SNS COLLEGE OF TECHNOLOGY

Coimbatore-35
An Autonomous Institution

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Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

19ECB204 – LINEAR AND DIGITAL CIRCUITS

II YEAR/ III SEMESTER

UNIT 1 – **FUNDAMENTALS OF OPAMP**

TOPIC 7 – Op-Amp circuits using diodes

Guess?????

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**

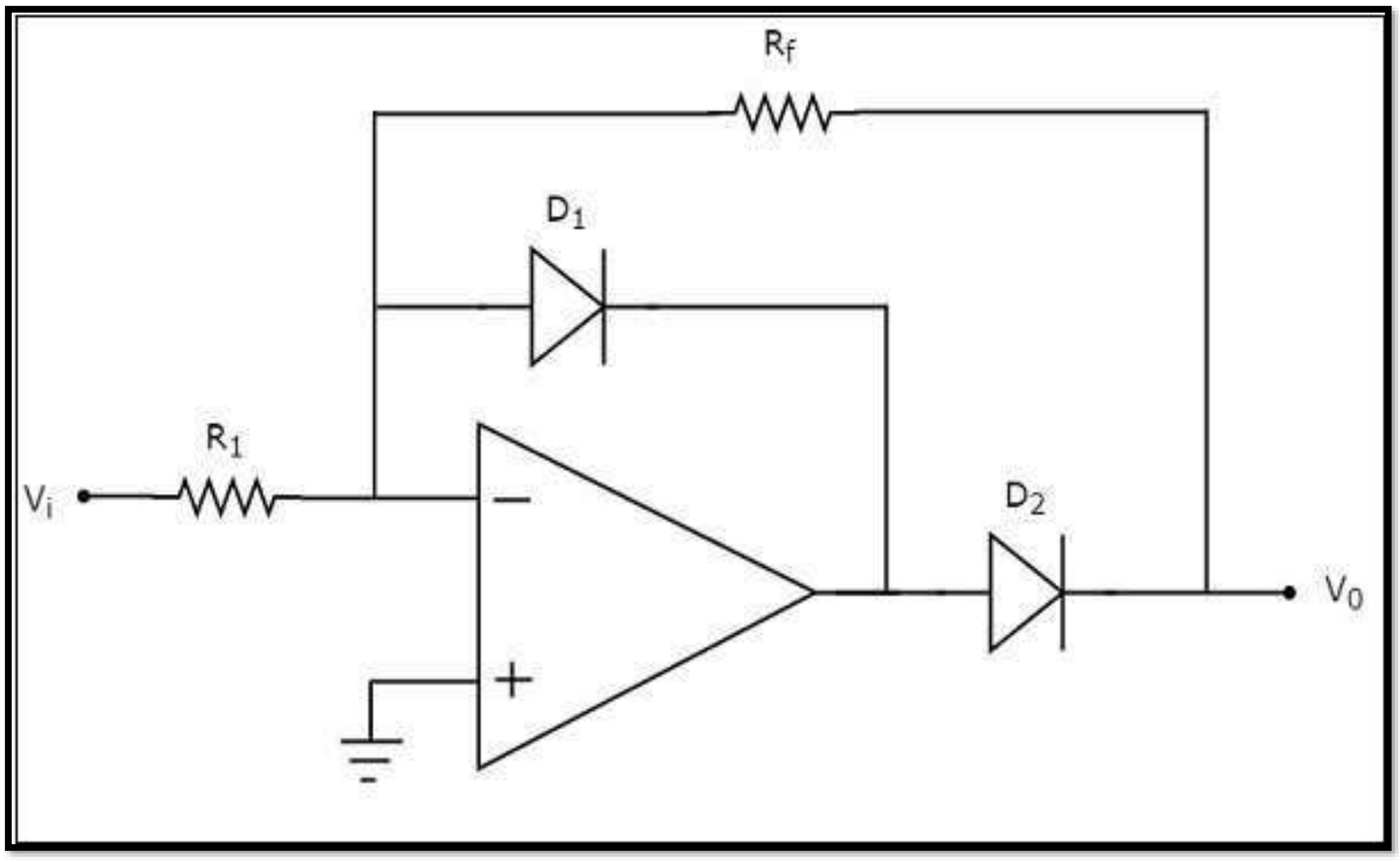
Types of Rectifiers

