2020

Aerodynamics

North Carolina Agricultural and Technical State University

NORTH CAROLINA AGRICULTURAL AND TECHNICAL STATE UNIVERSITY

COURSE SYLLABUS

College Name: College of Engineering
Department Name: Mechanical Engineering
Course Name: Aerodynamics

COURSE INFORMATION

- Course Number/Section: MEEN 315
- Term:
- Semester Credit Hours: 3
- Times and Days:
- Class Location:

INSTRUCTOR CONTACT INFORMATION

- Instructor:
- Office Location:
- Office Phone:
- Email Address:

Faculty must notify students of the approximate time and method they can expect to receive an answer to all communications (e.g., email, phone, course messages). Excluding holidays, the response should be provided within 48 hours.

If there's a graduate teaching assistant assigned to work with this course, please include their names also.

STUDENT HOURS

These are times students may visit the professor without an appointment to request the assistance they need.

NOTE: Students are responsible for reading, understanding, and following the syllabus.

: AM ☐ / PM ☐ – : AM ☐ / PM ☐

Monday ☐ Tuesday ☐ Wednesday ☐ Thursday ☐ Friday ☐

COURSE PREREQUISITES

MATH 231 ("C" or higher), MEEN 233

COURSE DESCRIPTION

The course begins with the fundamentals of fluid statics and dynamics followed by an introduction to inviscid flow theory with applications to incompressible flows over airfoils, wings and flight vehicle configurations. Credit: 3

STUDENT LEARNING OBJECTIVES/OUTCOMES (SLO)

Learning outcomes should be specific, measurable, and focused on the content knowledge the students are expected to master and not what the faculty will teach.

If the course is a General Education Course, the SLO should be listed and labeled as "General Education."

SLO 1: Define the concepts of a fluid and devise fluid property measurement methods
SLO 2: Analyze forces and moments due to aerodynamic flow
SLO 3: Determine inviscid fluid flow parameters found using Bernoulli's equation
SLO 4: Determine viscous fluid flow parameters found using differential and/or integral methodology
SLO 5: Determine drag on flight vehicle and the size of boundary layers
SLO 6: Determine airfoils requirements for practical flow regimes

REQUIRED TEXTBOOKS AND MATERIALS

Any course-level subscriptions and tools linked in Blackboard Learn learning management system (LMS) should be listed here. The Blackboard LMS must have links to their student data privacy statement.

REQUIRED TEXTS:

ANDERSON, J. D. (2016). *Fundamentals of aerodynamics*. Tata McGraw-Hill Education.

REQUIRED MATERIALS:

SUGGESTED COURSE MATERIALS

SUGGESTED READINGS/TEXTS:

SUGGESTED MATERIALS:

GRADING POLICY

ASSIGNMENTS AND GRADING POLICY

94% and above	A		76% - 74%	C
93% - 90%	A-		73% - 70%	C-
89% - 87%	B+		69% - 67%	D+
86% - 84%	B		66% - 64%	D
83% - 80%	B-		63% - 0%	F
79% - 77%	C+			

For GRADUATE COURSES: See 2019-2020 Graduate Catalog p.38 for graduate grading scale and Non-Graded Courses

GRADING ALLOCATION

Course grades are based on a weighted grading scale of 100%. The breakdown for the course is as follows: *[Faculty, please adjust according to your course.]*

Category	# of Activities	Percentage Grade Weight
Smart Book Assignments	12	4%
Unit Assignments	12	10%
Project	1	16%
Quizzes	3	30%
Exam	1	40%
Total	**29**	**100%**

COURSE POLICIES

USE OF BLACKBOARD AS THE LEARNING MANAGEMENT SYSTEM

Blackboard is the primary online instructional and course communications platform. Students can access the course syllabus, assignments, grades, and learner support resources. Students are encouraged to protect their login credentials, complete a Blackboard orientation, and log in daily to the course.

Note: Uploading assignments through Blackboard presents a challenge for Chromebook users in locating the files for submission. If you use a Chromebook, please be sure you also have access to a Mac computer or Windows computer so you can fully participate in your Blackboard class. For more information about student computer recommendations, please visit https://hub.ncat.edu/administration/its/computer-recommendations.php.

