# Electronics II

Lecture 23
Oscillators II

Muhammad Tilal
Department of Electrical Engineering
CIIT Attock Campus





# Previous Lecture

- Basic structure and operation of oscillator circuit
  - Barkhausen Criterion.

# Session Overview

| | |
|---|---|
| **Topic** | Oscillators. |
| **Concepts** | RC Phase Shift Oscillator, Wien Bridge Oscillator. |
| **Recommended Reading** | Sections 17.6 & 17.7 of [1].<br>Section 12-3 of [2]. |
| **Keywords** | Oscillator, RC Phase Shift, Wien Bridge. |



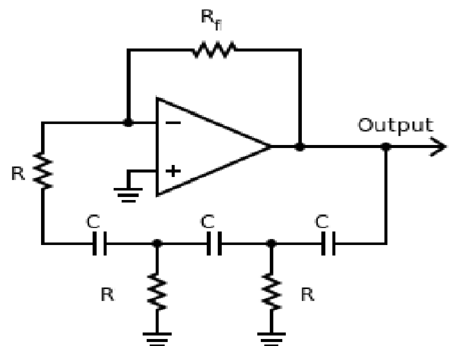


# Types of Oscillators

- Four basic oscillator configurations will be covered which include
  - RC Phase Shift Oscillator.
  - Wien Bridge Oscillator.
  - Collpits Oscillator.
  - Hartley Oscillator.

# RC Phase Shift Oscillator

- RC phase shift oscillator is the simplest oscillator using an op-amp in the inverting configuration ($180^0$ phase shift).
- The op-amp drives three cascaded RC sections with $180^0$ phase shift. Thus the total phase shift around the loop is $360^0$.
- An important point here is that the total phase shift by three cascaded RC sections is equal to $180^0$.
- The loss in the RC network is compensated by the op-amp gain that is $v_o/v_i = -(R_f/R)$.



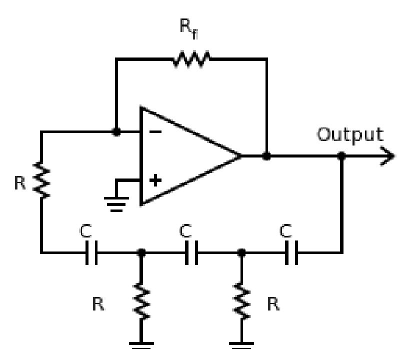

Theodore F. Bogart, Jeffery S. Beasley, Guilermo Rico, Electronics Devices and Circuits, 6th Edition, Pearson Education Inc, ISBN: 978-81-775-8887-3





# RC Phase Shift Oscillator

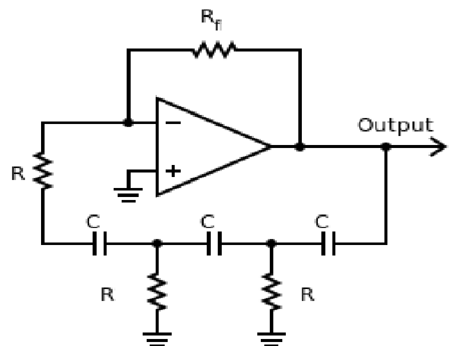
- $\beta = R^3/[\,(R^3 - 5RX_C^2) + j(X_C^3 - 6R^2X_C)\,]$
- $f_o = 1/\,2\pi RC\sqrt{6}$
- $R_f/R_1 = 29$




Theodore F. Bogart, Jeffery S. Beasley, Guilermo Rico, Electronics Devices and Circuits, 6th Edition, Pearson Education Inc, ISBN: 978-81-775-8887-3

# RC Phase Shift Oscillator

- *Example 12-6 (Bogart):* Design an RC Phase shift oscillator capable of oscillation at 100Hz.

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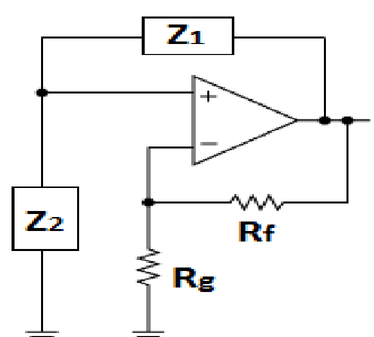
# Wien-Bridge Oscillator

- Wien bridge oscillator employees an op-amp in non-inverting configuration and two impedance blocks $Z_1$ and $Z_2$ forming a voltage divider.
- $R_f$ and $R_g$ determine the amplifier gain and these are selected to make the magnitude of the loop gain equal to 1.
- Amplifier is non inverting so choosing the feedback impedance such that there is $0^0$ phase shift in the signal fed back to the non-inverting input can make the total phase shift of $0^0$.

