E157 Lecture 6 Day Plan

Any questions before quiz

Quiz + Team Quiz + Talk through solution

Q roundup

- Bandpass fractional bandwidth = 1/Q
- RLC ring down in step/impulse response \( \sim \) number of peaks to 5% = Q
- Series RLC \( Q = \sqrt{L/C}/R \)
- Parallel RLC \( Q = R/\sqrt{L/C} \)
- Series component \( Q = X/R \) \( \leftrightarrow \) This is frequency dependent! Not a full tank!
- Parallel component \( Q = B/G \)
- Can find a compound \( Q \) by mixing components
  - Parallel LC where both cap and inductor have ESR
  - draw schematic and do series-parallel drawign

Calculating Compound \( Q \) from components

- Same circuit as above
- \( X_S = X_P \cdot Q^2/(Q^2 + 1), \) \( R_S = R_P/(Q^2 + 1), \)
- \( Q \) here is from each element, but we know \( w_0 \) will be 1/\( \sqrt{LC} \).
  - \( Q_1 = 1/w_0 R_C = \sqrt{L/C}/R \) \( \leftrightarrow \) still IM/RE because series elements
  - \( Q_2 = w_0 L/R = \sqrt{L/C}/R \)
- Transform, then overall is \( (R_S R_C || R_S L_P)/\sqrt{L/C} \)
- NOTE that \( X_S \) is always < \( X_P \) and \( R_S \) is always < \( R_P \)

Practice ringing out in shunt – 50 ohm || 10pF || 100nH @1Grad/s – see below

- You are designing a matching network for a 10pF capacitor in shunt with a 50 Ohm resistor driven by a 1Grad/s signal sent through a 50 Ohm transmission line.
- \( B_n = wC/(1/Z_0) = Z_0 \cdot w \cdot C = 0.5 \)
- Need negative susceptance, so shunt \( L \)
- \( B_n = 1/wL/(1/50) = 50/wL \rightarrow 100nH \)
- \( Q = R/\sqrt{L/C} = 50/\sqrt{100e-9/10e-12} = 50/\sqrt{1e4} = 5 \)
  - \( \sqrt{1/LC} = 1Grad/s \rightarrow L*1e-11 = 1e-18 \rightarrow L=100nH \)

Some practical stuff

- Emphasize that networks of bypass caps exist to manage ESR and ESL.
- Also mention winding resistance for inductors