# 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



UNIT 2 – **APPLICATIONS OF OPERATIONAL AMPLIFIERS**

TOPIC 6 – Op-Amp circuits using diodes

# Why?

- In digital circuits, an adder–subtractor is a circuit that is capable of adding or subtracting numbers
- A circuit that does adding or subtracting depends on a control signal.
- It is also possible to construct a circuit that performs both addition and subtraction at the same time.
- The Subtract or also called a differential amplifier, uses both the inverting and non-inverting inputs to produce an output signal which is the difference between the two input voltages V1 and V2 .

# RECTIFIER

➢An electronic circuit, which produces either DC signal or a pulsated DC signal, when an AC signal is applied to it is called as a **rectifier**

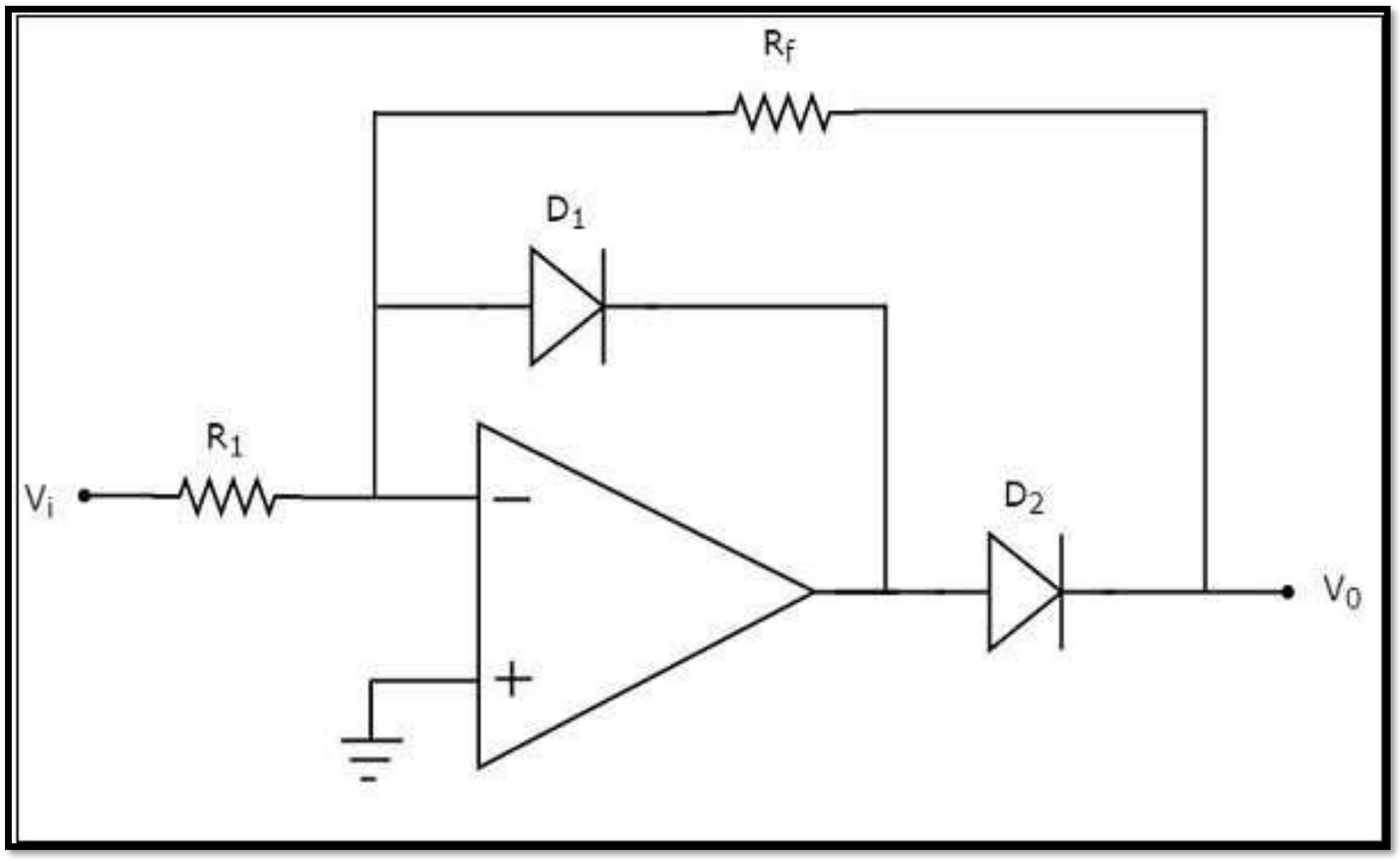
***Types of Rectifiers***

Two types:

