SNS COLLEGE OF TECHNOLOGY

Coimbatore-35
An Autonomous Institution

Accredited by NBA – AICTE and Accredited by NAAC – UGC with 'A+' Grade(III Cycle)
Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

23ECB202 – LINEAR INTEGRATED CIRCUITS

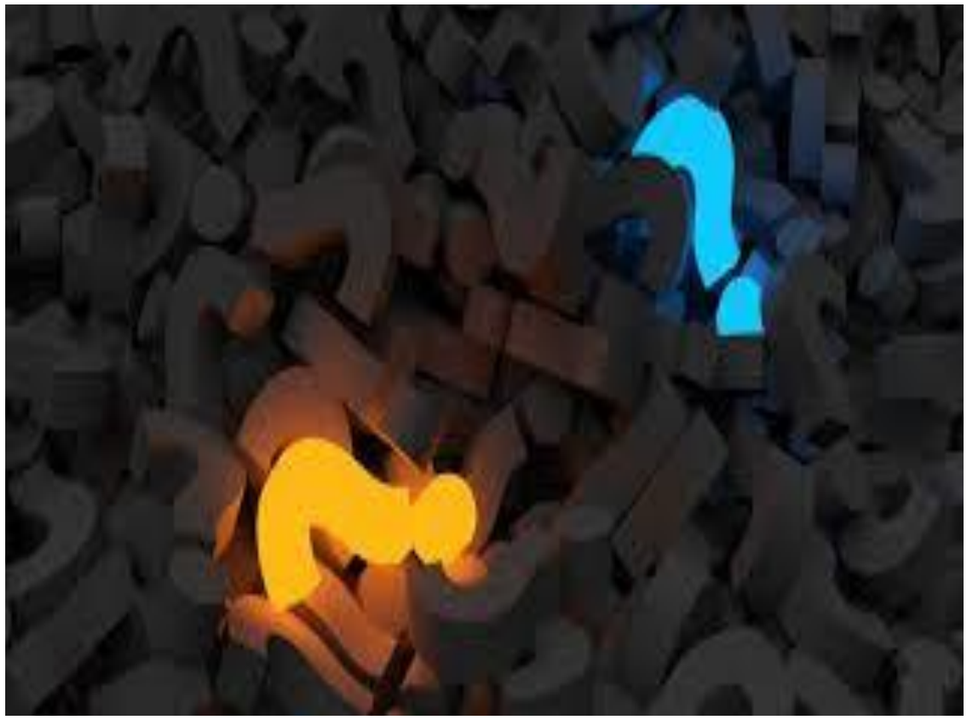
II YEAR/ IV SEMESTER

1

UNIT 2 – APPLICATIONS OF OPERATIONAL AMPLIFIERS

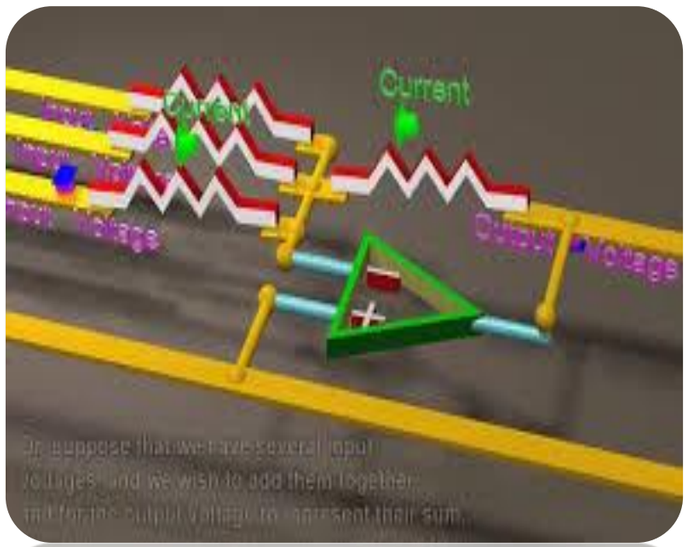
TOPIC 5 – Integrator and Differentiator

Guess?????