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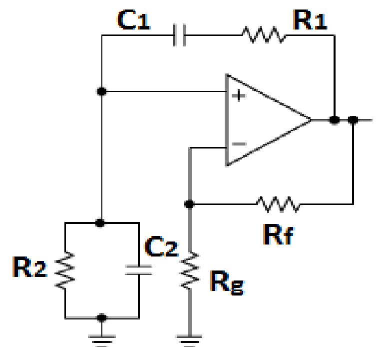
# Wien-Bridge Oscillator

- The most common WB oscillator uses series RC combination for $Z_1$ and parallel RC combination for $Z_2$.
- $Z_1 = R_1 - jX_{C1}$
- $Z_2 = -(jR_2X_{C2})/(R_2 - jX_{C2})$
- $\beta =$
- $w_o =$
- $f_o =$
- $R_f/R_g = 2$

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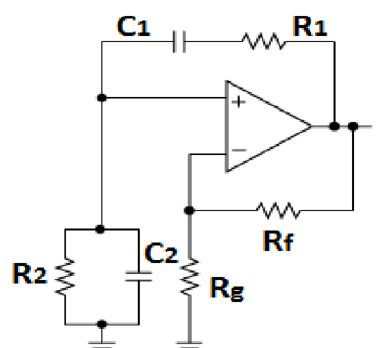
# Wien-Bridge Oscillator

- *Example 12-7 (Bogart):* Design a Wien Bridge oscillator that oscillates at 25 kHz.

  *Solution:*

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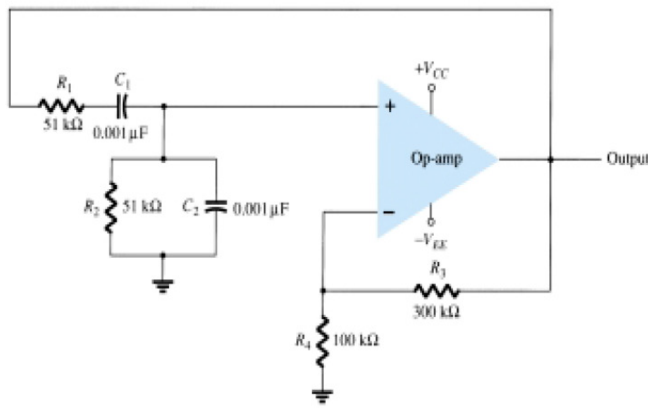
# Wien Bridge Oscillator

- *Example 18.8 (Boylestad):* Calculate the Resonant Frequency of the given oscillator.




Robert L. Boylestad, *Electronic Devices and Circuit Theory*, 8th Edition, Pearson Education Inc, ISBN: 81-7808-590-9.



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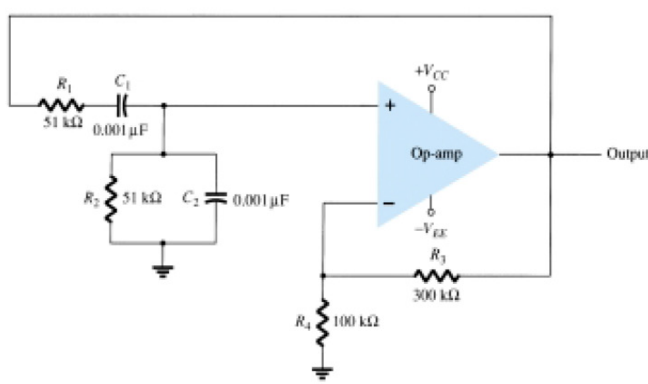
# Wien Bridge Oscillator

- *Example 18.9(Boylestad):* Design a Wein Bridge Oscillator for the resonant frequency of 10kHz .

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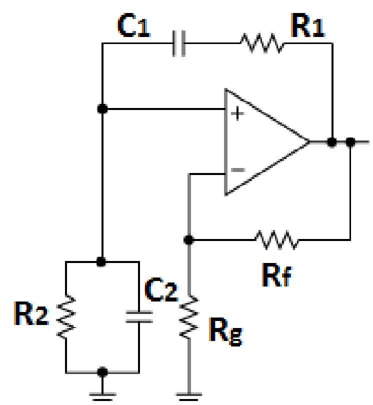
# Wien-Bridge Oscillator- Practical Considerations

- RG will not be exactly equal to Rf and same is the case with C1 and C2 because of component tolerance.
- Also amplifier is not ideal causing v- not exactly equal to v+.
- The solution to this problem is to use variable Rf in order to adjust the gain to meet the required Barkhausen criterion. This is applicable in laboratory circuits.
- Practical oscillators incorporate a nonlinear device in the feedback loop to provide automatic adjustment of the loop gain to sustain the oscillations. This is termed as *Automatic Gain Control (AGC)*.




Theodore F. Bogart, Jeffery S. Beasley, Guilermo Rico, Electronics Devices and Circuits, 6th Edition, Pearson Education Inc, ISBN: 978-81-775-8887-3





# Next Lecture

- The next lecture will cover the following topics
  - Voltage Comparators.
  - Basics of 555 Timer IC.

# References

[1] Robert L. Boylestad, *Electronic Devices and Circuit Theory,* 8th Edition, Pearson Education Inc, ISBN: 81-7808-590-9.

[2] Theodore F. Bogart, Jeffery S. Beasley, Guilermo Rico, Electronics Devices and Circuits, 6th Edition, Pearson Education Inc, ISBN: 978-81-775-8887-3