E157 Lecture 6 Day Plan

Any questions before quiz

Quiz + Team Quiz + Talk through solution

Sociotechnical minute: where do resistors/capacitors/inductors come from?

- https://eprints.whiterose.ac.uk/130419/1/LCA%20and%20EnvProfile%20Evaluations%20of%20Capacitors%20Manuscript%20-%20CLEAN.pdf
- Caps: Nickel paste for interlayer,
- Caps: Tantalum (Australia, Brazil, China, DRC, Rwanda, Nigeria, Colombia)
- Resistors: Carbon film
- Inductors: Just wire, ferric cores → iron
- All: Cu electrodes

Q roundup

- Bandpass fractional bandwidth = 1/Q
- RLC ring down in step/impulse response ~ 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 ← 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 drawing

Calculating Compound Q from components

- Same circuit as above
- XS=XP*Q^2/(Q^2+1), RS=RP/(Q^2+1),
- Q here is from each element, but we know w0 will be 1/sqrt(LC).
  - Q1=1/w0RC=sqrt(L/C)/R ← still IM/RE because series elements
  - Q2=w0L/R=sqrt(L/C)/R
- Transform, then overall is (RESRCP||RESRLP)/sqrt(L/C)
- NOTE that Xs is always < Xp and Rs is always <Rp

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.
- Bn = wC / (1/Z0) = Z0*w*C = 0.5
- Need negative susceptance, so shunt L
- Bn = 1/wL / (1/50) = 50/wL → 100nH
- Q = R/ sqrt(L/C) = 50/sqrt(100e-9/10e-12) = 50/sqrt(1e4) = 5
- sqrt(1/LC) = 1Grad/s → L*1e-11 = 1e-18 → L=100nH

Some practical stuff

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