**MAE 3315-001: Aircraft Structure Statics**

**Spring 2019**

**Instructor(s):** Ashfaq Adnan

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**Faculty Profile:** <https://mentis.uta.edu/explore/profile/ashfaq-adnan>

**Office Hours:** M-W 11.00 am – 12.30 am or by appointment

**Section Information:** MAE 3315-001

Time and Place of Class Meetings: NH 203

M-W-F 10.00 am – 10.50 am

**Description of Course Content:** The course is intended to provide students with a clear and thorough presentation of both the theory and applications of the fundamental principles of mechanics of materials that used in aircraft structural design.

**Student Learning Outcomes:** The course is intended to provide students with a clear and thorough presentation of both the theory and application of the fundamental principles of mechanics of materials for aircraft structural design. Students will develop an understanding of the meaning of stress and strain, and the relation between them for isotropic and anisotropic materials. They will also learn to use analytical/empirical tools for determining the distribution of load (or displacement) in typical aerospace structural components. In addition, they will develop an understanding of the relation between applied load and aerospace component failure/fracture. They will then use this skill to select appropriate aerospace materials against component failure.

**Required Textbooks and Other Course Materials:** C.T. Sun, Mechanics of Aircraft Structures, 2nd Edition,Published by John Wiley & Sons, Inc. in 2006

*The text book will be used as reference, and for some reading and homework assignments.*

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Additional materials and information will be uploaded at Blackboard on a regular bases. Students are responsible to regularly visit blackboard and collect materials.

**Course Content**: The topics listed below will be covered during this course.

**Part I: Essential Concepts**

Ch. 1: Aircraft Structures and Materials

* Introduction to design and analysis concepts of aircraft structure
* Brief review of elementary mechanics of solids
* Structural elements in aircraft structures
* Mechanical properties of aircraft materials.

Ch. 2: Essential Analytical Tool: Elasticity

* Concept of displacement, strain and stress.
* Static equilibrium conditions.
* Linear elastic stress-strain relations.
* Plane elasticity

**Part II: Structural Mechanics**

Ch. 3: Torsion

* Torsion of uniform bars
* Bars with circular sections
* Bars with rectangular sections
* Closed single-cell sections
* Multi-cell sections

Ch. 4: Bending and Flexural Shear

* Simple beam theory
* Bidirectional bending
* Transverse shear in beams
* Deformation of thing-walled beams.

Ch 5: Shear Flow in Thin-Walled Sections

* Concept of shear flow
* Shear center
* Shear flow in open and closed sections
* Combined flexural and torsional shear flow.
* Multi-cell closed sections.

**Part III: Material Selection and Failure Prediction**

Ch 6: Failure Criteria for Isotropic Materials.

* Failure criteria for brittle materials
* Yielding of ductile materials
* Fracture mechanics
* Fatigue Failure

Ch 7: Elastic Buckling

* Buckling and its sources
* Elementary buckling analysis
* Buckling of structures
* Post buckling behaviors

**Descriptions of major assignments and examinations:**

There will be ~10 homework assignments, **2 KEY Assignments,** three exams and one final exam.

**Purpose of Key Assignment:**

The key assignments are designed to assess students’ ability to “apply their knowledge of Math, Science and Engineering” in solving the assigned problems related to the course content.

Collected data will be analyzed and then entered into **ABET review documents**.

What is ABET? <http://www.abet.org/>

UTA and ABET? <http://www.uta.edu/engineering/about/accreditation.php>

## Why Does ABET Accreditation Matter?

(Taken from the link above)  
   
Accreditation is proof that a collegiate program has met certain standards necessary to produce graduates who are ready to enter their professions. Students who graduate from accredited programs have access to enhanced opportunities in areas such as employment, mobility, and providing a positive impact on society.  
   
ABET is an integral part of each of these areas because it accredits over 3,100 applied science, computing, engineering, and technology programs at more than 660 colleges and universities in 23 countries worldwide. Approximately 85,000 students graduate from ABET-accredited programs each year.   
   
Accreditation is an assurance that the professionals that serve us have a solid educational foundation and are capable of leading the way in innovation, emerging technologies, and in anticipating the welfare and safety needs of the public.

