Systems and Control Theory

Master Degree in ELECTRONICS ENGINEERING

(http://www.dii.unimore.it/∼lbiagiotti/SystemsControlTheory.html)

Exercises #2

Avvio di Matlab

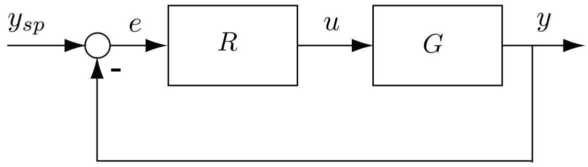
The exercises are carried out under Linux operating system. In order to start the MATLAB program and create the working directory `surname.name`, where all the MATLAB and SIMULINK files must be included, follow the procedure here reported:

1. Login with username and password used for the Unimore e-mail.
2. Open a `Terminal`.
3. Create the working directory and enter it with the commands
   ```
   mkdir cognome.nome
   cd cognome.nome
   ```
4. Open MATLAB with the command `matlab_R2006b`
5. Carry out the exercises, by using M-file, M-functions and SIMULINK schemes. Remember that the main file must be named `exercise.m` (in the first line of this file specify first name and surname, properly commented).

Text of the exercises

Design an M-file (exercise.m) that, with the help of other M-files and SIMULINK schemes if necessary, solves the following problems.

1. Given the feedback system reported in the figure



   (a) Build the Simulink scheme for simulating the step response when the continuous-time transfer functions $R(s) = \dfrac{10(s+0.5)}{s}$ and $G(s) = \dfrac{50}{(s+100)(s+0.5)}$ are considered (duration of the simulation 5s). In a unique figure plot the system's response $y(t)$ superimposed to the reference signal $y_{sp}(t)$ and the control variable $u(t)$ (two distinct subplots).

   (b) Simulate the step response of the feedback system with the discrete-time transfer functions $R(z) = \dfrac{10-9z^{-1}}{1-z^{-1}}$ and $G(z)$ obtained from $G(s)$ by discretization with sampling time $T_s = 0.1$ s (use the command `c2d` with the 'zoh' method). In a unique figure plot the system's response $y(k)$ superimposed to the reference signal $y_{sp}(k)$ and the control variable $u(k)$ (two distinct subplots).

   (c) Simulate the step response of the feedback system with the discrete-time transfer functions $R(z) = \dfrac{10-9z^{-1}}{1-z^{-1}}$ and the continuous-time plant $G(s)$. In a unique figure plot the system's response $y(t)$ superimposed to the reference signal $y_{sp}(t)$ and the control variable $u(t)$ (two distinct subplots).

   (d) Simulate the response of the system considered in the previous point, by considering a reference signal computed with the MATLAB function `[q_t] = TrjPoly3(q0,q1,T,dt)`, with $q_0 = 0$, $q_1 = 1$, $T = 2$, $dt = T_s$. Plot the same figure as in the points (a)-(c).

2. Design a Simulink system for solving the equation of a simple pendulum, i.e.

$$Ml^2\ddot{q}(t) + b\dot{q}(t) + Mgl\sin(q(t)) = \tau(t)$$

   where $\tau(t)$ denotes the input torque and q the pendulum angle. By assuming the parameters' values $M = 0.25$ Kg, $l = 1.2$ m, $g = 9.81$ m/sec^2, $b = 0.25$ Nm/rad sec, simulate the free response from the initial conditions $q(0) = \pi/2$, $\dot{q}(0) = 0$, the forced response to a constant input $\tau(t) = 2$ and the complete response of the system (duration of the simulations 8s). Plot in a unique figure (3 distinct subplots) the evolution of $q(t)$ in the three cases.