



FACULTY OF ENGINEERING  
DEPARTMENT OF ELECTRONICS AND COMMUNICATIONS

**GEE336**

**Electronic Circuits II**

Lecture #9

Function Generator & VCO

**Instructor:**

**Dr. Ahmad El-Banna**



# Agenda



Basic Signals Waveforms

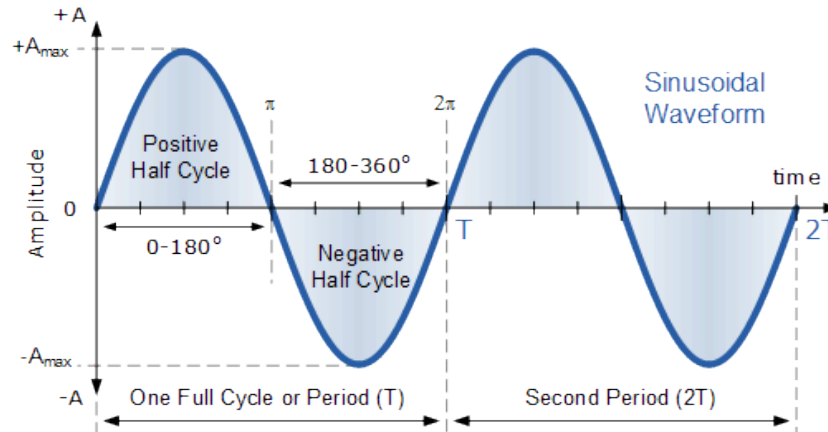
Function Generator

- Square, Triangular, ..

