Theoretical Frequency Calculation

R = 10.2 kΩ

C = 3 nF

Wien bridge frequency:

$$f_0 = \frac{1}{2\pi RC}$$

Substitute values:

$$f_0 = \frac{1}{2\pi(10.2 \times 10^3)(3 \times 10^{-9})}$$

$$f_0 = \frac{1}{2\pi(30.6 \times 10^{-6})}$$

$$f_0 = \frac{1}{192.2 \times 10^{-6}}$$

$$f_0 \approx 5203 \text{ Hz}$$

Expected Theoretical Frequency:

$$f_0 \approx 5.20 \text{ kHz}$$

Simulation Command

```
.tran 0 20m 0 1u uic
```

Frequency Measurement (.meas)

```
.meas T10 when v(vout)=0 rise=10
.meas T11 when v(vout)=0 rise=11
.meas Fre param 1/(T11-T10)
```

Task 3 – % Error Calculation

$$\%error = \frac{|\ f_{sim} - f_{theory}\ |}{f_{theory}} \times 100$$

Example (if Fre = 5208 Hz):

$$\%error = \frac{|\ 5208 - 5203\ |}{5203} \times 100$$
$$\%error = 0.096\%$$

Typically error < 1%

Task 4 – Gain Change Experiment

In a Wien oscillator:

Required gain ≈ 3

Because:

The Wien network attenuation = 1/3
So amplifier gain must be 3 to satisfy:

$$A\beta = 1$$

Case A – Gain Slightly Below 3

Example: Gain = 2.8

Observation:

- Oscillation starts
- Slowly decays

Frequency:
≈ 5.2 kHz (frequency unchanged)

Waveform:
Small amplitude, no diode conduction

Case B – Gain ≈ 3 (Stable)

Example: Gain = 3.02

Observation:

- Clean sine wave
- Stable amplitude
- Minimal distortion

Frequency:
≈ 5.2 kHz

Waveform:
Smooth sinusoid

Case C – Gain Above 3

Example: Gain = 3.5

Observation:

- Rapid growth
- Diodes conduct
- Peaks flattened
- Visible distortion

Frequency:
≈ 5.2 kHz (almost unchanged)

Waveform:
Slight clipping / diode limiting visible

Concept Questions

Q1 – Barkhausen Conditions

1. Total phase shift around loop = 0° (or 360°)
2. Loop gain magnitude $|A\beta| = 1$

Q2 – Why Gain ≈ 3?

The Wien network attenuates signal to 1/3 at resonance.

To make:

$$A\beta = 1$$
$$A = 3$$

Q3 – Role of Diodes (D1, D2)

*The diodes provide **automatic amplitude stabilization**.*

Operation:

• At small amplitude → diodes OFF → gain slightly > 3 → oscillation builds
• At large amplitude → diodes conduct → effective gain

reduces
• Gain settles near 3 → stable sine wave

They act as a nonlinear feedback element that prevents clipping.

Short Conclusion

The Wien bridge oscillator successfully generated a stable sinusoidal waveform near the theoretical frequency of 5.2 kHz. The simulated frequency closely matched the calculated value with minimal percentage error. Transient simulation clearly showed startup growth followed by amplitude stabilization. When amplifier gain was below the required value, oscillations decayed. At the correct gain near 3, a clean sinusoidal waveform was obtained. Increasing gain above the oscillation condition caused distortion due to diode conduction. The diodes effectively provided nonlinear automatic gain control, preventing uncontrolled amplitude growth. Overall, the experiment verified both Barkhausen conditions and practical amplitude stabilization in oscillator circuits.