



## GOVERNMENT COLLEGE OF TECHNOLOGY-COIMBATORE

### Proposal: Design and Analysis: RC phase shift oscillator using Op- Amps

#### PRESENTED BY

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**1) ABSTRACT :** R-C phase shift oscillator using op-amp uses an op-amp in inverting amplifier mode. Thus it introduces the phase shift of  $180^\circ$  between input and output. The feedback network consists of 3 RC sections each producing  $60^\circ$  phase shift. These circuits are highly stable, and the phase noise in the output will depend on the level of jitter in the amplifier circuit.

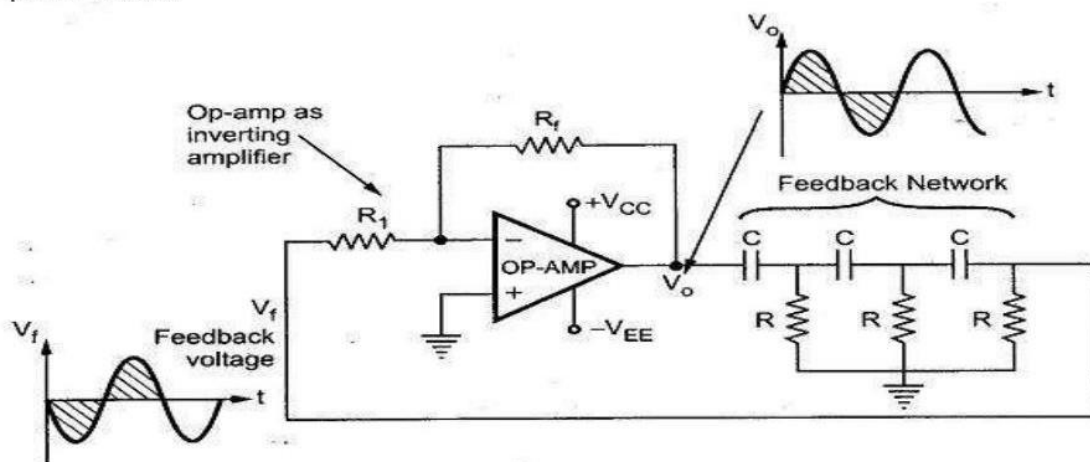


Fig. 2.92 R-C Phase shift oscillator using op-amp

#### 2) WORKING PRINCIPLE:

- When the circuit is powered, thermal noise or small variations in voltage initiate oscillations.
- These oscillations are amplified and fed back through the RC network.
- The RC network introduces a frequency-dependent phase shift.
- At the desired oscillation frequency ( $f_0$ ), the total phase shift of the RC network is exactly  $180^\circ$ .
- The inverting amplifier provides an additional  $180^\circ$  phase shift.

- The combined phase shift from the RC network ( $180^\circ$ ) and amplifier ( $180^\circ$ ) results in a total phase shift of  $360^\circ$  (or  $0^\circ$ ), ensuring positive feedback. For oscillations to be sustained, the loop gain must be equal to 1.
- If diodes D1, D2 are present, they stabilize the amplitude by clipping the output voltage once it exceeds the forward voltage of the diodes.

### 3) DESIGN OF RC PHASE SHIFT OSCILLATOR:

- The attenuation B of the three section RC feedback network is  $B = 1/29$ .
- To meet the greater than unity loop gain requirement, the closed loop voltage gain of op-amp must be greater than 29.
- To design an oscillator with frequency,  $f = 1 \text{ kHz}$ .
- We have  $f_0 = 1 / (15.3827955 R C)$

$$\text{Let } R_1 = R_2 = R_3 = R \text{ and } C_1 = C_2 = C_3 = C$$

- Assume  $C = 0.01 \mu\text{F}$ . Therefore,
- $R = 6.8 \text{ k}\Omega$
- Feedback Resistors ( $R_1 = R_F/10$ )  
 $R_F = 220 \text{ k}\Omega$ ,  $R_1 = 22 \text{ k}\Omega$ ,  $R_1$  is chosen to be of the same order as  $R_F$  for impedance matching and stability.
- $V_{CC} = +12 \text{ V}$ ,  $V_{EE} = -12 \text{ V}$ , this range ensures proper functioning of the op-amp with minimal distortion.
- Verify  $R \cdot C$

$$R \cdot C = 6.8 \text{ k}\Omega \cdot 0.01 \mu\text{F} = 68 \mu\text{s}$$

- The oscillation frequency will be slightly less than  $1 \text{ kHz}$  but close enough for practical use.

