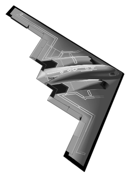
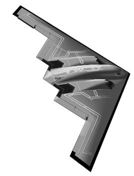


ECEN 3723 Systems I
Spring 2003

Computer Project



Objective: Using MATLAB tool to help you analyze the transient response of a system.

Requirement: Show all your steps, plots (responses) and clearly state your comments and explanations if required. Include all the MATLAB programs (documented), which is used to show your work.

Problem:

Given that the equation of motion for the system is as below:

$$\dddot{y}(t) + 52\ddot{y}(t) + 104\dot{y}(t) + 200y(t) = 50x(t)$$

1. Compute the transfer function (*full model*) of the equation of motion, where $x(t)$ is the input of the system. Assume all initial condition is zero.

2. Plot the step response of the transfer function from Part 1, where $x(t)$ is a step input to the system.

   (a) From the response clearly indicate the following specifications.

   - **Percentage Maximum overshoot** – The maximum overshoot is the maximum peak value of the response curve measured from the final steady state value of the response. It is defined by

     $$\%\ Max.\ Overshoot = \frac{y(t = peak\ value) - y(\infty)}{y(\infty)} \times 100\%$$

   - **Rise Time, t_r** – Time required for the response to rise from 10% to 90% (usually apply to second order overdamped systems) or 0%-100% (usually apply to second order underdamped systems).

   - **Peak Time, t_p** – Time required for the response to reach the first peak of the overshoot.

   - **Settling time, t_s** – Time required for the response curve to reach and stay within 2% of the final value. For second order system, t_s is about 4~5T.

- **Steady-State value** – The value that the response curve reaches the final value. ***Compute the*** $y(\infty)$ ***using the Final Value Theorem. Do the computed value match the steady state value from the response?***

3. From Part 1, **rewrite** the transfer function with the dominator polynomial has been **factored**. (Hint: You can use "***roots***" and "***poly***" commands to help you)

   (a) Compute the time constants, τ . Can the transfer function (*full model*) on Part 1 be reduced to a *reduced model*, which the question is "Are the time constants far apart" ? If so, what is the reduced model (Reduced transfer function)? (Hint: For second order system, the time constant, $\tau = \dfrac{1}{\zeta\omega_n}$)

   (b) Plot the step responses for the *full model* (transfer function in part 1) and the *reduced model* (Reduced transfer function in Part 3(a)) on the **same figure**. Do you agree that the reduced model is reasonable to approximate the full model? Explain.

4. (a) Get the discrete transfer function at the following sampling periods: $T = 0.01$; $T = 0.25$; $T = 1$.

   (b) Get the impulse responses of the discrete transfer functions from Part 4(a).

   (c) Plot the poles and zeros of the discrete transfer functions from Part 4(a).

5. Use the "***residue***" command to solve the transfer function from Part 1, where u(t) is an unit step input. (Hint: Solve for $y(t)$).