

ME 190-02 Air Breathing Engines

Course Objective/Student Learning Outcomes: This course will introduce students to the fundamentals of air breathing engines that are an important building block in aircraft propulsion. Starting with the basics of compressible fluid mechanics, the course will discuss the components of a typical engine that is installed on commercial aircraft. After successful completion of the course, the students will

- develop the ability to solve problems involving compressible fluid flows including supersonic flows involving shocks and expansion fans
- understand the operation of a basic gas turbine engine
- perform cycle analysis and determine performance of propulsion systems including turbojet, turbofan and turboprop configurations.
- familiarize themselves with other engine configurations on aircraft including an understanding of the Otto cycle, two-stroke and four-stroke engines.

When: Tues & Thurs 4:30 pm - 5:45 pm

Where: CLSSRM 110

Instructor: Prof. Venkatraman (Venkatt) Ayyaswamy (Pronounced When-cut-ra-mun I-yaswa-me)

Office Hours: Tues & Thurs 3:30 - 4:30 pm; **Office:** SE2 278

Email: vayyaswamy@ucmerced.edu; **Phone:** (209) 228 2359

Books (reference)

1. Saeed Farokhi, "Aircraft Propulsion", 2nd edition, 2014. *Please note that you do not have to buy this textbook. It can be used as a reference but is not required. The notes provided in class are sufficient to deal with homework and exam problems. Also, only chapters 1 to 4 with some material from 5 will be covered in this course.*

Course Outline

- **Introduction:** A general introduction to air breathing engines with some historical perspective
- **Compressible Flows:** Review of thermodynamics; conservation equations (mass, momentum and energy) in integral and engineering forms; Mach number and stagnation state; quasi one-dimensional flow; area-Mach relationship; sonic throat; normal and oblique shocks; expansion fans; Frictionless constant-area duct flows with heat transfer (Rayleigh flow); Adiabatic constant-area duct flow with friction (Fanno flow)
- **Engine Thrust and Performance Parameters:** Thrust equation; air breathing engine performance parameters (specific thrust, specific fuel consumption and specific impulse; thermal and propulsive efficiency; engine overall efficiency and some implications on aircraft performance); discussion on engine cut-away figures
- **Gas turbine engine cycle analysis:** Gas generator; Component-wise analysis for turbojet engine (inlet, compressor, combustion chamber, turbine, nozzle) and thermal, propulsive efficiency along with performance evaluation; turbojet with after-burner; component-wise analysis for turbofan engine and concept of bypass flow and core flow; component-wise analysis of turboprop; propeller theory (momentum theory and blade element theory).
- **Other engine configurations:** Discussion on Otto cycle; four-stroke cycle engines, diesel engines; two-stroke cycle engines; rotary engines and their performance; reciprocating engine on aircraft; electric propulsion concepts (depending on time available).

Academic Dishonesty Statement

- Each student in this course is expected to abide by the University of California, Merced's Academic Honesty Policy. Any work submitted by a student in this course for academic credit will be the student's own work.
- You are encouraged to study together and to discuss information and concepts covered in lecture and the sections with other students. You can give "consulting" help to or receive "consulting" help from such students. However, this permissible cooperation should never involve one student having possession of a copy of all or part of work done by someone else, in the form of an e mail, an e mail attachment file, a diskette, or a hard copy. Should copying occur, both the student who copied work from another student and the student who gave material to be copied will both automatically receive a zero for the assignment. Penalty for violation of this Policy can also be extended to include failure of the course and University disciplinary action.
- During examinations, you must do your own work. Talking or discussion is not permitted during the examinations, nor may you compare papers, copy from others, or collaborate in any way. Any collaborative behavior during the examinations will result in failure of the exam, and may lead to failure of the course and University disciplinary action.

Disability Statement: Accommodations for Students with Disabilities: The University of California Merced is committed to ensuring equal academic opportunities and inclusion for students with disabilities based on the principles of independent living, accessible universal design and diversity. I am available to discuss appropriate academic accommodations that may be required for student with disabilities. Requests for academic accommodations are to be made during the first three weeks of the semester, except for unusual circumstances. Students are encouraged to register with Disability Services Center to verify their eligibility for appropriate accommodations.

Grading

- Homework: 30%
- First Mid-term Exam: 20%
- Course Project/Second Mid-term Exam: 20%
- Final Exam: 30%

Homeworks are typically assigned on Fridays and will be due in a week's time. Homeworks are due at the end of the day (5 pm) in the box located outside SE2 278. Late homeworks will be accepted till Monday (immediately following the Friday on which the homework was originally due) noon but for a reduced credit of 75%. To reiterate, feel free to discuss among yourselves to complete the homework problems, but reproducing another person's work is not acceptable. Details of exams and project will be provided as the course progresses. The final exam will be comprehensive but with a higher weightage for topics covered in the second half. I would advice you not worry a whole lot about grades and focus more on the learning. Grades will automatically take care of themselves. **It is your responsibility to ensure that homework and exam grades are recorded accurately on CatCourses. If you notice that the recorded grade and the actual grade you received are inconsistent, you will have to report it within two weeks from the date on which the grade was posted.**

The instructor reserves the right to change the grading policy and syllabus depending on the overall course progress but any change will be communicated in advance to the students.