AEROSPACE VEHICLE DESIGN II

MAE 4351
(2-3) 3 Hours Credit

Spring 2018

Syllabus

Content
Analysis and design of an aerospace system such as a complete flight vehicle, a propulsion system, a structural system, or a control system; market analysis, operating studies, mission specification, civil and military certification requirements; design process, methods and tools; configuration concept selection, harmonization of individual design disciplines (aerodynamics, performance, flight mechanics, structures, cost, systems, etc.).

Topics Covered
The Spring 2018 capstone design experience is implemented via the capstone design project. Topics covered include business case identification, disciplinary analysis, multi-disciplinary synthesis, team work, time planning and professional reporting and presentation.

Course Objectives
The MAE 4350-4351 two-semester aerospace design course sequence is developed to integrate the fundamental courses taken earlier throughout the curriculum by the aerospace or mechanical engineering student. MAE 4351 requires applying the knowledge obtained throughout the undergraduate curriculum including MAE 4350. The MAE 4351 capstone design project does focus on the determination of a well-balanced multi-disciplinary aerospace flight vehicle system via the development and application of a robust design methodology.

Capstone Design Project: The capstone project serves as the primary vehicle throughout the spring semesters to systematically apply problem solving skills leading to a final deliverable to the individual student, the student design team, and possibly the industry sponsor. The capstone project challenges the students to apply disciplinary analysis in the context of a multi-disciplinary design methodology to an open-ended design problem. The students are required to respond to a given RFP (request for proposal) either provided by industry, a national design competition, or the design faculty. (The Design It, Build It, Fly It (DBF) competitions are omitted as a capstone project due to their poor educational value.) The capstone project RFP is usually selected as to confront the students with projects requiring innovative designs, which
they cannot extract from existing applications. This approach surely encourages creativity.

A multi-disciplinary design course will be ineffective if the student does not participate in a team. Therefore, there will be a chief engineer and the various head engineers for the disciplinary teams that make up the team. Generally, the course instructor has to reduce the scope of the typical industry engineering organization to adjust to the student body. The overall direction of the project is accomplished by the chief engineer with the guidance of the CEO and Consultant (the course instructor). During project initiation, each student is asked to indicate preferences on areas of contribution and willingness to serve as a head engineer if asked. The course instructor then fills the leadership positions and allocates disciplinary engineers according to disciplinary demand. A tentative organization chart is presented during the first three weeks of class. A PERT chart and a schedule must be constructed so the ‘executive committee’ (the chief engineer and head engineers) can ascertain what the ‘tent’ poles are and where the emphasis should be placed. **CAUTION:** These leadership positions will require a great deal of responsibility and will increase the amount of work for the student. In case students in leadership positions do not perform, the course instructors reserve the right to replace them within a warning period of two weeks. Any student has the right at all times to voice concerns about adverse performance shown by any individual in the class.

After being issued the request for proposal (RFP), the leader-team and disciplinary-teams then form a corporation with a specific identity (‘mythical’ organization), by drafting a corporate mission statement (statement of work – SOW) and selecting a corporate name and logo. The corporate mission statement specifies the philosophy, goals, and mission unique to the corporation (opportunity description, project objectives, requirements and constraints, data requirements, model requirements). A significant portion of the design-simulation work has to be accomplished ‘by hand’, but specialized disciplinary software tools will also be used to support certain aspects of the design process. Hands-on experience can be included in case the project requires the design-built-test sequence of a test specimen like a wind-tunnel model or of a small-scale R/C flight test demonstrator. The design team responds to the RFP by embarking on the conceptual design (CD) phase aiming to explore the design solution space via mission trades, design trades and technology trade studies. A configuration freeze of a single or selected alternative configuration concepts is required. Having completed the initial conceptual design (CD) trade phase leading to a configuration freeze, the project team will concentrate on the engineering aspect of the selected point design(s) by refining the disciplinary design analysis involving aerodynamic, propulsion, structures, etc.

The product development progress is monitored and documented by professional quality, bi-weekly individual design reports. Weekly project meetings are usually held with the individual teams. A mid-term team presentation and individual design report is expected where the teams
present their product development contribution. The feedback on the mid-term presentations and reports are then folded into the designs. The mid-term presentation and report prepare the students and their designs for the final presentation to an audience of students, faculty, and industry representatives who provide critical written and verbal assessment as to whether or not each design is responsive to the mission specification and RFP. The final individual report is a professional quality write up of the complete semester project.

In summary, the capstone course provides:

- an opportunity to learn,
- an opportunity to ready yourself for your career,
- an opportunity to stay curious.

