ME 4250/6250/6930 – Conceptual Design of Light Aircraft
Summer – On-line Version

Class Hours: on-line format only (Six weeks)
Instructor: R. S. Figliola, PhD, PE, Alumni Distinguished Professor of Mechanical Engineering
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COURSE OVERVIEW

This is an elective engineering design course that uses a popular product to develop the first step towards product realization – the conceptual design. At the end of the course, you will have developed a paper design of a general aviation aircraft that meets your initial product objectives. The on-line version is divided into 9 to 10 learning modules, each module containing several sections. Each module introduces a new step in the design process as it relates to aircraft flight static (unaccelerated flight) performance and each module builds on your prior analysis and independent research into available components. The graduate portion of this course studies the maneuvering flight and structural design aspects that affect both overall design and stability in a self-contained module. Your design culminates in a written report and presentation of your product, which form a major part of your grade.

Catalog Description: The course outlines the design of a general aviation aircraft with attention on the decision-making interplay between meeting goals against known constraints. Engineering principles are given in a just-in-time format to meet design expectations. Credits: 1 Science, 2 Design.

COURSE REQUIREMENTS

- **Prerequisities:** Basic Mechanics (Static and Dynamics); Fluid Mechanics (Flow character, pressure and shear forces)
  Internal Clemson Equivalency: ME 2010 and ME 2030 or ME 8010

COURSE TIMELINE

This is a six week asynchronous course divided into modules. All assignments will be posted and completed online.

COURSE MATERIALS

Textbook: Corke, Design of Aircraft, Prentice Hall (a softbound copy is in print and reasonably priced used copies exist).
Technology: Access to a computer with headsets or speakers and camera is mandatory. Your computer will need (1) internet capability, (2) spreadsheet and word processing software, and (3) a basic engineering CAD package.

COURSE OBJECTIVES: Letters in parentheses refer to Program Education Objectives listed on Department website (http://www.clemson.edu/ces/me/)

A. Conceptual Design realization of an aircraft. (a, e)
B. Develop the basic components of an aircraft necessary for a conceptual design and the decision process for competing interplay between goals and constraints. (e, k, l)
C. Develop and communicate the design methods used in a written format. (g)

COURSE CONTENT
- **Topics by Learning Module:**

1. Aircraft Systems and Overview
   - Flight: Historical Perspective.
   - Aircraft Design Definitions.

- Aircraft Components and variations on design
- Proposal: Selection of your aircraft type and mission objectives

2. Static Performance Part 1
   - Estimating cruise speed, stall speed, and climb performance with altitude effects
   - Definition of your aircraft design concept, intended buyer audience, mission
3. Initial Weight Estimate
4. Main Wing Shape and Loading
5. Fuselage Shape
6. Powerplant
7. Wing and Tail Design.
8. Static Performance: Part 2.
   - Tradeoff studies within your design
   - Turns, Take-off and landing distances
   - Interior packaging
9. Static Stability and Control and Weight Balance.
10. Maneuvering Flight and Structural Design Aspects (ME 6250/ME 6930 only)
11. Aircraft Design and Report.

Communications

Course modules are available on Blackboard/Canvas for registered students and will contain instructions for assignments. Course assignments and reports are submitted online through Blackboard/Canvas. You can communicate with me and classmates by posting on the on-line course forum or directly to me by email. Email is good for more personal questions but technical questions should be posted on the forum – its like raising your hand in class. Posting messages on the on-line forum is a good way to interact with classmates, many of whom may have similar questions so that my response to you helps everyone. I will monitor the forums and help as I can. You can expect a reply from me to any email within 24 hours but likely sooner if posted during work hours. For serious personal matters, you can arrange for an in-office appointment or Skype session. I may suggest a Skype session if I feel that you need special assistance on course material.

Course Content

Lectures: Lectures are delivered in modules using Powerpoint with audio components. The content is equivalent to 36 hours of classroom lectures and meets engineering and graduate school accreditation minimums for a three-credit hour semester based course.

Resources: In addition to your text, supplemental notes and provided software (Excel) will be available in the Course Documents folder. These are not all inclusive and part of your challenge will be to secure resources through internet searches or published literature.

Assignments: You will need to complete each module before you can continue to the next module. Each module has a set date for completion of assignments or quizzes. Starting with Day 1 and Module 1, you will have 72 hours to complete each successive module. Saturdays and Sundays are free days for you to catch up. If you fall behind, you lose 5 total points per day. Modules are sequential, each building from the previous module. Do not fall behind.

Reports: These will be submitted on-line for grading. The final report serves as the final examination.

