Wave Shaping Circuits

Sawtooth Generator

AET 11

Courtesy of the United States Air Force

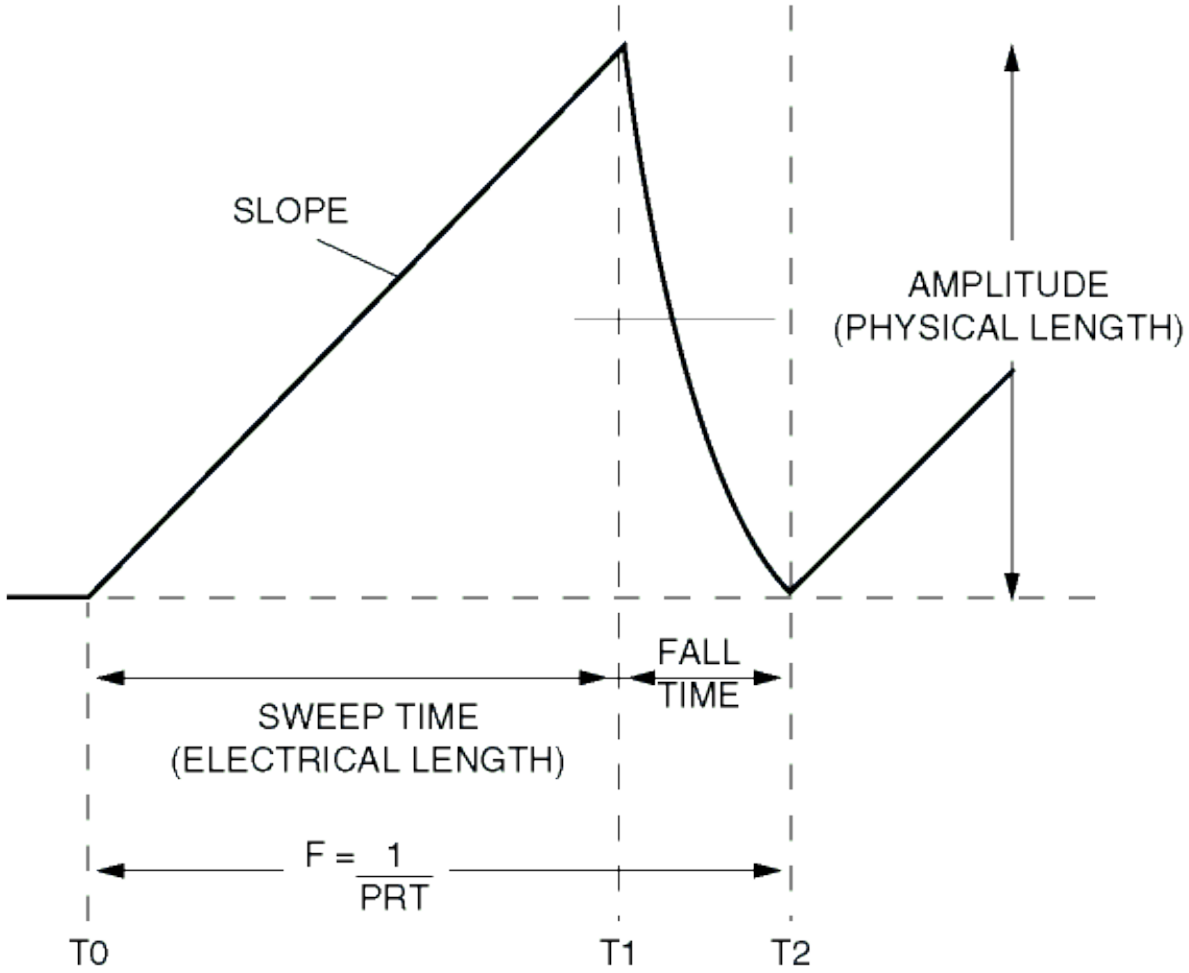
3c. Identify Sawtooth Generator Operating Principles

SAWTOOTH

- PURPOSE – To produce a sawtooth waveform. One input cycle will produce one output cycle.
- Also known as sweep, time/base, time/division, seconds/division, or ramp generator.
- This circuit is considered a relaxation oscillator.

