

Sample Syllabus

ME 431
INTERNAL COMBUSTION ENGINES
Fall 2024

Please note that the specifics of this Course Syllabus can be changed at any time, and you will be responsible for abiding by any such changes. All changes will be communicated to you via e-mail, course announcement and/or course discussion forum.

Class Meetings 9:05-9:55 AM MWF, Hammond Bldg 308

Instructor Dr. Richard Yetter
104 Research Building East
ray8@psu.edu – email is the best way to contact the instructor.

Teaching Assistant/Grading Assistant Unknown currently

Office Hours MW 3:30-4:30 PM (Yetter)

Textbook Willard W. Pulkrabek, Engineering Fundamentals of the Internal Combustion Engine, 2nd Edition, Pearson Prentice Hall, NJ, 2004.

Reference Texts Internal Combustion Engines: Applied Thermal Sciences, 4rd Edition, Allan T. Kirkpatrick, John Wiley and Sons, NY, 2020. Internal Combustion Engines: Applied Thermal Sciences, 3rd Edition, Colin R. Ferguson and Allan T. Kirkpatrick, John Wiley and Sons, NY, 2016. Engines: An Introduction, John L. Lumley, Cambridge University Press, 1999. Introduction to Internal Combustion Engines by Richard Stone, 3rd Edition, 1999, SAE International. Internal Combustion Engine Fundamentals, John B. Heywood, McGraw-Hill, Inc., NY, 1988. The Internal Combustion Engine in Theory and Practice, Vol. 1: Thermodynamics, Fluid Flow, Performance 2nd Edition, Charles F. Taylor, The MIT Press, Massachusetts Institute of Technology, Cambridge, MA, 1985. The Internal Combustion Engine in Theory and Practice, Vol. 2: Combustion Fuels, Materials, Design 2nd Edition, Charles F. Taylor, The MIT Press, Massachusetts Institute of Technology, Cambridge, MA, 1985. Another important resource is the Society of Automotive Engineers (SAE); the library has literally 1000's of SAE papers on microfiche; SAE also has a website (www.sae.org).



Goals/Objectives

Course Instructional Outcomes [Mapping to Student Outcomes shown in brackets]:

1. Learn to classify different types of internal combustion engines and their applications [3c].
2. Apply principles of thermodynamics, fluid mechanics, and heat transfer to the design and analysis of engines and engine components [1a,2b,2e].
3. Become aware of the relevance of environmental and social issues on the design process of internal combustion engines [3b].
4. Develop mathematical methods for designing components and systems [2c,2f]
5. Apply numerical methods to perform design calculations [3f,4d,4e].
6. Advance proficiency in professional communications and interactions [3d,3f].

Student Outcomes:

- 1a. Demonstrate knowledge of chemistry
- 2b. Perform analysis of thermal/fluids components
- 2c. Demonstrate the ability to design components
- 2e. Perform analysis of thermal/fluids systems
- 2f. Demonstrate the ability to design systems
- 3b. Demonstrate an appreciation of the economic, global, societal, ethical, and professional context of their work
- 3c. Demonstrate a knowledge of contemporary issues
- 3d. Demonstrate effective written communication
- 3f. Demonstrate a recognition of the need for and an ability to engage in life-long learning
- 4d. Demonstrate the ability to develop and utilize models

4e. Use software to solve engineering problems

Grading	Assignments (~8)	1/2
	Exams (2)	1/2

The following cutoffs normally are used to map from percentage to final course letter grade. The instructor may lower the cutoffs, depending on class performance, but will not raise them:

≥93 A; ≥90 A-; ≥87 B+; ≥83 B; ≥80 B-; ≥77 C+; ≥70 C; ≥65 D; <65 F

HW Assignments Students are encouraged to discuss assignments with one another, to the extent that they find that to be beneficial. However, each student is to turn in an individual solution that represents primarily their own effort. Each student is to upload their solution to Canvas by the end of the day (11:59 PM U.S. Eastern Time) on the specified due date. Do not wait until the last minute to upload your solution. Late assignments will not be accepted unless prior arrangements have been made with the instructor. The instructor may allow one exception to the late submission policy per student per semester, with a satisfactory explanation. See Guidelines for Graded Submissions posted on the Canvas webpage for the required formatting.