- **Half wave rectifier**
- **Full wave rectifier**

# Half wave Rectifier

❑A **half wave rectifier** is a rectifier that produces positive half cycles at the output for one half cycle of the input and zero output for the other half cycle of the input



# Subtractor using Op Amp

- An inverting amplifier, with two diodes $D_1$ and $D_2$ in addition
- If the input resistance are unequal then the circuit become a differential amplifier
- For the **positive half cycle** of the sinusoidal input, the output of the op-amp will be negative
- Hence, diode $D_1$ will be forward biased.
- When diode $D_1$ is in forward bias, output voltage of the op-amp will be -0.7 V
- So, diode $D_2$ will be reverse biased. Hence, the **output voltage** of the above circuit is **zero** volts

# Subtractor using Op Amp

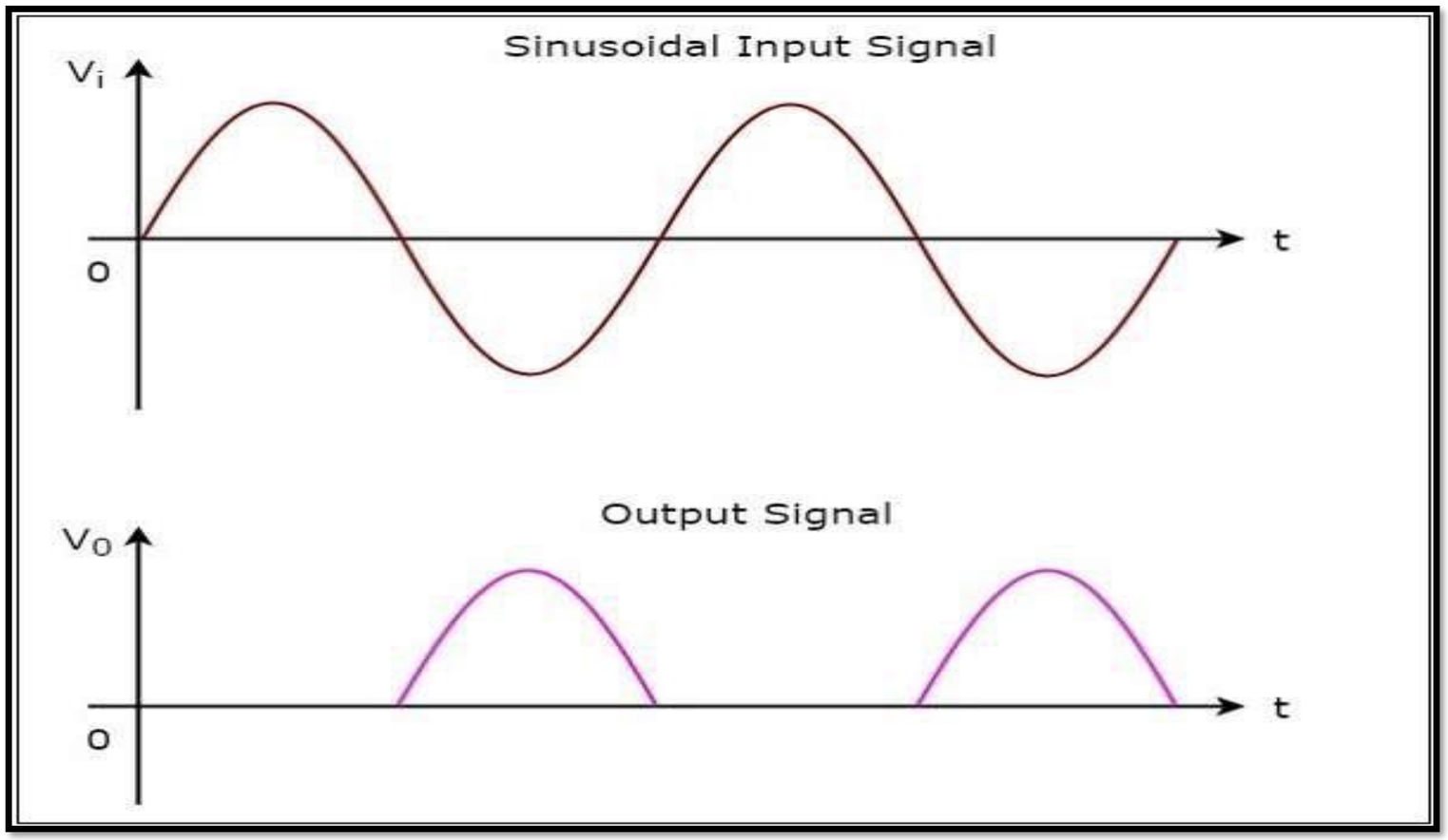
- There is **no (zero) output** of half wave rectifier for the positive half cycle of a sinusoidal input
- For the **negative half cycle** of sinusoidal input, the output of the op-amp will be positive
- Hence, the diodes $D_1$ and $D_2$ will be reverse biased and forward biased respectively
- So, the output voltage of above circuit will be