**Plan to accomplish:** Engineering techniques based on differential equations, constitutive relations, 2-D & 3-D geometry and mechanics of materials will be introduced.

**Plan to demonstrate:** Assignments that involve stress analysis and applications of simple structural design principles will be given. The students will be tested on their ability to: (a) solve differential equations, (b) evaluate geometric properties of closed/open thin solid sections and (c) apply engineering structural design principles involving axial/bending/torsional/shear/buckling loading scenarios.

**Key Assignments for Outcome a: APPLY KNOWLEDGE OF MATH, SCIENCE & ENG.**

Key Assignment 1: The first homework is essentially based on the properties of open and closed thin-walled section subjected to axial and torsional loads. The problems examine the students’ ability of analyzing the properties of open and closed section. The problems should also help students understand how torsional/axial load carrying capacity of a structure can be optimized through parametric studies and geometric variations.

Key Assignment 2: The second homework focuses on analyzing aerospace structure under flexural loads. The problems will allow students to evaluate shear flow and shear center of different open and closed-cell structures based on the properties of open and closed thin-walled sections subjected to flexural loads. The problems will also help students obtain geometry-property-performance relations of aerospace structural components.

**Exam 1:**  **Wednesday February 13, 2019, 10:00 am – 10:45 am.**

Syllabus: All class materials, solved problems, homework and reading assignments that are covered to date.

**Exam 2:**  **Monday March 25, 2019, 10:00 am – 10:45 am.**

Syllabus: All class materials, solved problems, homework and reading assignments that are covered between Exam 1 and to date.

**Exam 3:**  **Friday April 26, 2019, 10:00 am – 10:45 am.**

Syllabus: All class materials, solved problems, homework and reading assignments that are covered between Exam 2 and to date.

**Homework:** Assigned weekly and due in one week unless otherwise stated.

**Final Exam:** On the date scheduled by the University\* during the Final Exam Period. Covers all class materials including homework, solved problems, reading assignments and midterm exams. The format of the exam

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| --- | --- | --- |
| \***Friday** | **May 10, 2019** | **8:00 a.m. - 10:30 a.m.** |

**Important Note:**

* All students MUST check blackboard and UTA email periodically. All HWs, announcements and course related information will be made available to Blackboard only.
* **All homework assignments should be prepared on instructor-approved papers and turned in with a coversheet. All papers should be properly stapled. The template for the coversheet will be uploaded to Blackboard before the 1st HW assignment is due.**

**Any Homework Assignments submitted without following instructions above will be returned without grade. [NO EXCEPTIONS]**

* Homework turned in **LATE** will receive a 20% penalty per day until solution for that Homework is posted. Solutions to HWs will be posted within one week from the due date.
* No **LATE** home work will be accepted after the solution is made available to students. [NO EXCEPTIONS]
* UTA regulations permitting, missed midterms and/or final exams can only be rescheduled when missed due to major health problems or circumstances beyond the student’s control.
* With instructor’s discretion, students will be required to reschedule the missed exams at the earliest time possible.

**Attendance:** At The University of Texas at Arlington, taking attendance is not required but attendance is a critical indicator in student success. Each faculty member is free to develop his or her own methods of evaluating students’ academic performance, which includes establishing course-specific policies on attendance. ***As the instructor of this section, I will take attendance sporadically. Students are strongly recommended to attend each class.*** While UT Arlington does not require instructors to take attendance in their courses, the U.S. Department of Education requires that the University have a mechanism in place to mark when Federal Student Aid recipients “begin attendance in a course.” UT Arlington instructors will report when students begin attendance in a course as part of the final grading process. Specifically, when assigning a student a grade of F, faculty report the last date a student attended their class based on evidence such as a test, participation in a class project or presentation, or an engagement online via Blackboard. This date is reported to the Department of Education for federal financial aid recipients.

