MAE 335 – Incompressible Aerodynamics
Mechanical, Materials and Aerospace Engineering Department
Fall 2025

Lecture Info   Section 001 MWF, 10:00 AM - 10:50 AM, G-39 ESB

Instructor Info   Dr. Christopher Griffin, Teaching Associate Professor

Office Hours: MW, 2:00 – 3:00 PM; T, 11:00 AM – 12:00 PM; open door policy

Contact Info: 939 ESB, 304.293.3386, cgriffin@mail.wvu.edu

Prerequisites   MATH 251 and either MAE 215 or MAE 331

Required Text(s)   Anderson, John D. *Fundamentals of Aerodynamics* 6th ed. McGraw-Hill Education, 2017. (5th ed. also works)

Topics

Pertinent Fluid Properties	Stream Function
Conservation of Mass and Momentum Prinicples	Airfoil Nomenclature
Flow Similarity	Thin Airfoil Theory
Circulation and Vorticity	Lifting Line Theory
Superposition of Potential Flow Elements	Panel Methods
Velocity Potential	Boundary Layers

NOTE: This course relies heavily on mathematics to analyze incompressible flow around aerodynamic bodies, in particular vector calculus. Therefore, this course is not nearly as applied as other courses in the Aerospace Engineering Curriculum. However, the mathematical fundamentals are critical to a true physical understanding of not only this course, but also other courses in aerodynamics. Simply put, there is no way around this course being math intensive in order to properly cover the required topics. Students will be expected to use MATLAB in this course.

Grading Scheme

Assignment	Weight	ABET Outcome(s)
Homework	10%	1
Quizzes	10%	1
Midterm Exam 1	15%	1
Midterm Exam 2	15%	1
Midterm Exam 3	15%	1
Final Exam	20%	1
Semester Project	15%	1

Final course grade will be submitted as: A($\geq 89.5\%$), B($\geq 79.5\%$), C($\geq 69.5\%$), D($\geq 59.5\%$), F($< 59.5\%$)

Option to Bypass Final Exam and Receive Letter Grade of A

It is anticipated that some students will be offered the option to skip the final exam in this course and still receive a letter grade of "A". This invitation will be sent out to qualifying students the Friday prior to final exams. To qualify for this option, students will need to achieve the following during the semester:

1. A score of 90% or above on all mid-term exams, before corrections

2. ALL material assigned and/or due after the final mid-term exam has been submitted (homework, quiz, project)

3. An overall course average of 90% or above at the end of the week prior to final exam week

Option to Submit Mid-term Exam Corrections

It is my belief that reviewing your work, particularly exams, will benefit your overall performance in this course. Therefore, all students have the option to submit corrections to their mid-term exams **within one week** of them being graded and returned. Corrections must be done on separate pieces of paper, with new questions starting on a new piece of paper (all conceptual question corrections may be written on one piece of paper). The original exam must be submitted with corrections, in correct order, stapled on top of the original exam. The following is the schedule for percentage points added to the original exam score.

Original Exam Score	Potential Missed Points Returned
$90\% - 100\%$	60%
$80\% - 89\%$	50%
$70\% - 79\%$	40%
$< 70\%$	30%

Course Objectives

The overall objective of this course is to examine the fundamentals of flowing fluids that can be treated as incompressible and to use this foundation to analyze and predict the dynamics of the fluid flow fields. To this end, we will understand what it means to be an incompressible fluid, analyze and develop potential flow field solutions, and use techniques like airfoil theory and finite-wing theory to predict the aerodynamic performance of airfoils and wings.

Course Learning Outcomes

Through satisfactory completion of homework, quiz and exam problems, the semester project, as well as through classroom discussion, successful students will demonstrate the ability to

1. Simplify governing equations for the case of incompressible flow fields

2. Calculate aerodynamic forces and moments exerted on 2D and 3D aerodynamic geometries

3. Apply potential flow theory to solve engineering problems

4. Recognize the significance of boundary layer flow

5. Operate panel method based software to solve aerodynamic problems

These learning outcomes support ABET Outcome 1.

