BENHA UNIVERSITY
FACULTY OF ENGINEERING AT SHOUBRA

ECE-322
Electronic Circuits (B)

Lecture #6
Signals Generators

Instructor:
Dr. Ahmad El-Banna

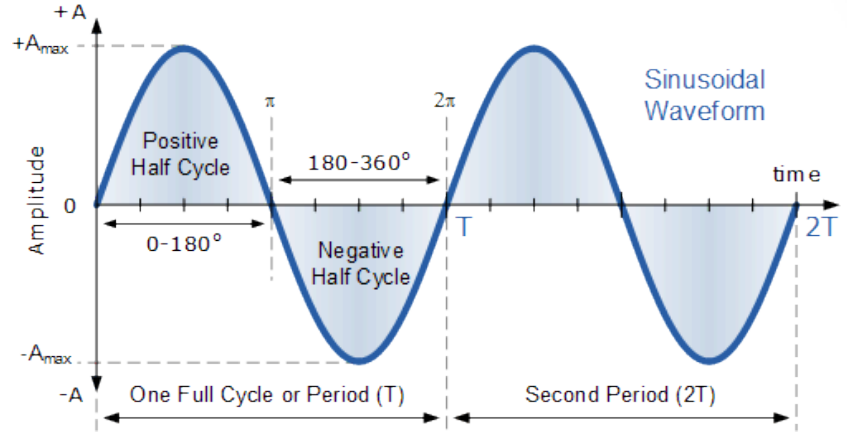
SPRING 2015

Agenda

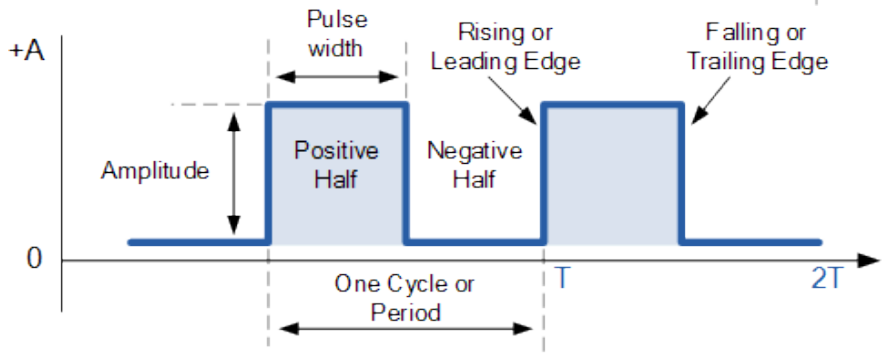
- Basic Signals Waveforms
- Feedback Oscillators
- Relaxation Oscillators
- Examples of Simple Function Generators