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

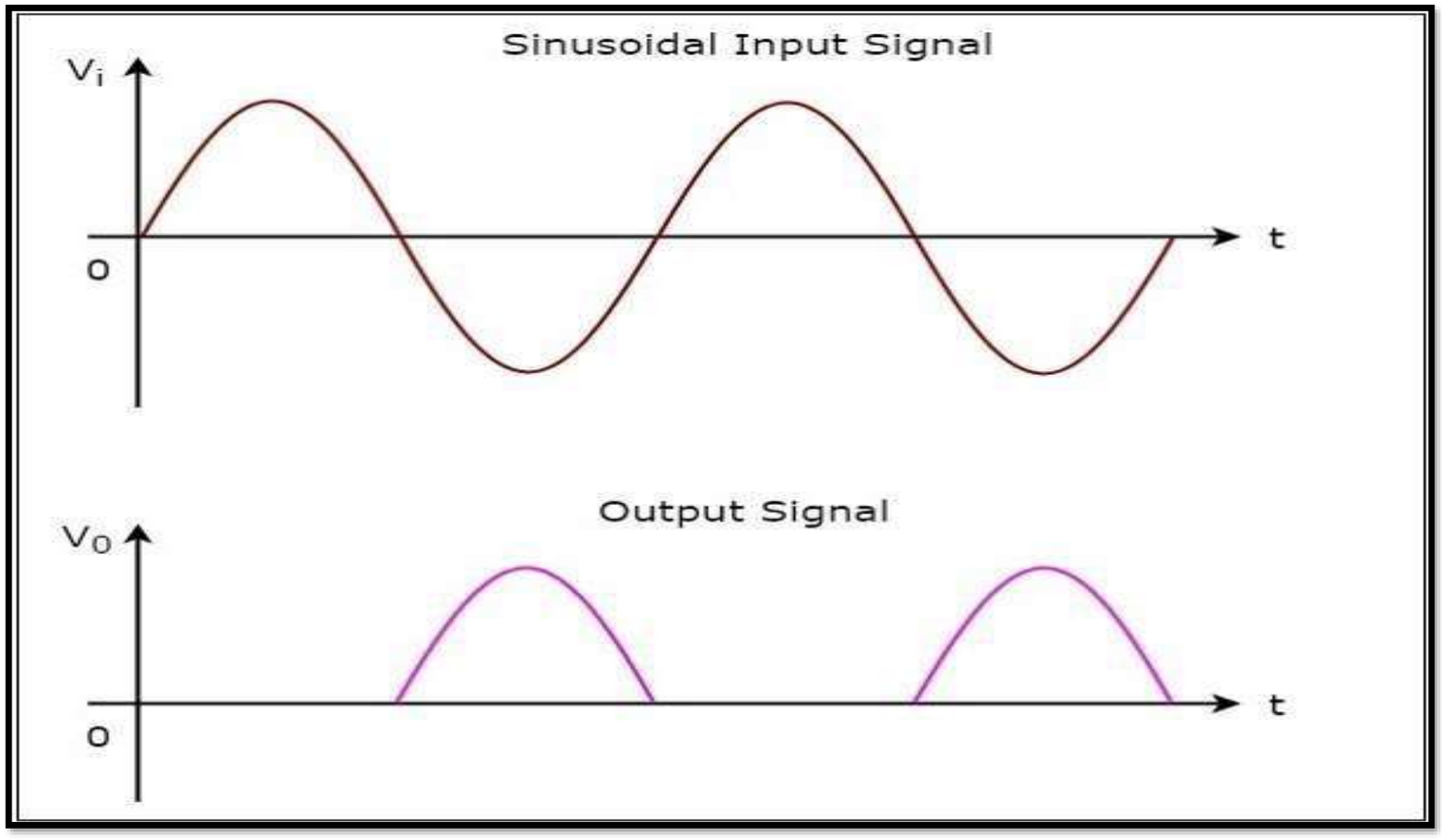
- There is **no (zero) output** of half wave rectifier for the positive half cycle of a sinusoidal input
- For the **negative half cycle** of sinusoidal input, the output of the op-amp will be positive
- Hence, the diodes D_1 and D_2 will be reverse biased and forward biased respectively
- So, the output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