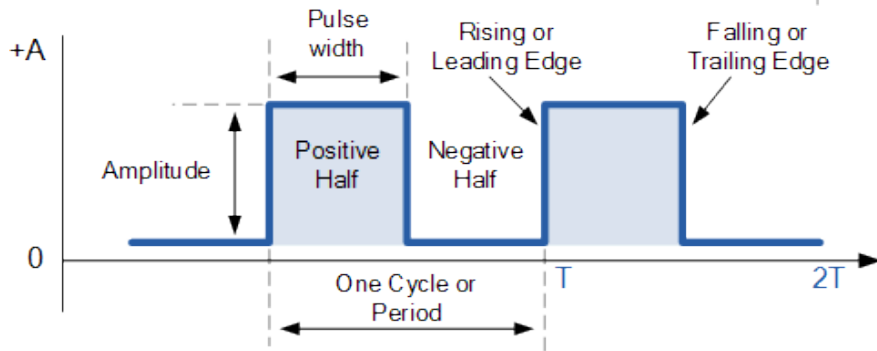
VCO

# BASIC SIGNALS WAVEFORMS

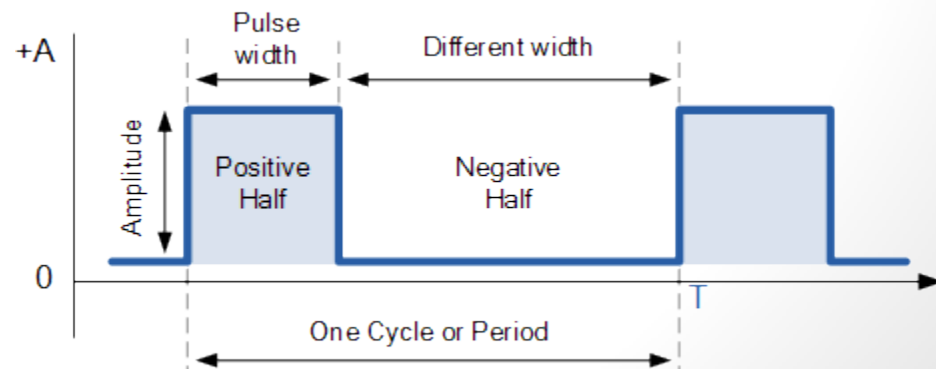
# Signals Waveforms



- Sine Wave Waveform

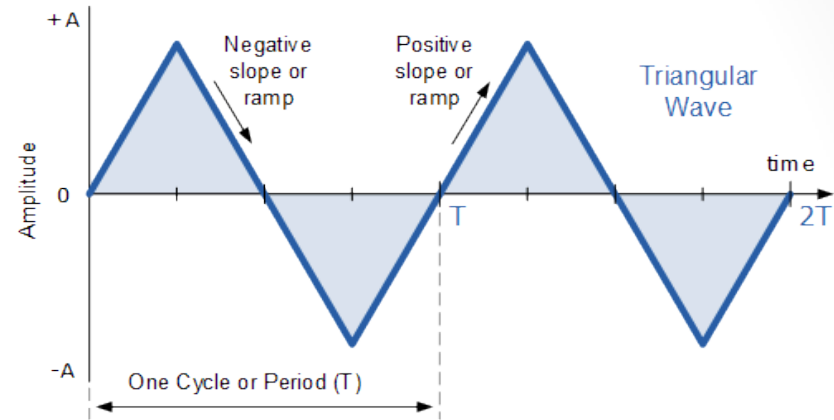


- Square Wave Waveform

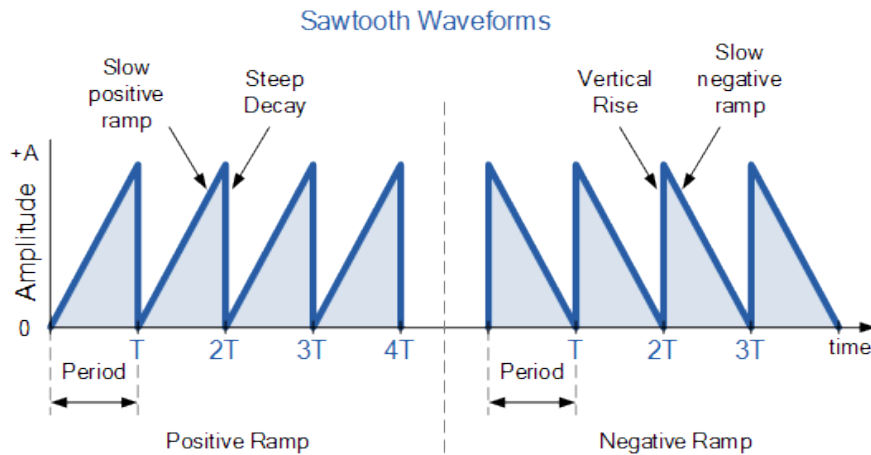


- Rectangular Waveforms

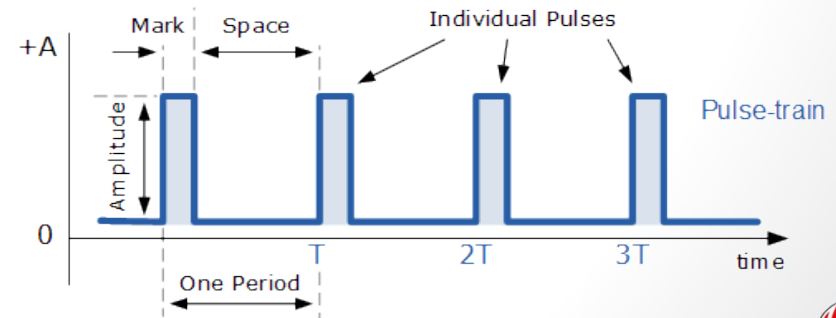
# Signals Waveforms..