Parts of sawtooth waveform

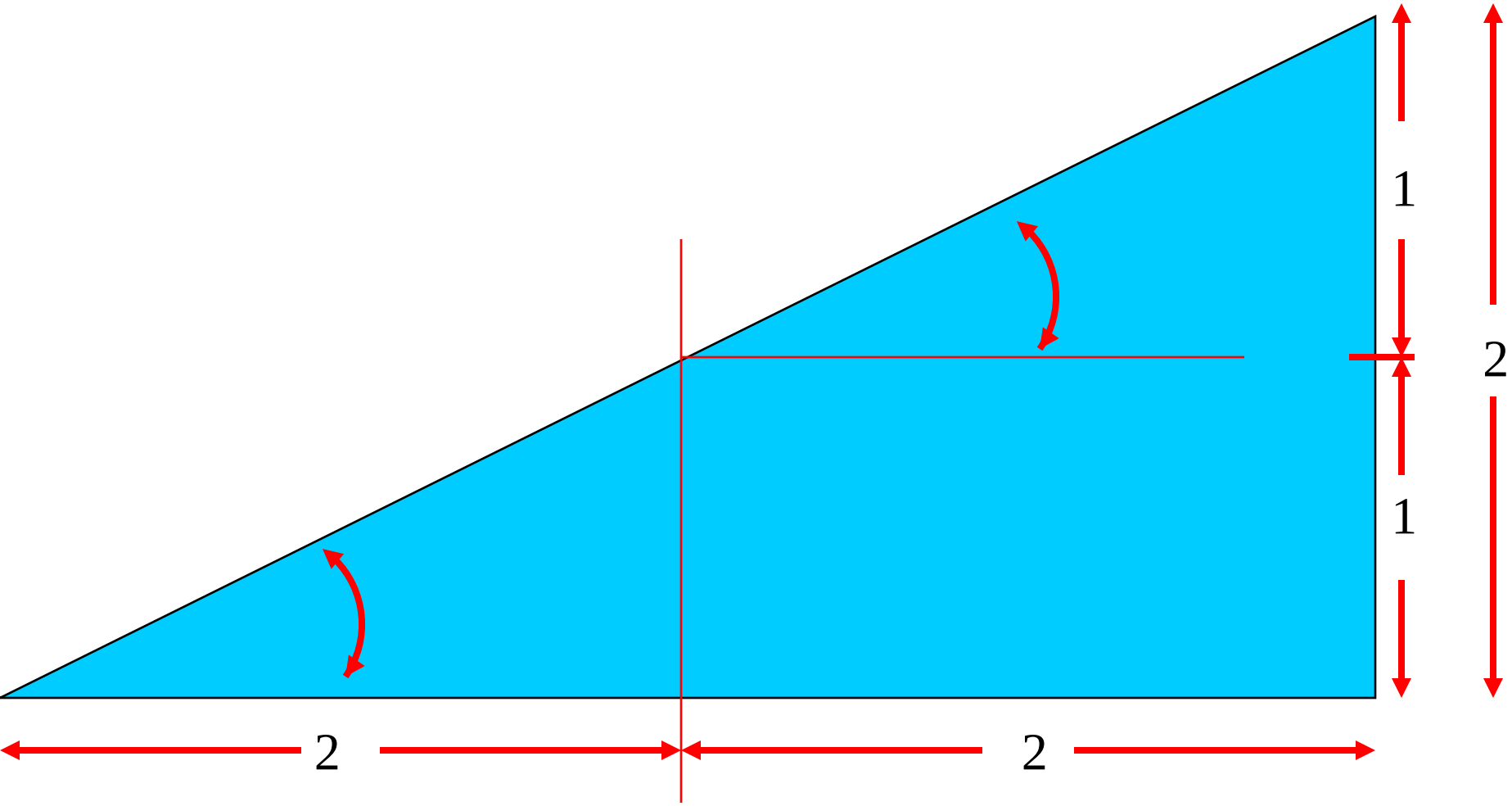
- Sweep time/electrical length
  (Time allowed to charge)
- Rest or flyback time (Discharge Time)
- Physical length (Amplitude)
- Slope (Rate of rise/percent of curve)
- PRT
- PRF



