Score summary (leave blank):	
P1:	____
P2:	____
P3:	____
P4:	____
P5:	____
Total:	____

Name: Solutions

SID: ____________________

Name of student behind you:

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Name of student in front of you:

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UNIVERSITY OF CALIFORNIA
College of Engineering
Department of Electrical Engineering
and Computer Sciences

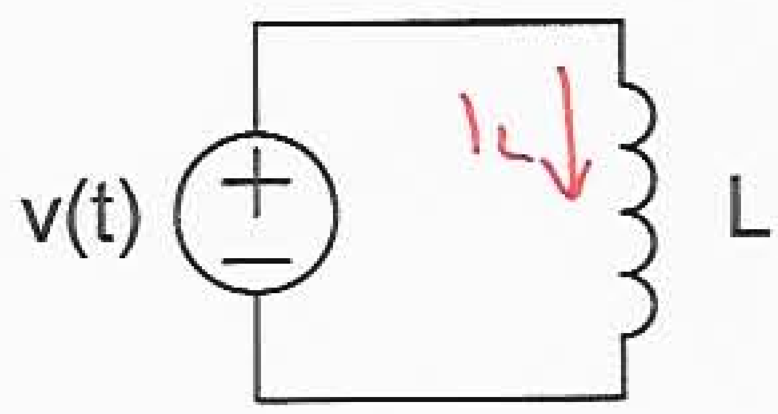
Midterm 2

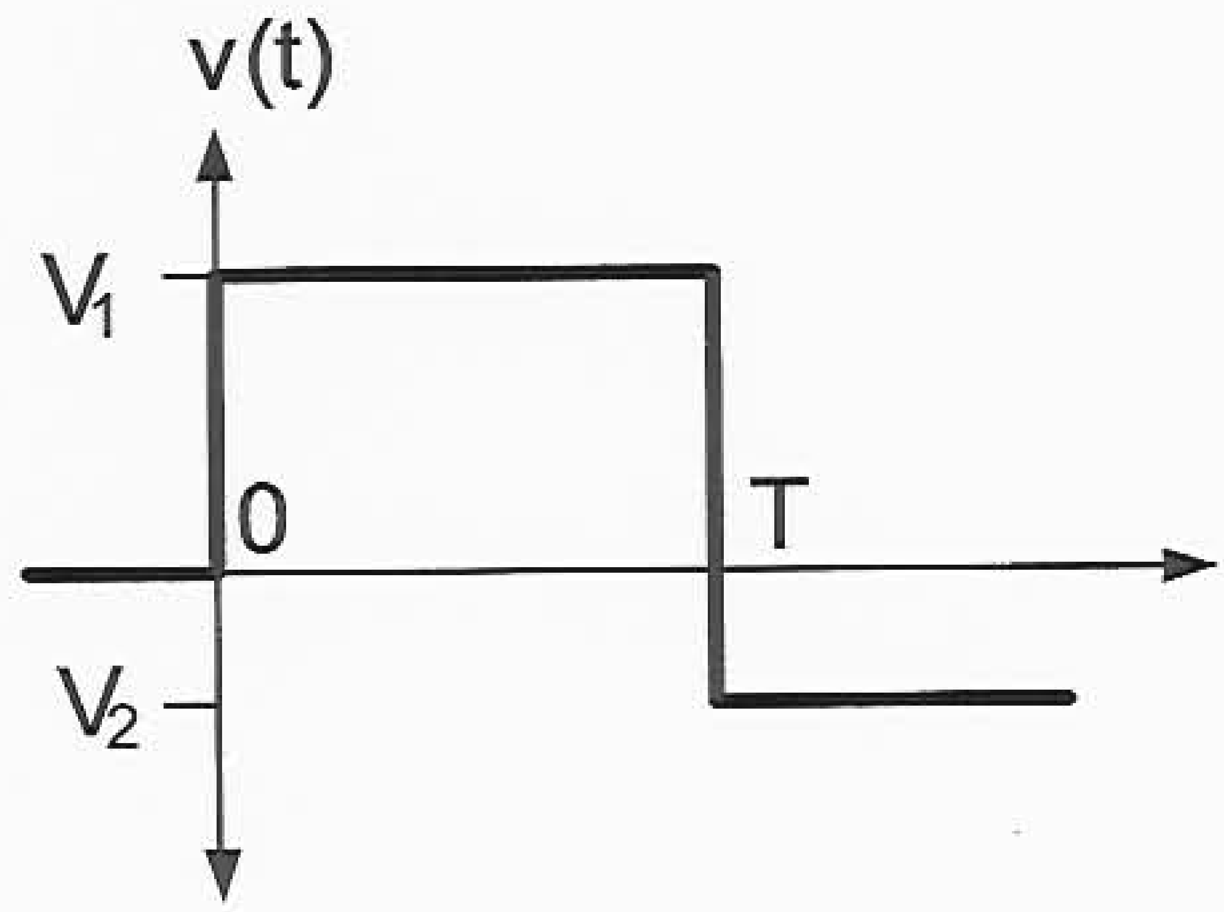
EECS 42/100
FALL 2007

B. E. BOSER

- *Closed book, closed notes.*
- *No calculators.*
- *Leave packs and with books and cell phones in isle.*
- *Copy your answers into marked boxes on exam sheets.*
- *Simplify numerical and algebraic results as much as possible.*
  Up to 10 points penalty for results that are not reasonably simplified.
- *Mark your name and SID at the top of the exam and all extra sheets.*
- *Be kind to the graders and write legibly. No credit for illegible results.*
- *No credit for multiple differing answers for same problem.*

Problem 1 [20 points]





The voltage source $v(t)$ in the diagram above applies a voltage V_1 for $0 \le t \le T$ and V_2 for $t > T$. For $t < 0$ the voltage is zero and the inductor current is zero. Derive algebraic equations for the power $p_1(t)$ delivered by the source for $0 \le t \le T$ and the power $p_2(t)$ delivered for $t > T$.

$p_1(t) = V_1^2 t / L$

$p_2(t) = \dfrac{V_2^2 (t-T)}{L} + \dfrac{V_1 V_2 T}{L}$

$$V(t) = L \frac{di_L}{dt}$$

$$\int_0^t \frac{V(\tau)}{L} d\tau = i_L(t)$$

FOR $0 < t < T$

$V(t) = V_1$

$i_L(t) = V_1 t / L$

FOR $t > T$ $V(t) = V_2$

$$i_L(t) = \int_T^t \frac{V(\tau)}{L} d\tau + i_L(T) = \int_T^t \frac{V_2}{L} d\tau + \frac{V_1 T}{L}$$