- Triangular Waveform



- Sawtooth Waveforms



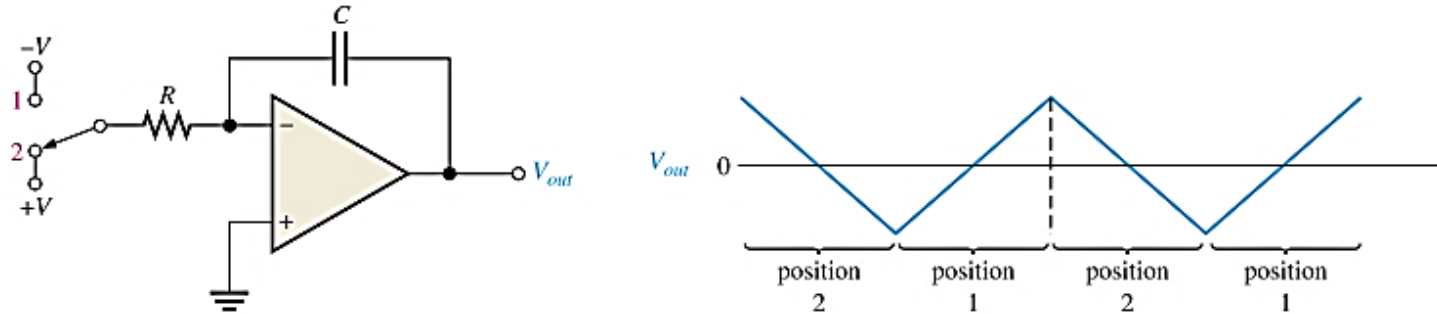
- Pulse Waveform

# Sinusoidal Oscillators

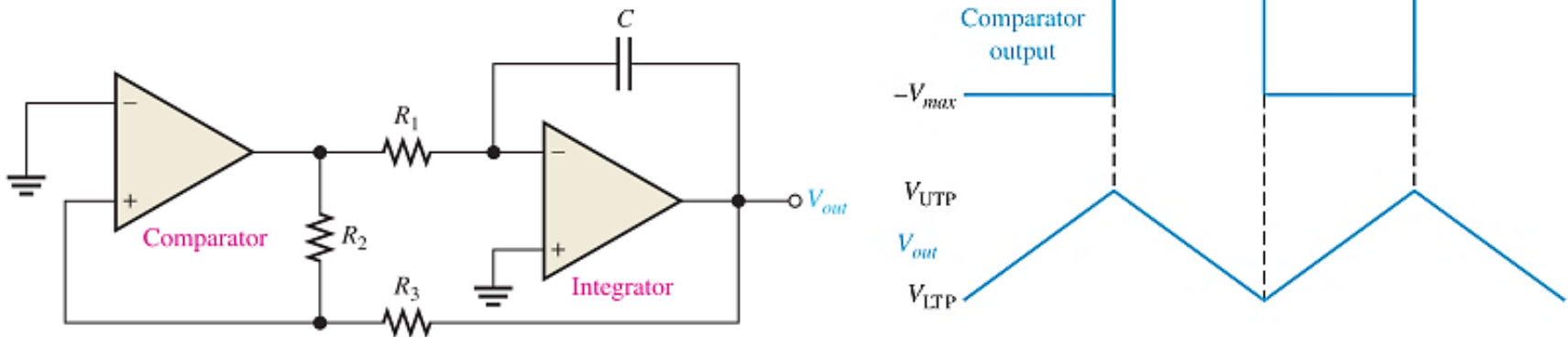
- It's the 1<sup>st</sup> major category of oscillators.
- It returns a fraction of the output signal to the input with no net phase shift, resulting in a reinforcement of the output signal.
- Feedback / Harmonic / Sinusoidal
- RC , LC & Crystal
- Find details at:
  - Chapter 16, T. Floyd, **Electronic Devices**, 9<sup>th</sup> edition.