Graduate Course Credit (ME 6250/6930)

This course will be offered at the undergraduate and graduate levels. For graduate-level course credit, the student will take the design process further to model maneuvering flight to predict the speed – load factor diagram, maximum load factors, and minimum turn radius for the conceptual aircraft. These findings are applied to the basic structural design of the aircraft affecting both its layout and stability.

The graduate-level course is appropriate for students who would not normally take a design course at the graduate level. The course is an exercise in just-in-time design and covers basic aerodynamic principles that might be needed for a graduate research project. Assignments will be graded with an expectation of graduate-level effort, quality and critical thinking.

Assessment and Assurance

The course will contain an on-line quiz following each of the first eight modules. Preliminary reports will be required on the following: (1) defining the product, target audience, and market strategy, and (2) verification of analysis modules. The course culminates in a written final design report using a well-structured format and an oral presentation of the design.

1. Assignments and Quizzes 30%
2. Preliminary Report (following Module 4) 20%
3. Final Report and Presentation 50%

You must complete your module and complete assignments or quizzes before moving to the next module.
Grades will be earned based on total cumulative score (100 points): A: 100 – 90; B: 80-89; C: 70-79; F: 0-69

Student Learning Outcomes

To successfully complete this course ('C' or better), you will be able to demonstrate (Numbers in brackets refer to the assessment measure used to judge performance):

Course Objective 1:

1. You will be able to outline and explain the major steps involved conceptual design process of an aircraft. [3]
2. You will be able to make reasonable judgements on design values and show reason for such estimates. [1]
3. You will show initiative and be able to make use of all available resources (text, notes, references, library, internet, phone calls). [3]

Course Objective 2:

1. You will be demonstrate the ability to size components to meet applicable mission goals. [1]
2. You will be able to conceive and specify appropriate components for a specific application and to set objectives, to justify appropriate modifications of objectives , and to meet objectives. [3]

Course Objective 3:

1. You will generate and justify an original design analysis of a light aircraft that meets at least 90% of the performance criteria specified in the problem definition. [3]
2. You will be able to communicate design results effectively in a written report that demonstrates structured thinking and appropriate use of graphs in a succinct, appropriate format and consistent with expectations from a senior-level engineering student. [3]

Academic Integrity and Ethics – It's a Moral and Professional Issue!

All undergraduate and graduate students, faculty and administrators at Clemson University are expected to abide by ethical standards of conduct. The *Academic Integrity* Policy is stated in the *Undergraduate Announcements* and can be accessed directly through the website http://www.clemson.edu/academics/integrity/.

In particular, plagiarism is a serious academic offense. ***Copying or submitting any work done by others for your personal credit is plagiarism. This includes copying homework, spreadsheets, programs, or test***

work from someone else, using excerpts from published work without citation, submitting someone elses work with your name attached, placing your name on any document on which you did not participate or placing your name on a document that was developed by another person(s), are all examples of plagiarism. Simply put: if your name is on it and you submit for credit, then you are attesting that it is your work and your work alone. Otherwise you must cite which and what materials in the submitted work belong to others.

Violators may receive an 'F' in the course and could face University disciplinary action. If you are cited with a violation, the *Undergraduate Announcements* describes appropriate actions you can take towards due process and grievance. The Clemson University *Office of Undergraduate Studies* handles grievances. **Understand this policy and what it intends.** Questions or concerns? Ask the instructor.

I provide the pledge below made by all professional engineers. I expect engineering students to strive to do likewise:

> **As a Professional Engineer**, I dedicate my professional knowledge and skill to the advancement and betterment of human welfare. I pledge: To give the utmost of performance; To participate in none but honest enterprise; To live and work according to the laws of man and the highest standards of professional conduct; To place service before profit, the honor and standing of the profession before personal advantage, and the public welfare above all other considerations. In humility and with need for Divine Guidance, I make this pledge. ***Adopted by National Society of Professional Engineers***

Know Your Instructor:

I have been on the faculty at Clemson University since 1980 and have served the Department of Mechanical Engineering in almost all ways, including nine years as Department Chair. I currently hold the position of Alumni Distinguished Professor of Mechanical Engineering, Academically, I have earned degrees in Aerospace Engineering with a PhD specializing in Fluid Mechanics. Over these years, I have taught thousands of students in 14 different courses. Professionally, I have held positions at Pratt and Whitney, as a jet engine test engineer, and at the von Karman Institute for Fluid Dynamics in Brussels, as a NATO Engineering Fellow studying environmental flows. I am an active researcher in the areas of aerodynamics, biofluid mechanics, and engineering education. As a licensed professional engineer, I am a consultant on flow and energy applications to many companies and I have helped to bring several products successfully to the consumer market.

I am also a licensed pilot and a single engine aircraft owner who has restored aircaft, which I hope may help to make my discussions in this aircraft design course both realistic and enthusiastic.