MAKE-UP EXAMS

See << Update Academic Year >>*Undergraduate Bulletin:*

https://www.ncat.edu/provost/academic-affairs/bulletins/index.php

For GRADUATE STUDENTS: See 2019-20 Graduate Catalog p. 54

EXTRA CREDIT

LATE WORK

SPECIAL ASSIGNMENTS

For GRADUATE STUDENTS: FAILING TO MEET COURSE REQUIREMENTS (Graduate Catalog p.40)

For GRADUATE STUDENTS: CLASS ATTENDANCE (see 2019-20 Graduate Catalog p. 53-54)

Students are expected to attend class and participate on a regular basis in order to successfully achieve course learning outcomes and meet federal financial aid requirements (34 CFR 668.22). Class attendance in online courses is defined as active participation in academically-related course activities. Active participation may consist of course interactions with the content, classmates, and/or the instructor. Examples of academically-related course activities include, but are not limited to:

- Completing and submitting assignments, quizzes, exams, and other activities within Blackboard or through Blackboard (3rd-party products).
- Participating in course-related synchronous online chats, discussions, or meeting platforms such as Blackboard Collaborate in which participation is tracked.

CLASSROOM CITIZENSHIP

Courtesy, civility, and respect must be the hallmark of your interactions.

COMPLIANCE WITH THE AMERICANS WITH DISABILITIES ACT

North Carolina A&T State University is committed to following the requirements of the Americans with Disabilities Act Amendments Act (ADAAA) and Section 504 of the Rehabilitation Act.
If you need an academic accommodation based on the impact of a disability, you must initiate the request with the Office of Accessibility Resources (OARS) and provide documentation in accordance with the Documentation Guidelines at N.C. A&T. Once documentation is received, it will be reviewed. Once approved, you must attend a comprehensive meeting to receive appropriate and reasonable accommodations. If you are a student registered with OARS, you must complete the Accommodation Request Form to have accommodations sent to faculty.

OARS is located in Murphy Hall, Suite 01 and can be reached at 336-334-7765, or by email at accessibilityresources@ncat.edu. Additional information and forms can be found on the internet at https://www.ncat.edu/provost/academic-affairs/accessibility-resources/index.php.

Please note: Accommodations are not retroactive and begin once the Disability Verification Form is provided to faculty.

TITLE IX

North Carolina A&T State University is committed to providing a safe learning environment for all students—free of all forms of discrimination and harassment. Sexual misconduct and relationship violence in any form are inconsistent with the university's mission and core values, violates

university policies, and may also violate federal and state law. Faculty members are considered "Responsible Employees" and are required to report incidents of sexual misconduct and relationship violence to the Title IX Coordinator. If you or someone you know has been impacted by sexual harassment, sexual assault, dating or domestic violence, or stalking, please visit the Title IX website to access information about university support and resources. If you would like to speak with someone confidentially, please contact Counseling Services at 336-334-7727 or the Student Health Center at 336-334-7880.

TECHNICAL SUPPORT

If you experience any problems with your A&T account, you may call Client Technology Services (formerly Aggie Tech Support and Help Desk) at 336-334-7195, or visit https://hub.ncat.edu/administration/its/dept/ats/index.php.

FIELD TRIP POLICIES / OFF-CAMPUS INSTRUCTION AND COURSE ACTIVITIES

If applicable:

Off-campus, out-of-state, foreign instruction, and activities are subject to state law and university policies and procedures regarding travel and risk-related activities. Information regarding these rules and regulations may be found at https://www.ncat.edu/campus-life/student-affairs/index.php.

STUDENT HANDBOOK

https://www.ncat.edu/campus-life/student-affairs/departments/dean-of-students/student-handbook.php

STUDENT TRAVEL PROCEDURES AND STUDENT TRAVEL ACTIVITY WAIVER

https://hub.ncat.edu/administration/student-affairs/staff-resources/studen_activity_travel_waiver.pdf

OTHER POLICIES *(e.g., Copyright Guidelines, Confidentiality, etc.)*

STUDENT HANDBOOK

https://www.ncat.edu/campus-life/student-affairs/departments/dean-of-students/student-handbook.php

Graduate Catalog

SEXUAL MISCONDUCT POLICY

https://www.ncat.edu/legal/title-ix/sexual-harassment-and-misconduct-policies/index.php

FAMILY EDUCATIONAL RIGHTS AND PRIVACY ACT (FERPA)

https://www.ncat.edu/registrar/ferpa.php

STUDENT COMPLAINT PROCEDURES

https://www.ncat.edu/current-students/student-complaint-form.php

STUDENT CONDUCT AND DISCIPLINE

North Carolina A&T State University has rules and regulations that govern student conduct and discipline meant to ensure the orderly and efficient conduct of the educational enterprise. It is the responsibility of each student to be knowledgeable about these rules and regulations.

