (Hz)
1.	$1 k\Omega$	96.15 Hz
2.	$2.2 k\Omega$	192 Hz
3.	$3.9 k\Omega$	277 Hz
4.	$5.6 k\Omega$	357 Hz

→ On Replacing Zener diode & replacing it by ~~ai~~ a resistor we should get $v_b \approx 5v$.

For; $1k\Omega \rightarrow v_b = -7.6v$

$2.2k\Omega \rightarrow v_b = -5.6v$ } B/w them.

$3.9k\Omega \rightarrow v_b = -4.2v$

For $v_b \approx 5v$; we require "2.2 kΩ" resistor.

→ Ideally resistance required is 2.75 kΩ to set $v_b \approx 5.0V$.

The frequency at 2.2 kΩ = 357 Hz.

Pulse Width at 2.2 kΩ = 15 μs.

Precautions →

1) Make sure power supply is Connected to Circuit ground.
2) Both +ve & -ve power supplies must be present whenever Op Amp is powered.
3) Don't interchange +ve & -ve supplies as it Can be damage Op Amp.
4) For IC chip; never exceed V_i beyond power supply limits.
5) Keep ground terminals of ~~Oscillop~~ Oscilloscope probes beyond & function generator Output & power supply Common Connected together throughout the experiment.

Result →

1) With increasing in resistance; the frequency also increases.

Resistances ($k\Omega$)	Frequency ($f = 1/T$) (Hz)
1 $k\Omega$	96.15 Hz
2.2 $k\Omega$	192 Hz
3.9 $k\Omega$	277 Hz
5.6 $k\Omega$	357 Hz.

2) On replacing the zener diode with a "2.2 $k\Omega$" resistor; we get $V_b \approx 0.5V$.

3) The frequency at 2.2 $k\Omega$ after replacing is "357 Hz".

4) The pulse width at $V_b \approx -0.5V$ is "15 μs"

~~E~~- OBSERVATIONS:

2) $\cdot R_1 = 10\,k\Omega$ & ~~[illegible]~~

a) For $R_2 = 1\,k\Omega$

$V_a = 4.8 \times 2 = 9.6\,V$

$V_b = -2.6 \times 2 = -5.2\,V$

Time period = 10.4 ms

frequency = 96.15 Hz.