BASIC SIGNALS WAVEFORMS

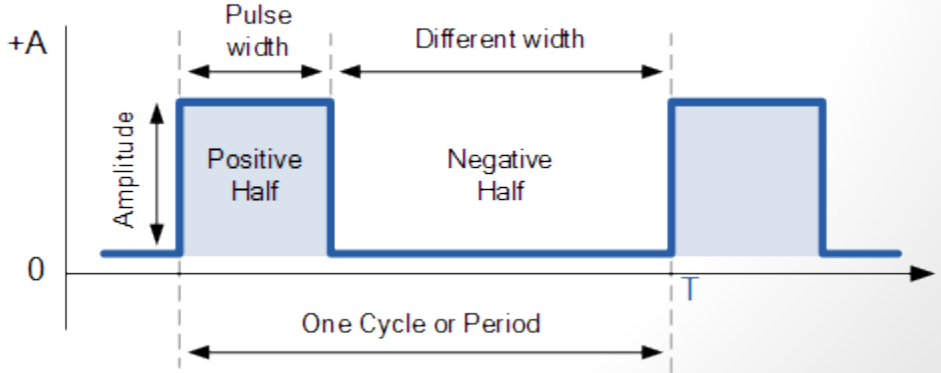
Signals Waveforms



- Sine Wave Waveform

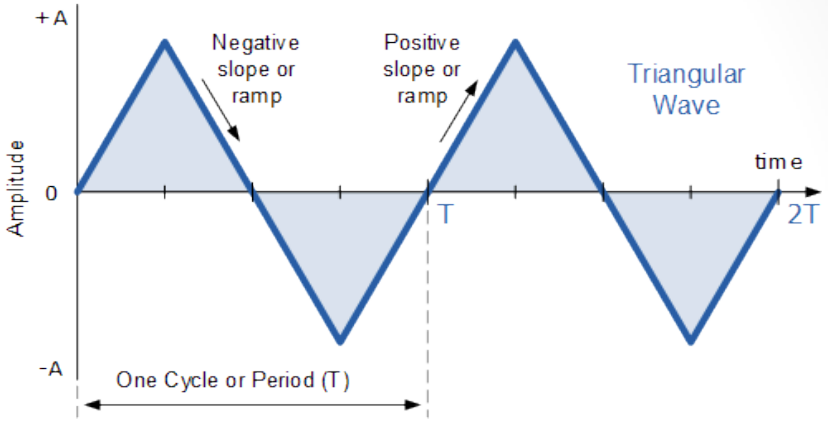


- Square Wave Waveform

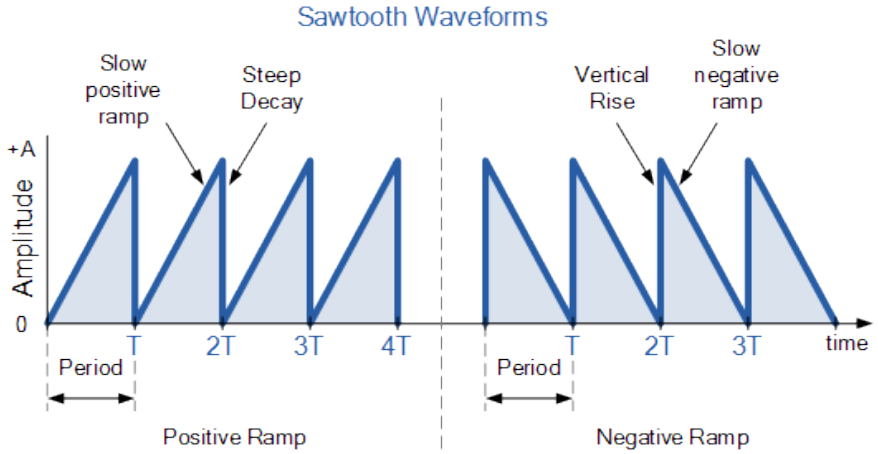


- Rectangular Waveforms

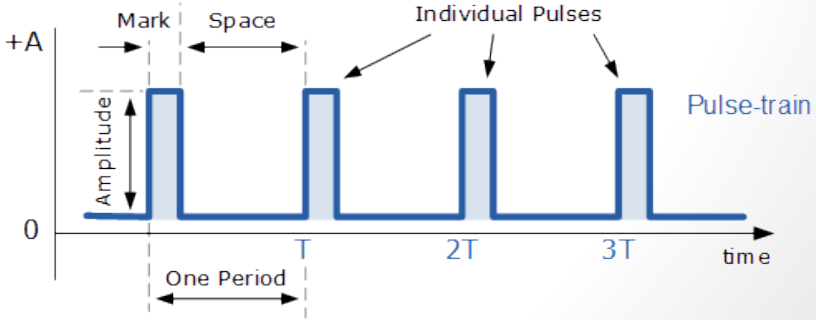
Signals Waveforms..



- Triangular Waveform



- Sawtooth Waveforms



- Pulse Waveform

FEEDBACK OSCILLATORS

Feedback Oscillators

- It's the 1st major category of oscillators.
- It returns a fraction of the output signal to the input with no net phase shift, resulting in a reinforcement of the output signal.

- Feedback / Harmonic / Sinusoidal
- RC , LC & Crystal

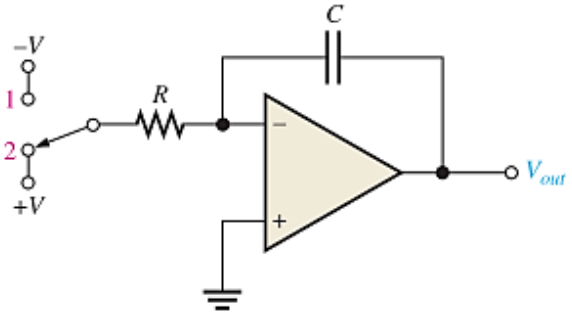
- They were covered last semester
- Find details at:
  - Chapter 16, T. Floyd, **Electronic Devices**, 9th edition.

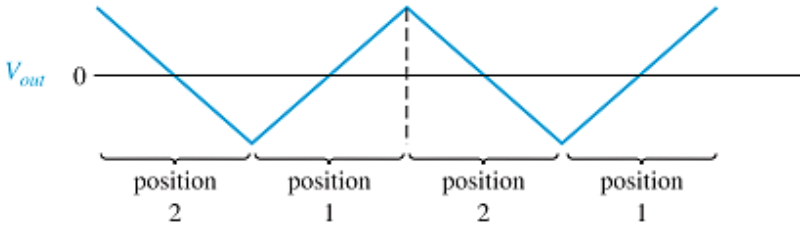
RELAXATION OSCILLATORS

- The **second** major **category** of oscillators is the relaxation oscillator.
- Relaxation oscillators use an **RC timing circuit** and a device typically a **Schmitt trigger** or other device that **changes states** to alternately charge and discharge a capacitor through a resistor to generate a periodic waveform.

