Department of Electrical & Computer Engineering
University of California, Santa Barbara

ECE 2B
Summer 2009
Shynk
H.O. #11

EXAMPLE MIDTERM EXAM

INSTRUCTIONS

1. This exam is **open book and open notes**. You may use a calculator.
2. It consists of 3 problems and is worth a maximum of 80 points. The problems are not of equal difficulty, so use discretion in allocating your time. Answer all questions in any order.
3. Show your answers in the spaces provided, and use the back side of the exam pages if you need additional work space. **Show your reasoning and the essential steps clearly and concisely.**

Last Name, First Name: ____________________

Scores:

1. ______

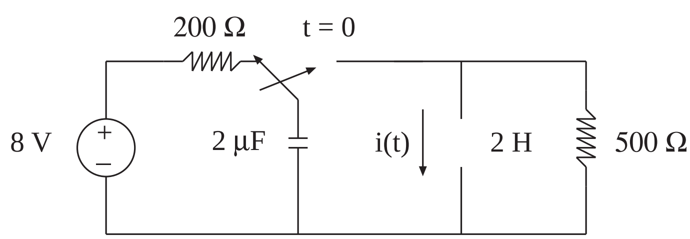
2. ______

3. ______

Total: ______

1. TIME-DOMAIN CIRCUIT ANALYSIS (30 points)

The switch in the RLC circuit shown below has been open since $t = -\infty$. (a) Write a differential equation that models the current $i(t)$ for $t \geq 0$. (b) Determine the characteristic equation and specify the type of damped circuit. (c) Write an expression for $i(t)$ for $t \geq 0$ (using the appropriate initial conditions) that satisfies the differential equation.



Solution:

2. LAPLACE TRANSFORM ANALYSIS (30 points)

Consider an RLC circuit with a voltage described by

$$v(t) + \frac{R}{L}\int_0^t v(\tau)d\tau + RC\frac{dv(t)}{dt} = V_o u(t) \qquad (1)$$

where V_o corresponds to an independent voltage source, and $v(0^-) = 0$ V. Assume that $R = 50\ \Omega$, $C = 2 \times 10^{-3}$ F, $L = 10$ H, and $V_o = 5$ V. (a) Find an expression for the Laplace transform $V(s)$ of the voltage. (b) Find an expression for the time-domain voltage $v(t)$ (for $t \geq 0$) from a partial fraction expansion of $V(s)$. (c) Determine if the type of circuit changes (i.e., overdamped, underdamped, or critically damped) if R is increased, and state whether $v(t)$ decays faster or slower to its final value.

Solution:

3. TRUE/FALSE STATEMENTS (20 points)

Determine which of the following statements are true (T) and which are false (F). You need not give any reasons for your answers (because partial credit will not be given). Each one is worth 4 points.

1. ___ The function $h(t)$ must decay to zero if its Laplace transform is $H(s) = \frac{5}{s(s+2)}$.
2. ___ A diode is placed in series with a 500 Ω resistor and a 2 V source. Using the exponential model of the diode with $n = 1$, $V_T = 0.025$ V, and $I_S = 10^{-12}$ mA, and with an initial voltage estimate of $V_D = 0.7$ V, the first computed value of V_D will be smaller.
3. ___ The inverse transform of $F(s) = \frac{s+e^s}{s^2}$ is $f(t) = u(t) + tu(t-1)$.
4. ___ In the RLC circuit of Problem 1, the voltage across the 500 Ω resistor has the same characteristic equation as the current through the inductor.
5. ___ If the load impedance Z_L at the output of a transformer (with nonzero and finite values of L_1, L_2, and M) is increased, then the input impedance of the transformer is decreased.