ELECTRIC CIRCUITS ECSE-2010

Lecture 15 and 16



REVIEW: CIRCUITS WITH LAPLACE

- 1. Find Initial Conditions
- 2. Determine Laplace Equivalent circuit
- 3. Use Unit 1 concepts (node/mesh/voltage dividers etc.) to find an expression for the parameter of interest (impedances)
 - a. "Clean up" expression to have -N(s)
- 4. Find poles (zeros, Unit 3) D(s)
- 5. Partial fraction expansion
 - a. Cover up rule for coefficients or F(0), F(1)
- 6. Inverse Laplace gives time domain response



CP 15



In the circuit above, the voltage source is 5V for t<0 and 10 V for t >0.

a. Draw the s-domain equivalent circuit. Include the intial conditions in your s-domain circuit. Label your component values using symbolic notation (i.e. sL1).



.....A TOUGH ONE - FALL 2015 FINAL

3) Transient Response (25 points)

This problem was graded with grace. It's a tough one.



In the above circuit, switch U1 is closed (shorted) for t<0 and opens at t = 0. (Be careful with polarities which are indicated for C and L).

Remember this problem from Exam 2! You were asked to find VC(t) for t>0 using differential equations. The exponential version of the correct answer is:

$$V_{C}(t) = 6 + \left[(2 - 4.271i) \left[e^{(-3+\sqrt{41}i)t} \right] + (2 + 4.271i) \cdot \left[e^{(-3-\sqrt{41}i)t} \right] \right]$$

a. Find VC(t) using laplace transforms. (It should match the equation above). Start by converting the above circuit elements to their laplace equivalents. Circuit diagrams are required for full credit.



www.rpi.edu/~sawyes

FIND INITIAL CONDITIONS

DRAW SCHEMATIC AT T=0-

- 1. Determine the voltage across the capacitor, VC, at t=0-
- 2. Determine the current through the inductor, IL, at t=0-

DRAW SCHEMATIC AT T=0+

- 1. Determine the voltage across the capacitor, VC, at t=0+
- 2. Determine the current through the capacitor, IC, at t=0+





S-DOMAIN CIRCUIT ANALYSIS

- Review S-domain conversion
- Circuit Theorems (Unit 1) in the S-Domain
 - KCL/KVL
 - Superposition
 - Thevenin/Norton
 - Node Analysis



S-DOMAIN CONVERSION





sawyes@rpi.edu

www.rpi.edu/~sawyes

HMWK 6 PROBLEM 4



In the above circuit, the source turns on at t=0 with a voltage of 10V. Additionally, switch U1 is closed and switch U2 is open. At 15E-6 s switch U1 opens and switch U2 closes. The source also turns off at 15E-6 s.

4.1: Use Laplace analysis to determine the voltage across the capacitor as a function of time for 0<t<15E-6 (s)



KCL/KVL



In the above circuit, a 5V DC source is shown. At t = 0, the switch in series with the capacitor is closed.







KCL/KVL





SUPERPOSITION

Two types of independent sources

- Voltage and current representing external driving forces for t>=0
- Initial condition voltage and current sources representing energy stored at t=0.
- S-domain response is the sum of two components
 - Zero input response (initial condition sources with external inputs turned off)
 - Zero state response (external inputs with the initial condition sources turned off).

SUPERPOSITION: ZERO INPUT, ZERO STATE





SUPERPOSITION: ZERO INPUT, ZERO STATE





NODAL ANALYSIS





NODAL ANALYSIS





S-DOMAIN W/INITIAL CONDITIONS





S-DOMAIN W/INITIAL CONDITIONS