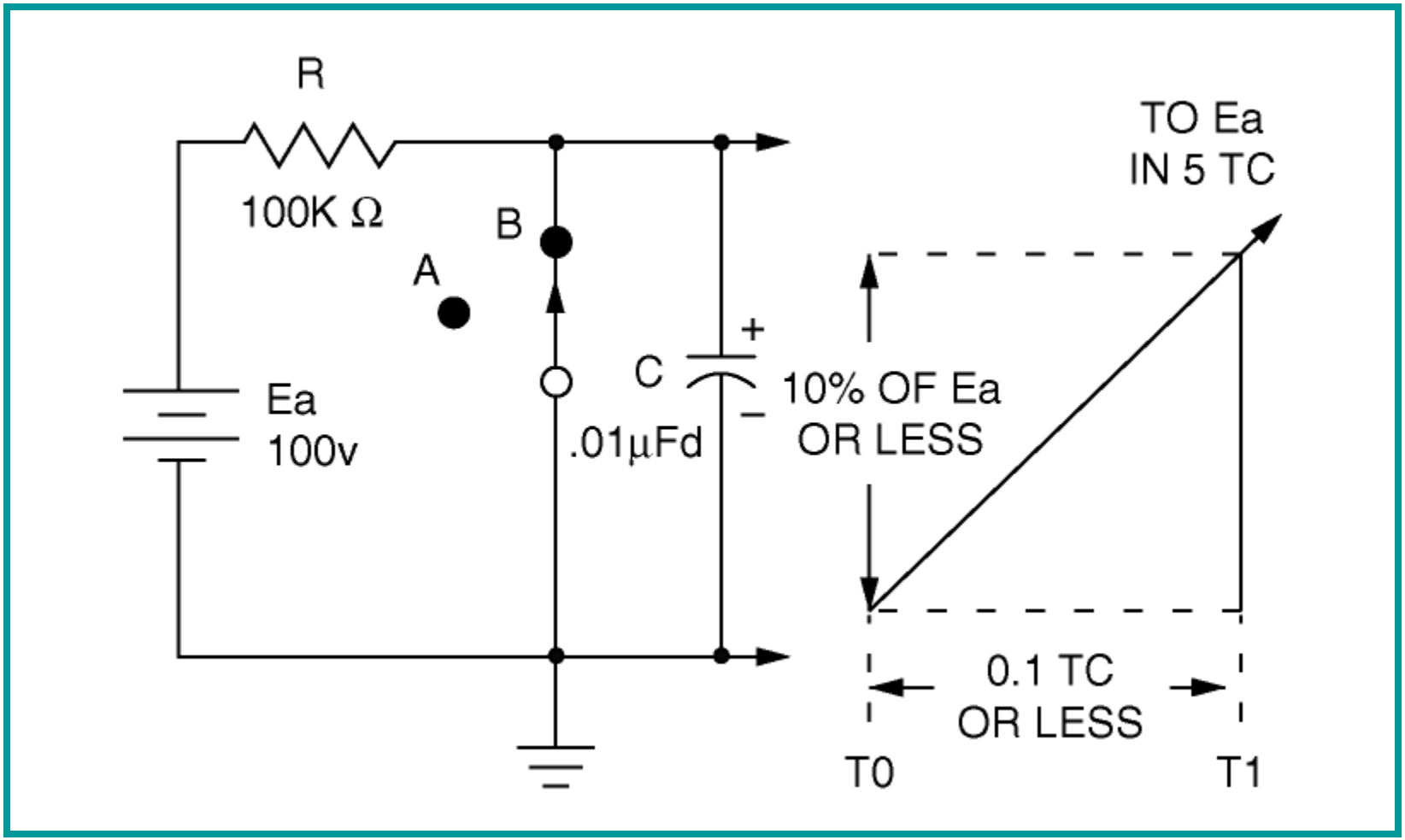
Sawtooth Waveform

The Sawtooth Generator, produces a waveform that will have a linear rise characteristic. RISE over RUN