**Grading Policy**:

Exam 1 100

Exam 2 100

Exam 3 100

Home Works 50

Final Exam 150

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Semester Total points 500

**Tentative Grading Scale Letter Grade**

450 or above A

401 – 449 B

351 – 400 C

301 – 350 D

000 – 300 F

**Drop Policy:** Students may drop or swap (adding and dropping a class concurrently) classes through self-service in MyMav from the beginning of the registration period through the late registration period. After the late registration period, students must see their academic advisor to drop a class or withdraw. Undeclared students must see an advisor in the University Advising Center. Drops can continue through a point two-thirds of the way through the term or session. It is the student's responsibility to officially withdraw if they do not plan to attend after registering. **Students will not be automatically dropped for non-attendance**. Repayment of certain types of financial aid administered through the University may be required as the result of dropping classes or withdrawing. For more information, contact the Office of Financial Aid and Scholarships (<http://wweb.uta.edu/aao/fao/>).

**Disability Accommodations:** UTArlington is on record as being committed to both the spirit and letter of all federal equal opportunity legislation, including *The Americans with Disabilities Act (ADA), The Americans with Disabilities Amendments Act (ADAAA),* and *Section 504 of the Rehabilitation Act.* All instructors at UT Arlington are required by law to provide “reasonable accommodations” to students with disabilities, so as not to discriminate on the basis of disability. Students are responsible for providing the instructor with official notification in the form of **a letter certified** by the Office for Students with Disabilities (OSD).Only those students who have officially documented a need for an accommodation will have their request honored. Students experiencing a range of conditions (Physical, Learning, Chronic Health, Mental Health, and Sensory) that may cause diminished academic performance or other barriers to learning may seek services and/or accommodations by contacting: **The Office for Students with Disabilities, (OSD)** <http://www.uta.edu/disability/> or calling 817-272-3364. Information regarding diagnostic criteria and policies for obtaining disability-based academic accommodations can be found at [www.uta.edu/disability](http://www.uta.edu/disability).

**Counseling and Psychological Services (CAPS)** [www.uta.edu/caps/](http://www.uta.edu/caps/) or calling 817-272-3671 is also available to all students to help increase their understanding of personal issues, address mental and behavioral health problems and make positive changes in their lives.

**Non-Discrimination Policy:** *The University of Texas at Arlington does not discriminate on the basis of race, color, national origin, religion, age, gender, sexual orientation, disabilities, genetic information, and/or veteran status in its educational programs or activities it operates. For more information, visit*[*uta.edu/eos*](http://www.uta.edu/hr/eos/index.php)*.*

**Title IX Policy:** The University of Texas at Arlington (“University”) is committed to maintaining a learning and working environment that is free from discrimination based on sex in accordance with Title IX of the Higher Education Amendments of 1972 (Title IX), which prohibits discrimination on the basis of sex in educational programs or activities; Title VII of the Civil Rights Act of 1964 (Title VII), which prohibits sex discrimination in employment; and the Campus Sexual Violence Elimination Act (SaVE Act). Sexual misconduct is a form of sex discrimination and will not be tolerated.*For information regarding Title IX, visit* [www.uta.edu/titleIX](http://www.uta.edu/titleIX) or contact Ms. Jean Hood, Vice President and Title IX Coordinator at (817) 272-7091 or [jmhood@uta.edu](../hannabas/AppData/Local/Microsoft/Windows/Temporary%20Internet%20Files/Content.Outlook/697W32M3/jmhood@uta.edu).

**Academic Integrity:** Students enrolled all UT Arlington courses are expected to adhere to the UT Arlington Honor Code:

*I pledge, on my honor, to uphold UT Arlington’s tradition of academic integrity, a tradition that values hard work and honest effort in the pursuit of academic excellence.*

*I promise that I will submit only work that I personally create or contribute to group collaborations, and I will appropriately reference any work from other sources. I will follow the highest standards of integrity and uphold the spirit of the Honor Code.*

UT Arlington faculty members may employ the Honor Code in their courses by having students acknowledge the honor code as part of an examination or requiring students to incorporate the honor code into any work submitted. Per UT System *Regents’ Rule* 50101, §2.2, suspected violations of university’s standards for academic integrity (including the Honor Code) will be referred to the Office of Student Conduct. Violators will be disciplined in accordance with University policy, which may result in the student’s suspension or expulsion from the University. Additional information is available at <https://www.uta.edu/conduct/>.

**Electronic Communication:** UT Arlington has adopted MavMail as its official means to communicate with students about important deadlines and events, as well as to transact university-related business regarding financial aid, tuition, grades, graduation, etc. All students are assigned a MavMail account and are responsible for checking the inbox regularly. There is no additional charge to students for using this account, which remains active even after graduation. Information about activating and using MavMail is available at <http://www.uta.edu/oit/cs/email/mavmail.php>.

