RLC CIRCUIT ANALYSER

WITH BODE PLOT

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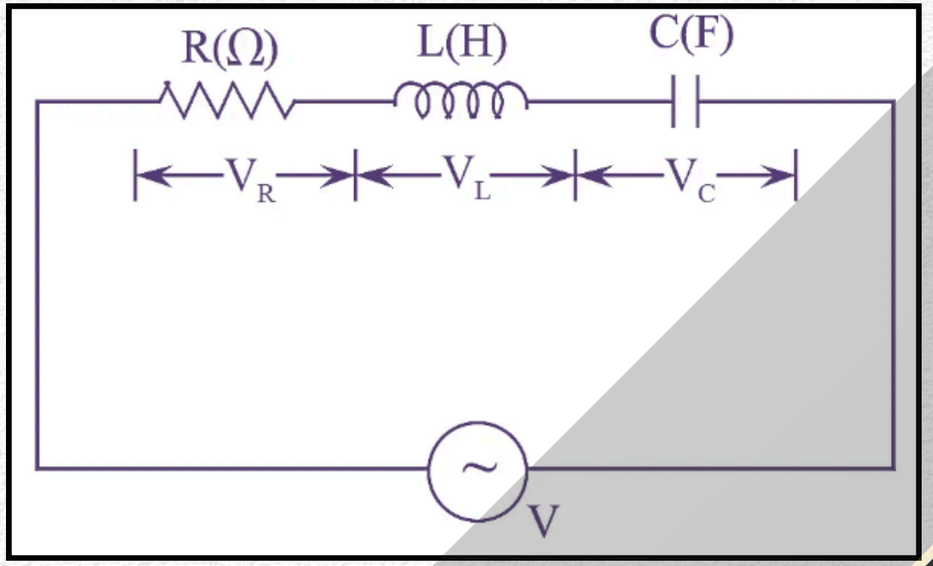
What is RLC Circuit Analyser?

- Software tool analyzing RLC circuits
- Uses Python for frequency analysis
- Computes impedance across given frequencies
- Generates automatic circuit type detection
- Produces accurate Bode magnitude plots
- Checks system stability using margins

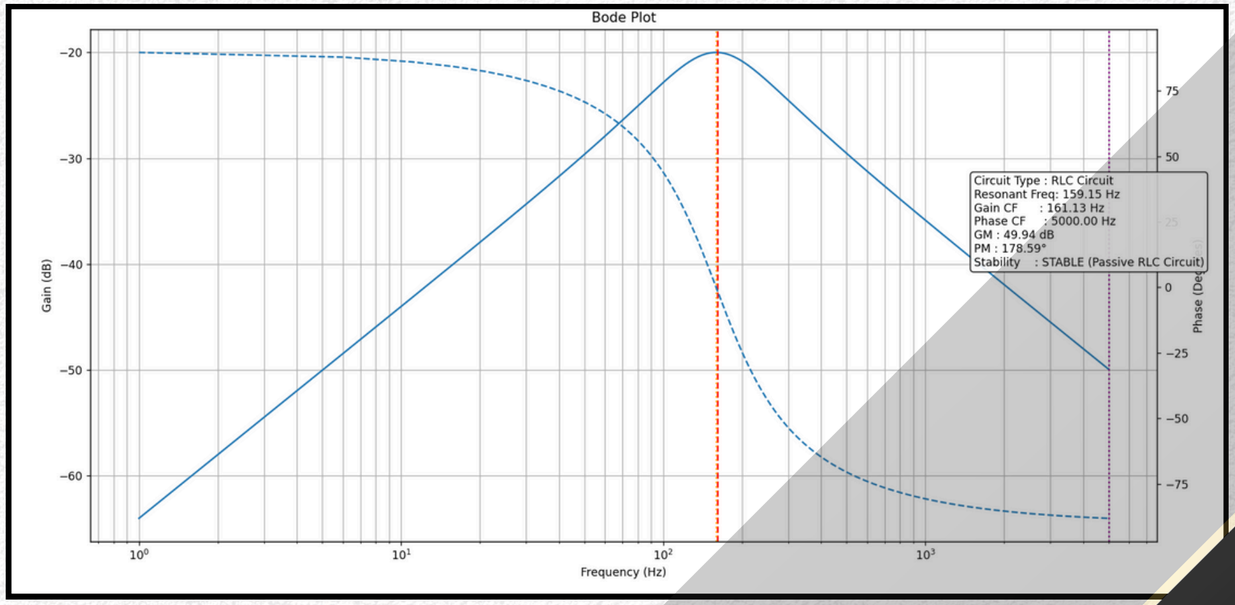


Why This Project is Useful?

