Course Description:

This course is designed to teach the principles and practice of modern aircraft propulsion. It builds on the principles taught in ASEN 4013 (Fundamentals of Aerospace Propulsion). Gas turbine engines, principally turbofans, form an overwhelming fraction of modern aircraft engines. So the focus will be on turbofans, especially for commercial aircraft, although turboprops and military turbofans will also be considered. The emphasis will be more on the current state of aircraft propulsion, how engine selections are made, and what is necessary for success in the highly competitive field of aircraft propulsion. We will start with a review of the current state of aircraft propulsion and a brief history of gas turbine engines. After a brief overview of the Brayton cycle and a review of the principles of gas turbine engines, we will deal with analysis and design of various components: centrifugal and axial compressors, axial and radial flow turbines, inlets and nozzles, and burners. Compressor-turbine matching will be discussed, followed by analysis of off-design performance of gas turbine engines. Finally, environmental aspects of modern gas turbine engines, noise and emissions, will be dealt with.

We will be following an extensive set of notes I have prepared over the years. These notes will be made available on Canvas and will be supplemented by material from a recent textbook on Aircraft Propulsion by Farokhi, and a monograph on Jet Propulsion by Cumpsty, as needed.

Instructor:

Dr. Lakshmi Kantha
Professor
Department of Smead Aerospace Engineering Sciences
Office: Aerospace Building Room 463. Cell phone: 720-891-1775 (Please note that because of Covid-19 impact, I will be teaching from home. So it is best to e-mail me. Call me only if you need to contact me on an urgent matter).
E-mail: kantha@colorado.edu.

Office Hours: Tuesdays 3:00 PM to 5:00 PM

In addition, you can e-mail me any time for an appointment at a mutually convenient time. You are also welcome to call me to chat about latest events in the field or on any relevant issue or topic of your interest, but first notify me by e-mail to make sure I am free and available.

Office hours will be conducted remotely and not in the office as per CU regulations. The same applies to office hours with the TA.

Course Assistant (Teaching Fellow):

TBD
Email: TBD
Office Hours: TBD
Prerequisites: ASEN 4013 Undergraduate Course on Propulsion or Instructor’s consent

Grading: Homework (8) – 40%, Quizzes (5) – 10%, Mid-Term Exam (1) – 20%, Final Project (or Exam) – 30%

Course Outline:

1. Introduction to Current State of Aircraft Propulsion
2. Brief Overview of Jet Propulsion
3. Thermodynamic Cycles – Brayton Cycle
4. Engine Selection
5. Brief Overview of Ideal and Real Cycle Analyses
6. Centrifugal and Axial Flow Compressors
7. Axial and Radial Flow Turbines
8. Inlets and Nozzles
9. Combustion and Burners
10. Component Matching
11. Engine Performance Analysis
12. Environmental Aspects – Noise and Emissions

Books and References:


5. *Fundamentals of Jet Propulsion with Applications*, by R. D. Flack, Cambridge University Press, 2005 (ISBN 0-521-81983-0). Call # TL709.F5953 2005 *(This text is very well-written but notations are irksome making it unsuitable as a text for this course).*


**Journals:**

- AIAA Journal of Propulsion and Power
- AIAA Journal of Aircraft
- AIAA Journal
- ASME Journal of Engineering for Gas Turbines and Power
- ASME Journal of Turbomachinery

**Logistics:**

We will make use of Canvas, to which I will upload my lecture notes for you to download if you like, post homework, homework solutions, quizzes and grades. We will be using Canvas for all matters related to the course, including e-mail. Please try not to use my regular e-mail for class business, since it may get lost in other e-mails I receive, including junk mail. For access to Canvas, please contact OIT at help@colorado.edu or 303-735-help. Obviously, you need to be registered for the course and you will need your identikey. All homework and assignments should be submitted in electronic form (.pdf, .docx, .ppt, .xlsx formats) with following naming convention: HW#_LastName.pdf . The same goes for other assignments with HW replaced by QZ, Exam or Finals.

The preferred programming language in this course is MatLab. We will be using MatLab at various stages during this course and therefore you need to know how to use it. Please brush up, if you are rusty.
Campus-mandated Syllabus Statements

Classroom Behavior
Both students and faculty are responsible for maintaining an appropriate learning environment in all instructional settings, whether in person, remote or online. Those who fail to adhere to such behavioral standards may be subject to discipline. Professional courtesy and sensitivity are especially important with respect to individuals and topics dealing with race, color, national origin, sex, pregnancy, age, disability, creed, religion, sexual orientation, gender identity, gender expression, veteran status, political affiliation or political philosophy. For more information, see the policies on classroom behavior and the Student Code of Conduct.