b) For $R_2 = 2.2\,k\Omega$

$V_a = 4.6 \times 2 = 9.2\,V$

$V_b = -2.6 \times 2 = -5.2\,V$

Time period = 5.2 ms

frequency = 192 Hz

c) For $R_2 = 3.9\,k\Omega$

$V_a = 4.6 \times 2 = 9.2\,V$

$V_b = -2.6 \times 2 = -5.2\,V$

Time period = 3.6 ms

frequency = 277 Hz

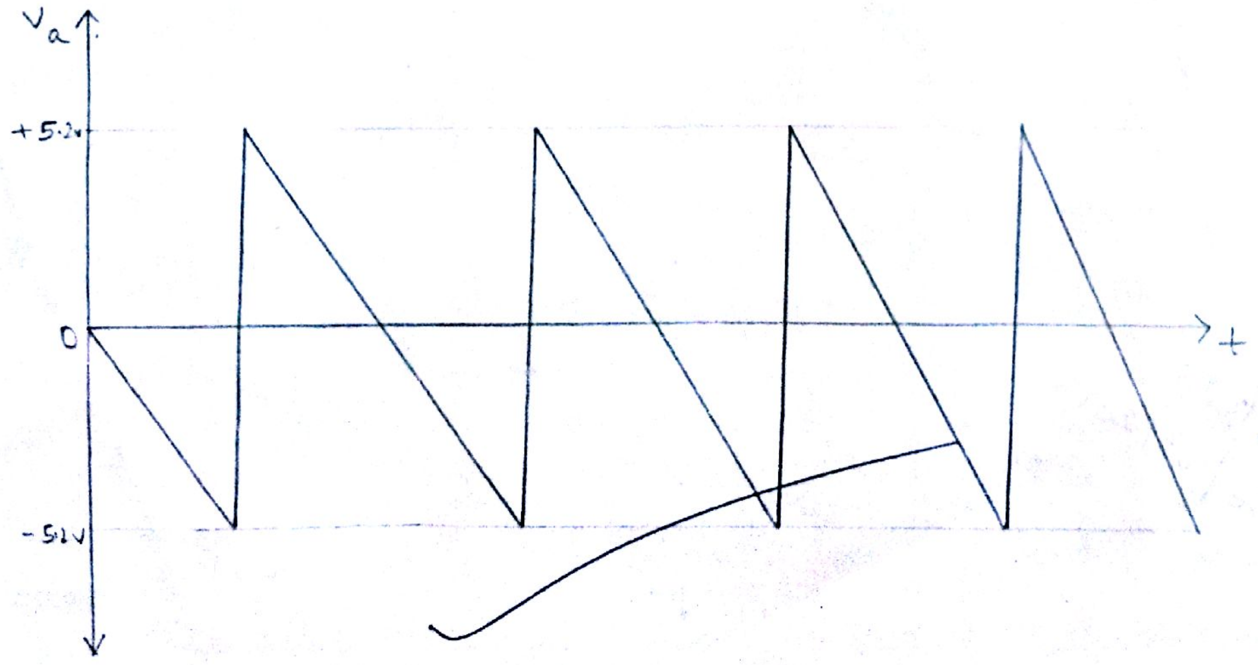
d) For $R_2 = 5.6\,k\Omega$

$V_a = 4.6 \times 2 = 9.2\,V$

$V_b = -2.6 \times 2 = -5.2\,V$

Time period = 2.8 ms

frequency = 357 Hz



~~3) For $R_1 = 10k\Omega$; At Point "b".~~

4)

∴ $\underline{\underline{2.2k\Omega}}$, resistor so that V_b is approx at $-5.0V$

$1k\Omega \rightarrow v_b = \underline{\underline{-7.6v}}$

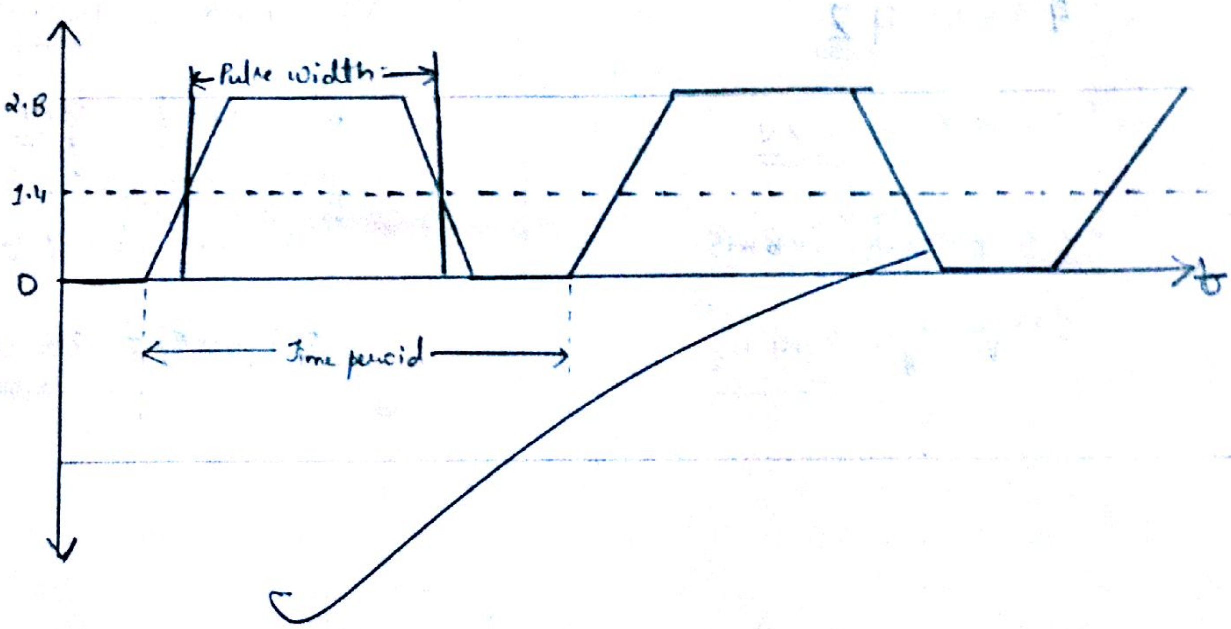
$2.2k\Omega \rightarrow v_b = -\underline{\underline{5.6v}}$ } B/w them.