**Campus Carry:** Effective August 1, 2016, the Campus Carry law (Senate Bill 11) allows those licensed individuals to carry a concealed handgun in buildings on public university campuses, except in locations the University establishes as prohibited. Under the new law, openly carrying handguns is not allowed on college campuses. For more information, visit <http://www.uta.edu/news/info/campus-carry/>

**Student Feedback Survey:** At the end of each term, students enrolled in classes categorized as “lecture,” “seminar,” or “laboratory” shall be directed to complete an online Student Feedback Survey (SFS). Instructions on how to access the SFS for this course will be sent directly to each student through MavMail approximately 10 days before the end of the term. Each student’s feedback enters the SFS database anonymously and is aggregated with that of other students enrolled in the course. UT Arlington’s effort to solicit, gather, tabulate, and publish student feedback is required by state law; students are strongly urged to participate. For more information, visit <http://www.uta.edu/sfs>.

**Final Review Week:** for semester-long courses**,** a period of five class days prior to the first day of final examinations in the long sessions shall be designated as Final Review Week. The purpose of this week is to allow students sufficient time to prepare for final examinations. During this week, there shall be no scheduled activities such as required field trips or performances; and no instructor shall assign any themes, research problems or exercises of similar scope that have a completion date during or following this week *unless specified in the class syllabus*. During Final Review Week, an instructor shall not give any examinations constituting 10% or more of the final grade, except makeup tests and laboratory examinations. In addition, no instructor shall give any portion of the final examination during Final Review Week. During this week, classes are held as scheduled. In addition, instructors are not required to limit content to topics that have been previously covered; they may introduce new concepts as appropriate.

**Emergency Exit Procedures:** Should we experience an emergency event that requires us to vacate the building, students should exit the room and move toward the nearest exit. When exiting the building during an emergency, one should never take an elevator but should use the stairwells. Faculty members and instructional staff will assist students in selecting the safest route for evacuation and will make arrangements to assist handicapped individuals.

**Woolf Hall 406 Computer Teaching Lab Policies:**

1. WH 406 must be officially reserved for all events including classroom instructions due to the limited classroom space equipped with computers and scheduling logistics. Please see Lanie or Janet for reservation.

2. WH 406 is a computer teaching lab. Faculty and Instructors must be present while students occupy this room.  When an instructor leaves the room, students are to leave WH 406 as well.  Instructors should encourage students to use WH 320 if needed after class is over. The computer lab in WH 320 is available for MAE student access 24/7.

3. WH 406 doors are not to be propped open.  Propped doors are considered a security breach by the UTA Police Department and a hazard violation by the Fire Inspector.

4. Food, drink, and tobacco products are prohibited in WH 406.

**Student Support Services:** UT Arlington provides a variety of resources and programs designed to help students develop academic skills, deal with personal situations, and better understand concepts and information related to their courses. Resources include [tutoring](http://www.uta.edu/universitycollege/current/academic-support/learning-center/tutoring/index.php), [major-based learning centers](http://www.uta.edu/universitycollege/resources/college-based-clinics-labs.php), developmental education, [advising and mentoring](http://www.uta.edu/universitycollege/resources/advising.php), personal counseling, and [federally funded programs](http://www.uta.edu/universitycollege/current/academic-support/mcnair/index.php). For individualized referrals, students may visit the reception desk at University College (Ransom Hall), call the Maverick Resource Hotline at 817-272-6107, send a message to [resources@uta.edu](mailto:resources@uta.edu), or view the information at <http://www.uta.edu/universitycollege/resources/index.php>.

