Syllabus for MECH 5334, 6334: Space System Design

Instructor

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Policy: Open Door
Office Hours: Tuesday 1 PM -2 PM. Also available by appointment.
Office Location: Engineering Building, Room A315

Course Information

Time: Tuesdays and Thursdays, 10:30am-11:50am
Location: Psychology Building | Room 307
Prerequisites: Aerodynamics, Compressible Flow, CFD, Heat Transfer

Course Description

The course will describe the following key areas of Space System Design

- Classifications of space system based on mission and propulsion system.
- Current Status, challenges, failures, and possible causes of Space systems
- Understand the space vehicles aerodynamics flow features, aerothermodynamic heating and learn the methods to characterize the properties.
- Some flight control of space vehicle dynamics
- Material Choices for Space Vehicles

Course Objectives

1. **Introduction to Hypersonic Vehicles**
    - Understanding the types of hypersonic vehicles based on mission and propulsion system.
    - Science and technological challenges to understand aerothermodynamics, structure and propulsion design issues.
    - Historical disasters and failures and the possible causes
    - Current status of the space vehicle research, capability of ground testing and sustainable flight demonstration

2. **Aerothermodynamics**
    - Understand the space vehicles aerodynamics flow features and learn the methods to characterize the properties.
    - Understand the sources of aerodynamics heating and learn the methods to demonstrate the surface heating
    - Understand chemically reacting boundary layer for re-entry vehicles
    - CFD solutions for hypersonic flow simulation

- Open-ended design project development on space vehicles aerodynamics analysis in STAR-CCM+.
- Open-ended design project development on space vehicles heat transfer analysis in STAR-CCM+

3. **Flight Dynamics and Control**
   - Understand basic flight dynamics and control
   - Learn mission based hypersonic flight
   - Development of hypersonic flight control from general flight control
4. **Extreme Environmental Material Choices**
   - Understand the definition of 'extreme environment'
   - The properties of the materials required for design and analysis for hypersonic/reentry vehicle
   - A list of materials suitable for this purpose with details of their material properties
   - How to modify the materials' internal structure to enhance properties
   - What measures should be taken to take care of the main deterioration (oxidation) of the material
   - Behavior of composite materials and how different components of the composite affects overall performance of the material
5. **Space Propulsion**
   - Different types of propulsion
   - Rocket nozzle design
   - High-Speed Wind Tunnel Design

Course Materials

- There is no required textbook for this course; all required materials will be provided. Book chapters and articles will be provided along with the lectures.

Grading

The final grade will be computed via the following weighting:

- 20% Surprise quizzes
- 40% Midterm Project and Report
- 40% Final Project and Report
- Extra Credit: Extreme material properties need to be incorporated in the projects

A (100-90): B (89-80): C (79-70): D (69-60): F (59 and Below)

Due Dates

- No fixed dates for surprise quizzes
- Midterm project is due by October 11, 2023
- Final Project is due by December 1, 2023