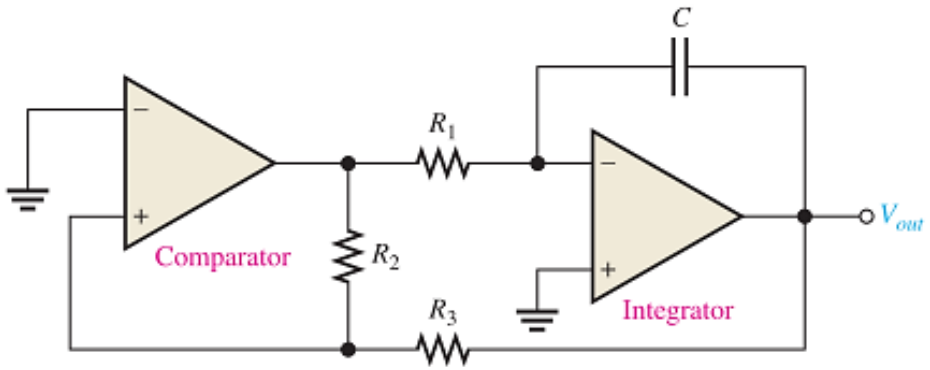
Triangular-Wave Oscillator

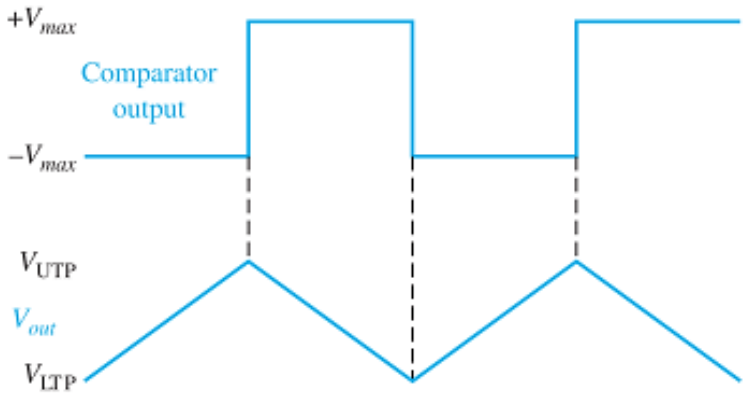
- **Basic triangular-wave oscillator**





- **Practical Triangular-Wave Oscillator**





$$V_{UTP} = +V_{max}\left(\frac{R_3}{R_2}\right)$$

$$V_{LTP} = -V_{max}\left(\frac{R_3}{R_2}\right)$$

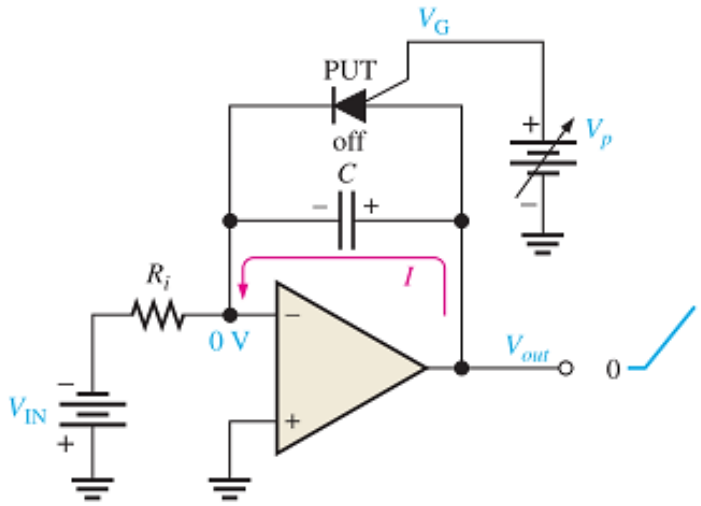
$$f_r = \frac{1}{4R_1C}\left(\frac{R_2}{R_3}\right)$$

Triangular & Square waveforms
→ Function Generator

Sawtooth Voltage-Controlled Oscillator (VCO)

- VCO is a relaxation oscillator whose frequency can be changed by a variable dc control voltage.
- VCOs can be either sinusoidal or nonsinusoidal.
- One way to build a sawtooth VCO is with an op-amp integrator that uses a switching device (PUT) in parallel with the feedback capacitor to terminate each ramp at a prescribed level and effectively "reset" the circuit.
- The PUT is a programmable unijunction transistor with an anode, a cathode, and a gate terminal.

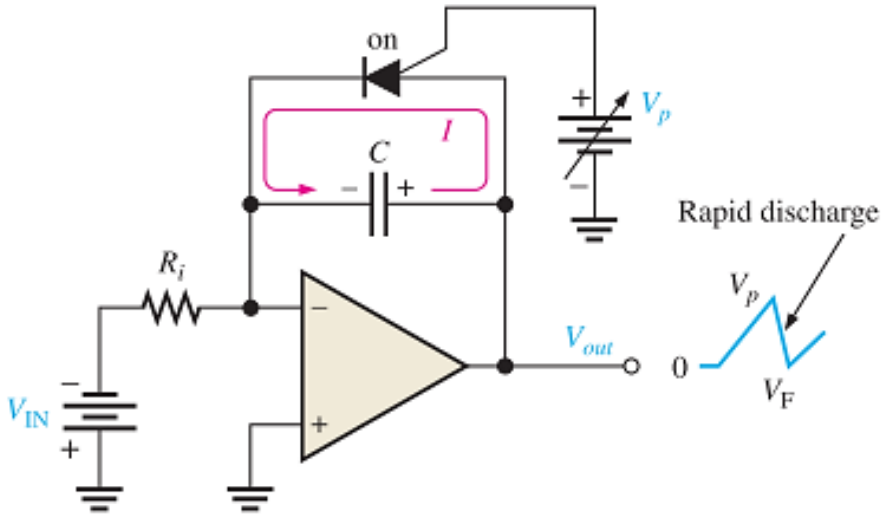
- Operation:



(a) Initially, the capacitor charges, the output ramp begins, and the PUT is off.

