

ME 521: Foundations of Fluid Mechanics I, Fall Semester 2017

John M. Cimbala, Penn State University. Latest update: 26 September 2017

- Lectures:** Mon., Wed., Fri., 3:35-4:25 p.m., Room 122 Engr SVC (Learning Factory Building)
- Text:** Recommended: *Fluid Mechanics, Ed. 6*, Kundu, Cohen, and Dowling. Elsevier Academic Press, 2016 [older editions okay]. Many reference books are on reserve in the Engineering Library - see website for a list.
- Prerequisite:** At least one undergraduate fluid mechanics course.
- Web Pages:** The material for this course will be posted on Penn State Canvas at canvas.psu.edu/ I also maintain a second website for this course at www.mne.psu.edu/cimbala/me521. Students are expected to check the websites regularly for homework assignments, announcements, videos, and other information. Hardcopies (handouts) of homework assignments and class material will *not* be given in class.
- Instructor:** John M. Cimbala, Professor of Mechanical Engineering, 234 Reber Building, 814-863-2739, jmc6@psu.edu, www.mne.psu.edu/cimbala. Office hours and weekly schedule posted on website.
- TA/Grader:** To be announced.

General Description and Course Outline:

This is the first course of a two-semester fluid mechanics sequence for graduate students in the thermal sciences. After a brief introduction and a short discussion about tensors and tensor notation, the conservation equations for fluid flow are derived. The remainder of the course deals with *solutions* of these equations, both exact and approximate. The approximate solutions include irrotational (potential) flow, low Reynolds number (creeping) flow, and high Reynolds number (boundary layer) flow. Some computational solution techniques are introduced as well – students solve similarity problems using the Runge-Kutta technique, and are introduced to some commercial CFD packages. Only *laminar* flows are considered in this first semester; stability, transition, and turbulence will be studied next semester in the follow-on course, ME 522.

Approx. week	Topic(s) to be covered	Suggested reading
1	Introduction: notation; review; vectors, tensors, and tensor notation	Chapters 1 and 2
2	Kinematics: Lagrangian vs. Eulerian descriptions; material derivative; streamlines; stress and strain; vorticity; circulation; stream function; cylindrical and polar coordinates	Chapter 3
3, 4	Conservation Laws: control volume integrals; stress tensor; constitutive equations; differential equations for conservation of mass, momentum and energy; Bernoulli equation; buoyancy	Chapter 4
5, 6	Vorticity Dynamics: Kelvin's circulation theorem; vorticity equation; interaction of vortices	Chapter 5
7, 8, 9	Irrotational Flow: complex variables; elementary flows; superposition; images; conformal mapping; numerical solutions; application to aerodynamics; axisymmetric flows; 3-D flows	Chapters 7 and 14
10, 11, 12	Laminar Flow Solutions: diffusion; exact analytical solutions; similarity solutions; Runge-Kutta technique; creeping flow; introduction to CFD; introduction to compressible flow	Chapters 9 and 6
13, 14, 15	Laminar Boundary Layers: introduction to the boundary layer approximation; flat plate; Falkner-Skan flow; separation; cylinders and spheres; free shear flows	Chapter 10

Grades: All exams and homework assignments are *comprehensive*. Mark your calendars!

Component of Grade		Schedule
Assigned homework	20%	Approximately weekly, typically due on Fridays
Mid-term examination 1	25%	In class, Friday September 29 [other arrangements for World Campus students]
Mid-term examination 2	25%	In class, Friday November 10 [other arrangements for World Campus students]
Final examination	30%	Monday Dec. 11, 4:40-6:30 pm, 7 Business Bldg [other arrangements for WC students]

Note: Class participation is encouraged and will be taken into account for students whose final grade is "on the border." For example, you are encouraged to bring in newspaper or magazine articles that relate to the topics discussed in class.

Grade Disputes: If a student feels that an exam or homework set was graded unfairly, or if there is an error in the grading, it should be brought to the attention of the grader (HW→TA, Exams→instructor) within one week after the graded material is handed back. Scores will *not* be reconsidered beyond one week after they are handed back, except under unusual circumstances.

Academic Dishonesty: Cheating is not tolerated in this course. You should refer to the Academic Integrity website at <http://www.engr.psu.edu/faculty-staff/academic-integrity.aspx> which explains what behaviors are in violation of academic integrity, and the review process for such violations. On the next page is a summary of the policy. Specifically for this course:

- **First offense:** Zero score for the item in question, and infraction reported to the College.
- **Second offense:** Failure of the course, and infraction reported to the College.

