MAE 3315-001: Aircraft Structure Statics

Fall 2020
Instructor Information

Instructor(s):
Ashfaq Adnan

Office Number:
315B Woolf Hall

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Faculty Profile:
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Office Hours: Tu-Th 3.30 pm – 5.00 pm or by appointment

Course Information

Section Information: MAE 3315-001
Time and Place of Class Meetings: Online Synchronous, Classroom - TBA
Tu-Th 11.00 am – 12.20 pm

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.

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

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

Technology Requirements
- Students must have access to a computer installed with a webcam. It is student's responsibility to ensure proper functioning of the computer and webcam.
- All classes will be delivered online. Students must have access to reliable internet/wifi.
- Students must be familiar with the online teaching tools including Canvas, Teams, Respondus Lockdown or other proctoring tools, etc. Students may use the tutorials on these tools by clicking on the "Get Started" Box on their Canvas Homepage.
- Students MUST check Canvas and UTA email periodically. All HWs, announcements and course related information will be made available to Canvas only.
- Unless otherwise announced, all classes will be delivered via MS TEAMS. The class links will be posted in canvas.
- Unless otherwise announced, all live classes will be recorded. The links will be available via MS TEAMS and at CANVAS.

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, two exams and one final exam.

Two of the all HW assignments will be designated as KEY ASSIGNMENTS. Each Key assignment will be equivalent to 2 HW assignments. Please check CANVAS for specific instructions about Key Assignments.

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/](http://www.abet.org/)

UTA and ABET? [http://www.uta.edu/engineering/about/accreditation.php](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.

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**Exam 1:** Tuesday October 13, 2020, 11:00 am – 12:15 pm.

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

**Exam 2:** Tuesday November 24, 2020, 11:00 am – 12:15 pm.

**Syllabus:** All class materials, solved problems, homework and reading assignments that are covered between Exam 1 and to date.
**Homework:** Assigned weekly and due in one week unless otherwise stated.

**Final Exam:**
The final exam schedule can be found here:

[https://www.uta.edu/records/Fall%202020%20Final%20Exam%20Dates3.pdf](https://www.uta.edu/records/Fall%202020%20Final%20Exam%20Dates3.pdf)

As of August 16, 2020, the final exam for this class is scheduled as follows:

**Thursday, Dec 10 11 – 1:30 p.m.**

The final exam is comprehensive and covers all class materials including homework, solved problems, reading assignments and midterm exams.

**Important Note:**
- 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.

**Grading Information**

**Grading Policy:**

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<tr>
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<th>Points</th>
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<tr>
<td>Exam 1</td>
<td>150</td>
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<td>Exam 2</td>
<td>150</td>
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<tr>
<td>Home Works</td>
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<td>Final Exam</td>
<td>150</td>
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Semester Total points 500
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<tr>
<th>Tentative Grading Scale</th>
<th>Letter Grade</th>
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<td>450 or above</td>
<td>A</td>
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**Course Schedule**
<table>
<thead>
<tr>
<th>Date</th>
<th>Lecture</th>
<th>Chapter 1</th>
<th>Chapter 2</th>
<th>Chapter 3</th>
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<tbody>
<tr>
<td>Thursday, August 27, 2020</td>
<td>Lecture 1</td>
<td>Characteristics of Aircraft Structures and Materials</td>
<td>Introduction to Elasticity</td>
<td>Torsion</td>
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<tr>
<td>Tuesday, September 1, 2020</td>
<td>Lecture 2</td>
<td>• Basic structural elements;</td>
<td>• Basic concepts of stress/strain;</td>
<td>• Torsion of uniform bars with circular cross-sections;</td>
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<td>Thursday, September 3, 2020</td>
<td>Lecture 3</td>
<td>• Structural loads;</td>
<td>• Principal stresses and their planes;</td>
<td>• Torsion of uniform bars with rectangular cross-section;</td>
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<td>Tuesday, September 8, 2020</td>
<td>Lecture 4</td>
<td>• Review shear moment diagram;</td>
<td>• Maximum shears and their planes;</td>
<td>• Torsional rigidity;</td>
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<tr>
<td>Thursday, September 10, 2020</td>
<td>Lecture 5</td>
<td>• Aircraft materials</td>
<td>• Stress transformation;</td>
<td>• Closed Single-Cell Thin-Walled Sections;</td>
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<tr>
<td>Tuesday, September 15, 2020</td>
<td>Lecture 6</td>
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<td>• Linear stress/strain relationship;</td>
<td>• Multicell Thin-Walled Sections.</td>
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<tr>
<td>Thursday, September 17, 2020</td>
<td>Lecture 7</td>
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<td>• Elastic strain energy</td>
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<td>Date</td>
<td>Lecture</td>
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<td>Thursday, October 15, 2020</td>
<td>Lecture 14</td>
<td><strong>Chapter 4  Bending and Flexural Shear</strong></td>
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<td>- Structural Idealization</td>
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<td>- Simple beam theory</td>
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<td>- Deformation of thin-walled beams</td>
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<td>Tuesday, October 20, 2020</td>
<td>Lecture 15</td>
<td><strong>Chapter 5  Shear Flow in Thin-Walled Sections</strong></td>
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<td>Thursday, October 22, 2020</td>
<td>Lecture 16</td>
<td>- Concept of shear flow</td>
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<td>Thursday, October 27, 2020</td>
<td>Lecture 17</td>
<td>- Shear center</td>
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<tr>
<td>Thursday, October 29, 2020</td>
<td>Lecture 18</td>
<td>- Shear flow in open and closed sections</td>
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<tr>
<td>Tuesday, November 3, 2020</td>
<td>Lecture 19</td>
<td>- Combined flexural and torsional shear flow.</td>
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<td>Multi-cell closed sections</td>
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<td>Thursday, November 5, 2020</td>
<td>Lecture 20</td>
<td><strong>Chapter 6  Failure Criteria for Isotropic Materials.</strong></td>
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<tr>
<td>Tuesday, November 10, 2020</td>
<td>Lecture 21</td>
<td>- Failure criteria for brittle materials</td>
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<td>Thursday, November 12, 2020</td>
<td>Lecture 22</td>
<td>- Yielding of ductile materials</td>
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<td>Tuesday, November 17, 2020</td>
<td>Lecture 23</td>
<td>- Fracture mechanics</td>
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<td>Thursday, November 19, 2020</td>
<td>Lecture 24</td>
<td>- Fatigue Failure</td>
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<td><strong>Tuesday, November 24, 2020</strong></td>
<td>Exam 2</td>
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<td><strong>Thursday, November 26, 2020</strong></td>
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<tr>
<td>Tuesday, December 1, 2020</td>
<td>Lecture 25</td>
<td><strong>Chapter 7  Elastic Buckling</strong></td>
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<tr>
<td>Thursday, December 3, 2020</td>
<td>Lecture 26</td>
<td>- Buckling and its sources</td>
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<td>Tuesday, December 8, 2020</td>
<td>Lecture 27</td>
<td>- Elementary buckling analysis</td>
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<td>- Buckling of structures</td>
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<td>- Post buckling behaviors</td>
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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
**Institution Information**