N.B.
For more details regarding PUT, refer to ch. 11

Sawtooth VCO..



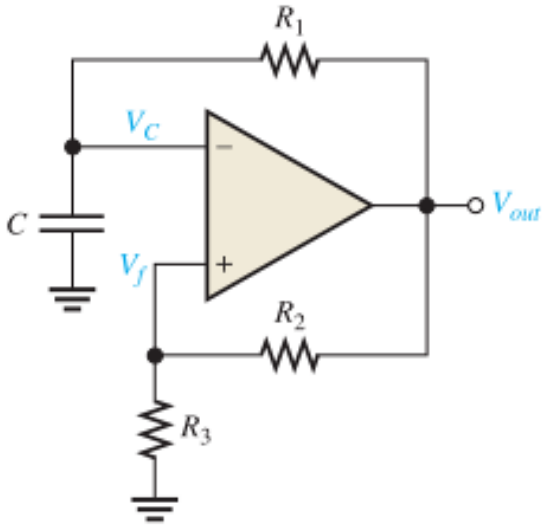
(b) The capacitor rapidly discharges when the PUT momentarily turns on.

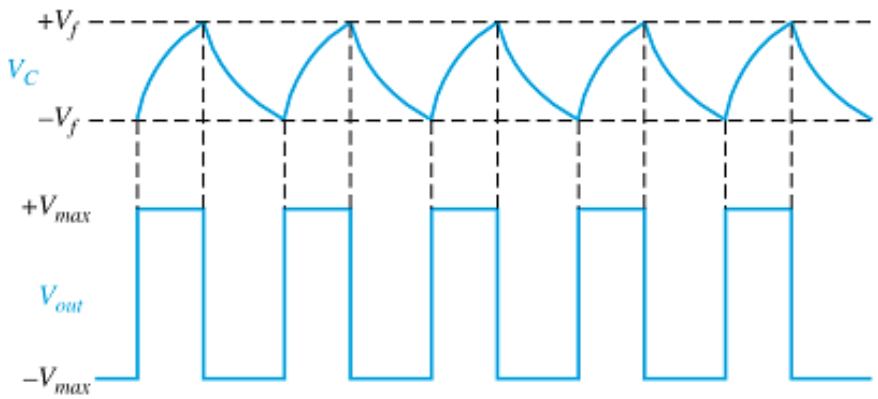
T, of the sawtooth waveform: $$T = \frac{V_p - V_F}{|V_{IN}|/R_iC}$$

f =1/T, gives $$f = \frac{|V_{IN}|}{R_iC}\left(\frac{1}{V_p - V_F}\right)$$

Square-wave Relaxation oscillator

- the op-amp's inverting input is the capacitor voltage and
- the noninverting input is a portion of the output fed back through resistors R_2, R_3 to provide hysteresis.

