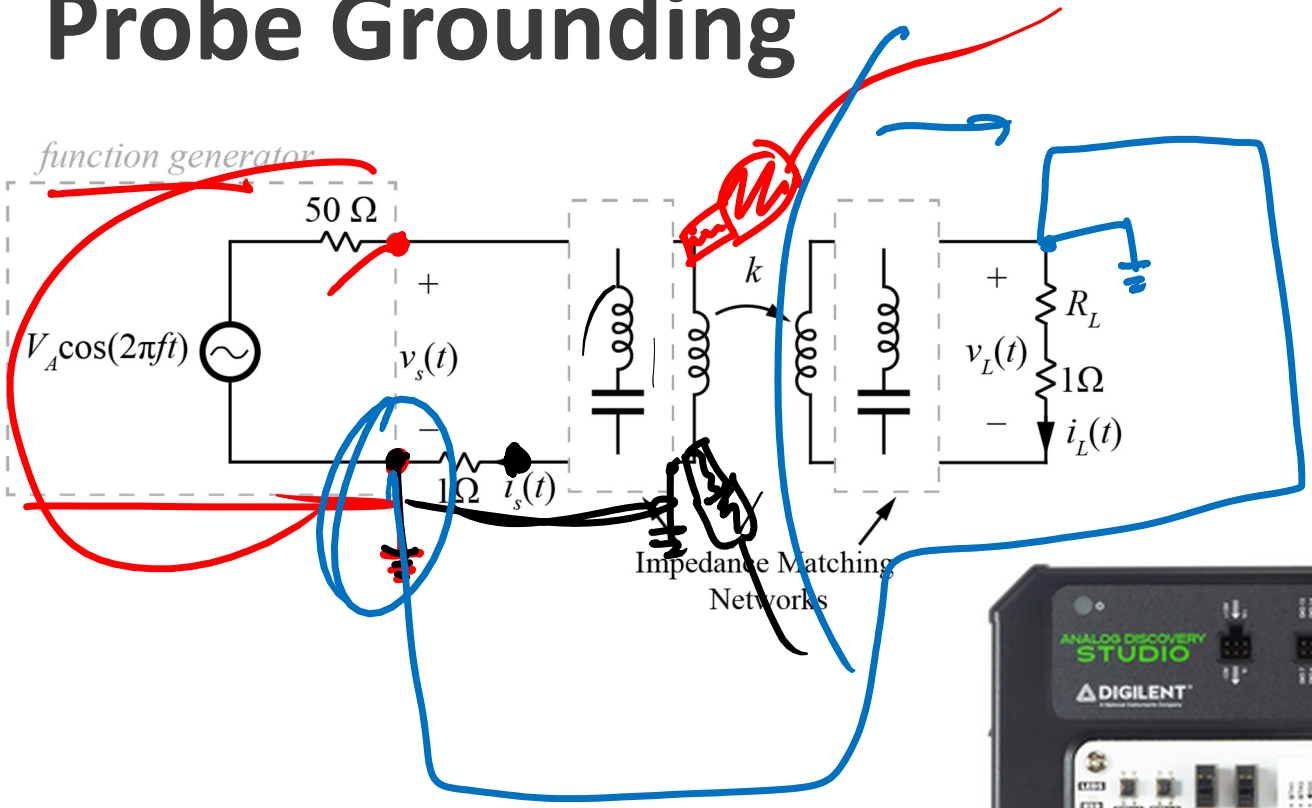
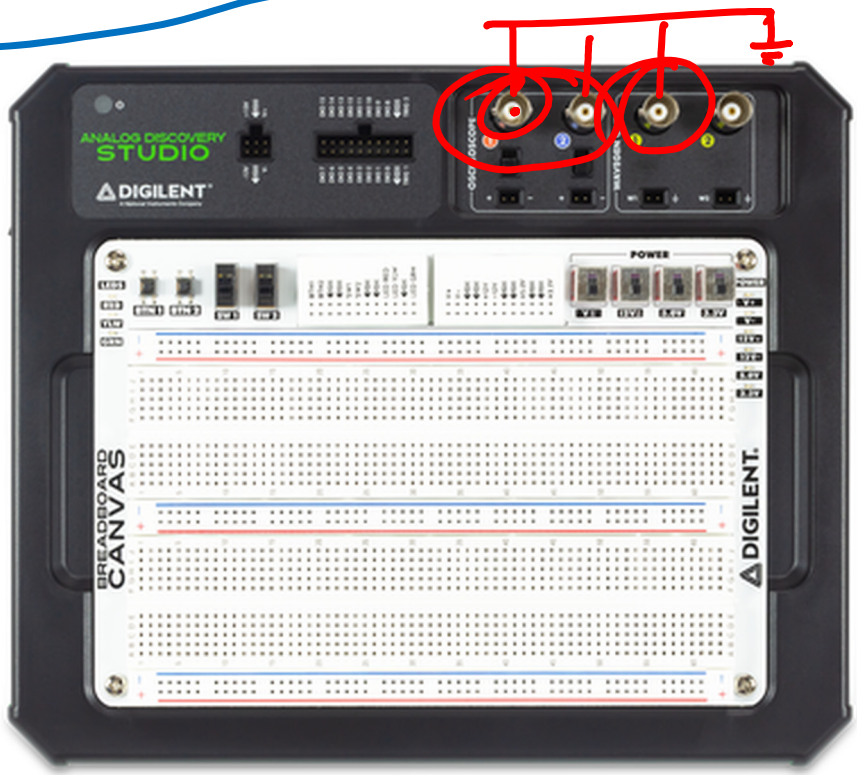
Probe Grounding