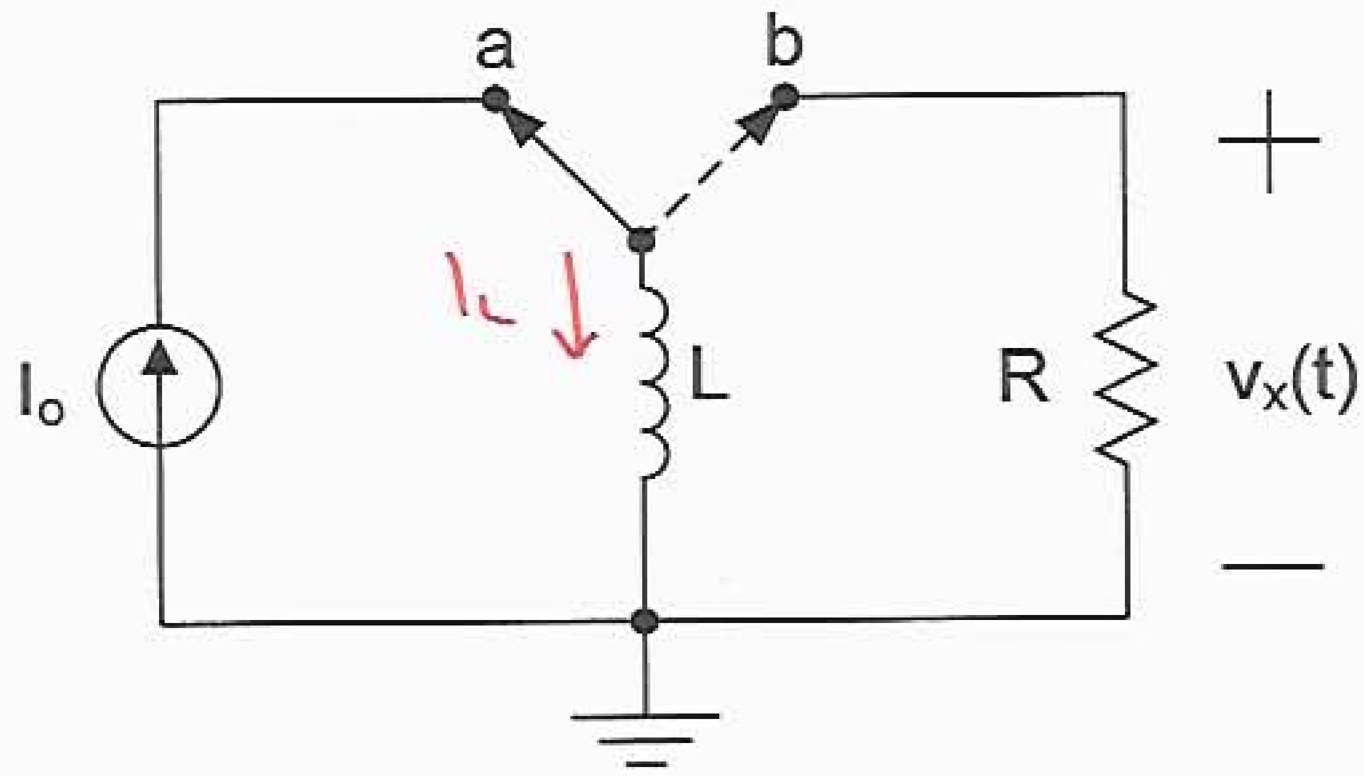
$$= \frac{V_2 (t-T)}{L} + \frac{V_1 T}{L}$$

$P = I \cdot V$

$P_1(t) = V_1 \cdot V_1 t / L = V_1^2 t / L$

$$P_2(t) = V_2 \left[\frac{V_2 (t-T)}{L} + \frac{V_1 T}{L} \right] = \frac{V_2^2 (t-T)}{L} + \frac{V_1 V_2 T}{L}$$

Problem 2 [20 points]



In the circuit shown above the switch is in position (a) for $t<0$ and in position (b) for $t\geq 0$. Find an algebraic expression for $v_x(t)$ for $t\geq 0$.