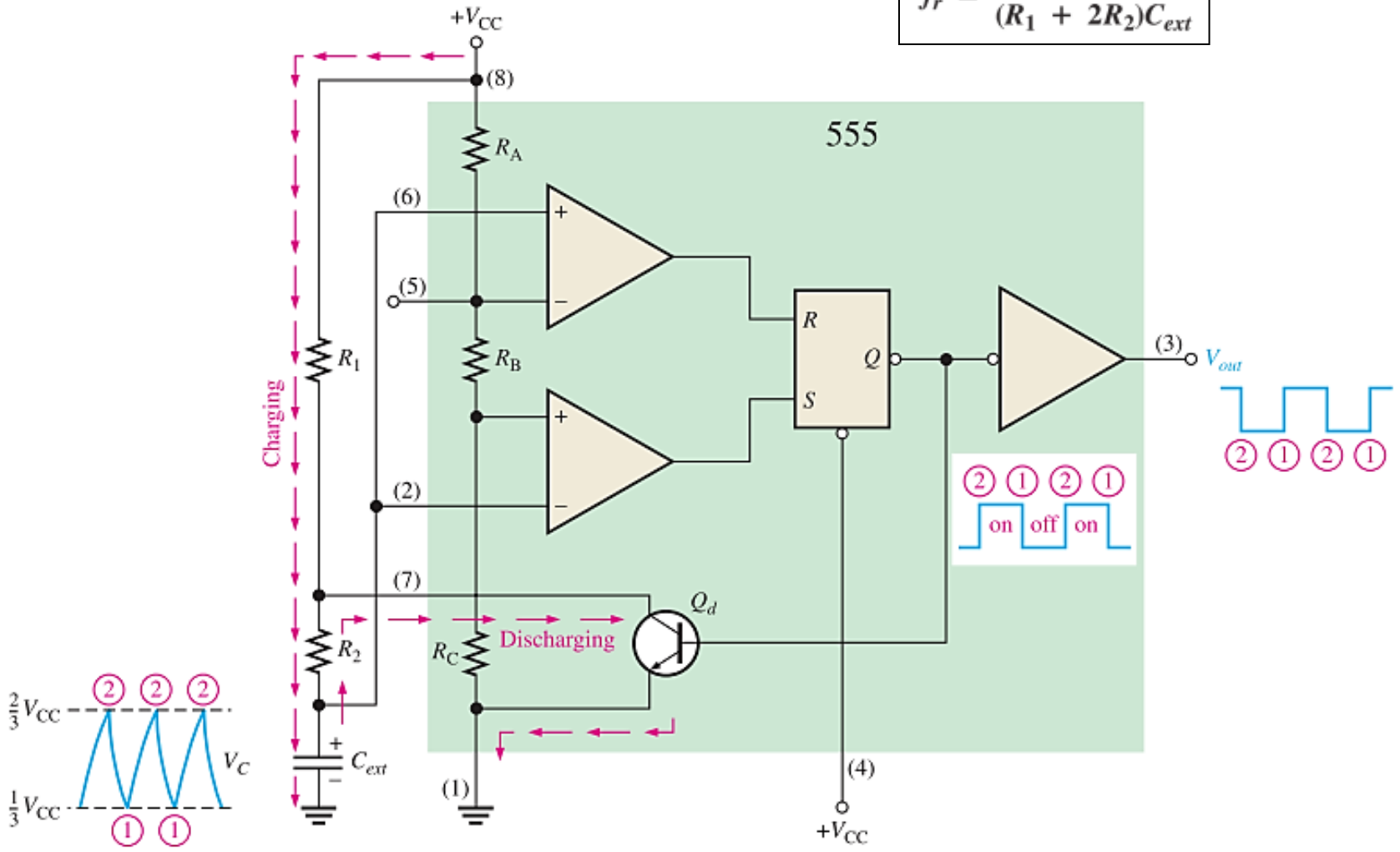




The 555 Timer as an Oscillator

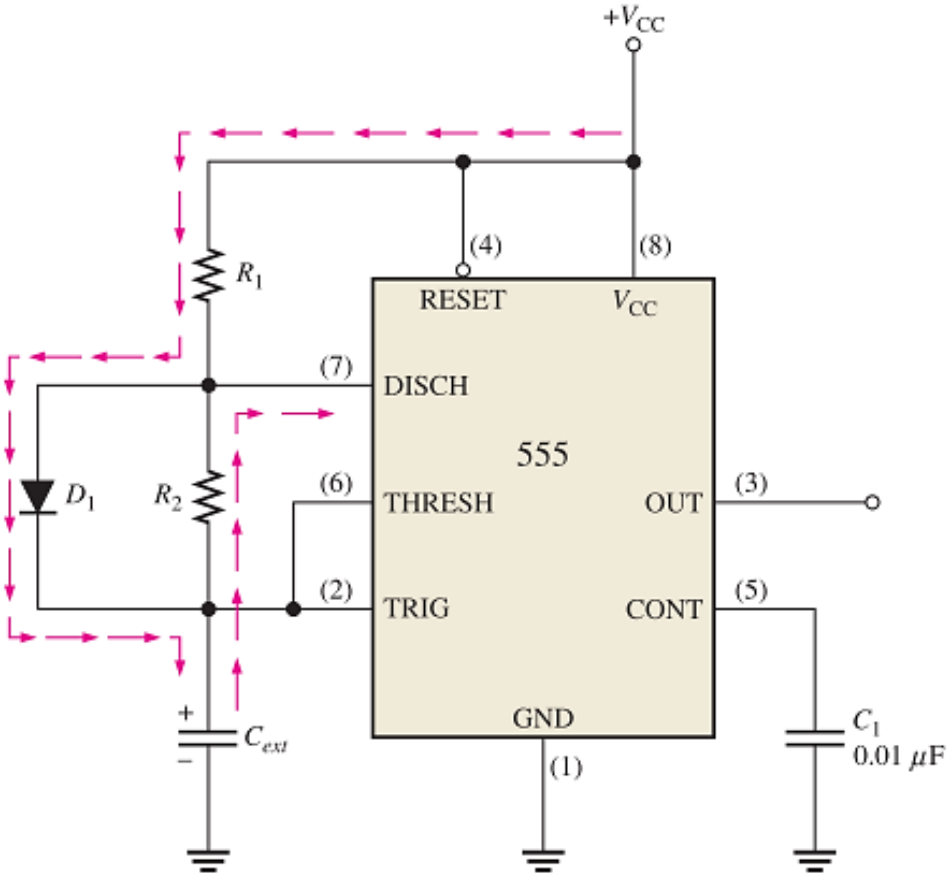
- **Astable Operation**

$$f_r = \frac{1.44}{(R_1 + 2R_2)C_{ext}}$$



555 Timer Oscillator ..

