**MAE 478 Guided Missile Systems, Spring 2017**

**Team Design Project**

**Sales Presentation and Project Report due April 27th, 2017 – NO LATE REPORTS ACCEPTED!**

Assume that your team represents a defense contractor that designs tactical missiles including both propulsion and aerodynamics phases. Given the specifications for the missile desired by the military, you are to perform a preliminary design to submit consideration under the request for proposals (RFP).

RFP – A tactical air-to-air missile is to be designed conforming to the following constraints:

1. The total missile length cannot exceed 9.5 feet.
2. The missile body outside diameter must be no more than 6 inches.
3. The missile launch weight must not exceed 263 pounds.
4. The missile is to carry a 30 lbf explosive payload.
5. The guidance, navigation & control (GNC) system will weigh 13.5 lbf. Allow 75 in3 for this system.
6. The missile is to have a fixed tail and is either wing or canard controlled. All designs must have an in-line cruciform configuration.
7. The missile load factor will be 16.5 ±4%.
8. The static stability margin must be such that 0.5 ≤ (xcp – xcg) ≤ 2 calibers at launch and must not change by more than 1.5 calibers during the burn.
9. The thrust versus time curve will be neutral with FT = 5,400 lbf ±5%.
10. The burn time is exactly 3.5 seconds.
11. The following propellant properties are to be used:



1. The maximum thrust will also be determined for Tgrain = -65 °F and 160 °F.
2. The missile is to be designed for optimum performance at 25,000 ft altitude (assume standard atmosphere conditions).
3. The missile is to be launched horizontally at M = 1.4 and must reach M = 3.2 during the power phase of the flight.

Your team’s response to this RFP must contain the following as a minimum:

1. Detailed internal ballistic calculations with a drawing of the final configuration and nozzle geometry. Show calculations and sketches to prove that your grain design is really neutral. Plot (Ab vs. d), (pc vs. time), and (FT vs. time). Note: Avoid grain designs that cannot withstand high lateral accelerations.
2. Detailed motor case design with considerations of internal pressure loads only.
3. Detailed aerodynamic design calculations including body and control surface design and complete missile CD, xcp, xcg, CNα, Cmα, Cmδ and CNδ. Values for these parameters must be listed for at least four different Mach numbers including the launch and maximum Mach numbers.
4. At your maximum Mach number and load factor, determine the radii for a level turn and for a pull-up maneuver.
5. Calculation and plots showing the velocity and range of the missile as a function of time for level flight up to 7 seconds after launch.
6. A final detailed drawing of the missile configuration complete with dimensions and an itemized list of component weights and cg locations.
7. A summary table of all the pertinent performance and aerodynamic parameters along with the missile specifications as required by the RFP. Indicate in the summary table if the specifications were satisfied by your design.

To encourage the timely completion of your team’s proposal, the following milestone chart must be followed, and **a single-page written proof-of-completion must be submitted to the instructor according to due dates specified in the table on the next page:**

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| **Milestone** | **Name** | **Description** |
| **1****(Jan. 26)** | Contractor ID | Contractor name and list of members with contact information |
| **2****(Feb. 2)** | Kickoff meeting | Summary of notes from team kickoff meeting – include relevant items such as member expertise, general design observations, team and individual action items, questions for funding agency point of contact (POC), etc. |
| **3****(Feb. 23)** | Design Iteration 1 | Identify perceived critical parameters (e.g., grain mass) and determine ballpark range estimates for acceptable values. Assign members to specified project effort areas. |
| **4****(Mar. 16)** | Design Iteration 2 | Fine tune early estimates for acceptable values of critical parameters. Evaluate member contributions & effectiveness and reassign tasks/efforts if necessary. |
| **5****(April 6)** | Prelim Response 1 | Demo code for internal ballistics calculations and provide evidence of case design calculations |
| **6****(April 13)** | Prelim Response 2 | Provide evidence of aero calculations for body and control surfaces as well as maneuvering aspects |
| **7****(April 20)** | Prelim Response 3 | Show early velocity and range plots of 7-second flight |
| **8****(April 27)** | Final Response | Submit final team response containing all minimum RFP requirements |