$3.9k\Omega \rightarrow v_b = \underline{\underline{-4.2v}}$

~~$5.6k\Omega \rightarrow v_b =$~~

frequency at $2.2k\Omega$ = $\underline{\underline{357 Hz}}$

Pulse width = ~~[illegible]~~. $\underline{\underline{15\mu s}}$.



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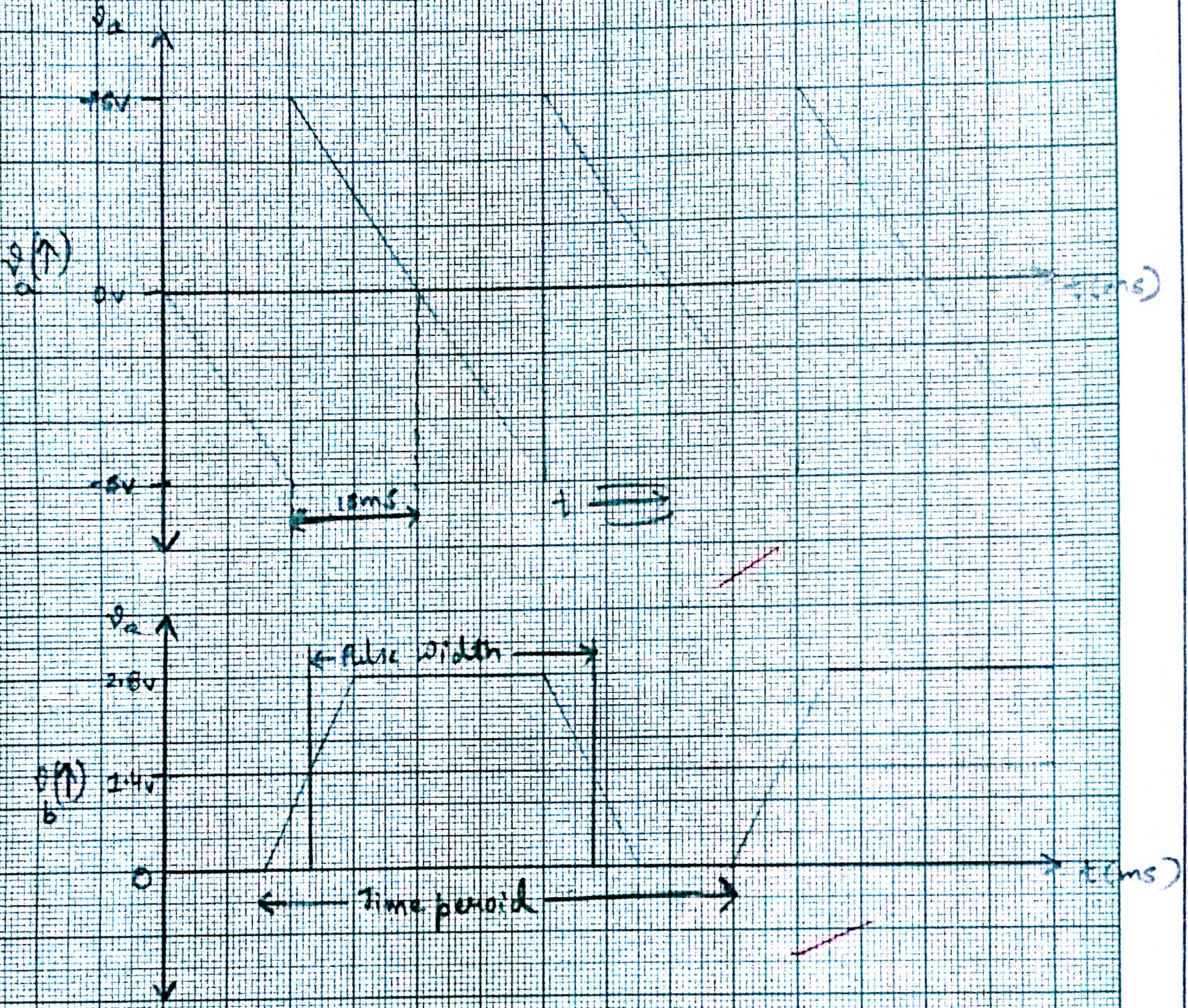
$R = 1k\Omega$



