HW 10 Control CENG 5131 Fall 2014

Due December 1 **Exam December 3**

November 20, 2014 Do the problems by hand unless otherwise indicated, but verify your results with MATLAB solutions to the problems when appropriate. You can only use symbolic MATLAB to check results.

Problem 1 10 points
If the impulse response of a system is

$$h(t) = 2e^{-5t}\cos(12t - \pi/2)\, U(t),$$

find the transfer function $H(s)$. Use properties to find result and then symbolic MATLAB "laplace" to check answer.

Problem 2 10 points
The input $x(t) = e^{-t}u(t)$ creates the output $y(t) = [1 - e^{-t}]u(t)$ when a linear, time-invariant system is tested. What is the transfer function $H(s)$?

Problem 3 30 points
Consider the first-order system defined by the equation

$$\tau\frac{dT(t)}{dt} + T(t) = f(t) \quad \text{with} \quad T(0) = 0.$$

If the input function is the ramp $f(t) = rt$,

1. Determine the response $T(t)$ using Laplace transform methods.
2. From $T(s)$, create the response in s using the "tf" command and plot the response from $0 \leq t \leq 1$ using the "impulse" command.
3. Plot $T(t)$ as in Part 2 using the "plot" command and compare results.

See the Example 1.2 in "Control Applications for 5131" on Web.
Problem 4 10 points
Is the control loop having the transfer function

$$T(s) = \frac{s+2}{s^2 + 2s + 3}$$

stable or unstable? Prove your result.

Problem 5 40 points
A system is described by the transfer function

$$G(s) = \frac{400}{s\ (s^2 + 30s + 200)},$$

(a) Plot the step response of the system in a unity feedback configuration. Note the rise time.

(b) Use a PID controller with $K_p = 9.0, K_d = 0.5, K_i = 40$ and plot the step response in the unity feedback configuration.

(c) Compare the two results and discuss.

(d) Consider the MATLAB command **step, tf, feedback, series**