## 5) PROPOSED CIRCUIT IN eSIM SOFTWARE:

The proposed system introduces RC phase shift oscillator circuit implemented using eSim software. This circuit aims to demonstrate the principles of sinusoidal oscillation, frequency control, and the interplay of amplification and feedback.

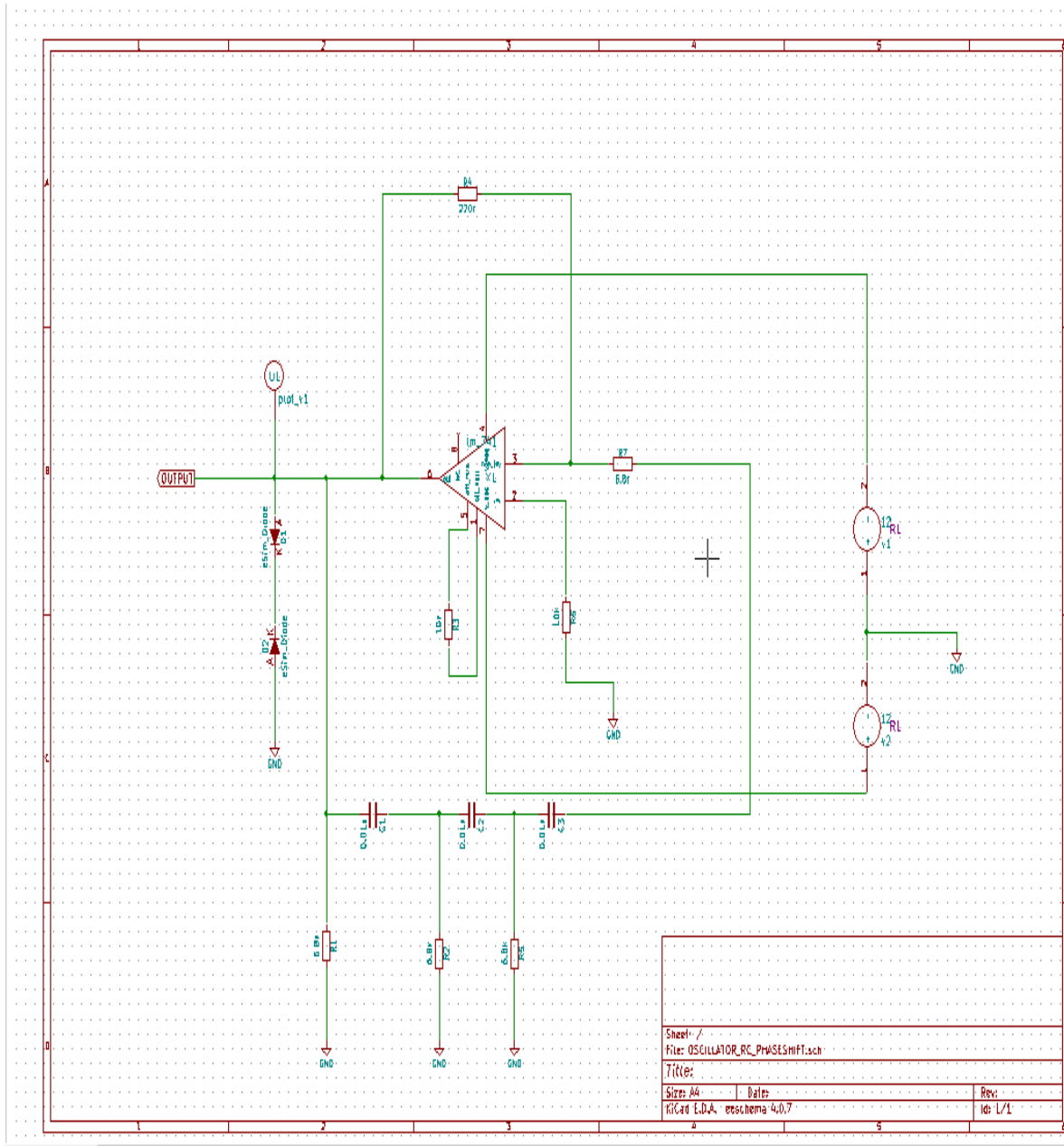


Fig 1: RC phase oscillator in eSim

## OUTPUT WAVEFORM:

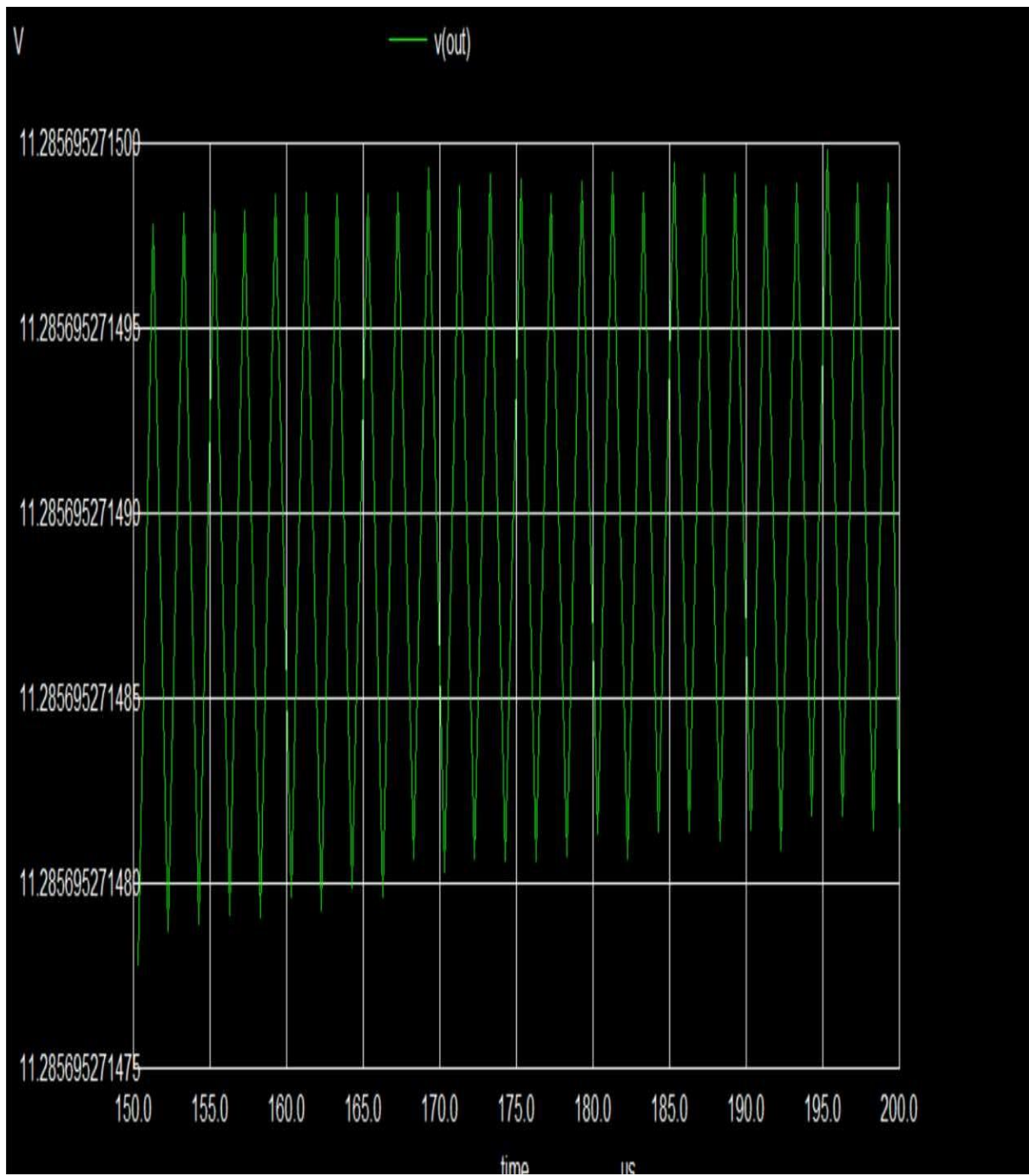


Fig 2: Output waveform of RC phase shift oscillator

## **8)CONCLUSION:**

The design and analysis of the RC phase shift oscillator using op-amps successfully show how stable sinusoidal waveforms can be generated with precise frequency control. By using an RC network for the phase shift and an op-amp for amplification, the circuit achieves reliable oscillations that meet the Barkhausen criterion. This project emphasizes the importance of choosing the right resistor and capacitor values, as they directly influence the oscillation frequency, making the circuit adaptable for various low-frequency applications. Additionally, the use of op-amps provides high gain stability and ensures the output signal is clean and free from distortion. Overall, this project not only demonstrates the core principles of oscillators but also highlights their practical importance in generating signals and audio applications, laying the groundwork for more advanced oscillator designs in the field of electronics.

## **9)REFERENCES:**

<https://www.researchgate.net/publication/336870328> **DESIGN AND IMPLEMENTATION OF OP-AMP-RC SINE WAVE OSCILLATOR**

<https://resources.pcb.cadence.com/blog/2023-cadrc-phase-shift-oscillators-using-op-amps>

<https://www.researchgate.net/publication/377844379> **Design a RC Phase Shift Oscillatorwith BJT or Op-Amp**

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