# Triangular-Wave Oscillator

- Basic triangular-wave oscillator



- Practical Triangular-Wave Oscillator



Triangular & Square waveforms  
 → Function Generator

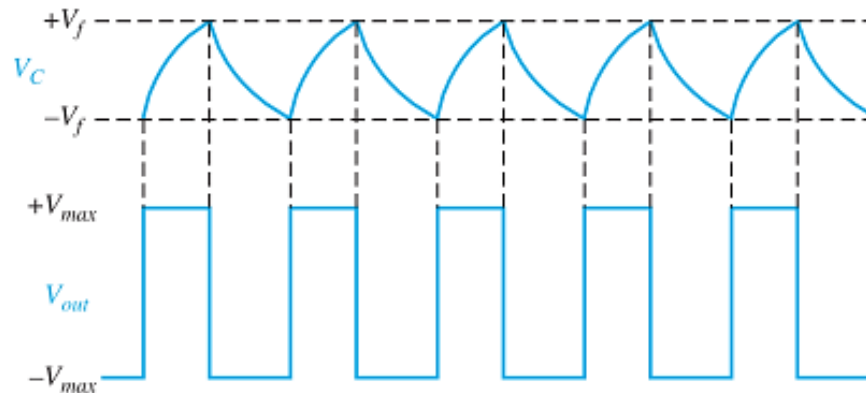
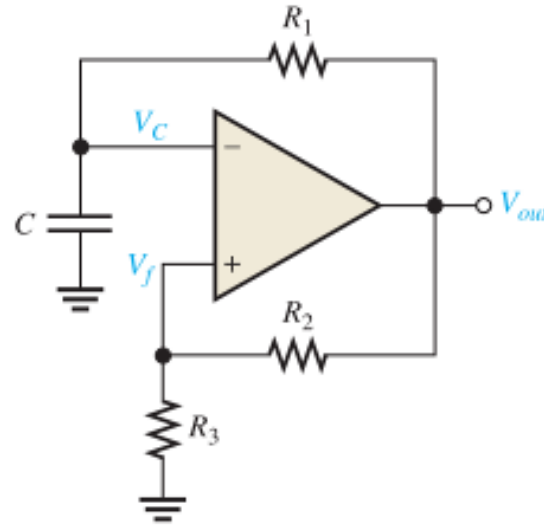
$$V_{UTP} = +V_{max} \left( \frac{R_3}{R_2} \right)$$

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

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

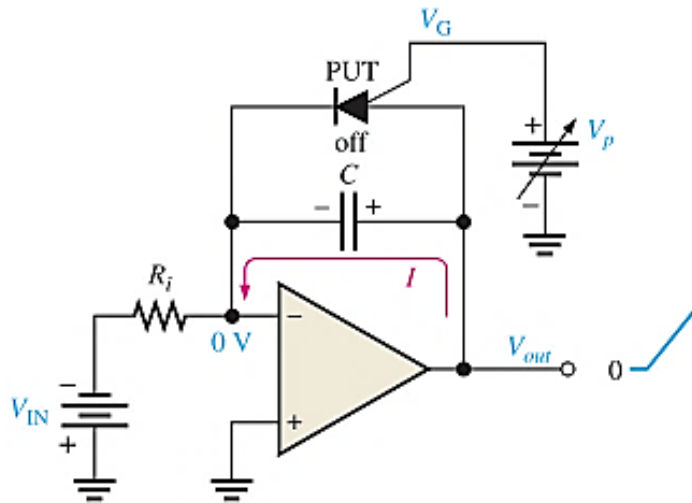
# Square-wave Relaxation oscillator

- 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.

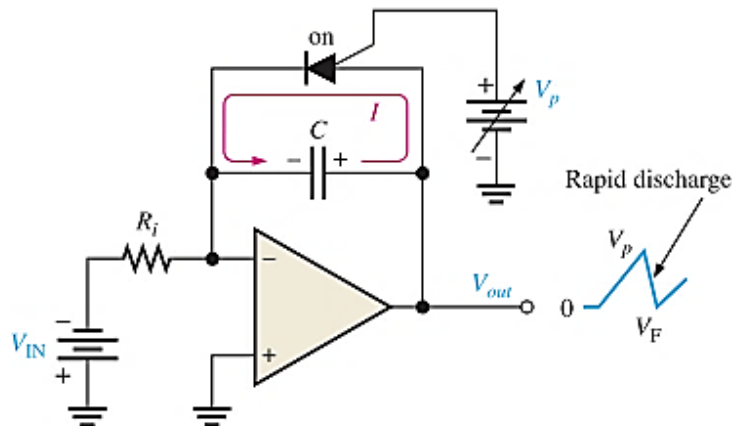




# Sawtooth VCO



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



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

$T$ , of the sawtooth waveform:

