Handout #12
E84: Fall ‘07
10/10/07

E84: Midterm 1 Study Sheet

You are expected to know the following for the exam:
Ohm’s law
Solving ‘simple’ circuits
Polarity and how it affects Ohm’s Law equations
Combining series/parallel resistances, capacitances, inductances and conductances
KVL, KCL
Dependent sources
Mesh analysis/Nodal analysis
Superposition
Power/Max Power
Thevenin/Norton equivalents/Equivalent resistances (with and without dependent sources)
Finite gain and Ideal op-amps
Voltage across an inductor in terms of current, current across a capacitor in terms of voltage
DC Substitutions and knowing when you can make the DC assumption
Duality
$t=0-$, $0+$, ∞ problems
Rules about what can and cannot change instantaneously across different elements
RC/RL/RLC circuits (discharging/charging, i.e. natural response/step response/forced response)
Creating the 1st and 2nd order differential equations for circuits with inductors and/or capacitors
Analyzing opamp circuits with capacitors/inductors
Overdamped, underdamped or critically damped solutions
Finding initial conditions and using boundary conditions to get complete solutions

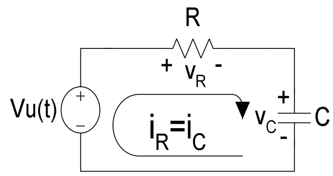
While you may be asked questions that stretch your thinking and that don’t look like something you’ve seen before, they will all be solvable using the tools we’ve learned in class.

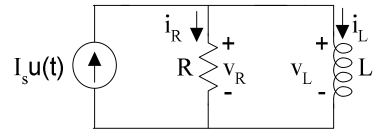
You will NOT have to know: equations in terms of charge, Cramer’s rule or determinants, energy equations or equations for calculating inductance, capacitance or resistance in terms of the area, length and material parameters.

You will be given the following equation sheet (on the back) and responsible for knowing when all of these equations apply and you should know the process for deriving the equations from the original circuits. You should know how the general equations I’ve provided change when there is no voltage source present (to get the discharging equations). You will only be asked to solve differential equations that follow the forms on this sheet. Again, you are expected to be able to handle manipulating the equations and determining the boundary conditions. Anything listed above that you need to know and isn’t on the back of this sheet – you should have memorized.

Calculators: You are allowed to use calculators – but only for basic mathematical operations. Meaning, you are not allowed to use them to solve integrals, systems of equations or even to do simple algebra. Basic math, perhaps a square or square root and an occasional exponential… that’s it. Rule of thumb – if you have to ask, you probably aren’t allowed to use your calculator for it.

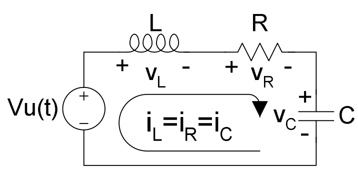
E84: Midterm Equation Sheet

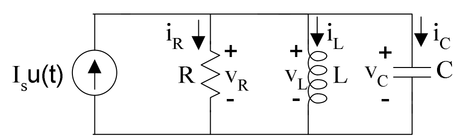




	RC in series with Voltage Source	**RL in parallel with a current source**
	$\frac{dv(t)}{dt}+\frac{1}{RC}v(t)=\frac{V_s}{RC}$	$\frac{di_L(t)}{dt}+\frac{R}{L}i_L(t)=\frac{RI_s}{L}$
Discharging (no source)	$v(t)=v(0)e^{\frac{-t}{RC}}$	$i_L(t)=i_L(0)e^{\frac{-tR}{L}}$
Charging	$v(t)=V_s(1-e^{\frac{-t}{RC}})$	$i_L(t)=I_s(1-e^{\frac{-tR}{L}})$

Given the general 1st order differential equation: $\frac{dx(t)}{dt}+ax(t)=b$; $x(t)=\frac{b}{a}+Ae^{-at}$





RLC series

$$\frac{d^2v(t)}{dt^2}+\frac{R}{L}\frac{dv(t)}{dt}+\frac{1}{LC}v(t)=\frac{V}{LC}u(t)$$

RLC parallel

$$\frac{d^2i(t)}{dt^2}+\frac{1}{RC}\frac{di(t)}{dt}+\frac{1}{LC}i(t)=\frac{I_s}{LC}u(t)$$

Given the general 2nd order differential equation: $\frac{d^2y(t)}{dt^2}+2\alpha\frac{dy(t)}{dt}+\omega_n{}^2y(t)=K_1$

Solution is: $y(t)=\frac{K_1}{\omega_n{}^2}+A_1e^{s_1t}+A_2e^{s_2t}$, where: $s_1=-\alpha-\sqrt{\alpha^2-\omega_n{}^2}$, $s_2=-\alpha+\sqrt{\alpha^2-\omega_n{}^2}$

Specific "final" answers:

$\alpha^2>\omega_n{}^2$: overdamped, $y(t)=\frac{K_1}{\omega_n{}^2}+A_1e^{s_1t}+A_2e^{s_2t}$

$\alpha^2<\omega_n{}^2$: underdamped, $y(t)=\frac{K_1}{\omega_n{}^2}+e^{-\alpha t}(B_1\cos\omega_d t+B_2\sin\omega_d t)$ where $\omega_d=\sqrt{\omega_n{}^2-\alpha^2}$

$\alpha^2=\omega_n{}^2$: critically damped, $y(t)=\frac{K_1}{\omega_n{}^2}+(A_1t+A_2)e^{-\alpha t}$