$$\text{Duty cycle} = \left(\frac{R_1 + R_2}{R_1 + 2R_2}\right)100\%$$



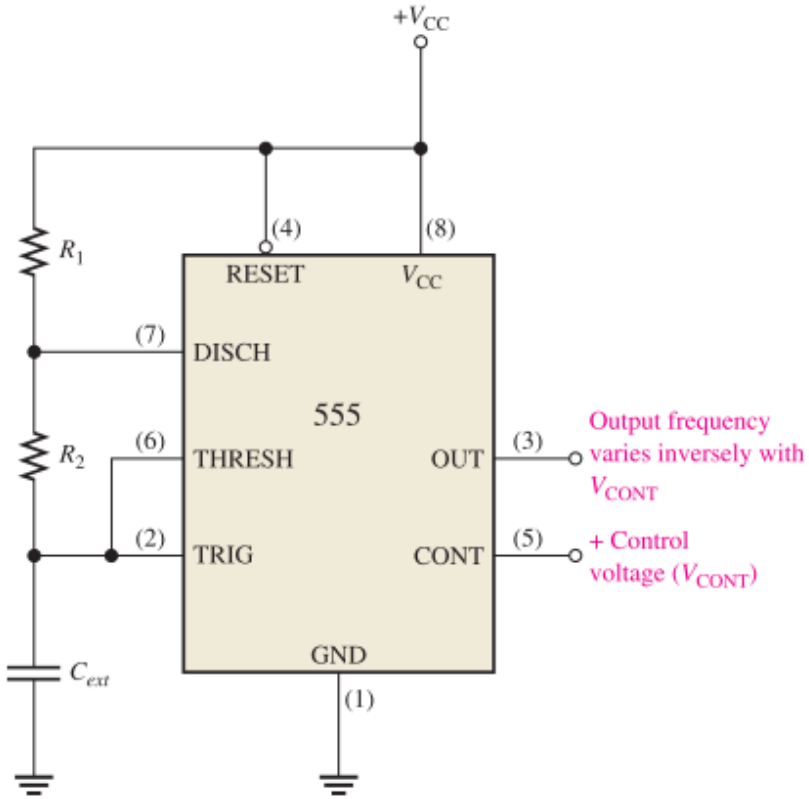
- **Using D1 :**

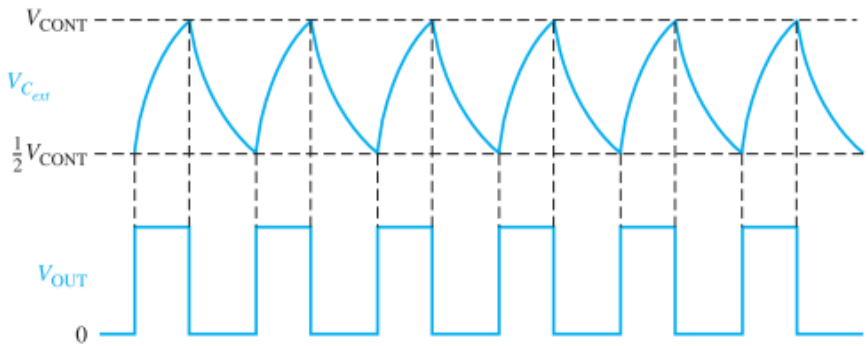
$$f_r \cong \frac{1.44}{(R_1 + R_2)\,C_{ext}}$$