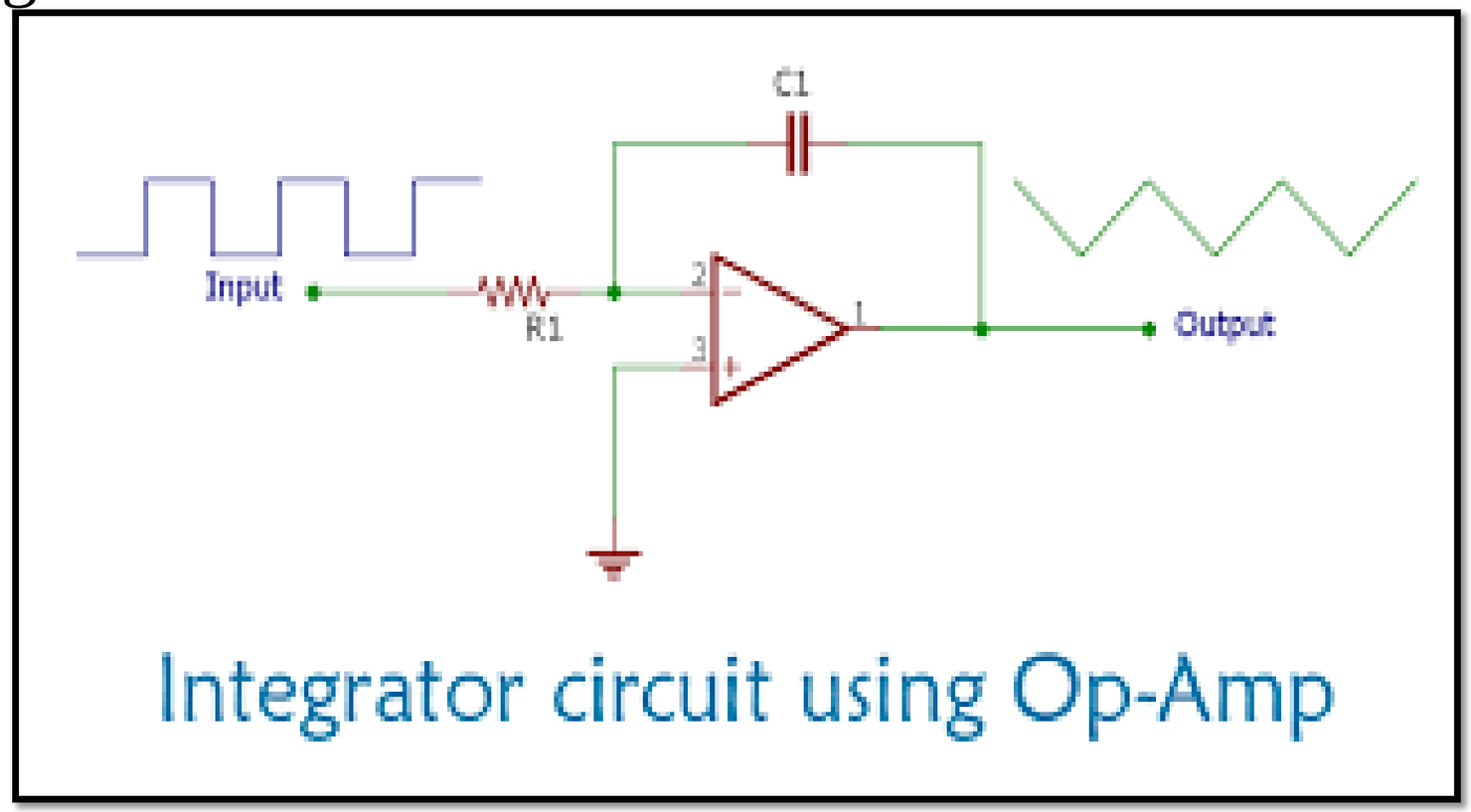
Why?

- It is a type of electronic amplifier
- It amplifies the difference between two input voltages
- Important part of many engineering and scientific applications….



