ASEN 5053
ROCKET AND SPACECRAFT PROPULSION

Tuesdays and Thursdays 11:30 AM – 12:45 PM

Aerospace Building N240

Course Description:

This course is designed to teach you the theory, analysis and design of modern rocket and spacecraft propulsion systems. We start from the basics of rocket propulsion, including some orbital mechanics to delineate the requirements. We will then discuss thermodynamics of rocket propulsion and nozzle flow theory, followed by in-depth study of various types of rocket propulsion: cold gas, monopropellant and bipropellant liquid rockets, solid and hybrid rockets, electric propulsion, nuclear rockets, and solar sails. If time permits, other exotic propulsion technologies will be dealt with. The goal is to provide you with a broad overview of this fast-changing field, including latest developments at NASA, ULA and SpaceX, as well as in-depth knowledge of rocket and spacecraft propulsion systems. The course is designed to be self-sufficient so that students who may not have taken the prerequisite undergraduate course on propulsion can successfully navigate it, albeit with some more effort, and benefit from it. ULA-sponsored graduate projects in the department, such as HySOR (Hybrid Sounding Rocket) and currently on-going AMARCS (Additively Manufactured Aerospike Reaction Control System), build upon the knowledge you gain in this course. Many of my students have also ended up working for major corporations such as ULA, SpaceX, Orbital ATK, Boeing and Lockheed Martin.

Instructor:

Dr. Lakshmi Kantha

Prerequisites: ASEN 4013 Undergraduate Course on Propulsion or Instructor's consent

Grading: Homeworks (8) – 40%, Quizzes (5) – 10%, Exams (1) – 20%, Final Project (or Exam) – 30%

Course Outline:

1. Introduction – History, Classification – Chemical, Electric, Nuclear. Examples
2. Principles of Jet and Rocket Propulsion, Ideal Rocket Equation, Single and Multi-Stage Rockets.
3. Basics of Orbital Mechanics, Space Flight, Orbit Perturbations, Orbit Maneuvers
4. Thermodynamics of Rocket Propulsion, Nozzle Theory, Over and Under-expanded Nozzles. Cold Gas Rockets
5. Heat Transfer, Regenerative and Radiative Cooling
6. Solid Propellant Rocket Motors, Burning Rate, Performance Analysis and Design. Examples.
7. Liquid Propellant Rockets - Monopropellant and Bipropellant. Combustion Thermodynamics. Pressure-