Exercises 4: Transien-Response Analysis by using MATLAB (FYSS 585)

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1. A first-order system, such as a R-C network, is given by the transfer function:

   $$G(s) = \frac{1}{1 + (sT)}$$

   Use the step and impulse functions in MATLAB to plot for $T = 1/5$
   (a) unit-step
   (b) unit-impulse
   (c) unit-ramp response. (Hint: See the latest version of the lecture notes from Lecture 3.)

2. A Boeing 747-300 aircraft has a transfer function between the joystick movement backwards-forwards in degrees and altitude in feet described by the transfer function:

   $$G(s) = \frac{30(s-6)}{s^3 + 4s^2 + 13s}$$

   Investigate the following using MATLAB:
   (a) The effect of a 1˚ impulse on the joystick backwards on the altitude of the plane.
   (b) The effect of a 1˚ impulse on the joystick forwards on the altitude of the plane.
   (c) The effect of a step change of 1˚ backwards in the altitude of the plane after 10 s.
   (d) The effect of a unit ramp movement of the stick backwards 1˚/s backwards for 10 s.
   (e) Which of (a), (b), (c), or (d) is best for passenger comfort?
   Hint : Movement of the joystick backwards moves the elevator ailerons up, lifting the nose. (FYI: 1 m is about 39 inches. 12 inches = one foot.)

3. The general 2nd order system transfer function that is characteristic of a servo-system is:

   $$G(s) = \frac{\omega_n^2}{s + 2\zeta\omega_n + \omega_n^2}$$

   where ω_n is the undamped natural frequency (rs^{-1}) and ζ is the damping ratio .
   Put $\omega_n = 1$ rs^{-1} and use MATLAB to plot the following:
   (a) The unit-impulse δ(0) response for $\zeta = 0, 0.2, 0.6, 1.0, 3.0$.
   (b) The response of a 3δ(0) impulse for $\zeta = 0, 0.2, 0.6, 1.0, 3.0$.
   (c) The unit-step l(0) response for $\zeta = 0, 0.2, 0.6, 1.0, 3.0$.
   (d) Make a table of ζ vs. the delay time t_d, rise time t_r, peaking time t_p, and settling time t_s for 5% deviation from steady state.
   (e) Comment on how to select ζ depending on what characteristics of the transient response is important.
   (f) When $\zeta >> 1$, what response form does G(s) approximate to?