Pulse Width = 15μs. } (R = 2.2 kΩ)

Frequency = 36.7Hz.

PARROT

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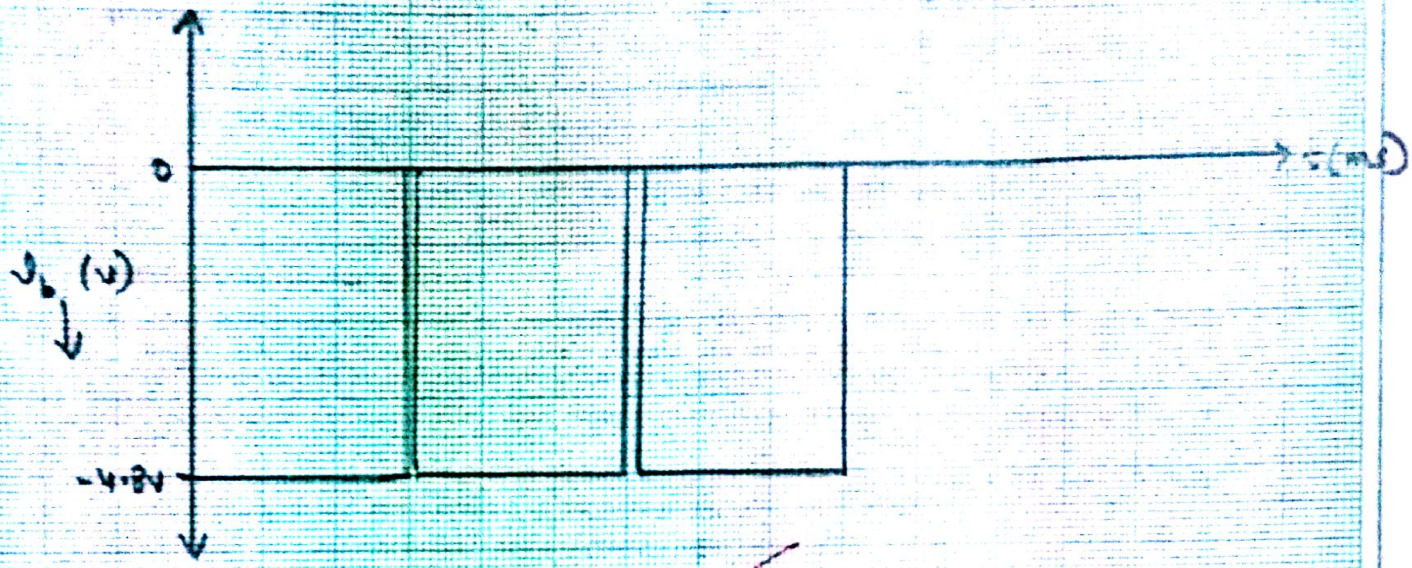
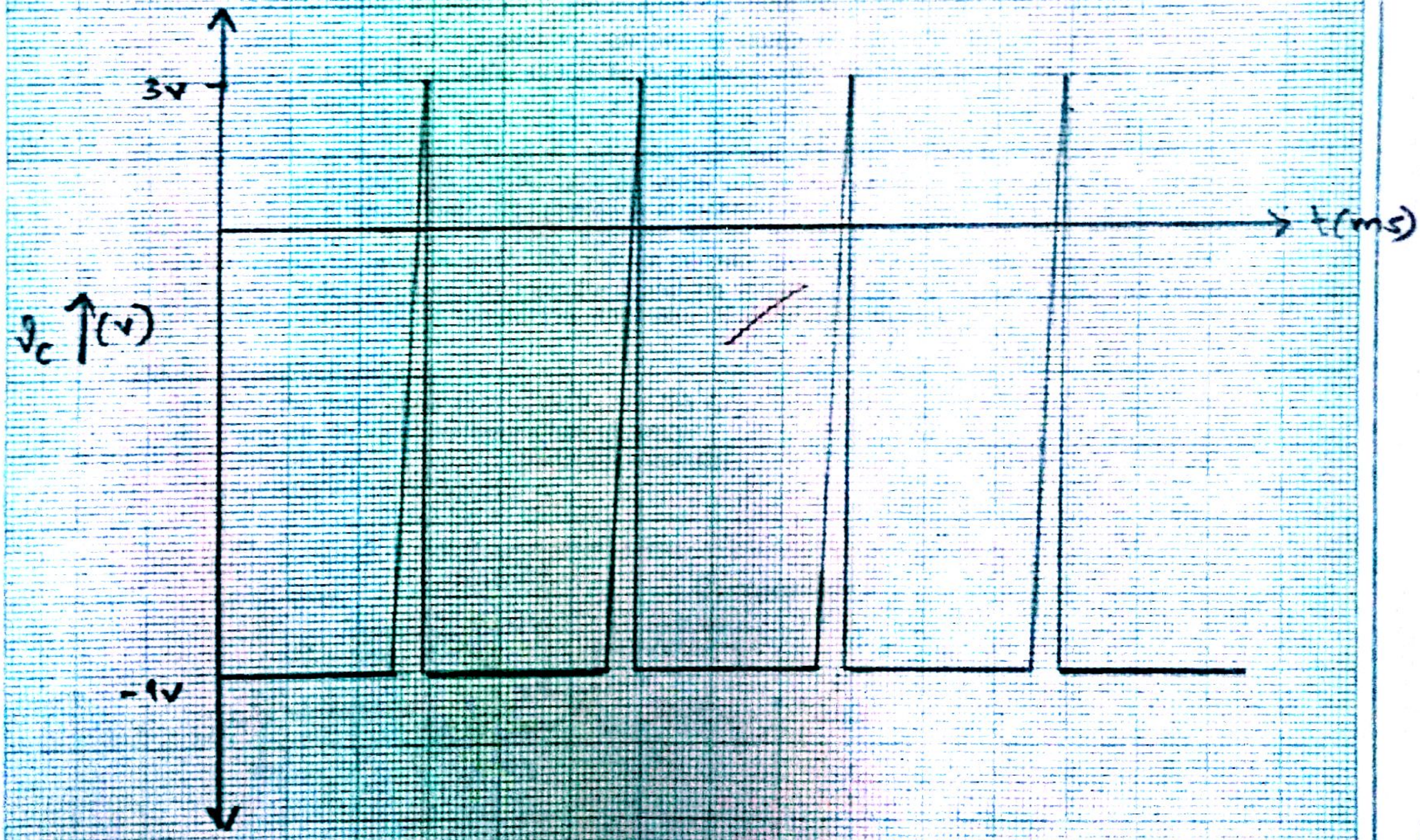
For R=1KΩ;