Op-amp Integrator

- It’s a operational amplifier circuit that performs the mathematical operation of integration
- It produces an output voltage which is proportional to the integral of the input voltage



Integrator circuit using Op-Amp

Op-Amp Integrator

From the above circuit,

G denoted as ground terminal

The flow of current through the ground terminal is equivalent to the flow of current out,

we can write as;

if **Iin + If = 0**

Iin = -If

$$\mathbf{V_{in}-V_a/R = -C\ d/dt(V_0-V_a)}$$

where $V_a = 0$

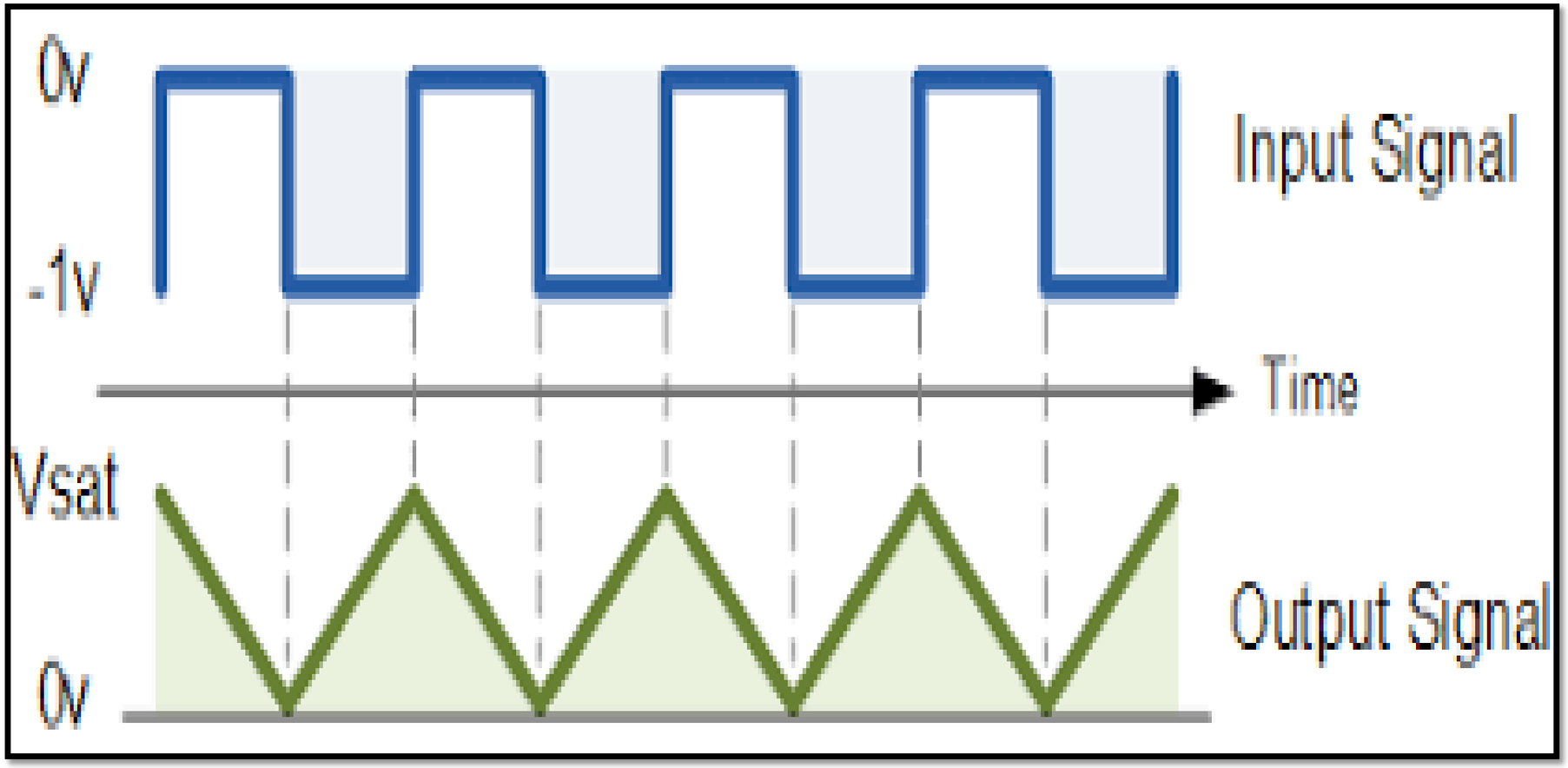
$$\mathbf{V_{in}/R = -C\ d/dt(V_0)}$$

Integrate the above equation,

$$\mathbf{1/R\ (or)\quad V_{out} = -(V_{in}/R)\ C\ dt + c}$$

The Vout voltage is equal to the constant -1/RC and integral of input voltage Vin.