$$\text{Duty cycle} \cong \left(\frac{R_1}{R_1 + R_2}\right)100\%$$

555 as VCO

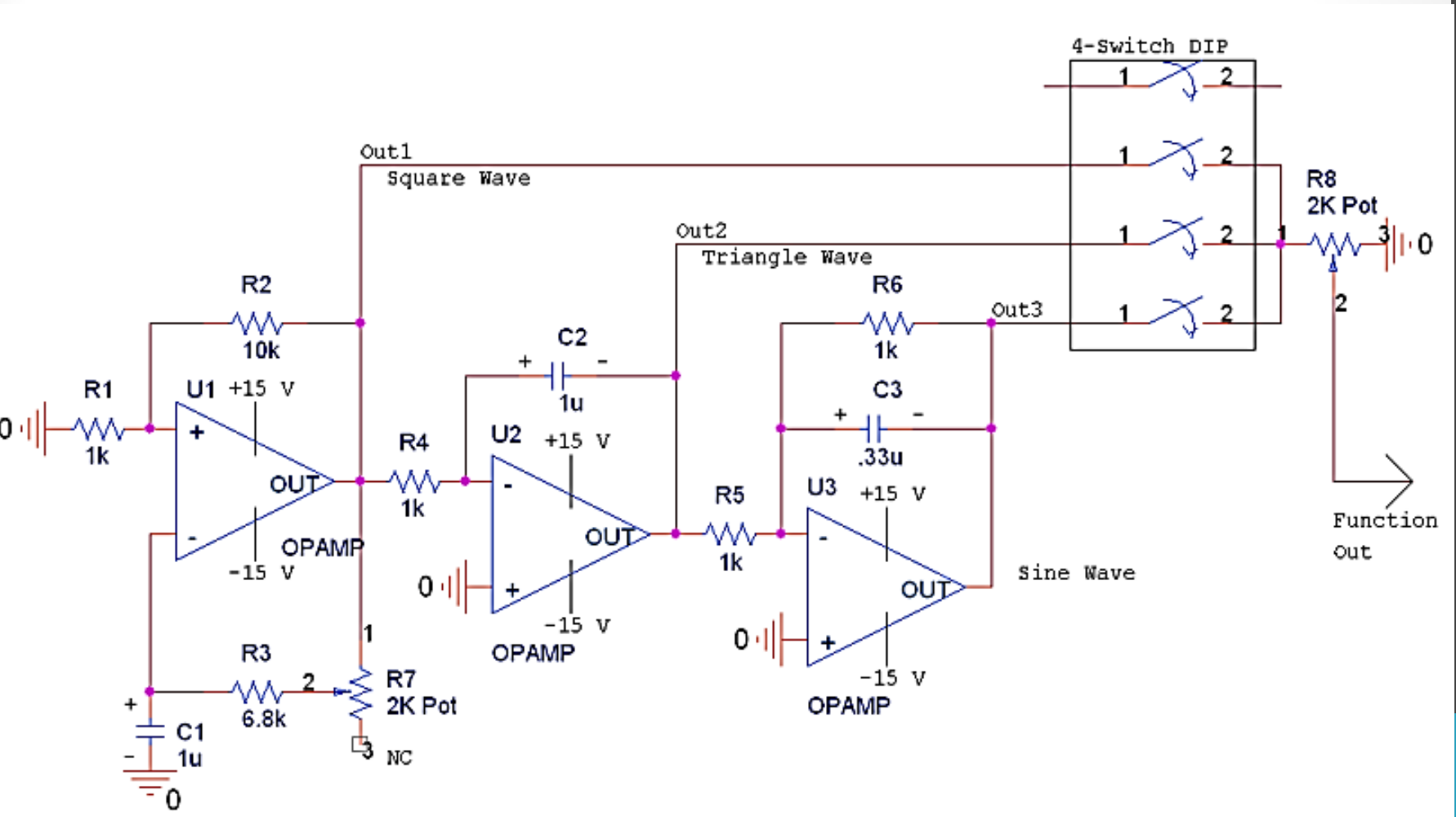
- a variable control voltage is applied to the CONT input (pin 5)