Prescribed ABET Student Outcomes for MAE 335

ABET Outcome 1   Upon graduation, all Bachelor of Science Students in mechanical or aerospace engineering will have an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.

Engagement Policy

Regular attendance is expected and necessary for students who wish to master the topics covered in this course. To promote attendance, four bonus percentage points are available to be added to your final course average. The breakdown of the awarded points are as follows.

Days Missed	Points Awarded
0	4
$1, 2$ (5%)	3
$3, 4$ (10%)	2
$5, 6$ (15%)	1
> 6	0

Excused and sanctioned absences, as outlined in the WVU Attendance Policy, are not counted against your attendance record. Unannounced in-class exercises may also be administered for credit. Only excused, sanctioned, or previously discussed absences will be permitted to make-up the exercise.

Fall 2025 General Academic Calendar Key Dates

AUG 20	First Day of Classes	NOV 21	Last Day to Drop/Withdraw
AUG 26	Last Day to Modify Courses	NOV 22 – 30	Fall Recess (No Classes)
SEP 01	Labor Day (No Classes)	DEC 11	Last Day of Classes
OCT 08	Mid-Check Grades Due	DEC 12	Prep Day for Finals
OCT 10	Fall Break (No Classes)	DEC 18	Final Exam (2:00 PM)

*If a student has more than three final examinations in one day, the student may make arrangements to reschedule the last examination of the day on a different day.

Assignment Policy

Make-up exams, quizzes, late homework, or late projects will **NOT** be accepted without **prior approval granted at least 2 days before the due date** from the instructor, consistent with WVU policies. Neat work is expected on all material submitted for grading (i.e. have to be able to read it to grade it). **All written assignments will be scanned and submitted via eCampus**.

Teaching Philosophy

As the instructor, I will do everything possible to help you learn and understand the material, but you must do your part. The student is ultimately responsible for learning the material. It is not a trivial matter to earn an "A" in my course, but in the same respect, it is also difficult to receive an "F". It is my opinion that discussion in the classroom helps reinforce concepts. Please participate in our discussions and never hesitate to ask a question.

If you have a question on material, homework, how I graded, or life in general, please come and see me as soon as possible. The earlier we can address a deficiency, the better. I am always open to meeting to discuss any questions and concerns.

Finally, I cannot stress enough the importance of doing all assigned work yourself. This includes reading, homework, projects, and self-study. I believe this approach is the only way to learn to address the following questions when solving a problem: a) what is the problem asking, b) what relevant theory do I need to apply, c) what is a representative system drawing for this problem, d) what assumptions and simplifications can I make, e) what local, initial or boundary condition information do I need, and f) what are the steps to solve this problem? **In other words, do not confuse copying solutions with asking your peers for help**.

Academic Integrity Statement

The integrity of the classes offered by any academic institution solidifies the foundation of its mission and cannot be sacrificed to expediency, ignorance, or blatant fraud. Therefore, instructors will enforce rigorous standards of academic integrity in all aspects and assignments of their courses. For the detailed policy of West Virginia University regarding the definitions of acts considered to fall under academic dishonesty and possible ensuing sanctions, please see the West Virginia University Academic Standards Policy, `http://catalog.wvu.edu/undergraduate/coursecreditstermsclassification/`. Should you have any questions about possibly improper research citations or references, or any other activity that may be interpreted as an attempt at academic dishonesty, please see your instructor before the assignment is due to discuss the matter.