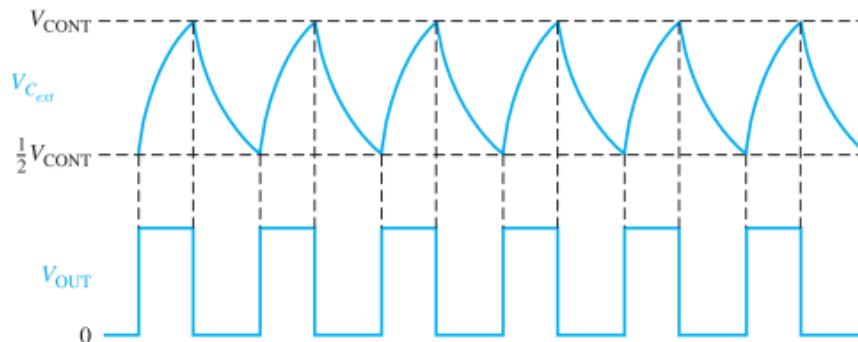
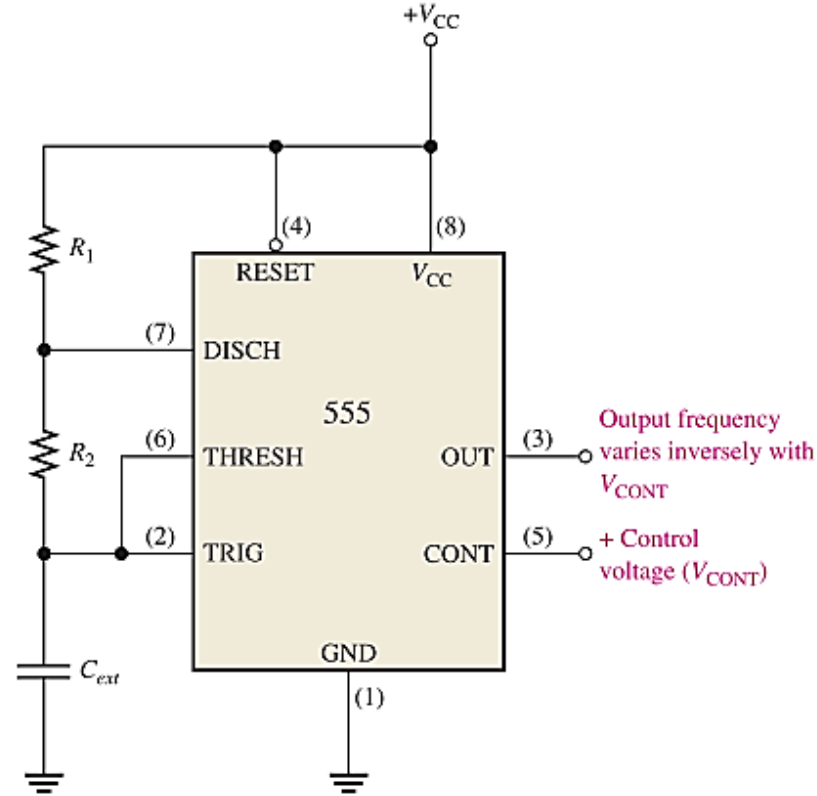
$$T = \frac{V_p - V_F}{|V_{IN}|/R_i C}$$

