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