ECE 3510 Exam 1 given: Spring 06

(The space between problems has been removed.)

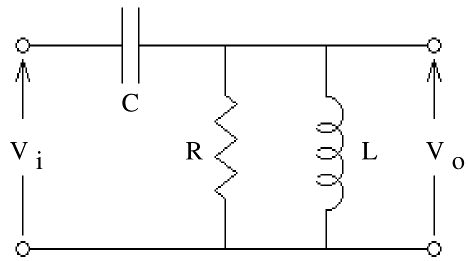
1. (24 pts) Find the inverse Laplace transform of the following function:

   Use partial fraction expansion and the tables.

   Show all your work to get credit.

$$F(s) := \frac{1}{(s+2)\cdot(s+1)^2}$$

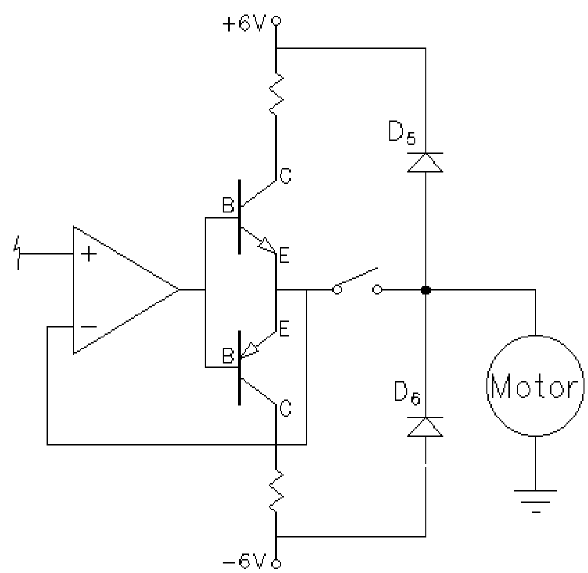
2. (15 pts) Find the transfer function $H(s) = \dfrac{V_o(s)}{V_i(s)}$ for this circuit.



   Write $H(s)$ in the normal form, as a ratio of polynomials.
   Don't divide the polynomials. Initial conditions are 0.

   You <u>MUST</u> show work to get credit.

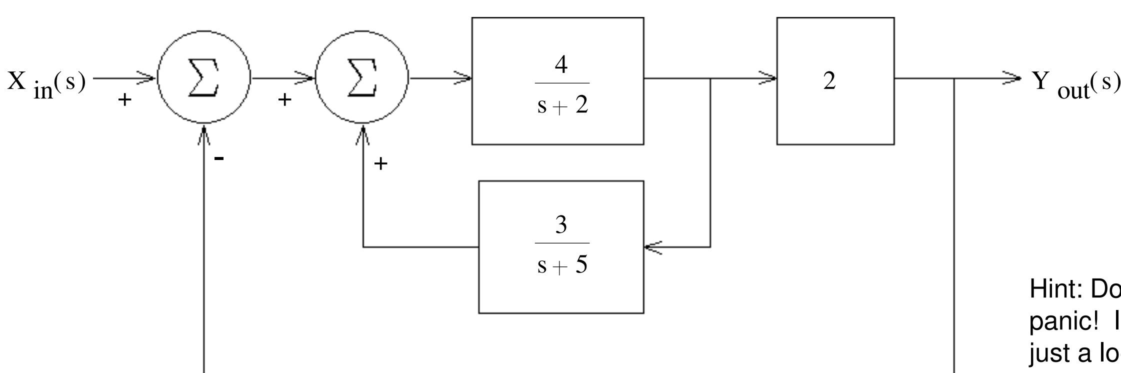
3. (5 pts) In the schematic at right,
   What is the purpose of diodes D_5 and D_6?



4. (21 pts) For the feedback system shown below, find the transfer function of the whole system, with feedback.

   Find $H(s) = \dfrac{Y_{out}(s)}{X_{in}(s)}$

   Simplify your expression for $H(s)$ so that he numerator and denominator are both simple polynomials



Hint: Don't panic! It's just a loop inside a loop.