$$v_x(t) = -R I_o e^{-tR/L}$$

$t<0$, $I_L = I_o$

$t>0$

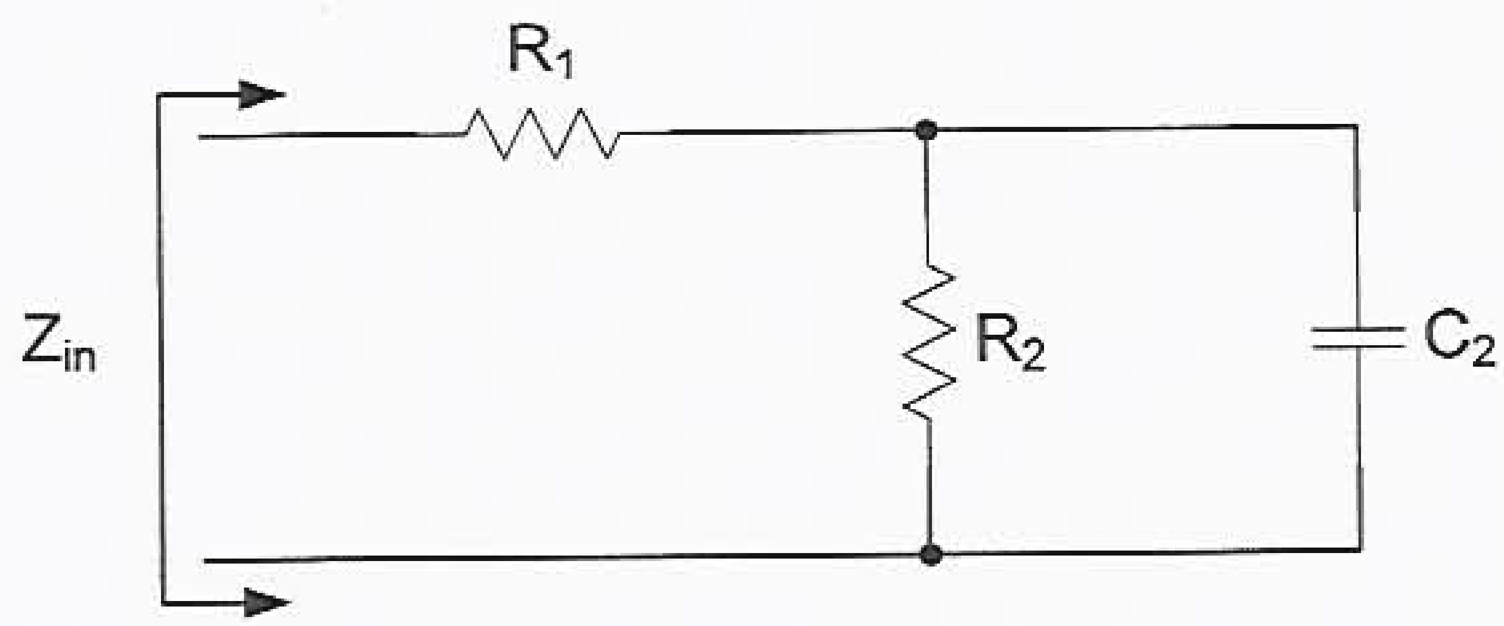
$V_x = -R I_L$, $V_x = L\frac{dI_L}{dt}$

I_L OF FORM $Ae^{-t/\tau}$ WITH $A = I_o$, $\tau = L/R$

$I_L = I_o e^{-t R/L}$

$V_x = -R I_o e^{-tR/L}$

Problem 3 [20 points]



Find an algebraic equation for the imaginary part of $Z_{in}(j\omega)$.

$$Im\{Z_{in}\} = \frac{-\omega R_2^2 C_2}{1+\omega^2 R_2^2 C_2^2}$$

$$Z_{in} = R_1 + R_2 // Z_{C2}$$

$$= R_1 + \frac{R_2 Z_{C2}}{R_2 + Z_{C2}} = R_1 + \frac{R_2 / sC_2}{R_2 + 1/sC_2}$$