**Course Schedule**

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| 14-Jan-19 | Monday | Lecture 1 | **Chapter 1 Characteristics of Aircraft Structures and Materials**   * Basic structural elements; * Structural loads; * Review shear moment diagram; * Aircraft materials |
| 16-Jan-19 | Wednesday | Lecture 2 |
| 18-Jan-19 | Friday | Lecture 3 |
| **21-Jan-19** | **Monday** | **No Class - Martin Luther King Day** | |
| 23-Jan-19 | Wednesday | Lecture 4 | **Chapter 2 Introduction to Elasticity**   * Basic concepts of stress/strain; * Principal stresses and their planes; * Maximum shears and their planes; * Stress transformation; * Linear stress/strain relationship; * Elastic strain energy * Plane stress/plane strain; * Equation of equilibrium; * Airy stress function |
| 25-Jan-19 | Friday | Lecture 5 |
| 28-Jan-19 | Monday | Lecture 6 |
| 30-Jan-19 | Wednesday | Lecture 7 |
| 1-Feb-19 | Friday | Lecture 8 |
| 4-Feb-19 | Monday | Lecture 9 |
| 6-Feb-19 | Wednesday | Lecture 10 |
| 8-Feb-19 | Friday | Lecture 11 | **Chapter 3 Torsion**   * Torsion of uniform bars with circular cross-sections; * Torsion of uniform bars with rectangular cross-section; * Torsional rigidity; * Closed Single-Cell Thin-Walled Sections. * Multicell Thin-Walled Sections. |
| 11-Feb-19 | Monday | Lecture 12 |
| **13-Feb-19** | **Wednesday** | **Exam 1** |
| 15-Feb-19 | Friday | Lecture 13 |
| 18-Feb-19 | Monday | Lecture 14 |
| 20-Feb-19 | Wednesday | Lecture 15 |
| 22-Feb-19 | Friday | Lecture 16 | **Chapter 4 Bending and Flexural Shear**   * Simple beam theory * Bidirectional bending * Transverse shear in beams   Deformation of thin-walled beams. |
| 25-Feb-19 | Monday | Lecture 17 |
| 27-Feb-19 | Wednesday | Lecture 18 |
| 1-Mar-19 | Friday | Lecture 19 |
| 4-Mar-19 | Monday | Lecture 20 |
| 6-Mar-19 | Wednesday | Lecture 21 |
| 8-Mar-19 | Friday | Lecture 22 |
| **11-Mar-19** | **Monday** | **Spring Vacation – No Class** | |
| **13-Mar-19** | **Wednesday** |
| **15-Mar-19** | **Friday** |
| 18-Mar-19 | Monday | Lecture 23 | **Chapter 5 Shear Flow in Thin-Walled Sections**   * Concept of shear flow * Shear center * Shear flow in open and closed sections * Combined flexural and torsional shear flow. * Multi-cell closed sections. |
| 20-Mar-19 | Wednesday | Lecture 24 |
| 22-Mar-19 | Friday | Lecture 25 |
| **25-Mar-19** | **Monday** | **Exam 2** |
| 27-Mar-19 | Wednesday | Lecture 26 |
| 29-Mar-19 | Friday | Lecture 27 |
| 1-Apr-19 | Monday | Lecture 28 |
| 3-Apr-19 | Wednesday | Lecture 29 |
| 5-Apr-19 | Friday | Lecture 30 |
| 8-Apr-19 | Monday | Lecture 31 | **Chapter 6 Failure Criteria for Isotropic Materials.**   * Failure criteria for brittle materials * Yielding of ductile materials * Fracture mechanics * Fatigue Failure |
| 10-Apr-19 | Wednesday | Lecture 32 |
| 12-Apr-19 | Friday | Lecture 33 |
| 15-Apr-19 | Monday | Lecture 34 |
| 17-Apr-19 | Wednesday | Lecture 35 |
| 19-Apr-19 | Friday | Lecture 36 |
| 22-Apr-19 | Monday | Lecture 37 | **Chapter 7 Elastic Buckling**   * Buckling and its sources * Elementary buckling analysis * Buckling of structures * Post buckling behaviors |
| 24-Apr-19 | Wednesday | Lecture 38 |
| **26-Apr-19** | **Friday** | **Exam 3** |
| 29-Apr-19 | Monday | Lecture 39 |
| 1-May-19 | Wednesday | Lecture 40 |
| 3-May-19 | Friday | Lecture 41 | Review |
| 10- May 19 | **Friday** | **FINAL** | **8:00 am to 10:30 am** |

*As the instructor for this course, I reserve the right to adjust this schedule in any way that serves the educational needs of the students enrolled in this course. –Ashfaq Adnan*