Requirements for COVID-19
As a matter of public health and safety due to the pandemic, all members of the CU Boulder community and all visitors to campus must follow university, department and building requirements, and public health orders in place to reduce the risk of spreading infectious disease. Required safety measures at CU Boulder relevant to the classroom setting include:

● maintain 6-foot distancing when possible,
● wear a face covering in public indoor spaces and outdoors while on campus consistent with state and county health orders,
● clean local work area,
● practice hand hygiene,
● follow public health orders, and

● if sick and you live off campus, do not come onto campus (unless instructed by a CU Healthcare professional), or if you live on-campus, please alert CU Boulder Medical Services.

Students who fail to adhere to these requirements will be asked to leave class, and students who do not leave class when asked or who refuse to comply with these requirements will be referred to Student Conduct and Conflict Resolution. For more information, see the policies on COVID-19 Health and Safety and classroom behavior and the Student Code of Conduct. If you require accommodation because a disability prevents you from fulfilling these safety measures, please see the “Accommodation for Disabilities” statement on this syllabus.

Before returning to campus, all students must complete the COVID-19 Student Health and Expectations Course. Before coming on to campus each day, all students are required to complete a Daily Health Form.

Classes for this course will be taught completely on-line, with lectures, homework, quizzes, exams and discussions conducted via Canvas, and so there is no need for students taking this course to be on campus. The only exception (TBD) may be Final Projects that may require access to Departmental facilities such as the Machine Shop and Rocket Testing Bunker, in which case above protocols must be obeyed.

Students who have tested positive for COVID-19, have symptoms of COVID-19, or have had close contact with someone who has tested positive for or had symptoms of COVID-19 must stay home and complete the Health Questionnaire and Illness Reporting Form remotely.
In this class, if you are sick or quarantined, please let me know about your absence by e-mail. Because of FERPA student privacy laws, students are not required to state the nature of their illness when alerting me.

Accommodation for Disabilities
If you qualify for accommodations because of a disability, please submit your accommodation letter from Disability Services to your faculty member in a timely manner so that your needs can be addressed. Disability Services determines accommodations based on documented disabilities in the academic environment. Information on requesting accommodations is located on the Disability Services website. Contact Disability Services at 303-492-8671 or dsinfo@colorado.edu for further assistance. If you have a temporary medical condition, see Temporary Medical Conditions on the Disability Services website.

Preferred Student Names and Pronouns
CU Boulder recognizes that students' legal information doesn't always align with how they identify. Students may update their preferred names and pronouns via the student portal; those preferred names and pronouns are listed on instructors' class rosters. In the absence of such updates, the name that appears on the class roster is the student's legal name.

Honor Code
All students enrolled in a University of Colorado Boulder course are responsible for knowing and adhering to the Honor Code. Violations of the policy may include: plagiarism, cheating, fabrication, lying, bribery, threat, unauthorized access to academic materials, clicker fraud, submitting the same or similar work in more than one course without permission from all course instructors involved, and aiding academic dishonesty. All incidents of academic misconduct will be reported to the Honor Code (honor@colorado.edu; 303-492-5550). Students found responsible for violating the academic integrity policy will be subject to nonacademic sanctions from the Honor Code as well as academic sanctions from the faculty member. Additional information regarding the Honor Code academic integrity policy can be found at the Honor Code Office website.

Sexual Misconduct, Discrimination, Harassment and/or Related Retaliation
The University of Colorado Boulder (CU Boulder) is committed to fostering an inclusive and welcoming learning, working, and living environment. CU Boulder will not tolerate acts of sexual misconduct (harassment, exploitation, and assault), intimate partner violence (dating or domestic violence), stalking, or protected-class discrimination or harassment by members of our community. Individuals who believe they have been subject to misconduct or retaliatory actions for reporting a concern should contact the Office of Institutional Equity and Compliance (OIEC) at 303-492-2127 or cureport@colorado.edu. Information about the OIEC, university policies, anonymous reporting, and the campus resources can be found on the OIEC website.

Please know that faculty and instructors have a responsibility to inform OIEC when made aware of incidents of sexual misconduct, dating and domestic violence, stalking, discrimination, harassment and/or related retaliation, to ensure that individuals impacted receive information about options for reporting and support resources.

Religious Holidays
Campus policy regarding religious observances requires that faculty make every effort to deal reasonably and fairly with all students who, because of religious obligations, have conflicts with scheduled exams, assignments or required attendance. In this class, just let me know so that we can avoid any conflicts. See the campus policy regarding religious observances for full details.