$$V_0 = -(R_f R_1) V_1$$

- Therefore, the output of a half wave rectifier will be a **positive half cycle** for a negative half cycle of the sinusoidal input Wave forms

# Waveform

The **input** and **output waveforms** of a half wave rectifier are shown in the following figure



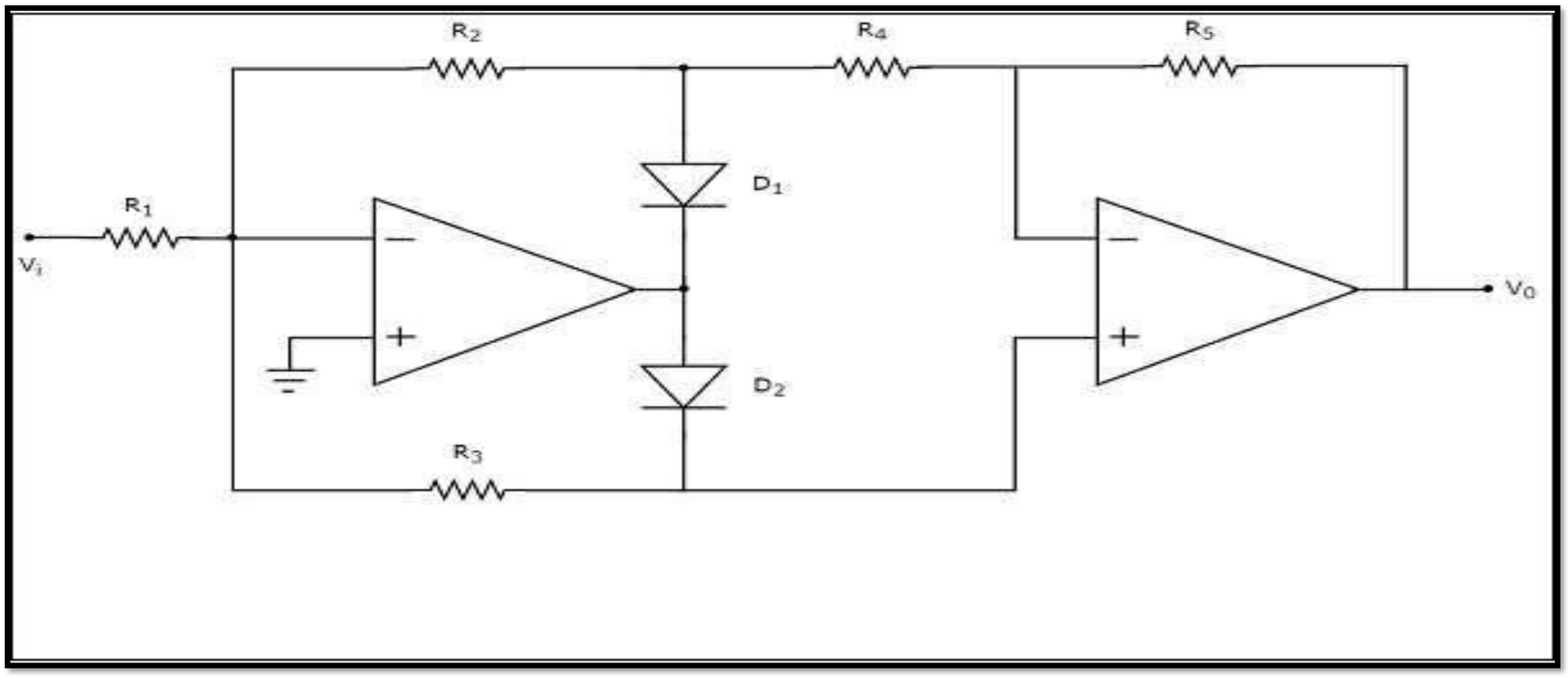
# Activity

***In class activity***

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

# Full wave Rectifier

- A **full wave rectifier** produces positive half cycles at the output for both half cycles of the input.
- The **circuit diagram** of a full wave rectifier is



# Digital to Analog conversion

- It consists of two op-amps, two diodes, $D_1$ & $D_2$ and five resistors, $R_1$ to $R_5$
- For the **positive half cycle** of a sinusoidal input, the output of the first op-amp will be negative.
- Hence, diodes $D_1$ and $D_2$ will be forward biased and reverse biased respectively
- Then, the output voltage of the first op-amp will be

$$V01=-(R2R1)Vi$$

# Output

- Observe that the output of the first op-amp is connected to a resistor $R_4$, which is connected to the inverting terminal of the second op-amp.
- The voltage present at the non-inverting terminal of second op-amp is 0 V. So, the second op-amp with resistors, $R_4$ and $R_4$ acts as an **inverting amplifier**.

$$V0=-(R5R4)V01$$

