EE321 Second Midterm Exam

Spring 2001

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Instructions: You are permitted to use a **self-prepared** study-guide limited to one ($8\frac{1}{2}$" $\times$ 11") page (both sides). **Show all the intermediate steps for credits.**

1. (20 pts.) Find the Laplace transforms of the following functions: (using either direct integration or convolution and time–shifting properties with table)

   (a) $f(t) = (10 - e^{-5t}) \cdot u(t-2)$

   (b) $x(t) = (\cos(2\pi t) - 3)^3 \cdot \delta(t)$

   (c) $y(t) = e^{-7t}u(t) * 3e^{-3t}u(t)$

   (d) $w(t) = 2tu(t-2)$

2. (15 pts.) Find the inverse Laplace transforms of the following functions:

   (a) $F_1(s) = \frac{s+6}{(s+1)(s^2+6s+8)}$

   (b) $F_2(s) = \frac{(s-5)e^{-2s}}{(s^2+5s+6)}$

   (c) $F_3(s) = \frac{s}{(s+1)(s^2+2s+5)}$

3. (10 pts.) **Initial and final value theorem:** Determine the initial and final values of the signals whose Laplace transforms are given. If the final values are not defined, state why.

   (a) $F_1(s) = \frac{s^2+s+2}{(s+2)(s^2+4s+3)}$

   (b) $F_2(s) = \frac{6s}{s^2+5s-6}$

4. (10 pts.) For a LTI system described by the transfer function

$$H(s) = \frac{s^2+4}{s^2+6s+8}$$

   find the steady–state system responses to the following inputs

   (a) $f_1(t) = 2 + \cos(2t+2)$

   (b) $f_2(t) = 2\cos(10\pi t - 1)$

5. (20 pts.) A LTI system is described by the following differential equation.

$$\frac{d^2y(t)}{dt^2} + 9\frac{dy(t)}{dt} + 14y(t) = 2\frac{dx(t)}{dt} + x(t)$$

   with the initial conditions: $y(0) = 2$, $\dot{y}(0) = -1$.

(a) Find transfer function $H(s)$ by observation.

(b) Find the zero input response using Laplace transform.

(c) Find the zero state response to $10e^{-4t}u(t)$ using the Laplace transform.

(d) Find the total response of the system to the signal $10e^{-4t}u(t)$.

6. (20 pts.) Draw Bode plots of following LTI systems

   (a) $H_1(s) = \frac{(s+10)}{(s+100)(s^2+25s+100)}$

   (b) $H_2(s) = \frac{10^4 s(s+20)}{(s+200)(s^2+85s+3600)}$

7. (15 pts.) The circuit in dashed box is a typical lowpass filtering circuit for a DC power supply found in many computer board. The purpose of this circuit is to remove high frequency noises that may be other wise coupled into the signal channel through the DC power supply. The voltage $f(t)$ is the input (source voltage) and the voltage $y(t)$ across the 10 KΩ load resister is the output (load voltage).

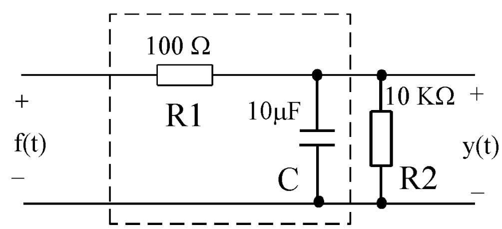

Figure 1:

   (a) Find the transfer function $H(s) = \frac{Y(s)}{F(s)}$. (Note: $z_1//z_2 = \frac{z_1 \cdot z_2}{z_1+z_2}$)

   (b) Calculate the eigenvalues at DC ($\omega = 0$), 3–dB cutoff frequency, and 10 times of the 3–dB cutoff frequency. Explain why it is a low pass filter.

   (c) If the capacitor is changed to $C = 50\mu F$, what will be the new 3–dB cutoff frequency and eigenvalues. Explain what will be the expected changes in frequency selectivity of the filter.

8. (10 pts. Matlab) Using Matlab to plot the magnitude (in dB scale) and phase (in degree) frequency responses of the LTI systems, $H_1(s)$ and $H_2(s)$, in problem 6. The frequency range should be the same as the Bode plots.

9. (10 pts. Matlab) Plot the magnitude and phase frequency responses (in linear scale) of the two lowpass filters (in problem 7 with two different capacitor values) on the same plots for the frequencies from DC to 100 Krad./sec. using Matlab.

Note: The matlab portion should be in one m-file. The m-file should be named with your_lastname.m. The m-file should be emailed to kxue@cs.wright.edu by 3pm on Wed. May 16, 2001.