Please consult the following about specific policies such as academic dishonesty, cell phones, change of grade, disability services, disruptive behavior, general class attendance, grade appeal, incomplete grades, make-up work, student grievance procedures, withdrawal, etc.:

- Undergraduate Bulletin
  https://www.ncat.edu/provost/academic-affairs/bulletins/index.php

- Graduate Catalog
  https://www.ncat.edu/tgc/graduate-catalog/index.php

- Student Handbook
  https://www.ncat.edu/campus-life/student-affairs/departments/dean-of-students/student-handbook.php

ACADEMIC DISHONESTY POLICY

Academic dishonesty includes but is not limited to the following:

1. Cheating or knowingly assisting another student in committing an act of cheating or other academic dishonesty;
2. Plagiarism (unauthorized use of another's words or ideas as one's own), which includes but is not limited to submitting exams, theses, reports, drawings, laboratory notes or other materials as one's own work when such work has been prepared by or copied from another person;
3. Unauthorized possession of exams or reserved library materials; destroying or hiding source, library or laboratory materials or experiments or any other similar actions;
4. Unauthorized changing of grades, or marking on an exam or in an instructor's grade book or such change of any grade record;
5. Aiding or abetting in the infraction of any of the provisions anticipated under the general standards of student conduct;
6. Hacking into a computer and gaining access to a test or answer key prior to the test being given. N.C. A&T reserves the right to search the emails and computers of any student suspected of such computer hacking (if a police report of the suspected hacking was submitted prior to the search); and
7. Assisting another student in violating any of the above rules.

A student who has committed an act of academic dishonesty has failed to meet a basic requirement of satisfactory academic performance. Thus, academic dishonesty is not only a basis for disciplinary action, but may also affect the evaluation of a student's level of performance. Any student who commits an act of academic dishonesty is subject to disciplinary action.

In instances where a student has clearly been identified as having committed an act of academic dishonesty, an instructor may take appropriate disciplinary action, including loss of credit for an assignment, exam, or project; or awarding a grade of "F" for the course, **subject to review and endorsement by the chairperson and dean**.

For GRADUATE STUDENTS: Reference for academic dishonesty – 2010-2020 Graduate Catalog, p.58-59

For GRADUATE STUDENTS: STUDENT RELIGIOUS OBSERVANCE (see Graduate Catalog, p.55)

ASSIGNMENTS AND ACADEMIC CALENDAR

Include topics, reading assignments, due dates, exam dates, withdrawal dates, pre-registration and registration dates, all holidays, and convocations.*

THE WEEK OF MM/DD/YY	SUBJECT	UNIT LEARNING OUTCOMES (ULO)	READING IN TEXT, ACTIVITY, HOMEWORK, EXAM
	Unit 1 - Aerodynamics: Some Introductory Thoughts	ULO 1: Define basic aerodynamic quantities. (SLO 1) ULO 2: Obtain aerodynamic Forces and Moments. (SLO 1) ULO 3: Define Lift and Drag. (SLO 1) ULO 4: Determine the center of pressure. (SLO 1) ULO 5: Analysis fluid statics. (SLO 1) ULO 6: Describe types of flows. (SLO 2)	1) **Read Textbook:** ANDERSON, J. D. (2016). *Fundamentals of aerodynamics*. Tata McGraw-Hill Education. a) Chapter 1 – Aerodynamics: Some Introductory Thoughts 2) **Complete:** SmartBook Assignment #1 (ULO 1-6) 3) **Complete:** Unit Assignment #1(ULO 1-6)
	Unit 2 - Aerodynamics: Some Fundamental Principles and Equations	ULO 1: Use vector relations to express aerodynamic parameters. (SLO 2) ULO 2: Use substantial derivative to describe the fundamental physics of flows. (SLO 2) ULO 3: Describe the conservation of mass. (SLO 2) ULO 4: Describe the conservation of momentum. (SLO 2) ULO 5: Describe the conservation of energy. (SLO 3) ULO 6: Evaluate streamlines, vorticity, circulation and stream	1) **Read Textbook:** ANDERSON, J. D. (2016). *Fundamentals of aerodynamics*. Tata McGraw-Hill Education. a) Chapter 2 – Aerodynamics: Some Fundamental Principles and Equations 2) **Complete:** SmartBook Assignment #2 (ULO 1-6) 3) **Complete:** Unit Assignment #2 (ULO 1-6)