UTA students are encouraged to review the below institutional policies and informational sections and reach out to the specific office with any questions. To view this institutional information, please visit the [Institutional Information](http://www.uta.edu/provost/administrative-forms/course-syllabus/syllabus-institutional-policies.php) page which includes the following policies among others:

- Drop Policy
- Disability Accommodations
- Title IX Policy
- Academic Integrity
- Student Feedback Survey
- Final Exam Schedule

**Additional Information**

**Mandatory Face Covering Policy:**
All students and instructional staff are required to wear facial coverings while they are on campus, inside buildings and classrooms. Students that fail to comply with the facial covering requirement will be asked to leave the class session. If students need masks, they may obtain them at the Central Library, the E.H. Hereford University Center’s front desk or in their department. Students who refuse to wear a facial covering in class will be asked to leave the session by the instructor, and, if the student refuses to leave, they may be reported to UTA’s Office of Student Conduct.

**Attendance:**
At The University of Texas at Arlington, taking attendance is not required but attendance is a critical indicator of 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. However, 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 must 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 Canvas. This date is reported to the Department of Education for federal financial aid recipients.

**Final Review Week:**
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 syllabi. 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. For Fall Semester 2019: We designate November 27 to December 4 as review week. This gives students a full week before finals for review. While the 28th is Thanksgiving, November 27 and 29 are review days as are December 2, 3 and 4.

**Emergency Exit Procedures:**
Should we experience an emergency event that requires evacuation of the building, students should exit the room and move toward the nearest exit. When exiting the building during an emergency, do not take an elevator but use the stairwells instead. Faculty members and instructional staff will assist students in selecting the safest route for evacuation and will make arrangements to assist individuals with disabilities.

**Student Success Programs:**
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 by appointment, drop-in tutoring, etutoring, supplemental instruction, mentoring (time management, study skills, etc.), success coaching, TRIO Student Support Services, and student success workshops. For additional information, please email resources@uta.edu, or view the Maverick Resources website.

**Emergency Phone Numbers**
In case of an on-campus emergency, call the UT Arlington Police Department at 817-272-3003 (non-campus phone), 2-3003 (campus phone). You may also dial 911. Non-emergency number 817-272-3381

**Library Information**

**Research or General Library Help**
Ask for Help
- Academic Plaza Consultation Services (library.uta.edu/academic-plaza)
- Ask Us (ask.uta.edu/)
- Research Coaches (http://libguides.uta.edu/researchcoach)

Resources
- Library Tutorials (library.uta.edu/how-to)
- Subject and Course Research Guides (libguides.uta.edu)
- Librarians by Subject (library.uta.edu/subject-librarians)
- A to Z List of Library Databases (libguides.uta.edu/az.php)
- Course Reserves (https://uta.summon.serialssolutions.com/#!/course_reserves)
- Study Room Reservations (openroom.uta.edu/)