Quizzes & Exams Quizzes and exams will be open book/open notes and will be administered via Canvas. **Each student is expected to work independently.** For each quiz and exam, every student will be required to certify that they did not receive any assistance from anyone else and did not provide assistance to anyone else. See Academic Integrity below. See Guidelines for Graded Submissions posted on the Canvas webpage for the required formatting. No make-up exams/quizzes will be given except as required by University policy. See me prior to any anticipated absence, preferably at the beginning of the semester.

Attendance It is required that you attend all classes. To encourage attendance, I often incorporate specific material on the Exams/Quizzes that has been covered during the lectures. Thus, you stand a better chance of obtaining a better grade by attending class.

Course Outline (Abbreviated)

1. Introduction – Ch 1
 - I. The engine and the atmosphere
 - II. Energy Consumption
 - III. Engine Classifications
 - IV. Engine History
 - V. Engine Cycles
 - VI. Engine Components
2. Operating Characteristics – Ch. 2
 - I. Slider Crank Mechanism
 - II. Mean Piston Speed
 - III. Work
 - IV. Mean Effective Pressure
 - V. Torque and Power
 - VI. Air Fuel Ratio
 - VII. Specific Fuel Consumption
 - VIII. Engine Efficiencies
 - IX. Volumetric Efficiency

- X. Emissions
- 3. Engine Cycles – Ch 3
 - I. Air Standard Cycles
 - II. Otto Cycle
 - III. Diesel Cycle
 - IV. Dual Cycle
 - V. Real Air Fuel Engine Cycles
 - VI. Intake and Exhaust Process
 - VII. SI Engine Cycle with Finite Combustion Time
- 4. Combustion Thermochemistry – Ch. 2
 - I. Thermodynamics review
 - II. Ideal Gas Mixtures and Mixture Properties
 - III. First-law concepts
 - IV. Stoichiometry and Equivalence ratio
 - V. Absolute Enthalpy and Enthalpy of Formation
 - IV. Adiabatic Flame Temperature
 - V. Second-law concepts
 - VI. Chemical Equilibrium
 - VII. Equilibrium Constants
 - VIII. Fuels
- 5. Air and Fuel Injection, Exhaust Flow, and Fluid Motion within Combustion Chamber Chs – 5,6,8
 - I. Valve Train Hardware
 - II. and Exhaust processes
 - III. Variable Valve Timing
 - IV. Manifold Tuning
 - V. Supercharging and Turbocharging

----- ~halfway through the semester -----
- 6. Combustion – Chs. 7
 - I. Chemical Reactions and Chemical Kinetics
 - II. Explosion Limits
 - III. Premixed Flame
 - IV. Turbulence and Turbulent Combustion
- 7. Emissions and Air Pollution – Ch 9
 - I. Emissions from SI Engines
 - II. Why are they regulated?
 - III. Emissions Control
- 8. Heat Transfer in Engines Ch – 10
 - I. Modes of Heat Transfer
 - II. Cylinder Heat Transfer
 - III. Heat Transfer Coefficients
- 9. Compression Ignition Engines
 - I. Engine types
 - II. Engine Ignition and Combustion
 - III. Engine Emissions and Control
- 10. Friction and Lubrication
 - I. Mechanical Friction and Lubrication
 - II. Engine Friction
 - III. Lubricating Oil
- 11. New Combustion Engines