LTSpice Parameter Sweeps

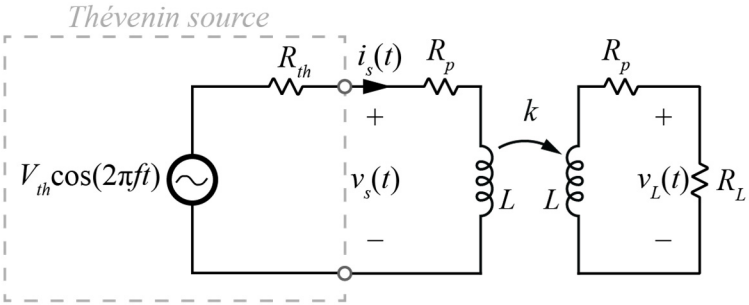
- Tutorial on website
  - linked from Experiment 1 on Assignments page

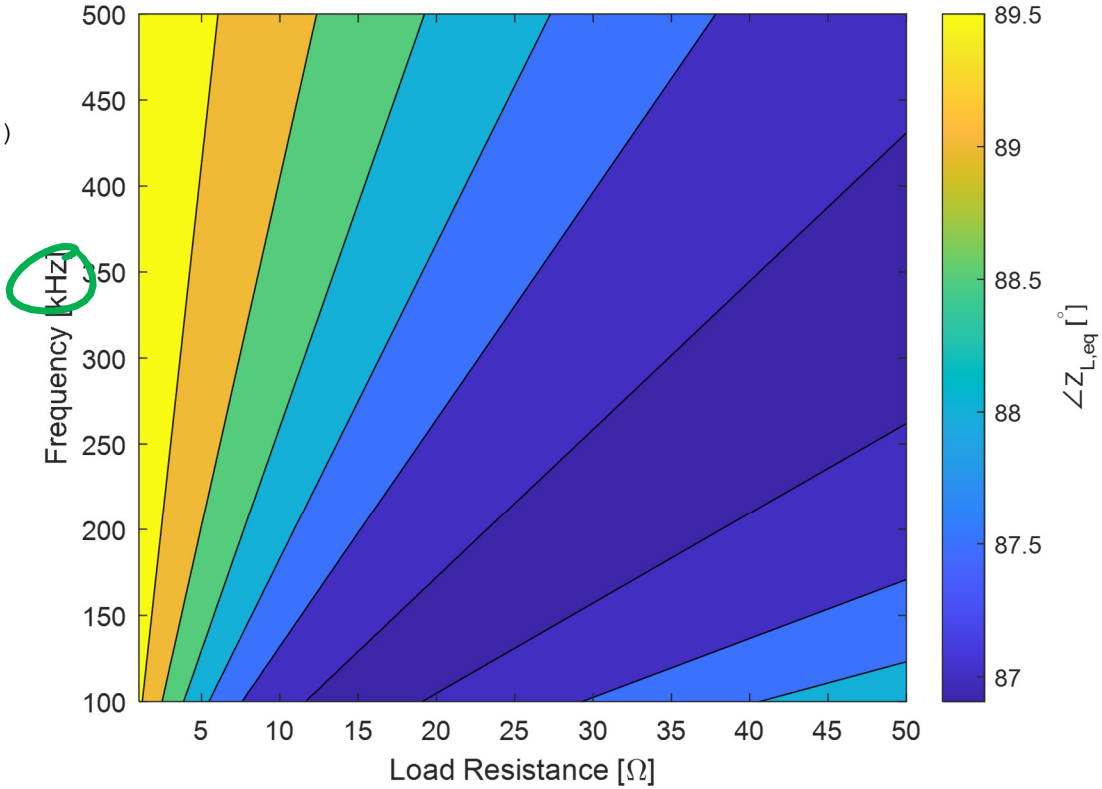
Elementwise Matrix Calculations in MATLAB

```
R = 1:1:50;
w = 2*pi*linspace(100e3,500e3,100);

[w,R] = meshgrid(w,R);

Zeq = 1j*w*(L-M)+1./(1./(1j*w*M) + 1./(1j*w*(L-M) + R));
contourf(R,w/2/pi/1000,angle(Zeq)*180/pi);
cb = colorbar;

ylabel('Frequency [kHz]');
xlabel('Load Resistance [\Omega]');

ylabel(cb,'\angle Z_{L,eq} [^\circ]')
```

