SNS COLLEGE OF TECHNOLOGY

Kurumbapalayam (Po), Coimbatore – 641 107

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE NAME : 19ECB201-ANALOG ELECTRONIC CIRCUITS

II YEAR /III SEMESTER

Unit 4- OSCILLATORS & MULTIVIBRATOR CIRCUITS

Topic 7 : Astable multivibrator

Multivibrators

- Multivibrators are two-stage switching circuits in which the output of the first stage is fed to the input of the second stage and vice-versa.
- The outputs of two stages are complementary.
- Multivibrators are of three types, namely,

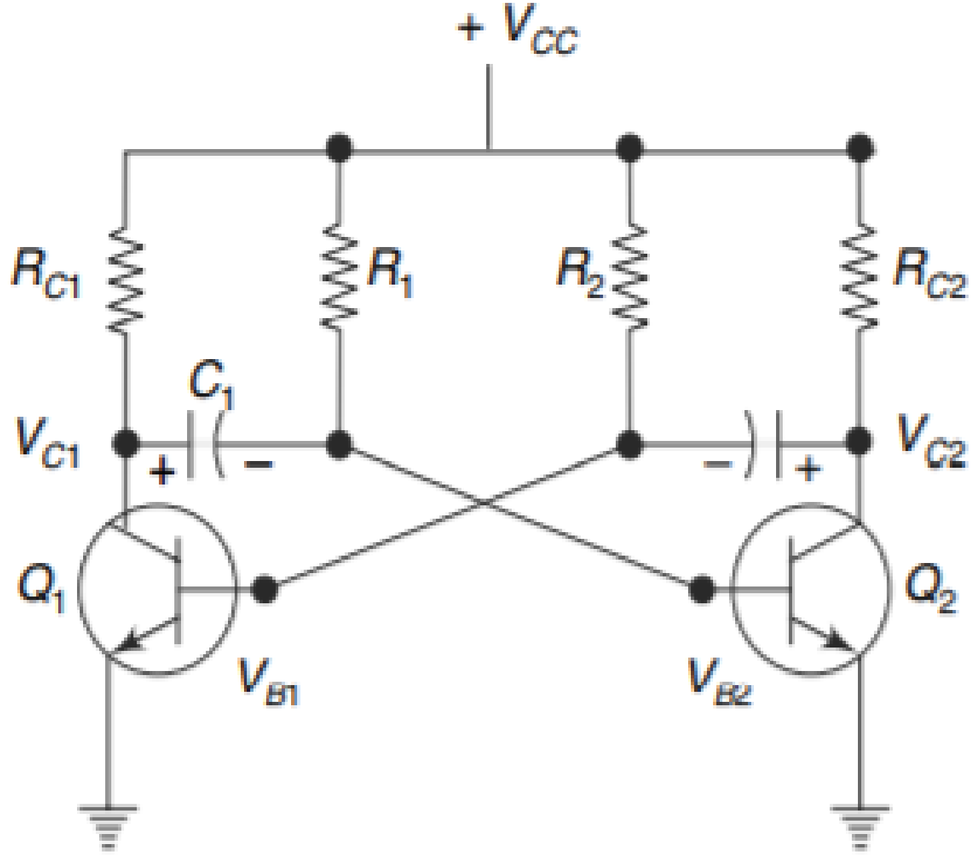
(i) Astable multivibrator,

(ii) Bistable multivibrator, and

(iii) Monostable multivibrator.