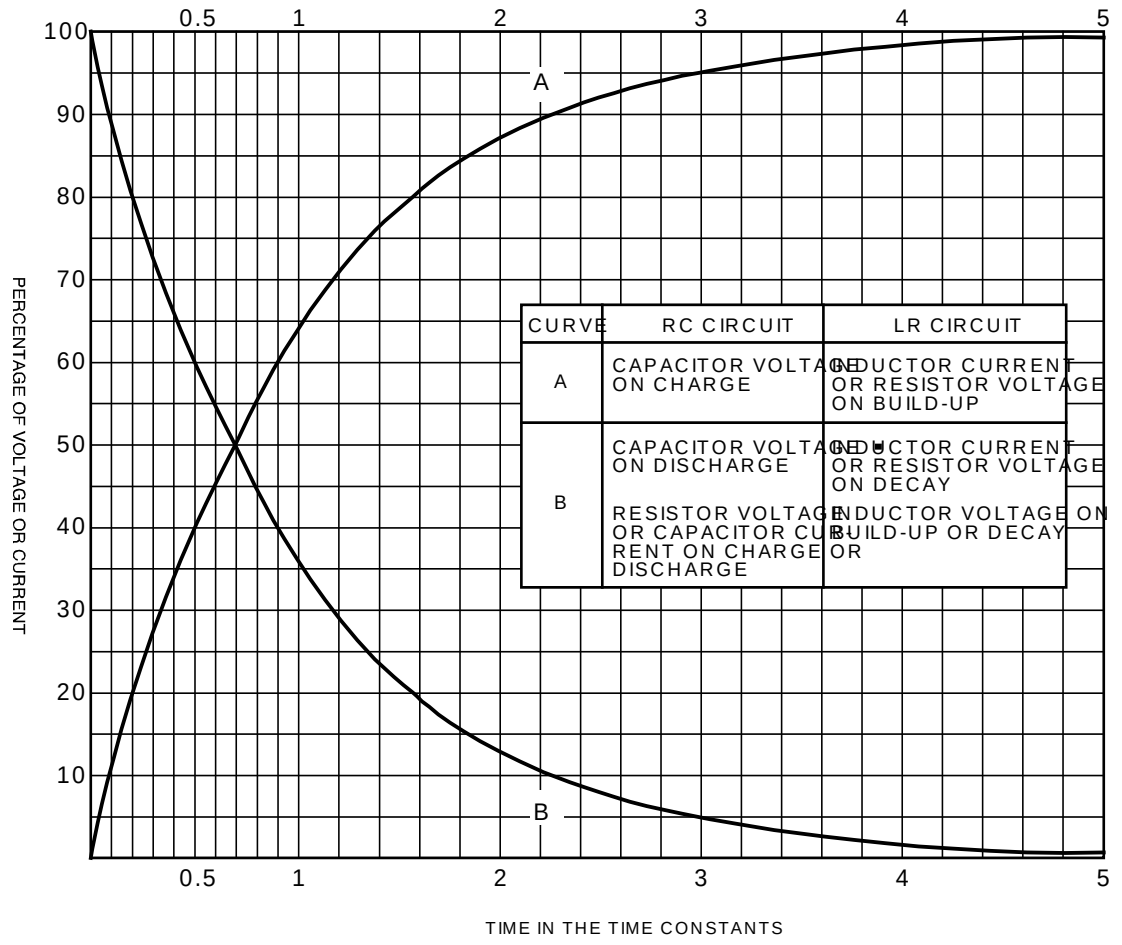
SLOPE



Simple Sawtooth Circuit



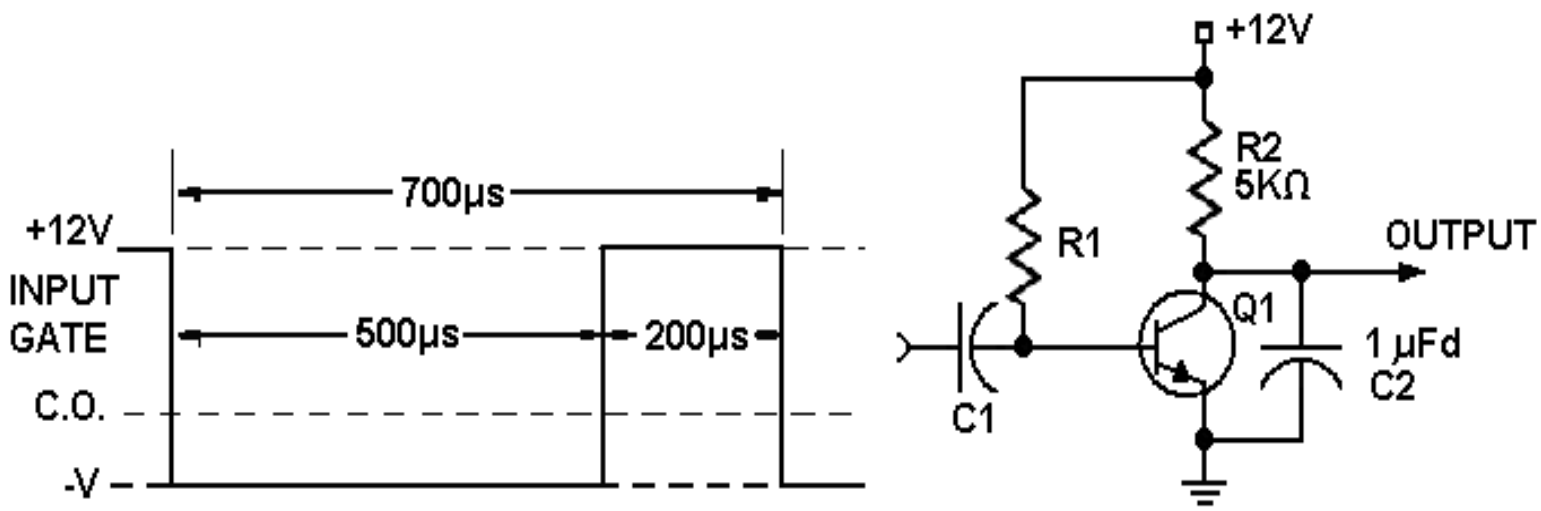
Universal Time Constant Chart



CURVE	RC CIRCUIT	LR CIRCUIT
A	CAPACITOR VOLTAGE ON CHARGE	INDUCTOR CURRENT OR RESISTOR VOLTAGE ON BUILD-UP
B	CAPACITOR VOLTAGE ON DISCHARGE RESISTOR VOLTAGE OR CAPACITOR CURRENT ON CHARGE OR DISCHARGE	INDUCTOR CURRENT OR RESISTOR VOLTAGE ON DECAY INDUCTOR VOLTAGE ON BUILD-UP OR DECAY OR

Referring to the Universal Time Constant Chart, you will find that the most linear part of the curve is the first 10% of the first time constant.

Sawtooth Generator

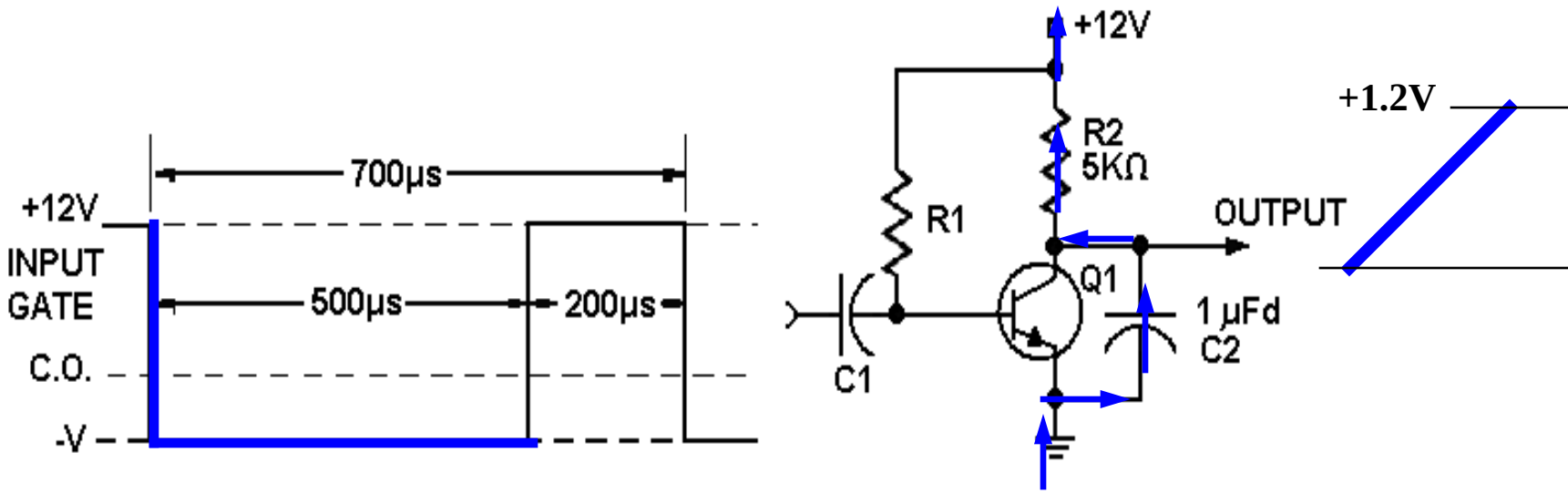


Purpose of Components

- R1 – Provides forward bias for Q1.
- C1 – Input signal coupling capacitor
- Q1 – Serves as charge and discharge switch for the RC network consisting of R2 and C2.
- R2/C2 – RC network that produces the slope/ramp portion of the output wave.