Statler College Policy of Academic Integrity

Case	Violation	Penalty
1	Cheating or plagiarism on minor course element (e.g., quiz, weekly lab report, homework as specified in the syllabus)	Report of academic dishonesty Grade of zero on the entire minor course element Possible one-letter reduction in final grade
2	Cheating or plagiarism on a major course element (e.g., exam, project)	Report of academic dishonesty Grade of zero on the entire major course element Possible one-letter reduction in final grade Possible UF† recommendation Possible exclusion from further participation in class
3	Collusion on major course element	Report of academic dishonesty Exclusion from further participation in class Failure in the course Recommendation for UF†
4	Other (document alteration, tampering with records, etc.)	Report of academic dishonesty Grade of zero on the entire major course element Possible additional one-letter reduction in final grade Possible failure in the course Possible exclusion from further participation in class Possible recommendation for UF†

† UF – Unforgivable F Grade; cannot be replaced under D-F repeat policy.

Additional notes:

- Dismissal from Statler College is permanent for Academic Integrity violations. Student conduct violations can be considered in dismissal.

- Seperable sanctions (e.g., dismissal from Statler College, suspension, or expulsion from WVU) will be recommended for aggravated or second AI offenses.

- Warning letters may be issued from the Statler College or the WVU Office of Student Conduct.

- Sanctions will be assessed at the instructor and at the college/university levels. Additional sanctions may be assigned at the level of the instructor, college, and/or university.

- FORBIDDEN on Exams and Quizzes: The use of programmable calculators or smart devices (including smart-phones, smart watches, tablets, cameras, wearable devices, etc.) is prohibited unless specifically indicated by the instructor.

Adverse Weather Statement

In the event of inclement or threatening weather, everyone should use his or her best judgment regarding travel to and from campus. Safety should be the main concern. If you cannot get to class because of adverse weather conditions, you should contact your instructor as soon as possible. Similarly, if your instructor(s) are unable to reach the class location, they will notify you of any cancellation or change as soon as possible, using agreed upon methods to prevent students from embarking on any unnecessary travel. If you cannot get to class because of weather conditions, instructors will make allowances relative to required attendance policies, as well as any scheduled tests, quizzes, or other assessments.

Inclusivity Statement

The West Virginia University community is committed to creating and fostering a positive learning and working environment based on open communication, mutual respect, and inclusion.

If you are a person with a disability and anticipate needing any type of accommodation in order to participate in your classes, please advise your instructors and make appropriate arrangements with the Office of Accessibility Services, `http://accessibilityservices.wvu.edu/`.

More information is available at the Division of Diversity, Equity, and Inclusion website as well, `http://diversity.wvu.edu/`.

Sale of Course Material Statement

All course materials, including lectures, class notes, quizzes, exams, handouts, presentations, and other course materials provided to students for their courses are protected intellectual property. As such, the unauthorized purchase or sale of these materials may result in disciplinary sanctions under the Student Conduct Code, `https://studentconduct.wvu.edu/campus-student-code`.

Sexual Misconduct Statement

West Virginia University does not tolerate sexual misconduct, including harassment, stalking, sexual assault, sexual exploitation, or relationship violence [BOG Rule 1.6, `https://policies.wvu.edu/finalized-bog-rules/bog-governance-rule-1-6-rule`]. It is important for you to know that there are resources available if you or someone you know needs assistance. You may speak to a member of university administration, faculty, or staff; keep in mind that they have an obligation to report the incident to the Title IX Coordinator, `http://titleix.wvu.edu/what-is-title-ix/who-is-the-title-ix-coordinator`.

If you want to speak to someone who is permitted to keep your disclosure confidential, please seek assistance from the Carruth Center, 304-293-9355 or 304-293-4431 (24-hour hotline), and locally within the community at the Rape and Domestic Violence Information Center (RDVIC), 304- 292-5100 or 304-292-4431 (24-hour hotline).

For students at WVU-Beckley, contact the Women's Resource Center at 304-255-1585 (toll free at 1-888-825-7836) or REACH at 304-340-3676. For students at WVU-Keyser, contact the WVU-Keyser Psychological Counseling Services Office at 304-788-6976, and locally in Keyser, the Family Crisis Center, 304-788-6061 or 1-800-698-1240 (24-hour hotline).

For more information, please consult WVU's Title IX Office (`https://titleix.wvu.edu/resources-offices`).