Op-Amp Integrator waveform



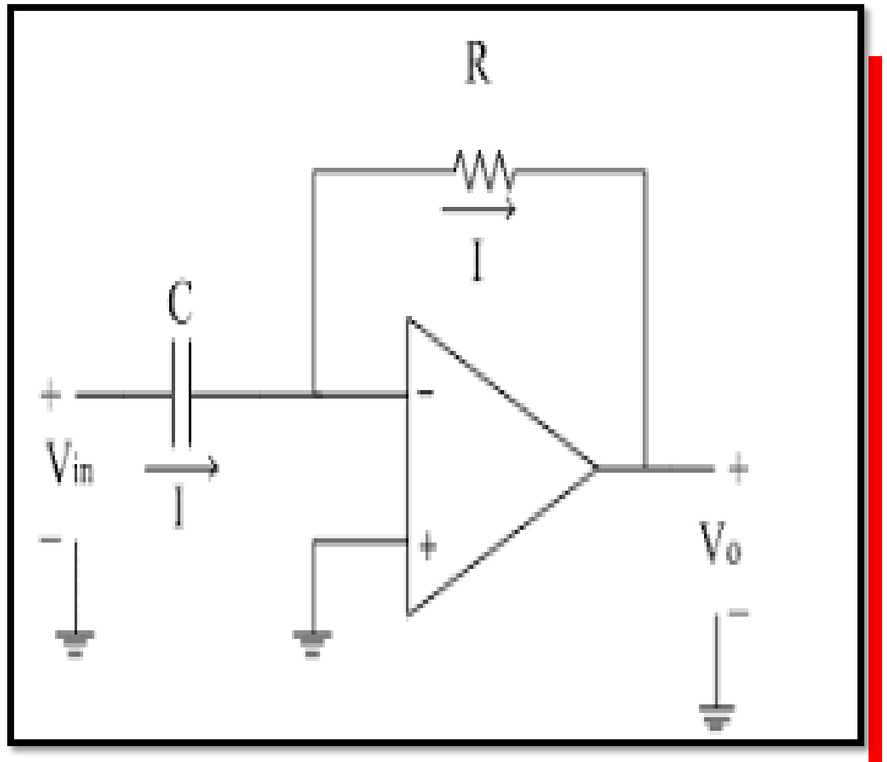
Activity

In class activity

Students should make the correct shape from the given tangram kit.

Op-amp Differentiator

- A differentiator circuit is one in which the voltage output is directly proportional to the rate of change of the input voltage with respect to time
- This means that a fast change to the input voltage singal , the greater the output voltage changes in response



Output Stage

- The op-amp node voltage at inverting terminal is zero
- The flow of current through the capacitor can be written as

$$I_{in} = I_f$$

Where $I_f = - V_{out} / R_f$

The capacitor charge equals the voltage with capacitance times across the capacitor

