Problem Statement Day #1

Circuit Designing
Analog
IEEE - Delhi Technological University

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Multivibrator Circuit

A *multivibrator circuit* is a circuit which switches it's output between a "HIGH" state and a "LOW" state. How fast the state changes depends on the frequency of multivibrator. Another important parameter for this circuit is "Duty Cycle" which is the defined as:

$$Frequency\ (\nu) = \frac{1}{t_{HIGH} + t_{LOW}}$$
$$Duty\ Cycle = \frac{t_{HIGH}}{t_{HIGH} + t_{LOW}} \cdot 100\ \%$$

Basic Principle
The circuit works by charging a capacitor C through a charging resistor $R_{charging}$. When the voltage across the capacitor reaches a certain threshold value $Threshold$ 1, output state is inverted and the discharging circuit is switched on. Now, the capacitor is discharged through resistor $R_{discharging}$. When valtage across capacitor reaches lower threshold value $Threshold$ 2, output state is again inverted, and the charging circuit is switched on. Both circuits will have different value of time constants, and hence will determine the time to rise/sink to respective threshold value. This time will determine the frequency of the *multivibrator circuit* and it's duty cycle:

$$Frequency\ (\nu) = \frac{1}{t_{T1} + t_{T2}}$$
$$Duty\ Cycle = \frac{t_{T1}}{t_{T1} + t_{T2}} \cdot 100\ \%$$

where, t_{T1} is time to reach $Threshold$ 1 and t_{T2} is time to reach $Threshold$ 2 from $Threshold$ 1.

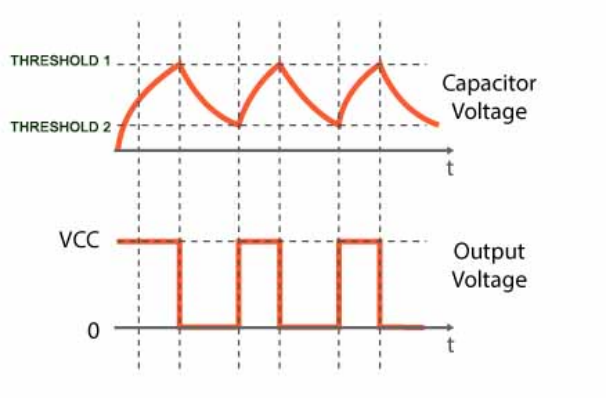

Figure 1: Waveform of Capacitor voltage (above) and corresponding Square Wave output (botom)

Problem Statement

A *multivibrator circuit* is used to generate high frequency square wave. Design a *multivibrator circuit* using principles described above, and generate a square wave of 41 kHz.

Additional Information

a) Highlight the charging resistor (using name `R_charging`), the discharging resistor (usung name `R_discharging`), and the capacitor (using name `C_t`).

b) Use of Pulse Voltage Source is not allowed. Use of behavioral digital components from LTSpice is NOT allowed.

c) Output voltage is $V_{pp} = 5V$.

d) Waveform of output square wave, and of voltage across capacitor `C_t` will be used to evaluate points for output (You should get a waveform similar to Fig. 1).

e) Also give the formula for frequency and duty cycle of output square wave, as a function of `R_charging`, `R_discharging` and `C_t` in your report. Also give a short explaination on how you derived this expression.

f) Keep checking the website for design tips.

Optional

Frequency of output square wave needs to be changed according to analog input $(0-5V)$. Input of $2.5V$ corresponds to 0 shift in frequency. Voltage of $0V/5V$ corresponds to +/- 1 kHz shift in frequency (keeping duty cycle constant while changing frequency is not necessary). Design a circuit (or modify the one you designed) to do so.