The capstone course demands from each individual student:

- serious time investment,
- visible initiative,
- cooperation and communication,
- individual creativity,
- timely, transparent, and industry-quality deliverables.

**COMPUTER USE**

The computer is used extensively for design computations (disciplinary analysis, vehicle synthesis), for utilizing and building technical databases, for configuration development and geometry visualization using a CAD system, for visuals for class presentations, and for producing weekly reports and the final report. Students are urged to utilize computer facilities provided by MAE to develop their own programs based on course text and lectures.

These computers feature a variety of software and documents to enhance your learning experience. The programs tab in the start menu gives access to CATIA, MATLAB, SciLAB, GUIPlot, and Solidworks. The desktop provides links to Digital DATCOM (Aerodynamics), OpenVSP (Geometry), GASTURB (Propulsion), AVL (Aerodynamics), and AAA (Roskam-based synthesis tool). The folder named *Capstone Documents* provides: (1) documentation for past years capstone projects, and (2) disciplinary folders with additional software, spreadsheets, methods, and/or reports for aerodynamics, stability & control, performance, weights & balance, geometry, cost & marketing, propulsion, structure, sizing & synthesis, systems, atmosphere models, etc.

**PREREQUISITES**

MAE 4350 for MAE 4351, permission of the instructor.

**CLASS SCHEDULE**

Capstone design project class schedule during the Spring 2018 semester is totaling 240 minutes per week; class times are MoWe 09:00am-09:50am and We 03:00pm-05:20pm.

**CLASS ATTENDANCE**

It is part of the students’ obligation to attend scheduled project meetings; lack of attendance results in penalty points.
LABORATORY  Utilization of the MAE Capstone Laboratory in WH 301; possible utilization of the machine shop, wind tunnel, and CAD Laboratory.

INSTRUCTOR  Bernd Chudoba, Associate Professor, UTA MAE
500 W. First St., Phone: 817-272-1436
E-Mail: chudoba@uta.edu
Office Hours: TBD

PLACE OF CLASS  MoWe 09:00am-09:50am WH 308; We 03:00pm–05:20pm LS 424

COURSE WEBSITE  Blackboard

GRADING PROJECT  Individual Weekly Progress Reports 15%
Mid-Term Presentation 10%
Mid-Term Report 25%
End-of-Semester Presentation 15%
End-of-Semester Report 35%

GRADING RUBRIC  Report grades will be assigned out of 100 points.

Documentation (40/100 points possible)
- Table of Contents Organization
- Literature Search
- Self-Explanatory Text
- Proper Use of Figures and Tables
- Referencing

Methodology (60/100 points possible)

Literature Review (20/60 points possible)
- Data-Base (DB) Development (i.e. baseline B737 aircraft descriptions; past, present, and future TVC aircraft descriptions; TVC technology components, specifications, and characteristics)
- Knowledge-Base (KB) Development (i.e. lessons learned TVC design)

Development of Analysis Capability (20/60 points possible)
- a) Individual disciplinary process development (MDA_Disciplinary)
- b) Integration of Individual Process into Overall Team Methodology (MDA_Synthesis)
- Process used to validate your contribution to steps (a) and (b)

Pre-Analysis; Execution; Post-Analysis (20/60 points possible)
- Individual process assumptions to be used in analysis (i.e. correction factors and justifications for approximations) and team methodology implementation (i.e. correction factors and justifications for approximations).
- Define the experiment (design/mission/technology trades); parametric variation to screen solution-space in order to identify baseline design.
• Discussion of correctness & accuracy of results (validation and calibration).

**SUBMISSION**

**Project Reports**
The reports will be digitally submitted to TBD by 5:00pm according to the following schedule:

- Project Report 1  TBD
- Project Report 2  TBD
- Midterm Report     TBD
- Project Report 3  TBD
- Project Report 4  TBD
- Final Report       TBD

The report file names will have the format: LAST NAME, FIRST NAME, PROJECT TEAM NAME, DISCIPLINARY TEAM NAME, REPORT NUMBER.

**Project Presentations**
The presentation schedule is as follows:

- Midterm Presentation  TBD
- Final Presentation    TBD

**PROJECT SUBMISSION Midterm Deliverables**

The Report (.doc), and Presentation (.pdf) will be submitted to TBD.

**Midterm Report**

- The *midterm report* is a formal deliverable (and a key assignment to graduate) for MAE 4351 and is not considered a working document like the working project reports throughout the semester (place holders, red text, rough draft text, rough draft figures, etc., are not permitted). The midterm report should be a self-contained document that has been revised and edited sufficiently to convey the current status of the project and your individual contributions.

