Project Problem & Instructions

AE 641: Introduction to Navigation and Guidance

Total Points: 100

Submission Deadline: November 24, 2025

(Group 3)

Instructions :

- A common report (only one per group) for every group needs to be submitted online in portable document format (pdf) on Moodle. Handwritten reports should be scanned in good quality to generate the pdf file. All the plots and figures need to be legible (with suitable font size).
- Please submit the codes for generating the necessary figures for your report. The filename for the report should be Team-number-Report. For instance, the final file of Group-01 must be named like Group-01-Report.
- All symbols have their usual meanings unless specified otherwise. If required, please assume the necessary data and mention it in your report.

Problem 1: [50] Consider the following discrete-time process and measurement models.

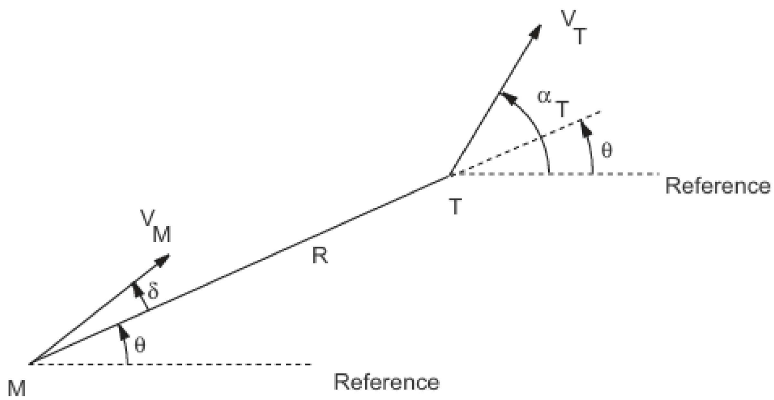
$$\begin{bmatrix} x_1(k+1) \\ x_2(k+1) \end{bmatrix} = \begin{bmatrix} -1/3 & 1 \\ 1/3 & 0 \end{bmatrix} \begin{bmatrix} x_1(k) \\ x_2(k) \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} w(k),$$

$$y(k) = \begin{bmatrix} 2 & 2 \end{bmatrix} \begin{bmatrix} x_1(k) \\ x_2(k) \end{bmatrix} + v(k).$$

1. Design the Kalman Filter (KF) to estimate the true states. Given: $\hat{x}_1(0|0) = 1$, $\hat{x}_2(0|0) = 0$, $y(1) = 2$, $w(k) \sim \mathcal{N}(0,1)$, $v(k) \sim \mathcal{N}(0,1)$, and $\mathbf{P}(0|0) = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$.
2. Plot the true states and their estimates, and discuss your observations.

Problem 2: [50] Consider an engagement scenario where the missile and target are launched from the ground and separated by 50 km. The missile aims to intercept the constant velocity target under deviated pursuit guidance law. Assume that the speeds of the missile and target are constant, and are denoted by V_M and V_T, respectively, while their flight path angles are denoted by α_M and α_T, respectively. The speed ratio of the missile and the target is denoted by $K = V_M/V_T$. The constant deviation angle of deviated pursuit is denoted by δ. The engagement geometry for deviated pursuit guidance is shown in Figure.

1. Plot the trajectories of the missile and target in inertial space, and plot the time evolution of the lateral acceleration of the missile until interception for the scenarios given in Table.
2. Comment on the profile of the lateral acceleration of the missile for the given scenarios.



	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
V_M	800 m/s	700 m/s	600 m/s	600 m/s	600 m/s
V_T	400 m/s	400 m/s	400 m/s	400 m/s	300 m/s
θ	30°	30°	30°	30°	30°
δ	10°	10°	10°	30°	30°
α_T	45°	45°	45°	45°	45°

Table 1: Engagement scenarios.

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