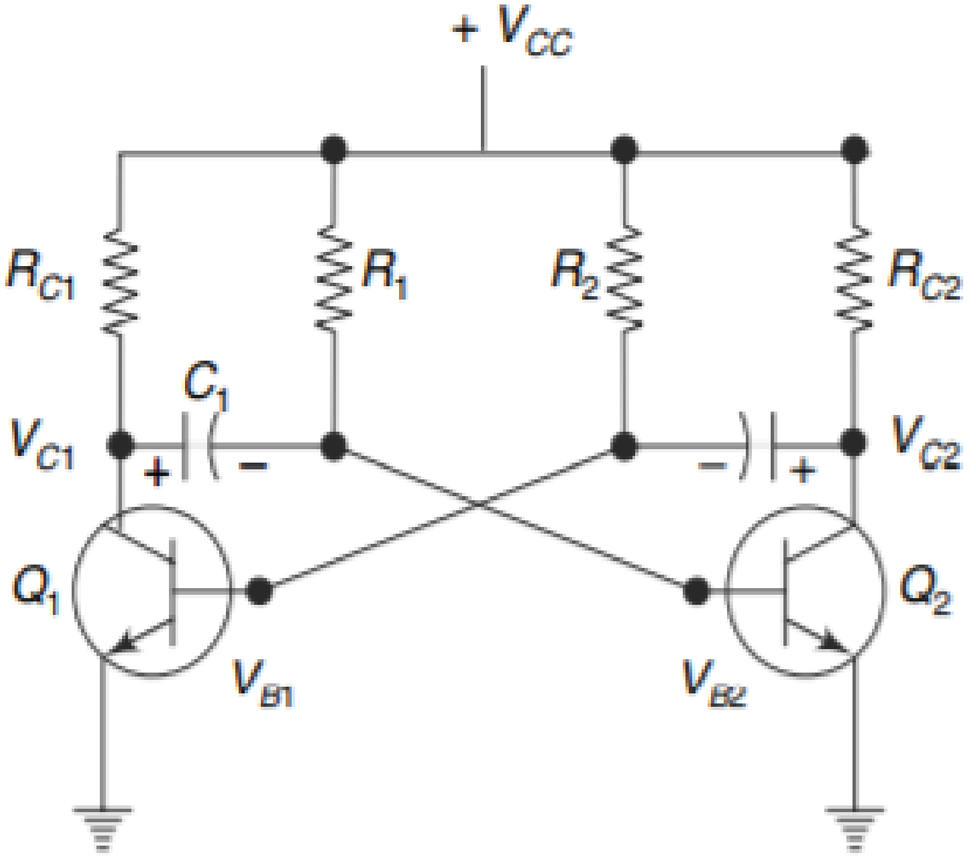
Collector Coupled Astable Multivibrator

- The astable or free running multivibrator generates square wave without any external triggering pulse.
- It has no stable states, i.e. it has two quasi stable states.