- Helps understand frequency domain response
- Simplifies RLC circuit performance analysis
- Avoids complex manual calculations fully
- Visualizes gain and phase variation
- Provides automatic stability prediction feature
- Ideal for electronics learning and simulation

What is a Bode Plot?

- Frequency response graph for systems
- Shows magnitude versus input frequency
- Shows phase shift versus frequency
- Helps identify resonance and behavior
- Used widely in control engineering
- Essential for stability margin estimation



Why Bode Plot Is Done?

- To determine gain crossover frequency
- To determine phase crossover frequency
- Check system stability using margins
- Visualize resonant frequency of circuit
- Observe damping and peak response
- Evaluate transfer function performance

Important Formulas

- **Angular frequency $\omega = 2\pi f$**
- **Impedance $Z = R + j\omega L + 1/j\omega C$**
- **Transfer function $H = 1/Z$**
- **Gain magnitude = absolute H**
- **Phase angle = angle of H**
- **Resonant frequency $f_0 = 1/2\pi\sqrt{LC}$**

Circuit Type and Stability Detection

- LC circuit : R equals zero ; RC circuit : L equals zero
- RL circuit : C equals zero ; RLC circuit : all present
- Pure resistive : only resistor exists

- Stable system : resistance is positive
- Unstable system : resistance is negative
- Marginal stability : resistance equals zero

- Code prints stability result clearly
- Code identifies circuit automatically

Important Code Lines

Taking User Inputs

```
R = float(input("Resistance R (Ohms)       : "))
L = float(input("Inductance L (Henrys)     : "))
C = float(input("Capacitance C (Farads)    : "))
f_start = float(input("Start Frequency (Hz)      : "))
f_end   = float(input("End Frequency (Hz)        : "))
points  = int(input("Number of Frequency Points: "))
```

Frequency and Impedance Calculation

```
frequencies = np.linspace(f_start, f_end, points)
omega = 2 * np.pi * frequencies
Z_total = R + 1j * omega * L + 1 / (1j * omega * C)
```

Transfer Function & Bode Data

```
H = 1 / Z_total
H_mag = np.abs(H)
H_phase = np.angle(H, deg=True)
H_mag_db = 20 * np.log10(H_mag + 1e-12)
```

Circuit Type Detection

```
if R == 0 and L != 0 and C != 0:
    circuit_type = "LC Circuit"
elif L == 0 and R != 0 and C != 0:
    circuit_type = "RC Circuit"
elif C == 0 and R != 0 and L != 0:
    circuit_type = "RL Circuit"
elif R != 0 and L != 0 and C != 0:
    circuit_type = "RLC Circuit"
else:
    circuit_type = "Pure Resistive Circuit"
```

Bode Plotting

```
fig, ax1 = plt.subplots(figsize=(10,6))
ax1.set_xscale("log")
ax1.plot(frequencies, H_mag_db, label="Gain (dB)")
ax2 = ax1.twinx()
ax2.plot(frequencies, H_phase, linestyle="--", label="Phase (Degrees)")
plt.title("Bode Plot")
plt.tight_layout()
plt.show()
```

Stability Check

```
if R < 0:
    stability = "UNSTABLE"
elif R == 0 and L != 0 and C != 0:
    stability = "MARGINALLY STABLE"
elif R > 0:
    stability = "STABLE"
```

Circuit Output and stability Cases

- LC circuit shows continuous oscillation
- RC circuit shows low-pass behavior
- RL circuit shows high-pass response
- RLC circuit shows resonance peak
- Pure resistor shows no phase shift
- Each case detected automatically

- Stable output decreases with frequency
- Unstable output grows uncontrollably high
- Marginal output maintains constant oscillation
- Gain margin displayed in decibels
- Phase margin shown in degrees
- Final stability printed on screen

Conclusion & Future Scope

- Analyzer works accurately for RLC circuits
- Provides complete frequency domain analysis
- Offers automatic circuit type identification
- Useful educational tool for electronics
- Future: add GUI interface feature
- Future: include time-domain simulation

THANK YOU