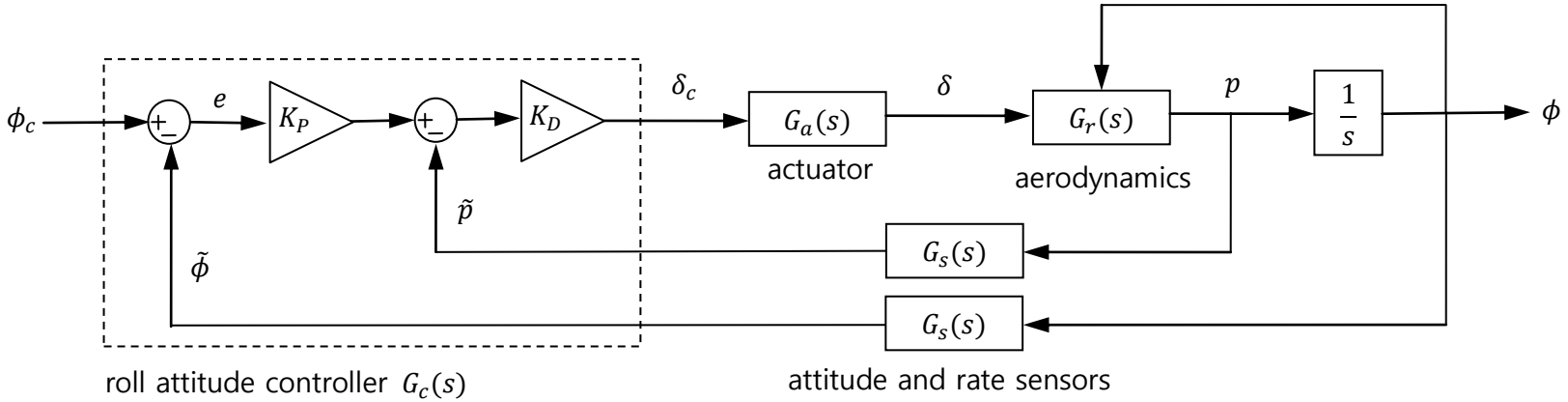
Numerical Analysis – Final Project

Due Data : Jun 23, 2014 (11:50pm)

On-line Submission Only (Report and Source Code)

Using your own C program, simulate the roll control loop of cruciform rocket system. The overall control loop is described by the following diagram.



The mathematical models and the relating parameters of subsystems consisting of the roll control loop are given as follows:

- roll attitude control gain $K_P = 27.0, \quad K_D = 0.003$
- transfer function of actuator $G_a(s) = \frac{\omega_a^2}{s^2+2\zeta_a\omega_a s+\omega_a^2}, \quad \zeta_a = 0.7$
- transfer function of sensor $G_s(s) = \frac{\omega_s^2}{s^2+2\zeta_s\omega_s s+\omega_s^2}, \quad \omega_s = 2\pi \cdot 100.0[rad/s], \ \zeta_s = 0.7$
- differential equations for aerodynamics $\dot{p}(t) = -L_p p(t) + L_\phi \sin\big(4\phi(t)\big) + L_\delta \delta(t), \qquad \dot{\phi}(t) = p(t)$
  $L_p = 3.2, \quad L_\phi = 1200, \quad L_\delta = 16000$

Using the Runge-Kutta4 method with the sampling time $T_s = 0.0005[sec]$ and the final time $T_f = 2.0[sec]$, calculate the response of the roll attitude control loop under the following conditions.

- actuator bandwidth $\omega_a = 2\pi \cdot 20.5[rad/s], \quad 2\pi \cdot 16.4[rad/s], \quad 2\pi \cdot 24.6[rad/s]$
- roll attitude command and initial roll angle $\phi_c = \frac{\pi}{4}[rad], \quad \frac{\pi}{8}[rad], \quad 0[rad], \qquad \phi(t=0) = \phi_c + 1.0 \cdot \frac{\pi}{180}[rad]$

Therefore, the simulation would be carried out for 9 different cases. For each case, you should attach three figures on your report.

- Figure 1: simulation time vs ϕ_c and $\phi[deg]$ plot
- Figure 2: simulation time vs $p[deg/s]$ plot
- Figure 3: simulation time vs δ_c and $\delta[deg]$ plot

The source code and the appropriate simulation results should be included in your report with brief comments for the source code.
(For verifying your program, you could compare the simulation results obtained by your own simulation program with those by the corresponding SIMULINK program.)