		function and velocity potential. (SLO 3) ULO 7: Solve practical aerodynamic problems. (SLO 3)	
	Unit 3 - Fundamentals of Inviscid, Incompressible Flow	ULO 1: Develop the Bernoulli's equation, with some straightforward applications. (SLO 3) ULO 2: Evaluate the Laplace's equation, which is the governing equation for inviscid, incompressible, irrotational flow. (SLO 3) ULO 3: Describe of some elementary flow patterns, how they can be superimposed to synthesize both the non-lifting and lifting flow over a circular cylinder, and how they form the basis of a general numerical technique, called the panel technique, for the solution of flows over bodies of general shape. (SLO 3)	1) **Read Textbook:** ANDERSON, J. D. (2016). *Fundamentals of aerodynamics*. Tata McGraw-Hill Education. a) Chapter 3 – Fundamentals of Inviscid, Incompressible Flow 2) **Complete:** SmartBook Assignment #3 (ULO 1-3) 3) **Complete:** Unit Assignment #3 (ULO 1-3)
	Unit 4 - Incompressible Flow over Airfoil	ULO 1: Describe airfoil characteristics. (SLO 3) ULO 2: Explain how the vortex distribution can be used to describe airfoil characteristics. (SLO 3) ULO 3: Evaluate airfoil drag. (SLO 3)	1) **Read Textbook:** ANDERSON, J. D. (2016). *Fundamentals of aerodynamics*. Tata McGraw-Hill Education. a) Chapter 4 – Incompressible Flow over Airfoil 2) **Complete:** SmartBook Assignment #4 (ULO 1-3) 3) **Complete:** Unit Assignment #4 (ULO 1-3)
	Unit 5 - Quiz	ULO 1: Evaluate, calculate,	1) **Complete:** Quiz 1 (ULO 1)

		and understand formulas and ideas from units 1-4. (SLO N/A)	
	Unit 6 - Introduction to the Fundamental Principles and Equations of Viscous Flow	ULO 1: Explain skin-friction drag. (SLO 4) ULO 2: Describe flow separation. (SLO 4) ULO 3: Evaluate aerodynamic heating. (SLO 4)	1) **Read Textbook:** ANDERSON, J. D. (2016). *Fundamentals of aerodynamics*. Tata McGraw-Hill Education. a) Chapter 15 – Introduction to the Fundamental Principles and Equations of Viscous Flow 2) **Complete:** SmartBook Assignment #5 (ULO 1-3) 3) **Complete:** Unit Assignment #5 (ULO 1-3)
	Unit 7 - A Special Case: Couette Flow	ULO 1: Explain important practical facets of any viscous flow without complication of geometry. (SLO 4) ULO 2: Calculate surface skin friction. (SLO 4) ULO 3: Evaluate exact solutions of the Navier-Stokes equations given boundary conditions using a simple geometry. (SLO 4)	1) Read: Incompressible (Constant Property) Couette Flow 2) **Complete:** SmartBook Assignment #6 (ULO 1-3) 3) **Complete:** Unit Assignment #6 (ULO 1-3)
	Unit 8 - Introductions to Boundary Layers	ULO 1: Explain the boundary layer. (SLO 5) ULO 2: Describe the importance of the boundary layer in determining drag. (SLO 5) ULO 3: Evaluate the boundary layer thickness and shear stress. (SLO 5) ULO 4: Distinguish the difference between	1) **Read Textbook:** ANDERSON, J. D. (2016). *Fundamentals of aerodynamics*. Tata McGraw-Hill Education. a) Chapter 17 – Introductions to Boundary Layers 2) **Complete:** SmartBook Assignment #7 (ULO 1-4) 3) **Complete:** Unit Assignment #7 (ULO 1-4)