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EXPT. No. 8 : VOLTAGE TO FREQUENCY CONVERTER

OBJECTIVE: Designing a voltage to frequency converter.

MATERIALS REQUIRED

- Breadboard
- Equipment : Multioutput DC Power Supply, Oscilloscope.
- Components : Op-Amp : Two LM741.
  : Transistor : One 2N2222A
  : Diode : one 6.2V zener diode.
  : Resistance: One 330Ω, One 1kΩ, two 2.2KΩ, one 3.9KΩ, one 5.6KΩ, two 10 kΩ, three 100 kΩ.
  : Capacitor : One 0.01 μF.

PRECAUTIONS AND GUIDELINES

1. The op-amp generally works on split power supply (e.g. ±12 V). Both positive and negative power supplies must be present whenever op-amp is powered. The range of power supply is from ±5 V to ±15 V. Do not forget to connect the common terminal of the power supply to the *ground* on the breadboard.
2. Connecting only one side of power supply or interchanging positive and negative power supplies damages the op-amp.
3. While switching on the set-up, switch on the oscilloscope first, then the power supply to the circuit, and finally the function generator. When switching off, follow the sequence in reverse order.
4. For any IC, never exceed the input voltage beyond the power supply limits.
5. Keep ground terminals of the oscilloscope probes and function generator output, and power supply common connected together throughout the experiment.

The circuit shown in Fig. 8.1 is of Voltage to Frequency converter

Working Principle: Initially, the capacitor C gets charged at constant rate of (V_i / R_3) amp. The output voltage V_a at point 'a' drops linearly till this voltage is not less than the voltage V_b at point 'b' which is approx. at about -5.0V. Note that, the comparator output voltage V_C is at approx. -12V when V_a is greater than -5.0V and the transistor is in 'off' state.

When the negatively increasing voltage V_a becomes less than -5.0V, the comparator output V_c goes to approx. +12V. The transistor gets 'on' and hence the emitter voltage (also voltage at comparator '+' input) of the transistor is about at zero voltage. The transistor is in saturated state. The capacitor starts discharging. The discharging continues and V_a increases positively, till V_a becomes greater than zero voltage. The comparator output V_C becomes about -12V and the transistor becomes 'off'. This charging and discharging process repeats again and again. Note that the discharging duration is same for any input voltage V_i and it should be much smaller than the charging time, which depends on the input voltage V_i.

<u>**Pre-experiment Reading:**</u>

(a) Draw the waveforms at (i) V_a (ii) V_b and (iii) V_c
(b) Compute the charging time of the capacitor.
(c) Compute the discharging time of the capacitor.
(Assume V_i= 4V for above)

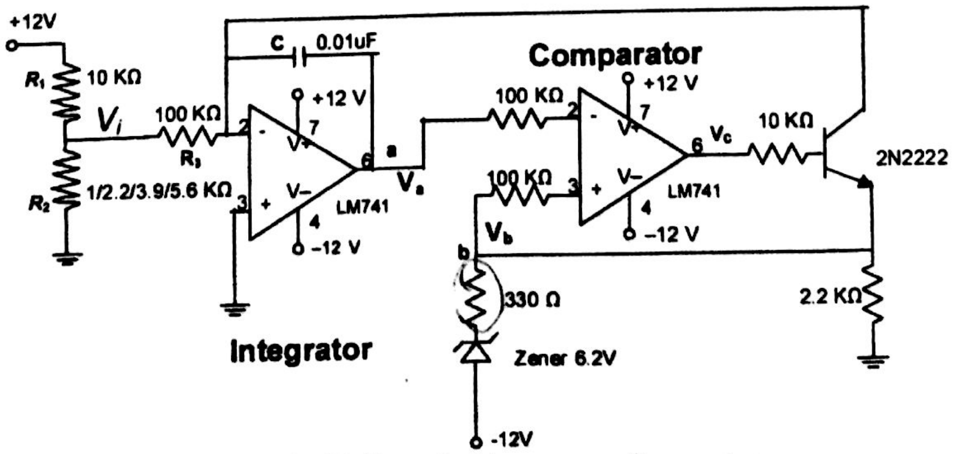

Fig. 8.1 Voltage to Frequency Converter

OBSERVATIONS:

1. Connect the circuit as shown in Fig. 8.1 with R_1 = 10 kΩ, and R_2 = 1 kΩ. Make sure the power supply ground is connected to the circuit ground.

2. Observe the waveform V_a at point 'a' for

   (a) for R_2 = 1 KΩ

   (b) for R_2 = 2.2 KΩ

   (c) for R_2 = 3.9KΩ

   (d) for R_2 = 5.6 KΩ

3. Similarly, observe the waveform V_b at point 'b' for all V_i as in step 2.

4. Remove the zener diode and replace it by a resistance so that V_b is approx. at -5.0V and observe V_b (both frequency and pulsewidth).