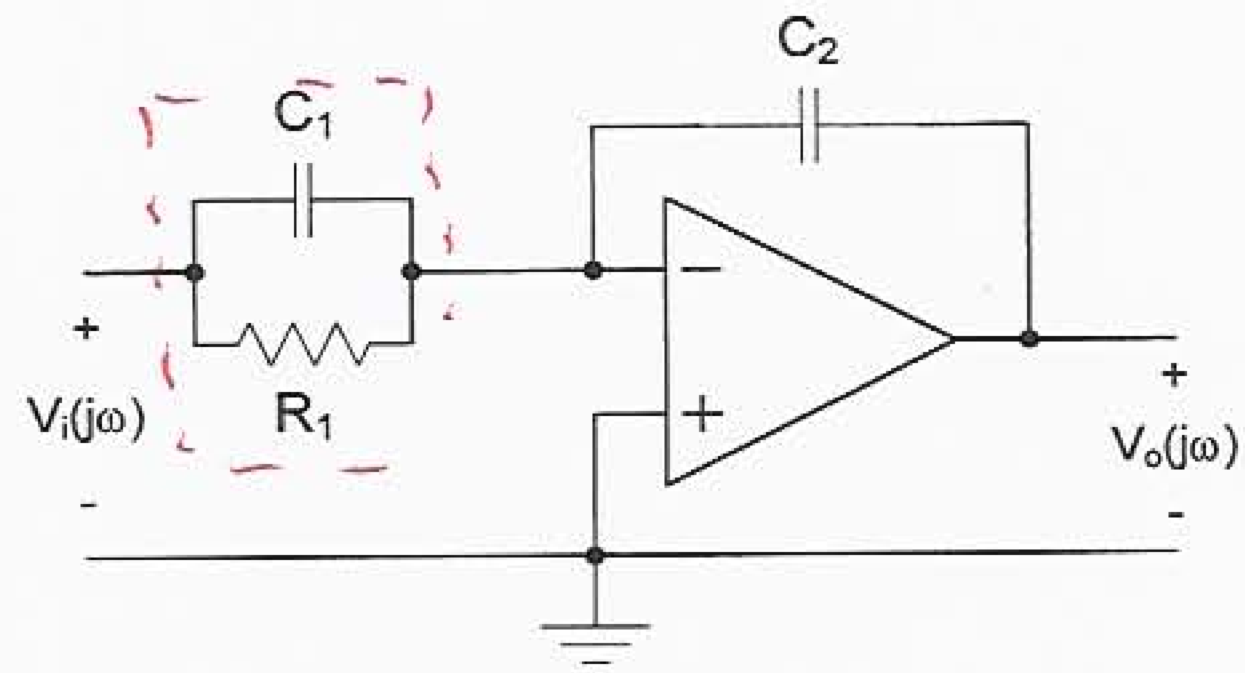
$$= R_1 + \frac{R_2}{1+sR_2C_2}$$

$$= R_1 + \frac{R_2}{1+sR_2C_2} \cdot \frac{1-sR_2C_2}{1-sR_2C_2}$$

$$= R_1 + \frac{R_2 - sR_2^2 C_2}{1+\omega^2 R_2^2 C_2^2} = R_1 + \frac{R_2 - j\omega R_2^2 C_2}{1+\omega^2 R_2^2 C_2^2}$$

$$Im(Z_{in}) = \frac{-\omega R_2^2 C_2}{1+\omega^2 R_2^2 C_2^2}$$

Problem 4 [20 points]



Derive an equation for the transfer function $H(j\omega) = \frac{V_o(j\omega)}{V_i(j\omega)}$.

$$\boxed{H(j\omega) = -\frac{1 + j\omega R_1 C_1}{j\omega R_1 C_2}}$$

$V_- = V_+ = 0$

KCL @ V_- CUTTREN ENTERING THE NODE

$$\frac{V_1}{R_1} + V_1 \cdot sC_1 + V_o \cdot sC_2 = 0$$

$$V_1\left(\frac{1}{R_1} + sC_1\right) + V_o s C_2 = 0$$

$$-V_1\left(\frac{1 + sR_1C_1}{R_1}\right) = V_o\, s C_2$$

$$H(s) = \frac{V_o}{V_1} = -\frac{1 + sR_1C_1}{sR_1C_2}$$

$$H(j\omega) = -\frac{1 + j\omega R_1 C_1}{j\omega R_1 C_2}$$

Problem 5 [20 points]

Draw the Bode plot (magnitude and phase) of the following transfer function:

$$H(s) = \frac{Ks}{1 - \frac{s}{p_1}}$$

for $K = \frac{1}{1krad/s}$ and $p_1 = -10krad/s$ in the semilog paper provided below. Mark the axes (units and tick values).