Mental Health Statement

Mental health concerns or stressful events can adversely affect your academic performance and social relationships. WVU offers services to assist you with addressing these and other concerns that you may be experiencing. You can learn more about the broad range of confidential mental

health services available on campus at the Carruth Center for Counseling and Psychological Services (CCCPS) website: `https://carruth.wvu.edu/`.

- If you are in need of crisis services, call the CCCPS main number 24/7: (304) 293-4431.

Crisis services are also available through text: Text WVU to 741741 for support 24/7 from a trained Crisis Counselor.

Planned Lecture Schedule

Lecture	Date	Topic	Text Section
1	8/20	Course Introduction; History; Classifications	1.1 − 1.2
2	8/22	Forces and Moments	1.4 − 1.5
3	8/25	Moments cont.; Aero Coefficients	1.5
4	8/27	Center of Pressure; Dimensional Analysis	1.6 − 1.7
5	8/29	Similarity; Types of Flow; Boundary Layer	1.8, 1.10 − 1.11
	9/01	**Labor Day (No classes)**	
6	9/03	Vector Calculus Review	2.2
7	9/05	Models of Fluid	2.3
8	9/08	The Governing Equations	2.4 − 2.5, 2.7
9	9/10	Momentum Deficit	2.6
10	9/12	Mom. Deficit Ex.; Path/Stream/Streak...lines	2.6, 2.11 − 2.12
11	9/15	Circulation, The Stream Function	2.13 − 2.14
12	9/17	Bernoulli's Equation; Velocity Potential	2.15 − 2.17, 3.2
13	9/19	Applications of Bernoulli's Equation	3.4
14	9/22	Exam 1 Review	
15	**9/24**	**Exam 1**	**1.1 − 2.16**
16	9/26	Incompressible and Irrotational Flow	3.6 − 3.7
17	9/29	Potential Flow: Uniform; Source; Superposition	3.9 − 3.11
18	10/01	SP: Uniform with Source and Sink	3.11
19	10/03	SP: Doublet; NL Cyl.; Vortex; L Cyl.; Kutta-Joukowski	3.12 − 3.16
20	10/06	Real Flow over a Cyl.; Potential Flow Ex.; Airfoils	3.15 − 3.16, 4.1 − 4.2
21	10/08	Airfoil Characteristics; Vortex Sheet	4.3 − 4.4
	10/10	**Fall Break (No classes)**	
22	10/13	Kutta Condition; Kelvin's Circulation Theorem	4.5 − 4.6
23	10/15	Exam 2 Review	
24	**10/17**	**Exam 2**	**3.1 − 3.18**
25	10/20	Thin Airfoil Theory	4.7
26	10/22	Thin Airfoil Theory: Symmetric	4.7
27, 28	10/24 − 10/27	Thin Airfoil Theory: Cambered	4.8
29	10/29	Aerodynamic Center; Vortex Panel Method	4.9 − 4.10 (3.17)
30	10/31	Vortex Panel Method cont.; XFLR5	4.10 (3.17)
31	11/03	Low-Speed Airfoils; Airfoil Drag	4.11 − 4.12
32	11/05	Real Airfoils; Finite Wing Theory	4.13 − 4.14, 5.1
33	11/10	More work in XFLR5	5.3
34	11/12	Downwash; Biot-Savart	5.1 − 5.2
35	11/14	Helmholtz; Lifting-Line Theory	5.2 − 5.3
36	11/17	Exam 3 Review	
37	**11/19**	**Exam 3**	**4.1 − 4.12**
38	11/21	LLT for Elliptical Loading	5.3
	11/24 − 11/28	**Fall Recess (No classes)**	
39	12/01	LLT for Elliptical Loading cont.	5.3
40	12/03	LLT for General Loading	5.3
41	12/05	Numerical Methods	5.4 − 5.5, 6.6
42	12/08	Airplane Lift and Drag	6.7
43	12/10	Final Exam Review	
	12/18, 2 PM	**Final Exam**	