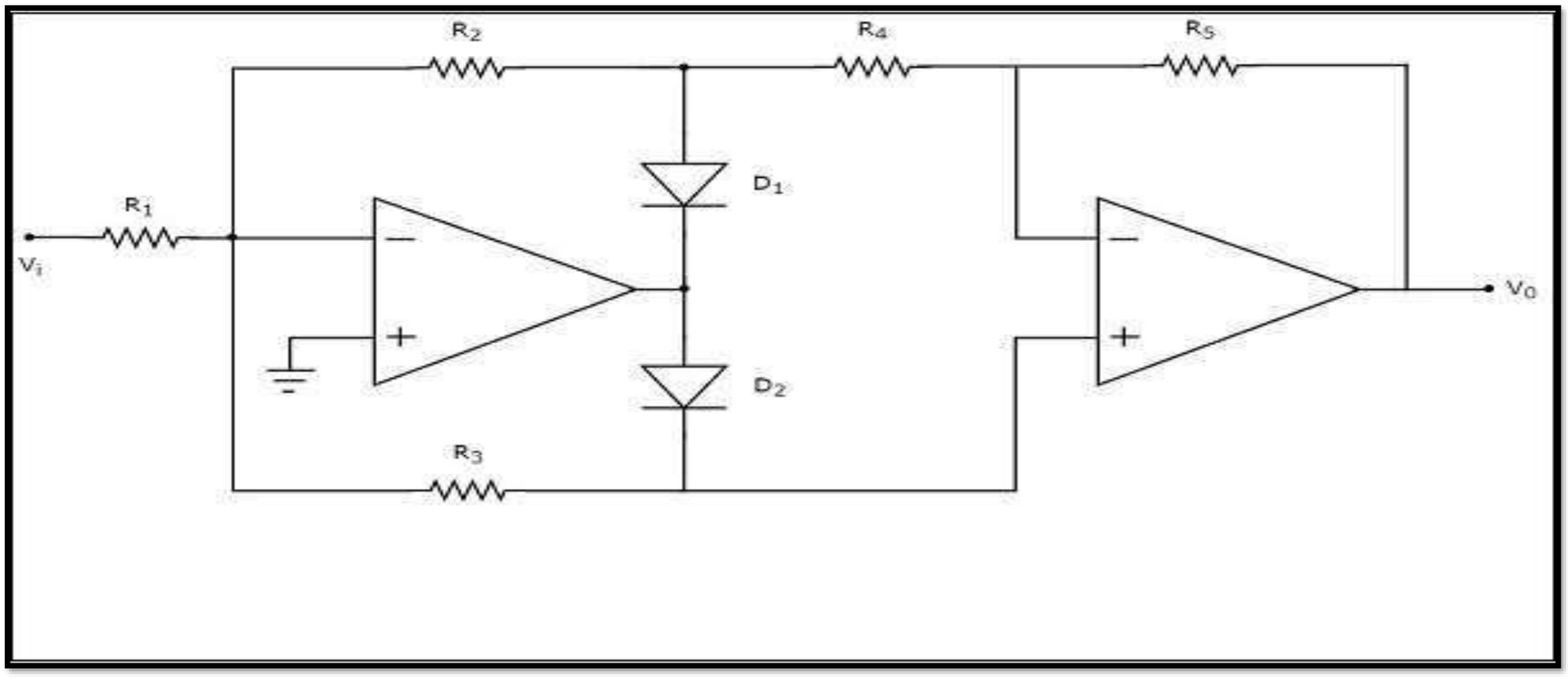
Activity

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