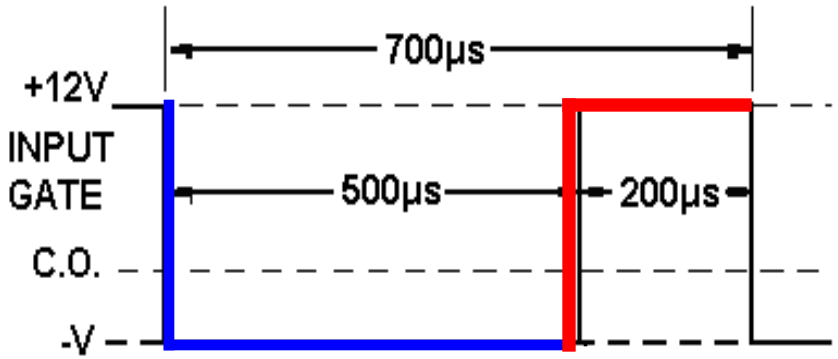
Sawtooth Generator Operation

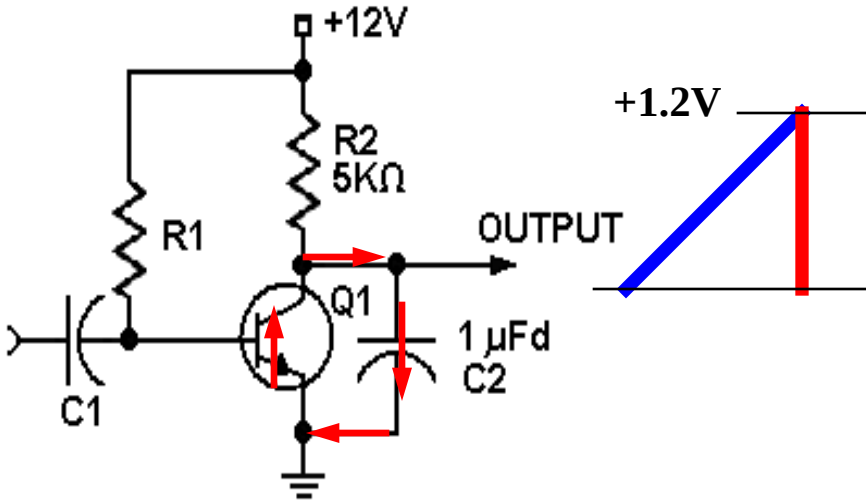
C2 charges through R2 developing the output slope when Q1 is cutoff by the negative gate.



Sawtooth Generator Operation

C2 discharges through Q1 when Q1 is saturated (conducting) by the positive gate and this is the flyback time.



