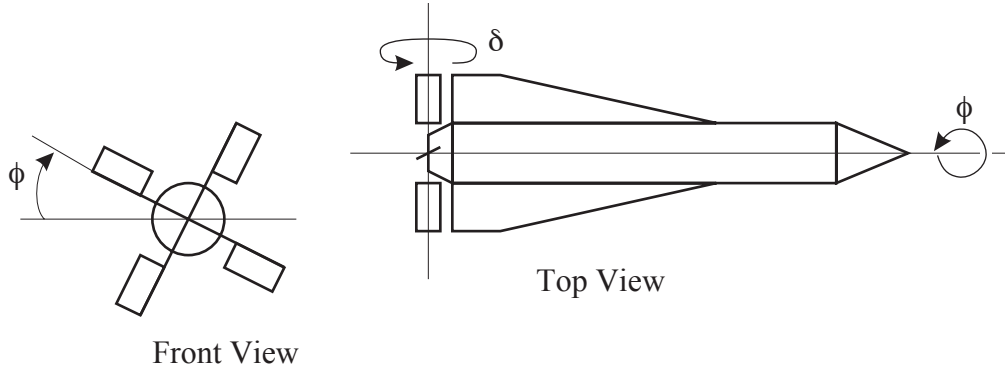


Missile Roll Control

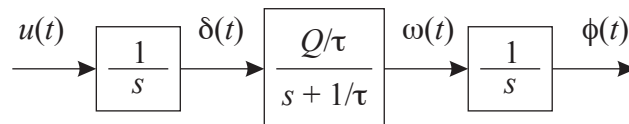
We wish to design a feedback controller for a missile, using hydraulic-powered ailerons, that will control the roll attitude ϕ by adjusting the aileron deflection δ .



The equations of motion are:

$$\begin{aligned}\dot{\delta} &= u \\ \dot{\omega} &= -\frac{1}{\tau}\omega + \frac{Q}{\tau}\delta \\ \dot{\phi} &= \omega\end{aligned}$$

where τ is the roll-time constant, Q is the aileron effectiveness, u is the command signal to the aileron actuators and ω is the roll angular velocity. The system block diagram is shown below. The numerical values to be used are $\tau = 1$ sec and $Q = 10$ sec⁻¹.



Design a feedback controller that will move the roll attitude to a desired reference angle in the quickest time, with the least overshoot. You can use MATLAB to perform all of the calculations. You may want to consider using the following MATLAB commands/tools: `sisotool`, `rlocus`, `ltiview`, `step`. (With `sisotool` you can adjust the controller and watch the step response change in real time.) Make a Simulink model for your final closed loop system, and demonstrate the system step response. Discuss your design steps and the reasons for your final design. Your design process should involve several potential designs before reaching a final design. (Consider at least proportional feedback and proportional-plus-derivative feedback.)

You should turn in the following: 1) a complete discussion of all of your design steps, describing what potential designs were tested, and a justification for your final design, 2) root locus plots illustrating the final design and other potential designs, 3) a printout of the Simulink block diagram of your closed loop system, 4) step response plots for the final design and other potential designs. This project should be considered an individual project. Although you may discuss general strategies with other students, you should perform your design and implementation individually. There is no single correct design. Each design should be different.