Official Syllabus
MAE 5540 – Propulsion Systems
Elective

CRN: ***11772***

Course Description:
Fundamentals of rocket and air breathing propulsion, including space flight dynamics, rocket propulsion systems overview, nozzle theory, combustion processes, 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. 3 credits, Spring.

Prerequisites: MAE 5420 or consent of instructor.

Textbook:

1. "*Rocket Propulsion Elements, 8th ed.,"* George P. Sutton, Oscar Biblarz, John Wiley & Sons, Inc., 2009.

References:

2. *"Introduction to Rocket Science and Engineering,"* Taylor, Travis S., Taylor-Francis CRC Press, 2009, ISBN-10: 1420075284

3. "*International Reference Guide to Space Launch Systems,"* 4th ed. Isakowitz, Stephen J., Hopkins, Jr., Joseph P., and Hopkins, Joshua B., American Institute of Aeronautics and Astronautics, Reston, VA, 2004.

Course Objectives:

1. This course covers fundamentals of turbine and rocket propulsion, including nozzle theory and thermodynamic relations, combustion processes and flight performance.
2. This course will establish the necessary physical and thermodynamic background and then develop the fundamental concepts that will allow the student to design rocket-based and air-breathing propulsions systems.
3. 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
4. Students should be able to intelligently interpret this and other information on the subject and relate it to other areas of study.
5. Students should be able to apply the material to solve problems provided

Topics Covered:

1. *Rocket Propulsion Systems*
   - Rocket System History and New Horizons,
   - Thrust Equation, Rocket Equation, Specific Impulse,
   - Propellant Mass Fractions, Launch System Staging,
   - Keplers Laws and Spaceflight Mechanics, Vis-Viva Equation, Hohmann Transfer, Continuous Thrust Orbit Transfer Maneuvers
   - Launch Systems Economics, Selection of Launch System,
   - Ideal Nozzle Theory, Thermodynamics Review; Integral Forms of Conservation Equations,
   - Non-ideal Nozzle Theory, Chemical Rocket Propellant Performance Analysis, Liquid
   - Propellant
   - Rocket Engine Fundamentals, Liquid Rocket Components and Design, Mono-propellant,
   - Bi-propellant systems, Solid Propellant Rocket Fundamentals, Solid Rocket Components, and Motor Design, Hybrid,
   - Propellant Rockets, Electric Propulsion,
2. *Airbreathing Propulsion Systems*
   - Introduction to Airbreathing Propulsion, 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

Class Schedule: 3 Days per Week, 2.5 Hours Lecture

Course Assessment Measures:

1. Homework is 100% of grade including three or four major projects,
Students may ask each other for advice; however, in the long run each must pull own weight
Homeworks will often involve programming assignments
Students will be expected to keep a library of self-written code for problem solving
Students may program in any language desired, however code should be clearly "readable"
Homeworks turned in over 1-week late will receive only partial credit
Successful Completion of ALL "major" assignments is essential for passing grade in class

2. "Midterm Project"
20% of grade, open book, 2-5 Day Take Home Project

3. "Final Projet "
20% of grade, open book, 2-5 Day Take Home Project

- ***Course Fees***
  - ***Per Student Course Fee: $37.50***
  - ***Graders/TA Cost Per Student:***
    - ***Grading hours =***
    - ***0.25 hrs per week per student Grader/TA cost = $10/hour***
    - ***Weeks grader/TA utilized = 15 weeks***
  - ***Fee cost per student = 0.25*10*15 = $37.5***

Contribution of course to meeting the requirements of ABET Criterion 5:

Professional Component Content			
Math & Basic Sciences	Engineering Topics	General Education	Engineering Design
	✓		✓

Relationship of course to program outcomes:

	Student Outcomes	Course * Outcomes
a)	an ability to apply knowledge of mathematics, science, and engineering,	✓
b)	an ability to design and conduct experiments, as well as to analyze and interpret data,	
c)	an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability	✓
d)	an ability to function on multi-disciplinary teams,	
e)	an ability to identify, formulate, and solve engineering problems,	✓
f)	an understanding of professional and ethical responsibility	
g)	an ability to communicate effectively	
h)	the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context	
i)	a recognition of the need for, and an ability to engage in life-long learning	
j)	a knowledge of contemporary issues,	✓
k)	an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice	✓
l)	an ability to work professionally in both thermal and mechanical system areas including the design and realization of such systems.	✓
*An ✓ indicates that this course helps the students to achieve the Program Outcomes.		

Course Coordinator: Stephen A. Whitmore

Last Updated: January *2022*