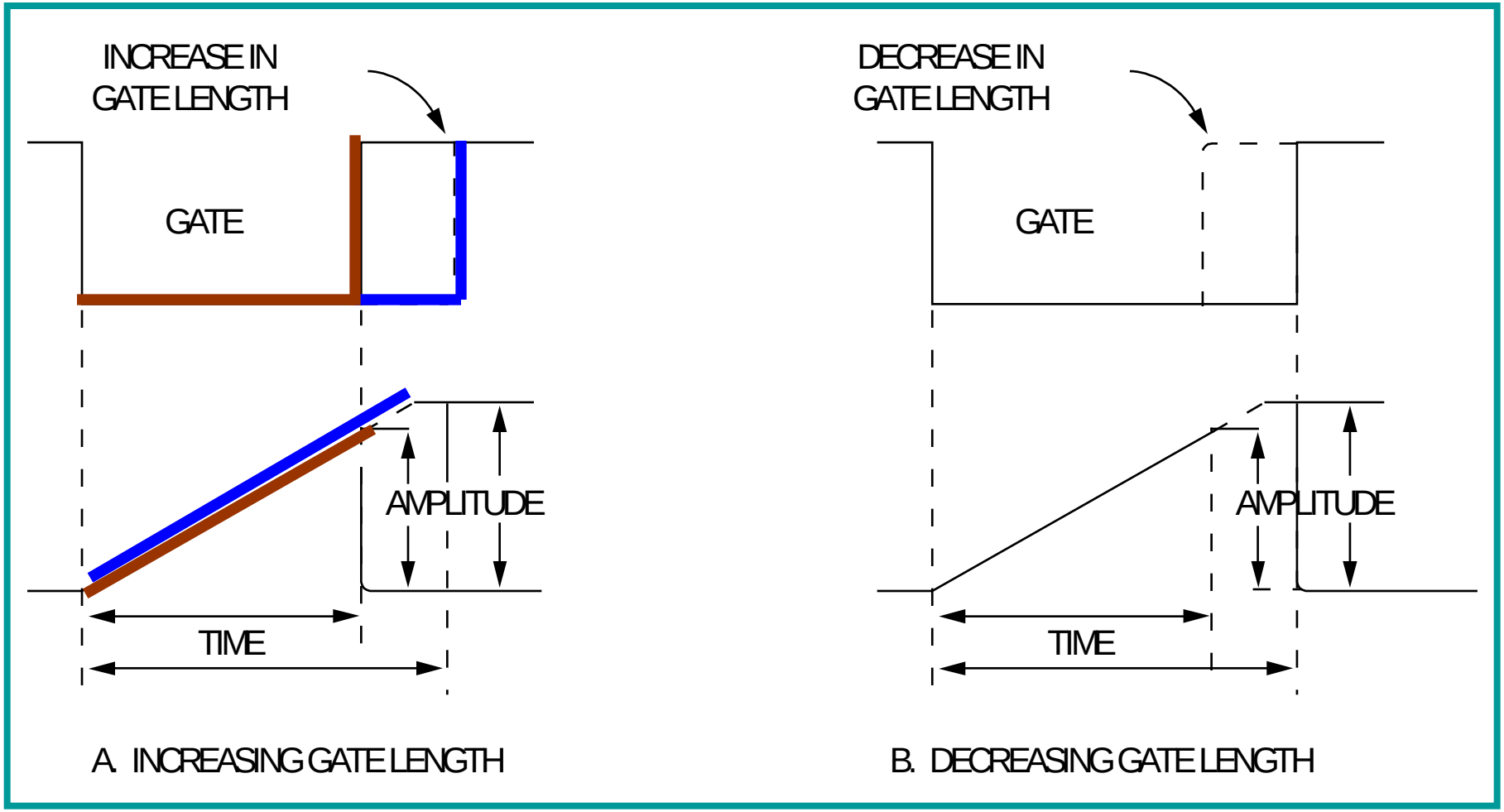


Relationships

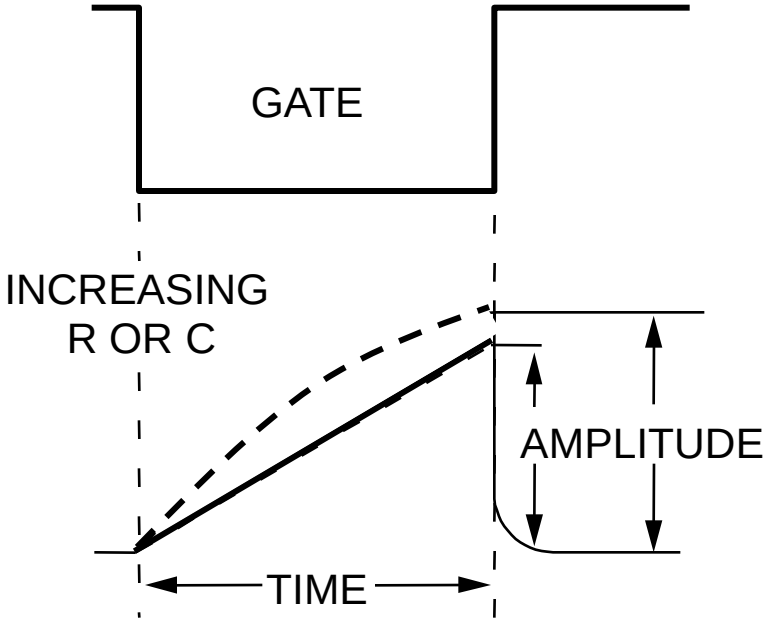
$$Amplitude = \frac{NegativeGateLength}{RC}$$