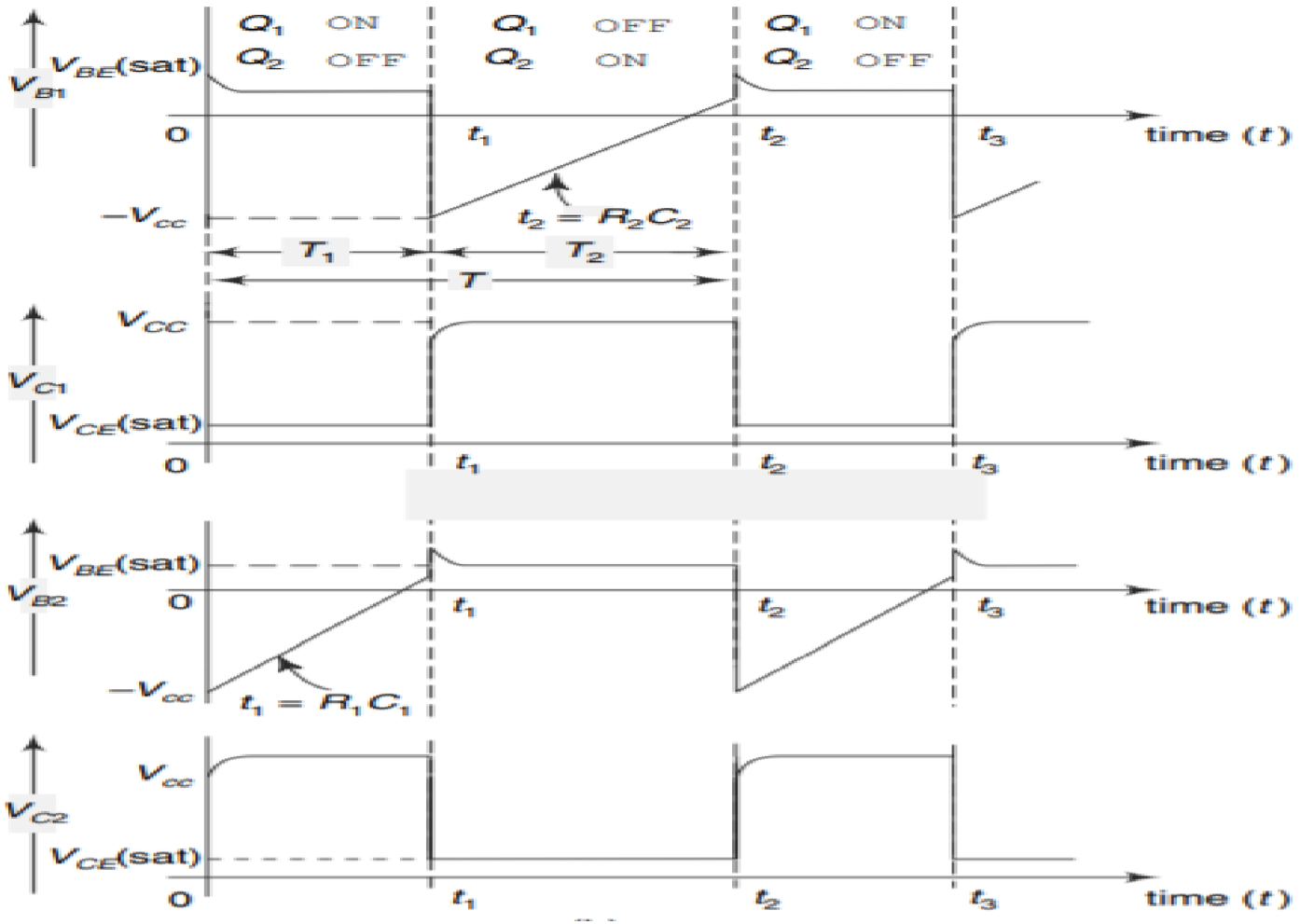


Collector Coupled Astable Multivibrator

- It switches back and forth from one state to the other, remaining in each state for a time depending upon the discharging of a capacitive circuit.



Input and Output Waveforms



Working of Astable Multivibrator

- When the supply voltage +VCC is applied, one transistor will conduct more than the other due to some circuit imbalance.
- Initially, let us assume that Q1 is conducting and Q2 is cut-off.
- Then VC1, the output of Q1 is equal to VCE(sat), i.e. approximately zero volt and VC2 = +VCC.
- At this instant, C1 charges exponentially with a time constant R1C1 towards the supply voltage through R1 and correspondingly VB2 also increases exponentially towards VCC.

Working of Astable Multivibrator

- When VB2 crosses the cut-in voltage, Q2 starts conducting and VC2 falls to VCE(sat).
- Also, VB1 falls due to capacitive coupling between collector of Q2 and base of Q1, thereby driving Q1, into OFF state.
- Now, the rise in voltage VC1 is coupled through C1 to the base of Q2, causing a small overshoot in voltage VB2.
- Thus Q1 is OFF and Q2 is ON.
- At this instant, the voltage levels are: VB1 is negative, VC1 = VCC, VB2 = VBE(sat) and VC2 = VCE(sat).

Working of Astable Multivibrator

- When Q1 is OFF and Q2 is ON, the voltage VB1 increases exponentially with a time constant R2C2 towards VCC.
- Therefore, Q1 is driven into saturation and Q2 is cut-off.
- Now, the voltage levels are: VB1 = VBE(sat), VC1 = VCE(sat), VB2 is negative and VC2 = VCC.

Working of Astable Multivibrator

- It is clear that when Q2 is ON, the falling voltage VC2 permits the discharging of the capacitor C2 which drives Q1 into cut-off.
- The rising voltage of VC1 feeds back to the base of Q2 tending to turn it ON.
- This process is said to be regenerative.