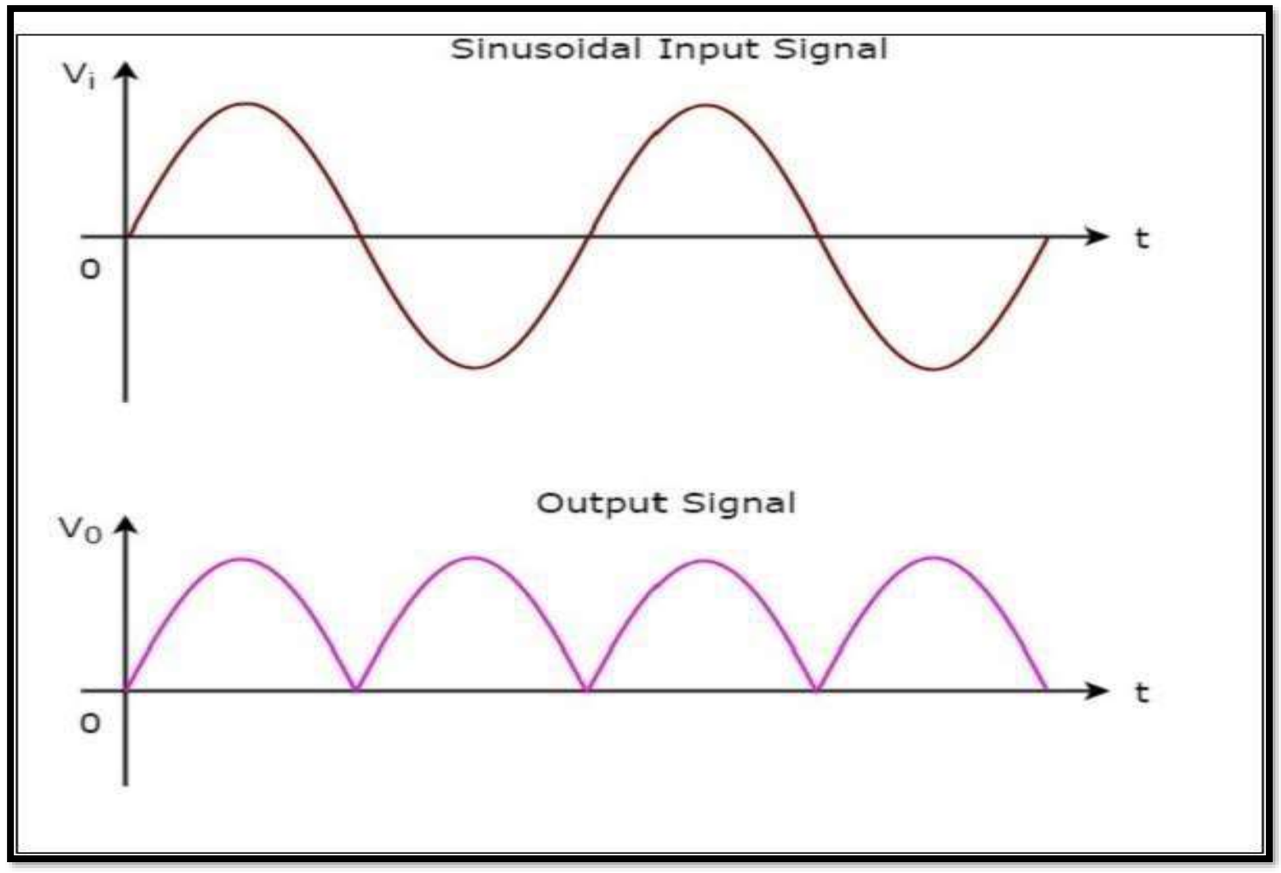
- The magnitude of the gain of the output is

(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