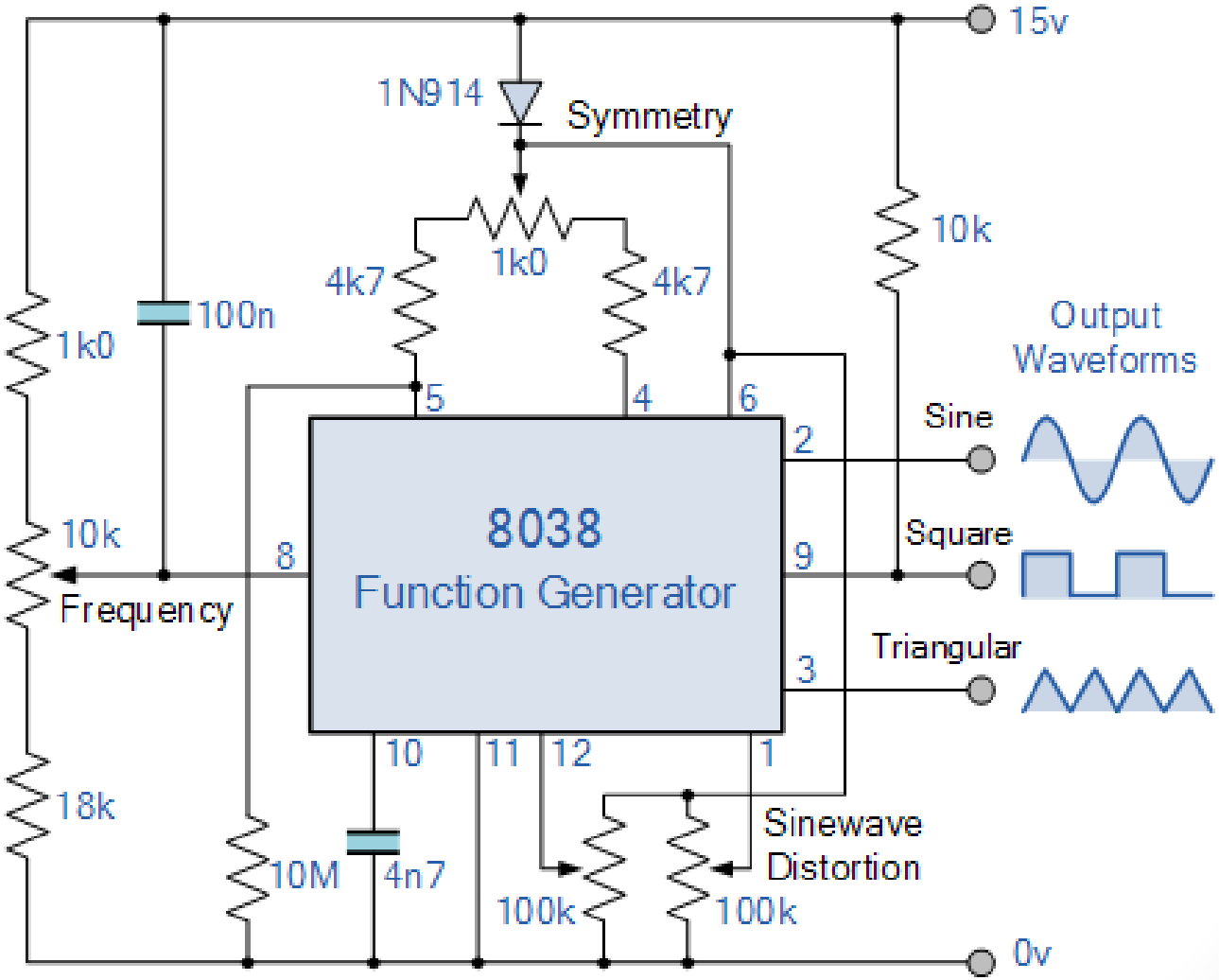


EXAMPLES OF SIMPLE FUNCTION GENERATORS

Waveform Generator, Discrete Circuit

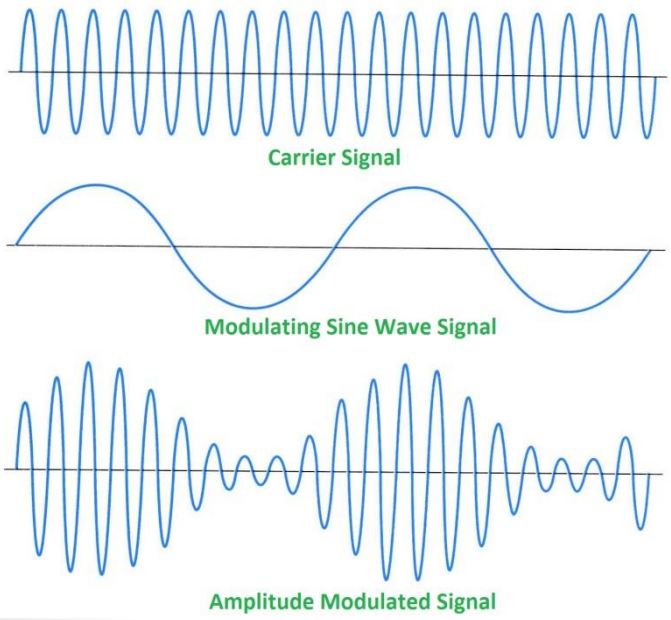


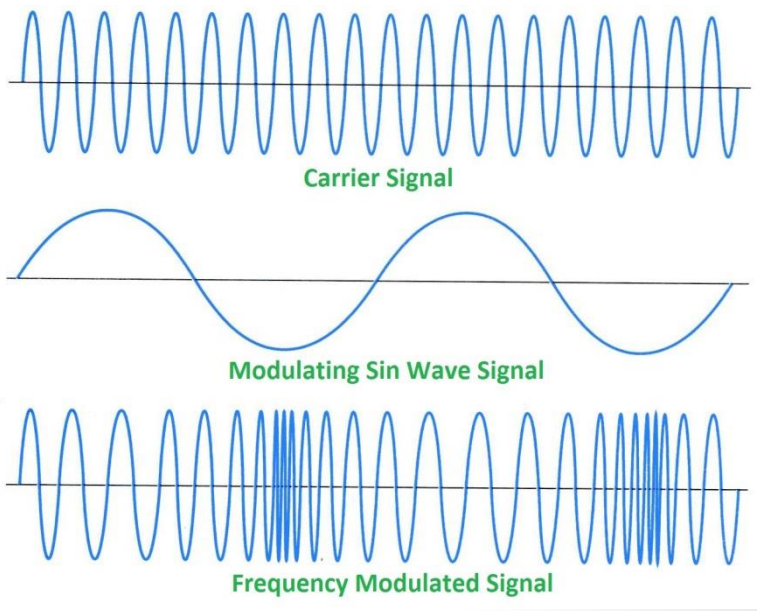
Waveform Generator IC



Project Delivery Time ..

- Be ready within 20 min @ Electronics laboratory …
- Each group has 5-8 mins to present his work.
- Lab entrance by packages
  - Each package consists of 3 groups.
- Any guidelines violation results in a minus in your mark !





- For more details, refer to:
  - Chapter 16, T. Floyd, **Electronic Devices**, 9th edition.
  - Online tutorial: Electrical Waveforms , http://www.electronics-tutorials.ws/waveforms/waveforms.html
- The lecture is available online at:
  - http://bu.edu.eg/staff/ahmad.elbanna-courses/12135
- For inquires, send to:
  - ahmad.elbanna@feng.bu.edu.eg