50 pts

100 pts





Limitations of Phasor Analysis

Developed by looking at particular solution of circuit ODE under sinusoidal inputs

1. single frequency
2. sinusoids only
3. only steady-state waveforms
4. LTI systems only

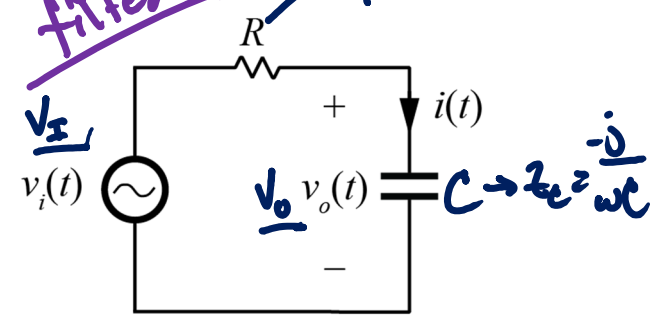
Next: develop methods to expand on 1–3

<u>Approaches</u>:

1. use superposition (in <u>time</u> domain) to produce multiple single-frequency subcircuits
   → Frequency Response Ch 15
2. Find a way to decompose <u>any</u> signal into a sum of sinusoids
   → Fourier Series & Transform Ch 17
3. Need to include exponentials in signals
   → Laplace Transform Ch 14

Frequency Response

Low-pass filter



$$\underline{V_o} = \underline{V_I}\,\frac{Z_C}{Z_R + Z_C} = \underline{V_I}\,\frac{-j/\omega C}{R - j/\omega C}$$

$$\underline{V_o} = \underline{V_I}\,\underbrace{\frac{1}{j R\omega C + 1}}_{\text{Frequency Response}}$$

$$\frac{\underline{V_o}}{\underline{V_I}} = \frac{1}{j\omega RC + 1} = \underline{\underline{H(j\omega)}}$$

= Frequency Response → some complex number that varies with ω and describes the t-ω relationship of the circuit or system.

$$H(j\omega) = \underbrace{|H(j\omega)| \measuredangle \angle H(j\omega)}$$

$$\underline{V_o} = \underline{V_I} \cdot H(j\omega)$$

$$= |V_I| \cdot |H(j\omega)| \measuredangle \left[\angle V_I + \angle H(j\omega)\right]$$

$$H(j\omega) = \frac{1}{j\omega RC + 1} = \frac{1}{\sqrt{1^2 + (\omega RC)^2}} \measuredangle \tan^{-1}(-\omega RC)$$