(10 points) **1.5** A ballistic missile is required to follow a predetermined flight path by adjusting its angle of attack α (the angle between its axis and its velocity vector v). The angle of attack is controlled by adjusting the thrust angle δ (angle between the thrust direction and the axis of the missile). Draw a block diagram for a digital control system for the angle of attack including a gyroscope to measure the angle α and a motor to adjust the thrust angle δ.

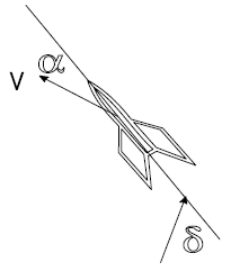

Figure 1. Missile angle of attack control

(20 points) **2.10** Solve the following difference equations
(a) $y(k+1) - 0.8\, y(k) = 0$, y(0) = 1
(b) $y(k+1) - 0.8\, y(k) = 1(k)$, y(0) = 0
(c) $y(k+1) - 0.8\, y(k) = 1(k)$, y(0) = 1
(d) $y(k+2) + 0.7\, y(k+1) + 0.06\, y(k) = \delta(k)$, y(0)=0, y(1)=2

(20 points) **2.15** Find the impulse response functions for the systems governed by the following difference equations
(a) $y(k+1) - 0.5\, y(k) = u(k)$
(b) $y(k+2) - 0.1\, y(k+1) + 0.8\, y(k) = u(k)$

(20 points) **2.23** The following open-loop systems are to be digitally feedback controlled. Select a suitable sampling period for each if the closed-loop system is to be designed for the given specifications
(a) $G_{ol}(s)=1/s+3$ Time Constant=0.1 s
(b) $G_{ol}(s)=1/s^2+4s+3$ Undamped natural frequency = 5 rad/s, Damping ratio = 0.7

(20 points) **2.25** Consider the closed-loop system of Problem 2.23(a)
(a) Find the impulse response of the **closed-loop** transfer function and obtain the impulse response sequence for a sampled system output.
(b) Obtain the z-transfer function by z-transforming the impulse response sequence.
(c) Using MATLAB, obtain the frequency response plots for the analog system and for sampling frequencies $\omega_s = k\,\omega_b$, k = 5, 35, 70.
(d) Comment on the choices of sampling periods of part (b).

(10 points) **How would you implement a PWM subsystem using NIOSII?**