- The overall team research problem(s) and mission description(s) must be clearly stated such that the reader can pick up an individual disciplinary report and sufficiently understand why/what research has been accomplished.

- All external work has to be properly referenced.

**Midterm Presentation**

- A single team *presentation* will be submitted by the chief engineer. Each slide will include the name(s) of those individuals who contributed in producing it.

**Final Deliverables**
All presentations (.pdf), reports (.doc), and research material (working material/hard drive dump) must be burned to a CD/DVD and submitted to the AVD Lab.

Final Report

• The final report is a formal deliverable (and a key assignment to graduate) for MAE4351 and is not considered a working document like the work-in progress reports and mid-term report. As such, placeholders, red text, rough draft text, rough draft figures, etc., are not included. The final report has to be a self-contained document that has been revised and edited to professionally report writing standards.
• The research problem(s) and mission description(s) must be clearly stated such that the reader can pick up an individual team member report and sufficiently understand why/what research has been accomplished.
• All work will be properly referenced.

Final Presentation

• A single team presentation will be submitted by the chief engineer. Each slide will include the names of those individuals who contributed in producing it.
• Team poster
• 3D printed flight vehicle configuration

Research Materials

• Every student is providing the research material accumulated until the end of MAE 4351. The material needs to be organized into DB (Data-Base), KB (Knowledge-Base), and PP (Parametric Process).
• The DB-KB-PP categories include all relevant material (references, reports, pictures, tools downloaded, tools developed, digital materials downloaded, and a record of all professional/research communications initiated, analysis or synthesis tools. methods library, etc.).

Additionally, all research material borrowed from Dr. Chudoba must be returned to the AVD Lab. Grades will not be submitted until all of these materials are returned and/or the proper disclosures and arrangements made.

GRADE ALLOCATION  Course grades will be earned based on the following criteria:

A = 90% - 100%
B = 80% - 89%
C = 70% - 79%
D = 60% - 69%
F = 0% - 59%

This criterion is ABSOLUTE and there is no intention to deviate from it.

PROGRAM EDUCATIONAL OBJECTIVES (MAE Outcomes; ABET A-K)
The MAE 4351 capstone course relates to the following MAE/ABET outcomes: C, D, F, G, I. The selected ABET A-K statements below describe what students are expected to know and be able to do by the time of graduation.

**Outcome C: DESIGN SYSTEM, COMPONENT OR PROCESS TO MEET NEEDS**

Plan to accomplish:
1) Specify technical and managerial requirements for assigned team design project.
2) Request comprehensive literature search using professional-quality resources.
3) Task the teams & individual students to produce a team/individual semester task & time plan aimed at producing a timely and performing system or component.
4) Specify milestone deliverables and their expected quality.
5) Question students during weekly contact team meetings about their design approach meeting the project requirements.

Plan to demonstrate:
1) Require and grade be-weekly individual design reports throughout the semester. See samples of bi-weekly design reports in course exhibit.
2) Require and grade by every student a report chapter explicitly outlining the product development strategy and overall development plan.
3) Require and grade a detailed report discussing the design of a system, component or process to meet overall mission objectives.

**Key Assignment for Outcome C:** The mid-term individual report and the final semester report, both documents demonstrate the student’s ability to design a system, a component and or process to mission within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability and sustainability. The very nature of this class is to synthesize individual components into the systems context. The students must use multi-disciplinary and disciplinary methodologies, analysis, geometry visualization, and possibly testing in the design of their components and systems. See samples of individual (a) mid-term reports and (b) final semester reports in course exhibit.

**Outcome D: AN ABILITY TO FUNCTION ON MULTIDISCIPLINARY TEAMS**

Plan to accomplish:
1) Divide class into two competing design teams, each consisting of disciplinary sub-team structure.
2) Assist teams in choosing a corporate identity and task to formulate a product development strategy and business case.
3) Introduce the chief engineers to define a project multi-disciplinary methodology and responsibilities, and all disciplinary engineers to formulate corresponding disciplinary methodologies & responsibilities.
4) Task project teams to produce (a) team/individual weekly update presentation(s), (b) bi-weekly individual project report.

Plan to demonstrate:
1) Collect from each team the written organization plan, assigned duties and time schedule for completing tasks. See samples of bi-weekly design reports in course exhibit.
2) Require each team member to evaluate other members of the team as to his or her contributions to the design project. Use these evaluations in determining final grades.
3) Observe and grade each team member’s contributions during weekly meetings and bi-weekly progress reports. See samples of bi-weekly design reports in course exhibit.