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Summary of Penn State's Academic Dishonesty Policy: The University defines academic integrity as the pursuit of scholarly activity in an open, honest and responsible manner. All students should act with personal integrity, respect other students' dignity, rights and property, and help create and maintain an environment in which all can succeed through the fruits of their efforts (refer to [Senate Policy 49-20](#)). Dishonesty of any kind will not be tolerated in this course. Dishonesty includes, but is not limited to, cheating, plagiarizing, fabricating information or citations, facilitating acts of academic dishonesty by others, having unauthorized possession of examinations, submitting work of another person or work previously used without informing the instructor, or tampering with the academic work of other students. Students who are found to be dishonest will receive academic sanctions and will be reported to the University's Office of Student Conduct for possible further disciplinary sanctions (refer to [Senate Policy G-9](#)).

Definition and expectations: Academic integrity is the pursuit of scholarly activity in an open, honest and responsible manner. Academic integrity is a basic guiding principle for all academic activity at The Pennsylvania State University, and all members of the University community are expected to act in accordance with this principle.

Disability Access Statement:

Penn State welcomes students with disabilities into the University's educational programs. Every Penn State campus has an office for students with disabilities. The Student Disability Resources Web site provides [contact information for every Penn State campus](#): <http://equity.psu.edu/student-disability-resources/disability-coordinator>. For further information, please visit the [Student Disability Resources Web site](#): <http://equity.psu.edu/student-disability-resources>.

In order to receive consideration for reasonable accommodations, you must contact the appropriate disability services office at the campus where you are officially enrolled, [participate in an intake interview, and provide documentation](#): <http://equity.psu.edu/student-disability-resources/applying-for-services>. If the documentation supports your request for reasonable accommodations, your [campus's disability services office](#) will provide you with an accommodation letter. Please share this letter with your instructors and discuss the accommodations with them as early in your courses as possible. You must follow this process for every semester that you request accommodations.

Counseling & Psychological Services (CAPS) Statement:

CAPS can help students resolve personal concerns that may interfere with their academic progress, social development, and satisfaction at Penn State. Some of the more common concerns include anxiety, depression, difficulties in relationships (friends, roommates, or family); sexual identity; lack of motivation or difficulty relaxing, concentrating or studying; eating disorders; sexual assault and sexual abuse recovery; and uncertainties about personal values and beliefs.

You can contact CAPS by calling the Main CAPS number/Appointment Scheduling: 814-863-0395 (Please call between the hours of 8am and 5pm, Monday-Friday to schedule an appointment) or visit us at our office location, 5th Floor Student Health Center.

Online Resources for Relaxation:

It's important to take care of yourself. There are a number of valuable online resources that you can use for relaxation and stress reduction.

Learn how stress impacts your health and life, as well as some self-help strategies for managing it through the [PSU Student Affairs EDGE online workshop](#). Check out other stress management resources available, including a guided program called [Stress Recess](#). There are also a number of relaxation, visualization, and mindfulness resources at the [Mind Body Spa](#). You can also download [mindfulness meditations](#) here. If winter has got you down and you need an [upbeat song to listen to, check this out](#).

Sexual Assault and Relationship Violence Hotline:

A hotline has been established for victims and observers of sexual assault and relationship violence. Trained counselors on the hotline will help students access appropriate resources. Penn State students from any campus can call 1 (800) 560-1637 to access the 24 hour a day, seven day a week hotline.

Additional Mandatory PSU Information:

Library Resources

Many of Penn State's library resources can be utilized from a distance. Through the University Libraries website, you can

- access magazine, journal, and newspaper articles online using library databases;
- borrow materials and have them delivered to your doorstep...or even your desktop;
- get research help via e-mail, chat, or phone using the [Ask a Librarian service \(Links to an external site.\)](#)[Links to an external site.](#); and much more.

You must have an active Penn State Access Account to take full advantage of the University Libraries' resources and services. Once you have a Penn State account, you will automatically be registered with the library within 24–48 hours. If you would like to check that your registration has been completed, visit the [Libraries home page \(Links to an external site.\)](#)[Links to an external site.](#), click on **Library Accounts**, and then click on **My Library Account**.

Engineering Programs Technical Requirements

Operating System

Windows 2000, XP, Windows 7, Vista

Note: Software used throughout this program may not be compatible with a Mac operating system, therefore, the use of Mac is not supported by engineering online programs.