Time Period Calculation

ON time for Q_2 is $T_2 = 0.693\ R_2C_2$

ON time T_1 for Q_1 can be expressed as $T_1 = 0.693\ R_1C_1$

Therefore, the total period of the waveform is

$$T = T_1 + T_2 = 0.69\ (R_1C_1 + R_2C_2)$$

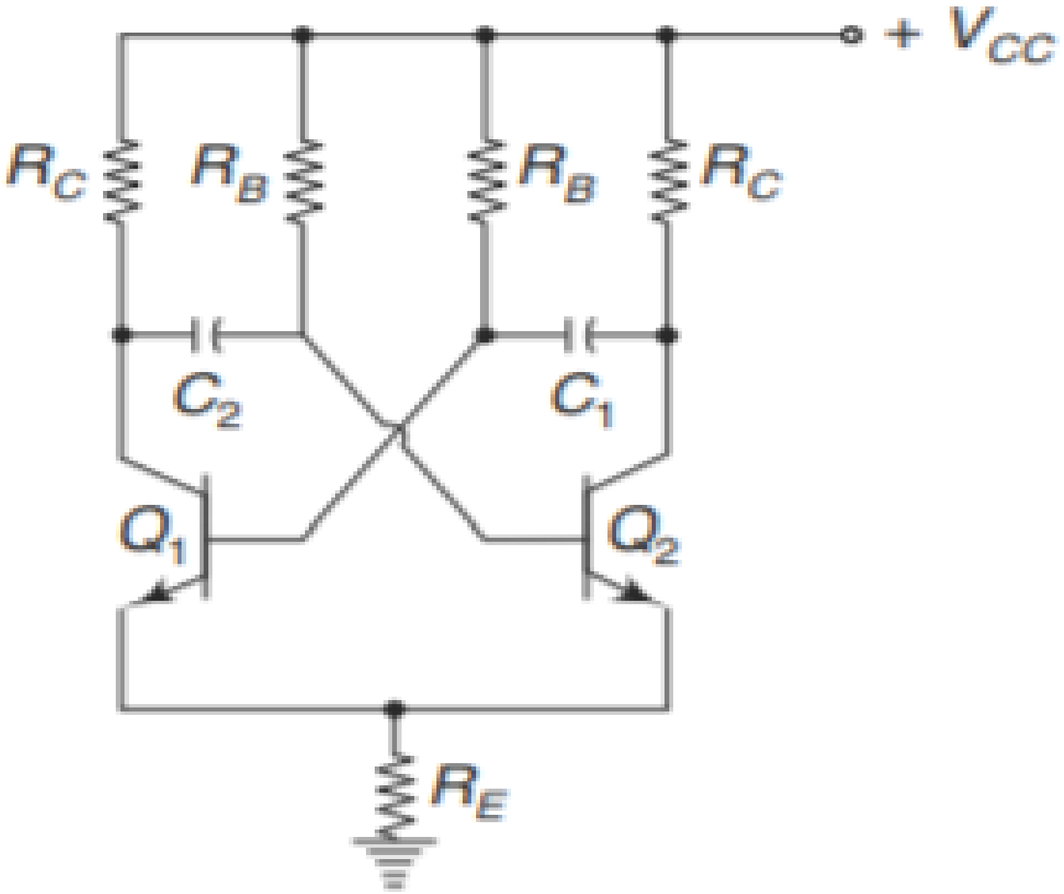
If $R_1 = R_2 = R$ and $C_1 = C_2 = C$, we have a symmetrical multivibrator, with outputs at the two collectors having the same waveforms but out of phase with each other.

Therefore, $T = 1.386\ RC$ and $f = \frac{1}{T} = \frac{1}{1.386\ RC}$

Applications of Astable Multivibrator

- The astable multivibrator is used as square wave generator, voltage to frequency convertor and in pulse synchronisation, as clock for binary logic signals, and so on.
- Since it produces square waves, it is a source of production of harmonic frequencies of higher order.
- It is used in the construction of digital voltmeter and SMPS.
- It can be operated as an oscillator over a wide range of audio and radio frequencies.

Emitter Coupled Astable Multivibrator



Assessment 1

If an astable multivibrator has $C_1 = C_2 = 1000$ pF and $R_1 = R_2 = 20$ kΩ, calculate the frequency of oscillation.

Solution The frequency of a symmetrical astable multivibrator is

$$f = \frac{1}{1.386\,RC} = \frac{1}{1.386 \times 20 \times 10^3 \times 1000 \times 10^{-12}} = 36.25 \text{ kHz}$$

Assessment 2

Determine the period and frequency of oscillation for an astable multivibrator with component values $R_1 = 2\ \text{k}\Omega$, $R_2 = 10\ \text{k}\Omega$, $C_1 = 0.01\ \mu\text{F}$ and $C_2 = 0.05\ \mu\text{F}$.

$$T = 0.693\,(R_1C_1 + R_2C_2)$$
$$= 0.693\,(2 \times 10^3 \times 0.01 \times 10^{-6} + 10 \times 10^3 \times 0.05 \times 10^{-6})$$
$$= 360.36\ \mu\text{s}$$

Therefore, the frequency of oscillation, $f = \frac{1}{T} = \frac{1}{360.36 \times 10^{-6}} = 2.775\ \text{kHz}$

References

Electronic Devices and Circuits By Salivahanan

Thank You