$$Linearity = \frac{RC}{NegativeGateLength}$$

Gate Length – Linearity Relationship

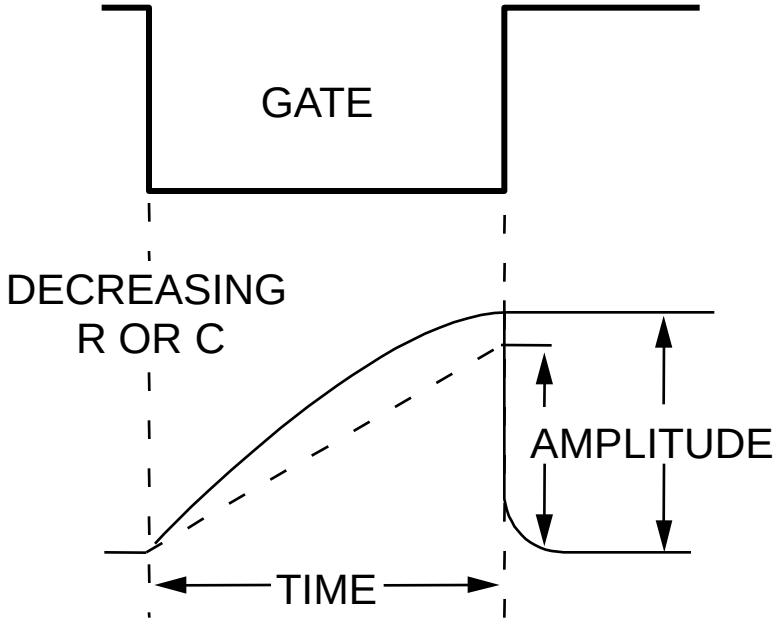


RC – Linearity Relationship



A. INCREASING R or C

Increases Linearity



B. DECREASING R or C

Decreases Linearity

Before **After**

Block 5

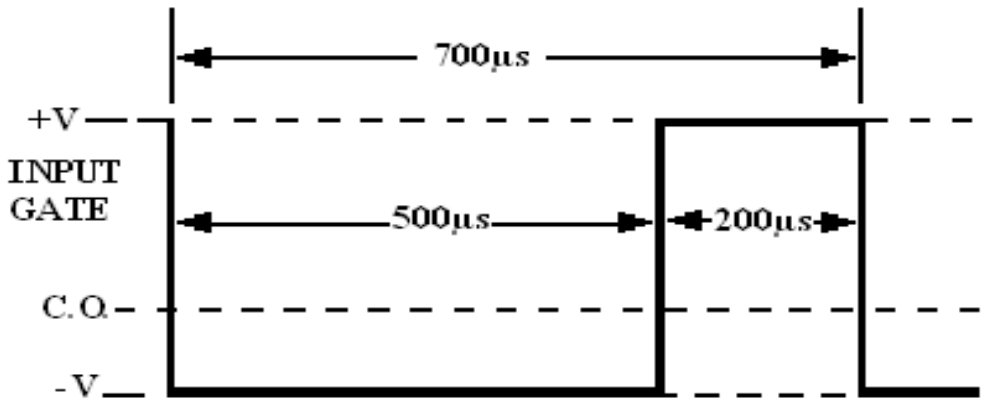
Summary 3c

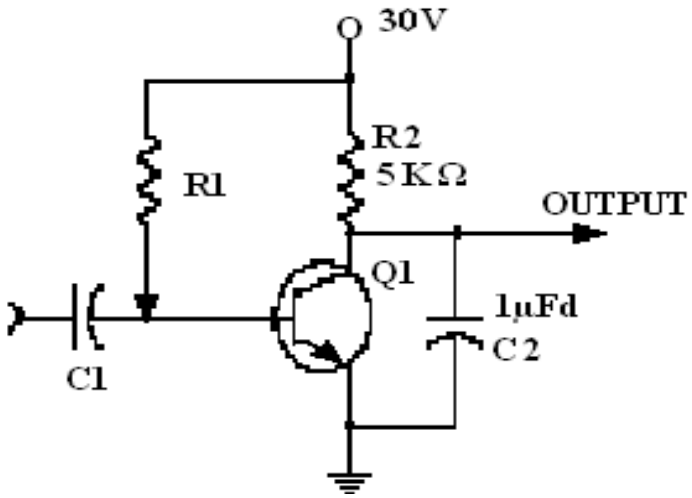
- Parts of the Waveform
- Sawtooth Generator components
- Circuit operation
- Parameter Changes

Sawtooth Generator

Appraisal

Sawtooth Generator



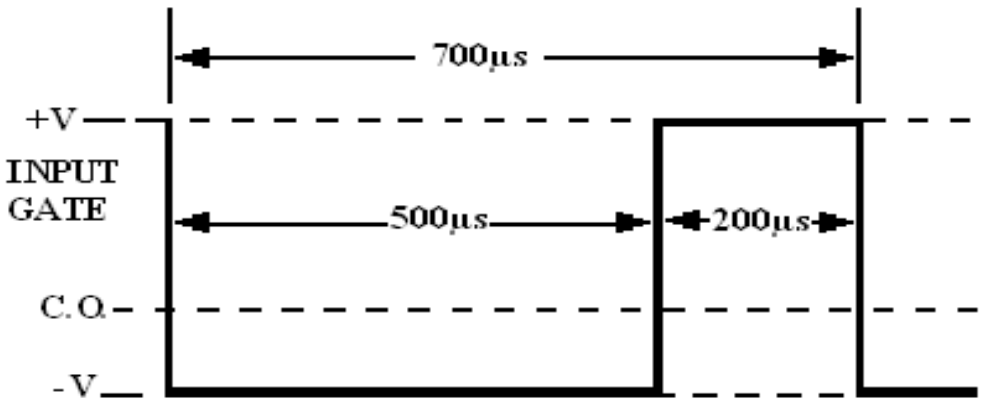


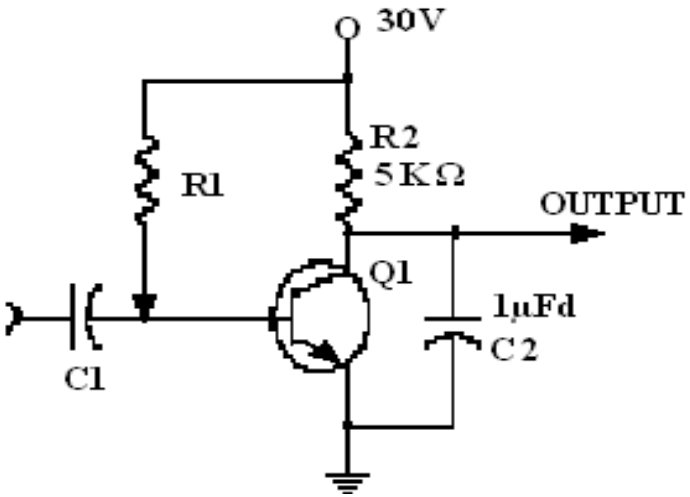
1. In the sawtooth generator circuit, a positive gate applied to the base of Q1 will _____ C2.

a. charge

b. discharge

Sawtooth Generator





2. In the sawtooth generator circuit, the rate of voltage change across capacitor C2 is almost linear during the first _____ of the capacitor charge time.