5. (25 pts) Consider the **step response** of a system has the following transfer function:

$$H(s) = \frac{s + 15\cdot k}{s^2 + 6\cdot s + 5\cdot k} \qquad \text{Step input:} \quad x(t) = 2\cdot u(t)$$

a) What is the DC gain of this system?

b) What is the final value of the output (steady-state value)?

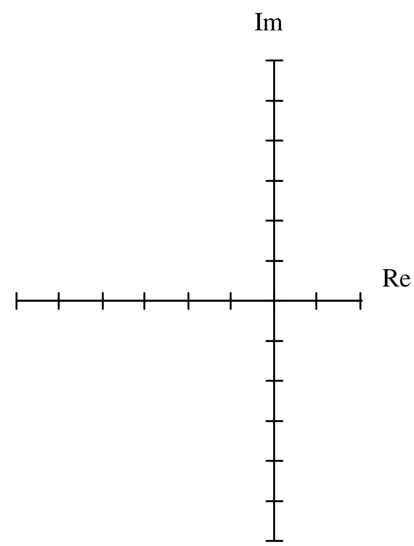
c) What value of k will make the output critically damped?
(you may leave k in the form of a fraction)

d) $k = 1$, the output is: (Circle one)

A) underdamped B) critically damped C) overdamped

e) $k = 5$, the output is: (Circle one)

A) underdamped B) critically damped C) overdamped



f) For the underdamped case above (d or e), Express $H(s)$ in the following form. Insert the value of k and find the values of a and b.

$$H(s) = \frac{s + 15\cdot k}{(s + a)^2 + b^2}$$

g) Draw the poles from the system of part f).
Make sure I can tell the values of the real & imaginary parts.

6. (10 pts) This system: $H(s) = \dfrac{k}{s + a}$

Has this input: Cosine input: $x(t) = \cos(\omega_o\cdot t)\cdot u(t)$ $\quad X(s) = \dfrac{s}{s^2 + \omega_o{}^2}$

Resulting in this output: $Y(s) = \dfrac{k}{(s + a)}\cdot\dfrac{s}{\left(s^2 + \omega_o{}^2\right)}$

This separates into 3 partial fractions that you can find in the laplace transform table. Show what they are, but don' t find the coefficients. $\quad Y(s) = \dfrac{k}{(s + a)}\cdot\dfrac{s}{\left(s^2 + \omega_o{}^2\right)} = ?$

Continue with the partial fraction expansion just far enough to find the **transient** coefficient.

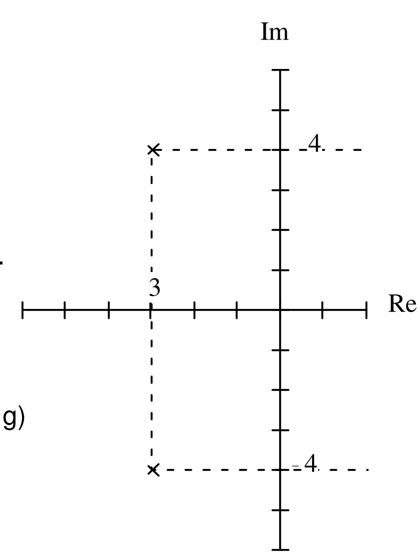
<u>Answers</u>

1. $\left(e^{-2\cdot t} - e^{-t} + t\cdot e^{-t}\right)\cdot u(t)$ 2. $\dfrac{s^2}{s^2 + \dfrac{1}{C\cdot R}\cdot s + \dfrac{1}{L\cdot C}}$

3. The motor is an inductive load, so its current cannot change instantaneously. This can be a significant problem when the transistors suddenly shut off. The "flyback" diodes provide a harmless path for the current to decay to zero.

4. $\dfrac{8\cdot s + 40}{s^2 + 15\cdot s + 38}$ 5. a) 3 b) 6 c) 1.8

d) C) overdamped e) A) underdamped f) $\dfrac{s + 75}{(s + 3)^2 + 4^2}$ g)



6. $\dfrac{-k\cdot a}{a^2 + \omega_o{}^2}$