**Substituting** the value of $V_{01}$ in the above equation, we get

$$=>V0=-(R5R4)\{-(R2R1)Vi\}$$

$$=>V0= (R2R5R1R4)Vi$$

# Full Wave Rectifier

- Therefore, the output of a full wave rectifier will be a positive half cycle for the **positive half cycle** of a sinusoidal input.
- In this case, the gain of the output is R2R5R1R4
- If we consider R1=R2=R4=R5=R, then the gain of the output will be one
- For the **negative half cycle** of a sinusoidal input, the output of the first op-amp will be positive.
- Hence, diodes $D_1$ and $D_2$ will be reverse biased and forward biased respectively.

# Full Wave Rectifier

- The output voltage of the first op-amp will be

$$V_{01} = -\left(\frac{R3}{R1}\right)V_i$$

- The output of the first op-amp is directly connected to the non-inverting terminal of the second op-amp
- R4 and R5 acts as a non-inverting amplifier
- The output voltage of the second op-amp will be

$$V_0 = \left(1+\frac{R5}{R4}\right)V_{01}$$

Substituting the value of $V_{01}$ in the above equation,

$$\Rightarrow V0 = \left(1+\frac{R5}{R4}\right)\left\{-\left(\frac{R3}{R1}\right)Vi\right\}$$

$$\Rightarrow V0 = -\left(\frac{R3}{R1}\right)\left(1+\frac{R5}{R4}\right)Vi$$

# Full Wave Rectifier

- The output of a full wave rectifier will be a **positive half cycle** for the negative half cycle of sinusoidal input also