**Key Assignment for Outcome D:** It is the very nature of this course to require students to work in teams on a project. The student team must respond to a request for proposal (RFP) with their ‘corporation’ which they have formed to work on this semester project. A chief engineer is selected who organizes managerial and engineering activities of the disciplinary groups. For each design discipline (e.g., aerodynamics, structures, cost), disciplinary sub-teams and team leaders are formed, dividing the disciplinary workload while depending upon each other to accomplish the group goals. The groups must work through problems of under-achievers, design trade-offs, and work from a published schedule and budget. The teams always use a multi-disciplinary approach to the project and utilize theory and experience gained from a variety of courses. All oral and written reports demonstrate the inner workings of the team. These reports are required to pass the course. See samples of individual (a) mid-term reports and (b) final semester reports in course exhibit.

**Outcome F: UNDERSTAND PROFESSIONAL & ETHICAL RESPONSIBILITY**

Plan to accomplish:
1) Classroom discussions about professional and ethical responsibility of the aerospace vehicle designer and technology forecaster.
2) Dedicate one lecture to flight vehicle safety, certification, and incident & accident investigation.
4) Organize a speaker from the FAA to introduce the subject flight safety and certification.

Plan to demonstrate:
1) Require an individual report chapter addressing design for safety & reliability. The overall design methodology needs to contain a concrete approach to design for safety & certification next to design for mission objectives. This bi-weekly report assignment counts as a major part of the course grade. See samples of bi-weekly project reports in course exhibit.
2) The students are required to research and document a project-relevant flight vehicle accident design case study. From the case study, it is required to take certain lessons learned into account with the safety methodology devised. Particular emphasis is directed to the discussion of engineering responsibility and the often fatal consequences in wrong-doing. See samples of bi-weekly design reports in course exhibit

**Key Assignment for Outcome F:** This particular bi-weekly report assignment explicitly requires a systematic approach towards professional & ethical responsibility in the context of design for flight safety and certification.

**Outcome G: AN ABILITY TO COMMUNICATE EFFECTIVELY**

Plan to accomplish:
1) Specify requirements for written reports and oral MS PPT presentation: (a) organization & presentation, (b) content & originality, and (c) practical application and feasibility. Outline use of text, tables, figures, and graphs.

2) Individual students receive written bi-weekly report feedback.

3) Three student-faculty contact opportunities per week are utilized to develop the skills of efficient oral communication and giving MS PPT update presentations.

Plan to demonstrate:
1) Grade bi-weekly individual written reports. See samples of bi-weekly project reports in course exhibit.
2) Grade mid-term and final reports. See samples of reports in course exhibit.
3) Grade mid-term and final team & individual presentation performance: (a) presentation material and (b) oral presentation skills. See samples of recorded mid-term and final presentations in course exhibit.

**Key Assignment for Outcome G:** The mid-term report & presentation and the final report & presentation serve to document the student’s ability to communicate effectively.

**Outcome I: RECOGNIZE THE NEED & ABILITY TO ENGAGE IN LIFELONG LEARNING**

Plan to accomplish:
1) Require an extensive literature search to be performed during the first weeks of class. The search is documented in the bi-weekly project reports covering project relevant aspect from the (a) past, the (b) presence, and the (c) projected future.
2) Require the literature search chapter to discuss the significance of project-relevant past, present and future design knowledge, and in particular how the design knowledge has been evolving (increasing or decreasing) over time.
3) Require each individual student to build a disciplinary data-base (DB) and knowledge-base aimed at retaining, organizing, and making available relevant design data, information and knowledge.
4) Require each student to utilize and enrich the DB & KB with new information generated throughout the project. Emphasize the need to engage in lifelong learning in order to efficiently shape future engineering products.

Plan to demonstrate:
1) Require and grade the particular bi-weekly report as a major part of the course grade aimed at delivering the primary DB & KB for the project. See samples of bi-weekly progress reports in course exhibit.
2) Require an individual student progress presentation as a major part of the course grade aimed at introducing the student’s disciplinary DB & KB for the project. See samples of DB & KB presentations in course exhibit.