Processor

1 GHz or higher

Memory

256 MB of RAM

Hard Drive Space

500 MB of free disk space

Browser

We recommend the latest Canvas-supported version of Firefox or Internet Explorer. To determine if your browser fits this criteria and for advice on downloading a supported version, please refer to the following ITS knowledgebase article: <http://kb.its.psu.edu/cms/article/6> [\(Links to an external site.\)](#)[Links to an external site.](#)

Plug-ins

Adobe Reader [[Download from Adobe \(Links to an external site.\)](#)][Links to an external site.](#)]

Flash Player (v7.0 or later) [\[Download from Adobe \(Links to an external site.\)](#)][Links to an external site.](#)]

Students should have the ability to install other web browser plugins as needed (i.e. Adobe connect browser plug-in)

Additional Software

Microsoft Office

[iTunes \(Links to an external site.\)](#)[Links to an external site.](#)

Internet Connection

Broadband (cable or DSL) connection required

Printer

Access to graphics-capable printer

DVD-ROM

Required

Sound Card, Microphone, and Speakers

Required

Monitor

Monitor (Capable of at least 1024 x 768 resolution)

Additional Hardware

It is a requirement for this online program that students have ready access to a document scanner that allows for the creation of PDF files, which will enable students to submit handwritten homework and exams in several of the mathematics-based courses.

Not sure if your computer is set up correctly? You can use the links below to test yours settings:

- [Adobe Acrobat \(Links to an external site.\)Links to an external site.](#)
- [Cookies \(Links to an external site.\)Links to an external site.](#)
- [Frames \(Links to an external site.\)Links to an external site.](#)
- [Java \(Links to an external site.\)Links to an external site.](#)
- [JavaScript \(Links to an external site.\)Links to an external site.](#)

Grading Scale

The following are minimum cutoffs for each grade:

- 90.00% = A
- 86.66% = A-
- 83.33% = B+
- 80.00% = B
- 76.66% = B-
- 73.33% = C+
- 70.00% = C
- 60.00% = D
- less than 60.00% = F

Academic Integrity

Academic integrity—scholarship free of fraud and deception—is an important educational objective of Penn State. Academic dishonesty can lead to a failing grade or referral to the [Office of Student Conduct \(Links to an external site.\)Links to an external site.](#)

Academic dishonesty includes but is not limited to

- cheating,
- plagiarism,
- fabrication of information or citations,
- facilitating acts of academic dishonesty by others,
- unauthorized prior possession of examinations,
- submitting the work of another person or work previously used without informing the instructor and securing written approval, and
- tampering with the academic work of other students.

The University defines academic integrity as the pursuit of scholarly activity in an open, honest and responsible manner. All students should act with personal integrity, respect other students' dignity, rights and property, and help create and maintain an environment in which all can succeed through the fruits of their efforts (refer to Senate Policy 49-20). Dishonesty of any kind will not be tolerated in this course. Dishonesty includes, but is not limited to, cheating, plagiarizing, fabricating information or citations, facilitating acts of academic dishonesty by others, having unauthorized possession of examinations, submitting work of another person or work previously used without informing the instructor, or tampering with the academic work of other students. Students who are found to be dishonest will receive academic sanctions and will be reported to the University's Office of Student Conduct for possible further disciplinary sanctions (refer to Senate Policy G-9).

How Academic Integrity Violations Are Handled

In cases where academic integrity is questioned, the [Policy on Academic Integrity \(Links to an external site.\)Links to an external site.](#) indicates that procedure requires an instructor to notify a student of suspected dishonesty before filing a charge and recommended sanction with the college. Procedures allow a student to accept or contest a charge. If a student chooses to contest a charge, the case will then be managed by the respective college or campus Academic Integrity Committee. If a disciplinary sanction also is recommended, the case will be referred to the [Office of Student Conduct \(Links to an external site.\)Links to an external site.](#) All Penn State colleges abide by this Penn State policy, but review procedures may vary by college when academic dishonesty is suspected. Information about Penn State's academic integrity policy and college review procedures is included in the information that students receive upon enrolling in a course. To obtain that information in advance of enrolling in a course, please contact us by going to the [Contacts & Help page \(Links to an external site.\)Links to an external site.](#)

Additionally, World Campus students are expected to act with civility and personal integrity; respect other students' dignity, rights, and property; and help create and maintain an environment in which all can succeed through the fruits of their own efforts. An environment of academic integrity is requisite to respect for oneself and others, as well as a civil community.

For More Information on Academic Integrity at Penn State

Please see the [Academic Integrity Chart \(Links to an external site.\)Links to an external site.](#) for specific college contact information or visit one of the following sites:

- Penn State Senate [Policy on Academic Integrity \(Links to an external site.\)Links to an external site.](#)
- [iStudy for Success! \(Links to an external site.\)Links to an external site.](#) (education module about plagiarism, copyright, and academic integrity)
- [Turnitin \(Links to an external site.\)Links to an external site.](#) (a web-based plagiarism detection and prevention system)

Accommodating Disabilities

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