$f = 1/T$ , gives

$$f = \frac{|V_{IN}|}{R_i C} \left( \frac{1}{V_p - V_F} \right)$$

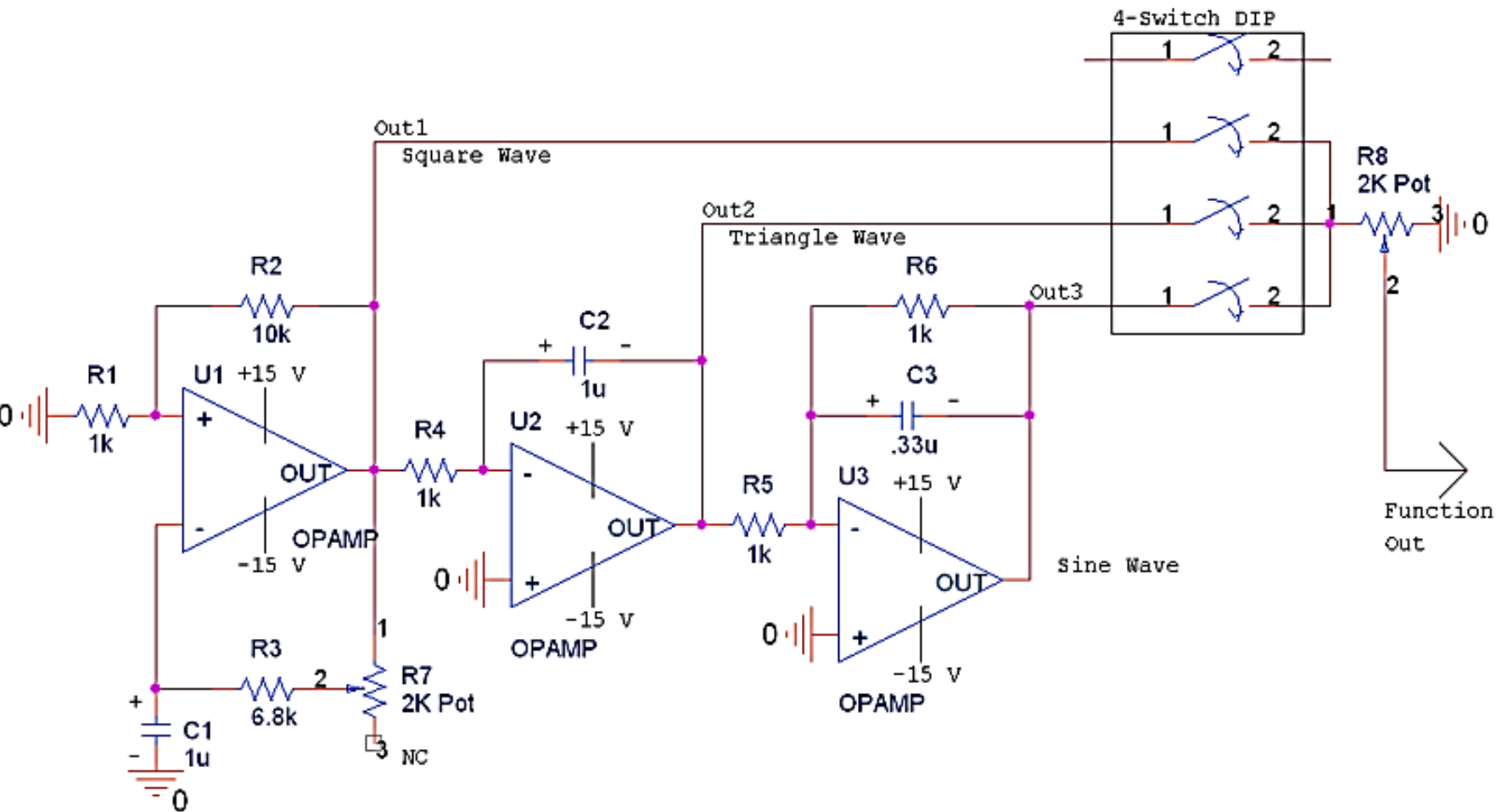
# 555 as VCO

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

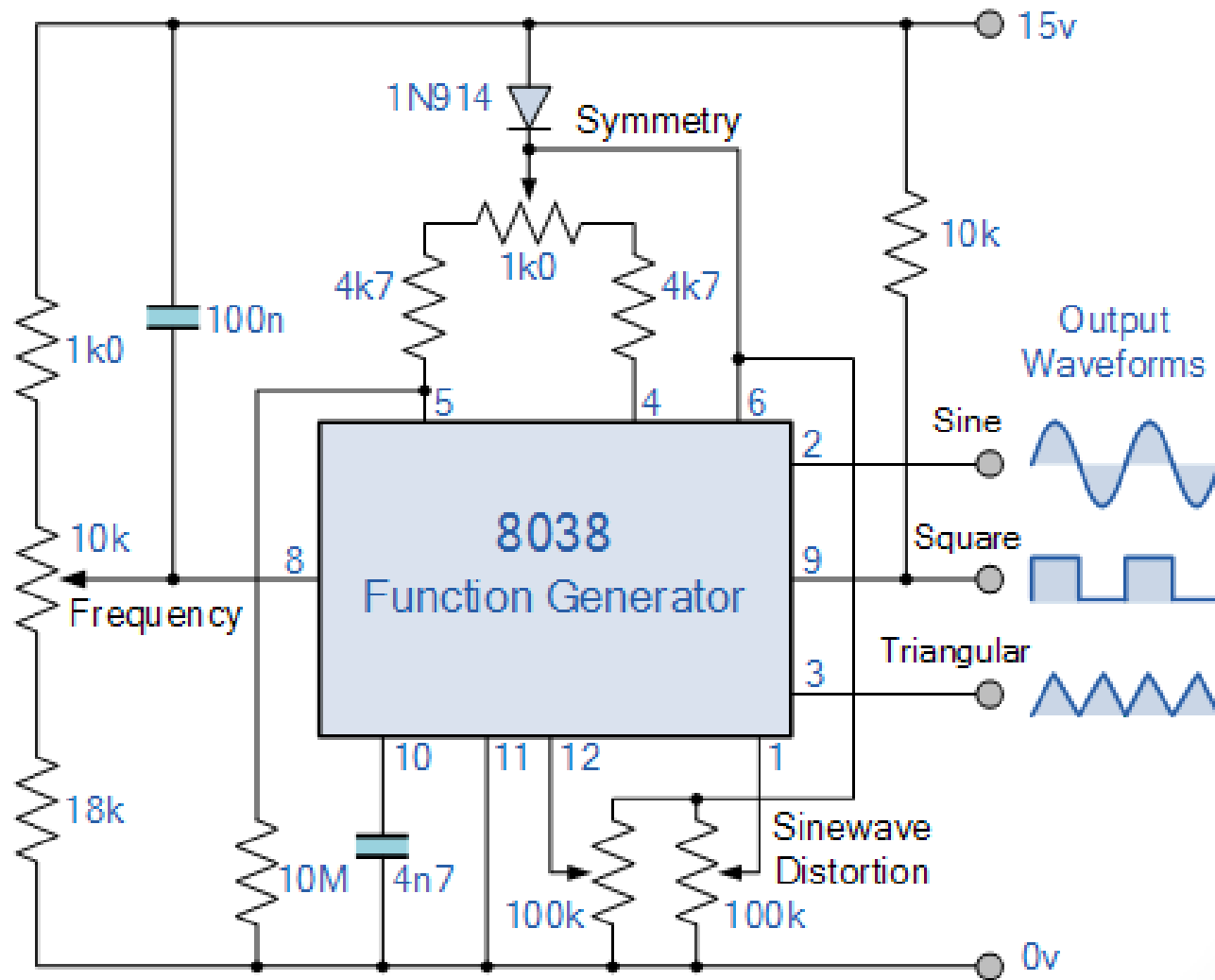


# EXAMPLES OF SIMPLE FUNCTION GENERATORS

# Waveform Generator, Discrete Circuit



# Waveform Generator IC



- For more details, refer to:
  - Chapter 16 at T. Floyd, **Electronic Devices**, 9<sup>th</sup> edition.
- The lecture is available online at:
  - <http://bu.edu.eg/staff/ahmad.elbanna-courses/12884>
- For inquiries, send to:
  - [ahmad.elbanna@feng.bu.edu.eg](mailto:ahmad.elbanna@feng.bu.edu.eg)