		laminar and turbulent flows. (SLO 5)	
	Unit 9 - Laminar Boundary Layers	ULO 1: Explain self-similar solutions. (SLO 5) ULO 2: Describe the boundary-layer solution in the region surrounding the stagnation point on a blunt-nosed body. (SLO 5) ULO 3: Describe both incompressible and compressible flows over a flat plate. (SLO 5) ULO 4: Discuss some more modern computational fluid dynamic solutions to laminar boundary layers. (SLO 5)	1) **Read Textbook:** ANDERSON, J. D. (2016). *Fundamentals of aerodynamics*. Tata McGraw-Hill Education. a) Chapter 18 – Laminar Boundary Layers 2) **Complete:** SmartBook Assignment #8 (ULO 1-4) 3) **Complete:** Unit Assignment #8 (ULO 1-4)
	Unit 10 - Quiz 2	ULO 1: Review units 6-9 ULOs. (SLO N/A)	1) **Complete:** Quiz 2 (ULO N/A)
	Unit 11 - Turbulent Boundary Layers	ULO 1: Evaluate empirically based formulas that allow the estimation of turbulent boundary-layer thickness. (SLO 5) ULO 2: Describe the conditions necessary to have turbulent flow. (SLO 5) ULO 3: Evaluate empirically based formulas that allow the estimation of turbulent coefficient of friction. (SLO 5)	1) **Read Textbook:** ANDERSON, J. D. (2016). *Fundamentals of aerodynamics*. Tata McGraw-Hill Education. a) Chapter 19 – Turbulent Boundary Layers 2) **Complete:** SmartBook Assignment #9 (ULO 1,2,3) 3) **Complete:** Unit Assignment #9 (ULO 1,2,3)
	Unit 12 - Incompressible	ULO 1: Explain general	1) **Read Textbook:** ANDERSON, J. D.

	Flow over Finite Wings	finite-wing aerodynamics like downwash, effective angle of attack, and induce drag. (SLO 6) ULO 2: Describe how the Biot-Savart law or Helmholtz vortex theorem can be used to finite wing analysis. (SLO 6) ULO 3: Evaluate lift using modern vortex lattice numerical methods or other lifting theories. (SLO 6)	(2016). *Fundamentals of aerodynamics*. Tata McGraw-Hill Education. a) Chapter 5 – Incompressible Flow over Finite Wings 2) **Complete:** SmartBook Assignment #10 (ULO 1,2,3) 3) **Complete:** Unit Assignment #10 (ULO 1,2,3) 4) **Complete:** Project (ULO 1,2,3)
	Unit 13 - Three-Dimensional Incompressible Flow	ULO 1: Explain a 3-dimensional doublet. (SLO 6) ULO 2: Describe flow over a sphere. (SLO 6) ULO 3: Evaluate 3-dimensional drag. (SLO 6)	1) **Read Textbook:** ANDERSON, J. D. (2016). *Fundamentals of aerodynamics*. Tata McGraw-Hill Education. a) Chapter 6 - Three-Dimensional Incompressible Flow 2) **Complete:** SmartBook Assignment #11 (ULO 1,2,3) 3) **Complete:** Unit Assignment #11 (ULO 1,2,3)
	Unit 14 - Navier Stokes Solution Examples/Use of SW to CFD/XFLIR for Wing Design	ULO 1: Demonstrate the use of SolidWorks for practical flows over a wing. (SLO 6) ULO 2: Demonstrate the use of XFLIR for practical flow over a wing. (SLO 6)	1) **Read Textbook:** ANDERSON, J. D. (2016). *Fundamentals of aerodynamics*. Tata McGraw-Hill Education. a) Chapter 20 - Navier-Stokes Solutions: Some Examples 2) **Complete:** SmartBook Assignment #12 (ULO 1,2) 3) **Complete:** Unit Assignment #12 (ULO 1,2)
	Unit 15 - Quiz	ULO 1: Review units 11-14	1) **Complete:** Quiz 3 (ULO 1)

		ULOs. (SLO 5,6)	2) **Complete:** Exam #1 (ULO 1)

** These descriptions and timelines are subject to change at the discretion of the instructor.*