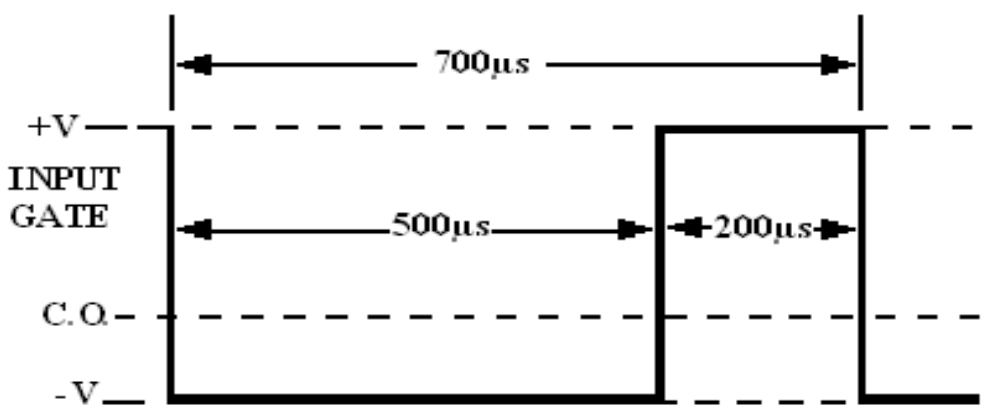
a. 1%

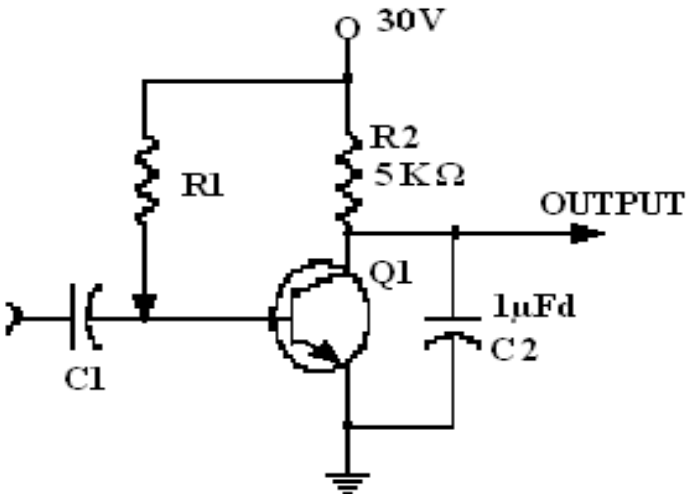
b. 5%

c. 10%

d. 20%

Sawtooth Generator





3. The linearity of the sawtooth waveform is controlled by

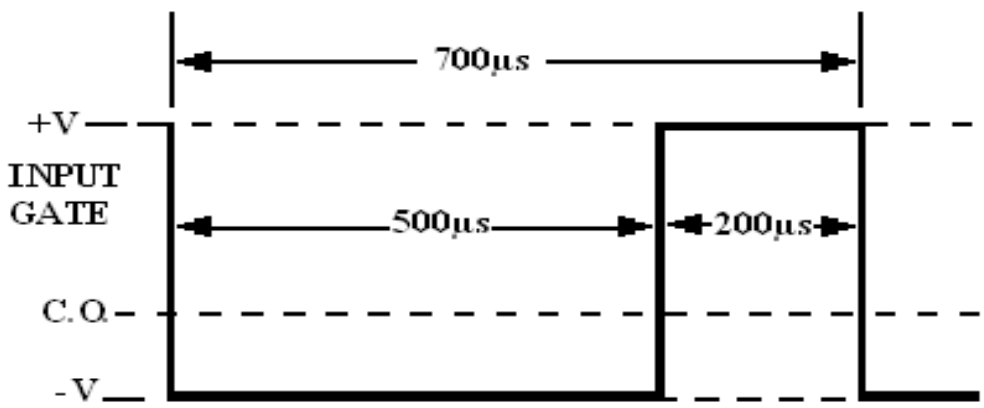
a. R2

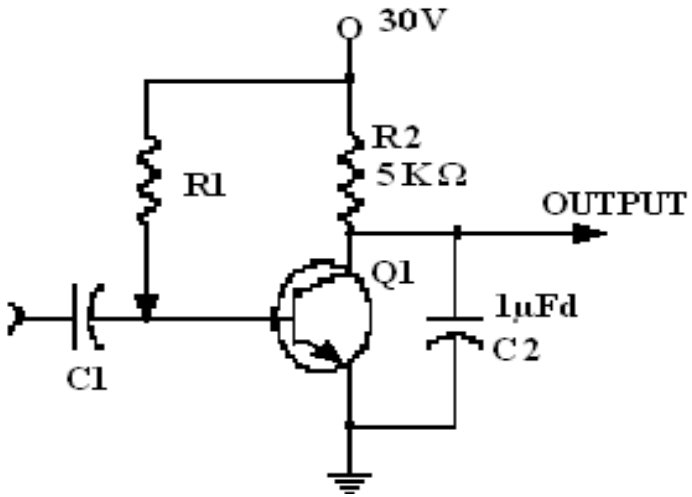
b. C2

c. negative input gate duration

d. all of the above

Sawtooth Generator





4. A negative gate applied to the base of Q1 will _____ Q1 and allow C2 to _____ through R2.

a. cutoff; charge

b. cutoff; discharge

c. saturate; charge

d. saturate; discharge

Appraisal Answers

1. **B**
2. **C**
3. **D**
4. **A**