Lecture #8 Homework

(Note that all problems are individual problems, i.e. no group homework)

1. Illuminator Power vs Active Seeker Power

A weapon system which employs MCG over HAW, and active missiles rather than semi-active missiles is considering switching to semi-active missiles in order to save money (active seekers are really expensive). The purpose of the study is to determine the ERP of the new illuminator system if it is to provide the same maximum search and homing time as the active missile variant based upon the following required scenario (assume the target is radially inbound). Plot the ERP required as a function of TGO

- $V_T = 300\ m/s$, target speed
- $V_M = 800\ m/s$, missile speed
- $\gamma_f = -20\ deg$, expected final flight path angle of the missile during search and homing
- $RIP_{Max} = 80\ km$, maximum range of intercept
- $ERP = 50\ dBW$, ERP of the active missile seeker

If the new weapon system were to utilize HAW missiles rather than MCG missiles, what is the required ERP for the same scenario if the missile was fired directly at the target ($\gamma_f = 0$)?

2. Rocket Motor Math

The burnout velocity of a rocket is 1000 m/s. Determine the weight of the propellant if the pressure differential and the effect of gravity are ignored and rocket has the following characteristics:

- $I_{SP} = 200\ seconds$
- $W_{BO} = 300\ kg$, where W_{BO} is the weight of the rocket at burnout

How much propellant is needed if we want to rocket to have a burnout velocity of 1200 m/s?

3. First Order Time Constant Autopilot

The response of a first order auto-pilot was described in the lecture in the frequency domain as:

$$\frac{N}{N_C} = \frac{Achieved\ Acc}{Commanded\ Acc} = \frac{1}{s(\tau_A) + 1}$$

This can be expressed in the time domain as:

$$\frac{N}{N_C} = \frac{Achieved\ Acc}{Commanded\ Acc} = \exp\left(-t/\tau_A\right)$$

Generate a simple simulation that will show how the first order autopilot affects the missile's ability to achieve the desired normal force.

For the simulation, the following is defined:

- Integration time step, $dt = 0.01$
- Autopilot time constant, $\tau_A = 0.45$

The commanded acceleration is held constant until a new command is issued, according to the table below:

Time	0	5	6	8	8.2	8.5	10	15
Command	+4	-2	+6	0	2	-4	-6	0

Plot the commanded acceleration and the achieved acceleration over a period of time from 0 to 20 seconds.