**Key Assignment for Outcome I:** According to the overall project time plan, the students are required to document their individual working DB & KB in two ways: (a) bi-weekly report, and (b) DB & KB update presentation.
COURSE POLICIES

COURSE DELIVERABLES
Failure to turn in any course-related assignment (weekly homework, weekly report, etc.) on its assigned date, and at the assigned time, will result in a grade of a 0% being assigned for that course-related assignment. No late deliverables will be accepted for any reason; no grades of incomplete will be assigned. The bi-weekly capstone reports are due & collected as specified by the TA documenting two weeks worth of project work. The new entries into the cumulative project reports are indicated in red. Responsibility rests with the individual student to turn his/her report in.

ATTENDANCE, PERFORMANCE EVALUATION
Attendance is mandatory during project group meetings, class meetings, and presentations (mid-term, final, or by guest speakers). Subjective evaluation of individual students’ performance is based on faculty impression, input from sponsors (customer satisfaction), team members (peer review), technical staff, and external judges.

UNIVERSITY POLICIES
STUDENT EVALUATION OF TEACHING
The students will be asked to complete feedback forms at the end of the semester.

ABSENCES BASED ON RELIGIOUS BELIEFS
A student who misses an examination, work assignment, or other project due to the observance of a religious holy day will be given the opportunity to complete the work missed. To be eligible for such a make-up, the students must notify his/her instructor in writing within the first 15 days of class. Failure to follow the rules provided above within the time frames listed will result in the absence being considered unexcused.

AMERICANS WITH DISABILITY ACT
The University of Texas at Arlington is on record as being committed to both the spirit and letter of federal equal opportunity legislation; reference Public Law 93112 – The Rehabilitation Act of 1973 as amended. With the passage of new federal legislation entitled Americans With Disabilities Act (ADA), pursuant to section 504 of The Rehabilitation Act, there is renewed focus on providing this population with the same opportunities enjoyed by all citizens. As faculty members, we are required by law to provide ‘reasonable accommodation’ to students with disabilities, so as not to discriminate on the basis of that disability. Student responsibility primarily rests with informing faculty at the beginning of the semester and in providing authorized documentation through designated administrative channels. For more information contact the Office for Students with Disabilities.

ACADEMIC DISHONESTY
It is the philosophy of The University of Texas at Arlington that academic dishonesty is a completely unacceptable mode of conduct and will not be tolerated in any form. Any person involved in academic dishonesty will be disciplined in accordance with University regulations and procedures. Discipline may include suspension or expulsion from the university. It is the student’s responsibility to know University policies on these matters. “Scholastic dishonesty includes but is not limited to cheating, plagiarism, collusion, the submission for credit of any work or materials that are attributable in whole or in part to another person, taking an examination for another person, any act designed to give unfair advantage to a student or the attempt to commit such acts.” (Regents’ Rules and Regulations, Part One, Chapter VI, Section 3, Subsection 3.2, Subdivision 3.22)
INCLEMENT WEATHER POLICY
In the event that weather or other conditions are such that normal campus operations could be impeded, the following policy will apply for this class. If the University is closed, this class will not meet. Any assignments due or examinations scheduled will be due or rescheduled to the very next class period that the class meets. Local media should announce any closings.

STUDENT SUCCESS
UTA supports a variety of student success programs to help you connect with the university and achieve academic success. They include learning assistance, developmental education, advising and mentoring, admission and transition, and federally funded programs. Students requiring assistance academically, personally, or socially should contact the Office of Student Success Programs for more information and appropriate referrals.

EMAIL TO FACULTY
To contact a faculty member, use the email address shown on the top of the syllabus. Use as the 'subject line' MAE 4351, put your name inside the email message, start with the main point/question of the message. Emails from outside the UTA domain are subject to being treated as spam by the server and are possibly deleted.

NOTICE
The instructors reserve the right to make changes to the course syllabus as necessary. It is the student’s responsibility to keep up with changes to the syllabus as posted on the class website.

COPYRIGHT
Copyright 2008 UTA COE as to this syllabus, all lectures, and all materials. Students are prohibited from selling notes taken during this course (or being paid for taking by) any person or commercial firm without the express written permission of the professor teaching this course.

By signing this syllabus, the student acknowledges that he/she has read and understood this document.

Print Name: __________________________________________
Signature: __________________________________________ Date: __________

Prepared by: Dr. Bernd Chudoba
Date: 16 January 2018

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AEROSPACE VEHICLE DESIGN II

MAE 4351
(2-3) 3 HOURS CREDIT

SPRING 2018

SYLLABUS

By signing this syllabus, the student acknowledges that he/she has read and understood this document.

Print Name:_________________________________________________

Signature:_________________________________________________ Date:_______________

Prepared by:  Bernd Chudoba
Date:  16 January 2018

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