Second Order Circuits III

EGR 220, Sections 8.5 – 8.7

October 27, 2009

Overview

- Second order circuits complete response
  - Natural response, *plus*
  - Forced response
- General RLC circuits
  - Develop the second order diff-eq. to solve for $i(t)$ or $v(t)$

Homework 8 Comments

- Finding $v(t)$ from $i(t)$ (8.17)
  - Integrate and include the initial condition as needed
- Using the differential equation to solve for $v(t)$ or $i(t)$
  - Using coefficients to find R, L, C and source

Terminology Review

- Define and describe how we find:
  - Characteristic equation $s^2 + \frac{R}{L}s + \frac{1}{LC}$ (series)
  - Natural frequencies $s_{1,2} = -\alpha \pm \sqrt{\alpha^2 - \omega_0^2}$
  - Resonant frequency $\omega_0 \equiv \frac{1}{\sqrt{LC}}$
  - Damping factor $\alpha \equiv \frac{R}{2L}$ (series) $\equiv \frac{1}{2RC}$ (parallel)
  - Damping frequency – for underdamped systems

2nd Order Circuit Analysis

1. Determine the type of damping (in order to know the form of the solution)
   - Write the general form of the solution, to use as you continue
2. Start finding the initial conditions
   - Decide which initial conditions are easiest to find, and do so
3. Find the natural or transient response
   - ⇨ Find the natural frequencies
4. Find the forced response, $x_f(t) = x_f(\infty)$
   - ⇨ Set up the solution with s_1 and s_2 substituted in, leaving the constants unknown
5. Solve for the constants, using the initial conditions
6. Check that your solution makes sense

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Recap: Solution Format

$$x(t) = X_f + X_n$$

$$x(t) = X_f + A_1 e^{s_1 t} + A_2 e^{s_2 t}$$

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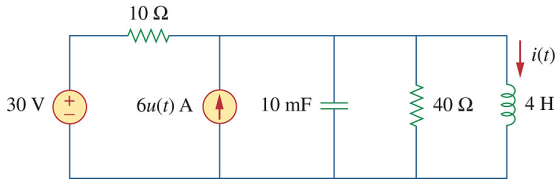
Step Response of Parallel RLC Circuit

- Find $v(t)$ for t > 0?



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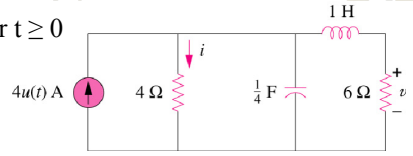
General Second Order Circuit

- Find $i(t)$ and $v(t)$ for t ≥ 0



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Summary

- Step response of
  - Parallel RLC circuits (KCL)
  - Series RLC circuits (KVL)
- General solution approach for second order circuits

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Office Hours

- Tuesday
  - 2:30 – 3:30
- Wednesday
  - Lunch

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