$$Q = C * Vin$$

Output Stage

Charge rate change

$$dq/dt = C\ d/dt(Vin)$$

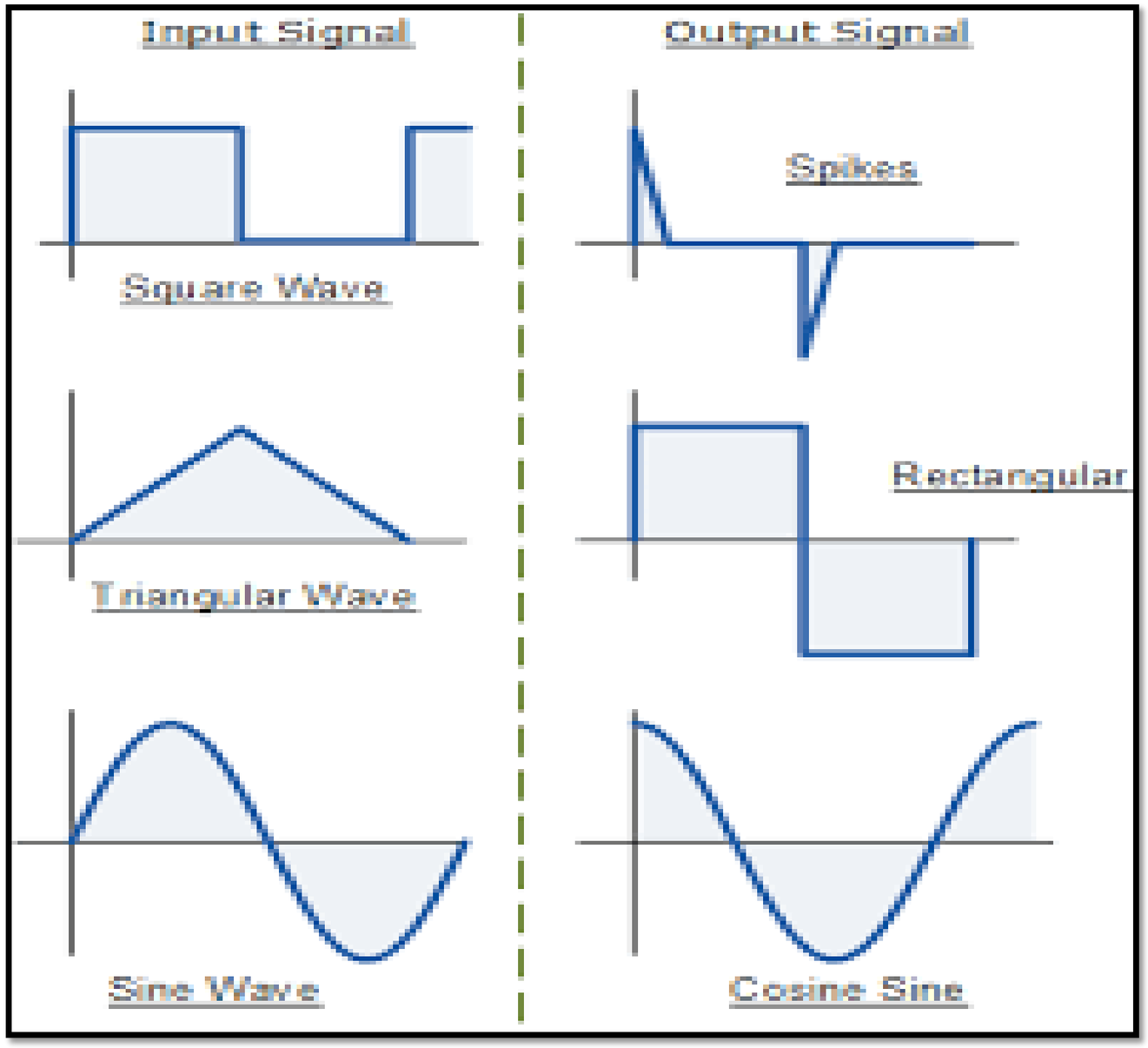
$$I_{in} = C\ d/dt(Vin) = I_f$$

$$-V_{out}/R_f = C\ d/dt(Vin)$$

An ideal output voltage (Vout) for the operational amplifier differentiator is

$$Vout = - R_f\ C\ d/dt(Vin)$$

Differentiator waveform



Applications

- Differentiating amplifier are most commonly designed to operate a triangular and rectangular signals
- Differentiators also find application as wave shaping circuits to detect high frequency components in the input signal
- Integrator circuits are mostly used in Analog computers, Analog to Digital Converters and wave shaping Circuits

Assessment

1. Write down the condition for good differentiation .

2. **What are the limitations of the basic differentiator circuit?**

THANK YOU