MAE 6530, Advanced Concepts for Propulsion Systems

Fall 2022

Utah State University, Mechanical and Aerospace Engineering Department
Instructor: Stephen A. Whitmore, Associate Professor
(435) 797-2951 stephen.whitmore@ usu.edu

Course Syllabus (ABET Format)

Catalog Description:

Advanced Topics in rocket and air-breathing propulsion. Fundamentals of rocket and air breathing propulsion, including space flight dynamics, nozzle theory, combustion processes, propellant modeling, and flight performance. Rocket propulsion systems, including solid, liquid, hybrid, and combined cycles. Air breathing propulsion systems, including ramjet, scramjet, turbojet, and turbofan engine concepts.

Course Prerequisites:

MAE 5420, MAE 5540

Course Materials:

Main text:

Instructors Notes

Materials taken from supplemental texts: (not required texts)

Rocket Propulsion Elements, 7th ed. George P. Sutton, Oscar Biblarz, John Wiley & Sons, Inc., 2001

Mechanics of Flight, Warren F. Phillips, John Wiley & Sons, Inc., 2004.

Elements of Propulsion, Gas Turbines and Rockets, Jack D. Mattingly, AIAA Press, ISBN1-56347-779-3

Topics Covered:

Rocket Propulsion Systems
Review of Rocketry Basics: Ideal and Non-Ideal Nozzle Theory, Launch Mission Analysis, Advanced Topics: Method of Characteristics for Nozzle Design, Aerospike Nozzle Theory, Liquid, Solid and Hybrid Rocket Combustion Cycles, CEA Models, Self-Pressurizing Propellants, Two-Phase Injector Flow Models

Airbreathing Propulsion Systems
Introduction to Airbreathing Propulsion, Brayton Cycle Ramjet, ScramJet, Turbojet Engines, Airbreathing Combustion Cycle Analysis, Turbojet Engine with Afterburner, Turbofan Engines, Advanced Concepts, Rocket and Turbine-Based Combined Cycle Systems, Liquid Air Collection Systems, Systems of Shockwaves, Supersonic Inlet Design.

Propeller Theory
Propeller Basics, Advance Ratio and Braking Power, Momentum, Blade-element &

Combined Theories. Nonlinear Corrections to Blade-Element-Momentum Theories.

Course Schedule:

4 Days Per Week, 4 Hours Lecture, 2 Hour Lab, Lecture sessions will be Instructed Currently on-line Using Adobe Connect.

Course Contribution:

Mathematics and Basic Sciences: 0 credit hour(s).
Engineering Sciences and Design: 3 credit hour(s).
General Education Component: 0 credit hour(s).

Course Objectives:

This course covers advanced topic relating to airbreathing and rocket propulsion. This course will review propulsion, fluid mechanics and thermodynamics fundaentals, and then then develop advanced concepts that will allow the student to design rocket-based and air-breathing propulsions systems. *With Instructor Supervision, students will be required to instrumentation and test a small rocket or propeller system, and compare test results to analytical models.*

Relevant ABET Topic ..... 1. Students should gain a broad knowledge of propulsion technology and concepts, ...as well as the ability to dig deeper for in formation on advanced concepts 2. Students should be able to intelligently interpret this and other information ....on the subject and relate it to other areas of study. 3. Students should be able to apply the material to solve problems provided to ....them and perform detailed system analysis in each of the subject areas.

Course Assessment Measures:

1. Homework Assignments (25%)
2. Three Major Projects (50%)
3. Final report (25%)