Contesting grades	<p>We are all human, and there may be grading mistakes from time to time. If you have an issue with how an assignment was graded, please provide a formal application for grade change, including a copy of the particular question and your original answer, and a paragraph explaining why you believe you deserve a grade change. These applications should be emailed to me NO LATER than 24 HOURS after the assignment was returned; verbal requests for grade change will not be considered. If there was an obvious mistake in grading, I will immediately correct the issue. If the grade change is more subjective in nature, I will file your request and reconsider at the end of the semester if a change in this grade could change your final grade in the class.</p>
Academic Integrity	<p>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. Consistent with this expectation, the University's Code of Conduct states that 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.</p> <p>Academic integrity includes a commitment by all members of the University community not to engage in or tolerate acts of falsification, misrepresentation or deception. Such acts of dishonesty violate the fundamental ethical principles of the University community and compromise the worth of work completed by others.</p> <p>In this course, students are encouraged to discuss assignments with one another, to the extent that they find that to be beneficial – but each student is to turn in an individual solution that represents primarily their own effort. Quizzes and exams are to be individual efforts. Failure to abide by these rules, or the commission of any other deliberately dishonest act, may result in failure of the course with no late drop permitted. Examples of acts that would be considered as academic misconduct include posting of course materials online, or getting help from, or giving help to, another student on a quiz or exam. See https://undergrad.psu.edu/aappm/G-9-academic-integrity.html .</p>
Course Copyright	<p>All course materials students receive or to which students have online access are protected by copyright laws. Students may use course materials and make copies for their own use as needed, but unauthorized distribution and/or uploading of materials without the instructor's express permission is strictly prohibited. University Policy AD 40, the University Policy Recording of Classroom Activities and Note Taking Services addresses this issue. For example, uploading completed labs, homework, or other assignments to any study site constitutes a violation of this policy. Students who engage in the unauthorized distribution of copyrighted materials may be held in violation of the University's Code of Conduct, and/or liable under Federal and State laws.</p>
Mask Policy	<p>Students will be required to comply with current University policy. There may be changes in policy as the semester progresses. See https://virusinfo.psu.edu for the latest information.</p>
Accommodations	<p>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 (SDR) website provides contact information for every Penn State campus:</p>

<http://equity.psu.edu/sdr/> disability-coordinator. For further information, visit the Student Disability Resources website at <http://equity.psu.edu/sdr/> and <http://equity.psu.edu/ods/considering-penn-state/reasonable-accommodations> .

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; see the documentation guidelines at <http://equity.psu.edu/sdr/guidelines> . If the documentation supports your request for reasonable accommodations, your campus 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 the semester as possible. You must follow this process for every semester that you request accommodations.

Counseling

Many students at Penn State face personal challenges or have psychological needs that may interfere with their academic progress, social development, or emotional wellbeing. The university offers a variety of confidential services to help you through difficult times, including individual and group counseling, crisis intervention, consultations, online chats, and mental health screenings. These services are provided by staff who welcome all students and embrace a philosophy respectful of clients' cultural and religious backgrounds, and sensitive to differences in race, ability, gender identity and sexual orientation.

Counseling and Psychological Services at University Park (CAPS): <http://studentaffairs.psu.edu/counseling/> 814-863-0395

Counseling and Psychological Services at Commonwealth Campuses: <https://senate.psu.edu/faculty/counseling-services-at-commonwealth-campuses/>

Penn State Crisis Line (24 hours/7 days/week): 877-229-6400 Crisis Text Line (24 hours/7 days/week): Text LIONS to 741741

Educational Equity

Penn State takes great pride to foster a diverse and inclusive environment for students, faculty, and staff. Acts of intolerance, discrimination, or harassment due to age, ancestry, color, disability, gender, gender identity, national origin, race, religious belief, sexual orientation, or veteran status are not tolerated and can be reported through Educational Equity via the Report Bias webpage: <http://equity.psu.edu/reportbias/> .

Recording Notice

Video and audio recordings of class lectures may be part of the classroom activity. The video and audio recording are used for educational use/purposes and may be made available to all students presently enrolled in the class. For purposes where the recordings will be used in future class session/lectures, the videos will adequately remove any type of student identifying information.