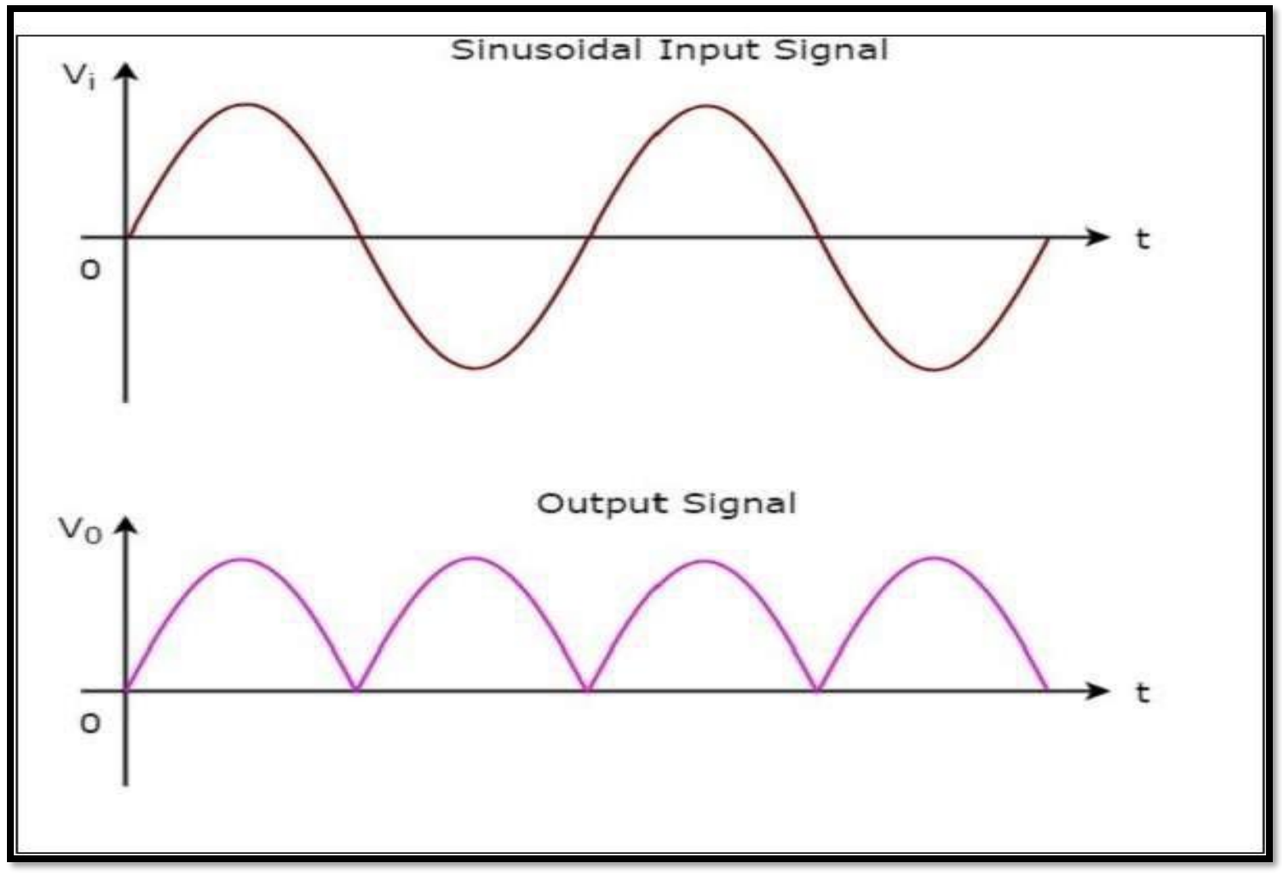
- The magnitude of the gain of the output is

(R3R1)(1+R5R4)

- If we consider R1=2R3=R4=R5=RR1=2R3=R4=R5=R then the gain of the output will be **one**.

# Full Wave Rectifier

The **input** and **output waveforms** of a full wave rectifier



# Assessment

1. In a full wave rectifier, the current in each diode flows for
a. whole cycle of the input signal
b. half cycle of the input signal
c. more than half cycle of the input signal
d. none of these

2. In a full wave rectifier, if the input frequency is 50 Hz, then output frequency will be
a. 50 Hz
b. 75 Hz
c. 100 Hz
d. 200 Hz

# THANK YOU