

# ME 433 Combustion Engine Systems

## Catalog Description:

Theory and characteristics of combustion engines; combustion process analysis; fuels, exhaust emissions and controls; system analysis and modeling.

## Textbook:

Heywood, Internal Combustion Engine Fundamentals, 1989.  
(PDF version available online for <\$20)

## Course Web Page:

[http://www.webpages.uidaho.edu/mindworks/ic\\_engines.htm](http://www.webpages.uidaho.edu/mindworks/ic_engines.htm) & videos on BbLearn

## Instructor Information:

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## Prerequisite Skills:

1. Reading engineering textbooks for new understanding based on reading questions.
2. Graphing functions with mathematics software.
3. Explaining physical behavior based on governing equations, including units.
4. Documenting engineering calculations so that others can follow your reasoning.
5. Finding roots of equations that describe engineering phenomena.
6. Solving systems of ordinary differential equations that describe dynamic systems.
7. Performing atom balances for simple chemical reactions.
8. Using first and second laws of thermodynamics to analyze engineering systems.
9. Representing and interpreting thermodynamic processes on PV and TS diagrams.
10. Calculating single-mode conduction and convection heat transfer.

## Course Outcomes:

1. Identify and define purpose of common engine components and test equipment.
2. Apply the first and second laws of thermodynamics along with balanced chemical reactions to estimate the performance of ideal air cycles.
3. Specify and interpret engine design parameters as well as performance data for a variety of internal combustion engine systems.
4. Predict heats of reaction and concentrations of exhaust species using equilibrium thermodynamics for both conventional and alternative fuels.
5. Predict work output from heat release data and estimate pollutant formation for real fuel-air cycles.
6. Complete a literature review, computer modeling project, or an engine lab project on an aspect of combustion engine technology and communicate discoveries in a 5-page technical paper.

### **Professional Behaviors Promoted by Course:**

1. Locates and consults relevant literature to answer technical questions.
2. Questions manufacturer claims and popular beliefs by using knowledge and tools from the course to make informed decisions and recommendations.
3. Uses engineering concepts and analysis tools when performing diagnostics on engines/vehicles.
4. Documents engineering work for future use in a professional manner.
5. Aware and concerned about significance of global energy problem and its relationship to next generation vehicle design.
6. Seeks collaboration, when appropriate, to solve difficult problems.
7. Values self directed learning as a value-added source of personal development.
8. Periodically reflects on experiences, events, products, and processes to capture and reuse lessons learned.

### **Course Topics/Activities:**

1. Reviewing of chemical, thermodynamic, and fluid fundamentals.
2. Representing processes and cycles on PV and TS diagrams.
3. Identifying and explaining typical engine components.
4. Making distinctions between SI and CI engines from the standpoint of load control, air/fuel mixture control, ignition control, and pollutant formation.
5. Describing purpose and function of engine control systems, MBT timing, carburetion, fuel injection hardware, and emissions abatement technology.
6. Calculating brake power, brake torque, arbitrary efficiency, and specific fuel consumption.
7. Relating engine design specifications and performance parameters, including different service classifications.
8. Using rules of thumb to select and size engines.
9. Determining road load power and simulating acceleration events.
10. Estimating mean effective pressures (brake, indicated, friction etc).
11. Differentiating between premixed and diffusion flames as well as their burning velocities.
12. Balancing chemical reaction equations for common combustion scenarios.
13. Classifying hydrocarbon fuels, measuring heating values, computing heats of reaction, estimating flame temperatures, and determining chemical equilibrium.
14. Becoming familiar with issues associated with alternative fuel production and emissions.
15. Simulating engine cycles, including finite combustion time, cylinder heat transfer, crevice effects, and blowdown.
16. Analyzing performance data from an engine on a test-stand and a vehicle on a chassis dynamometer.

## **Course Evaluation:**

**Homework** 70%  
**(due each Monday evening)**

**Research Project** (literature review or mini-research project) 30%

Potential topics include: design and analysis of a powerplant concept (2-stroke engine, turbocharged engine, rotary engine, etc), pollution abatement equipment, fuel handling systems, ignition systems, intake/exhaust design, engine testing equipment and procedures, energy storage options for hybrid vehicles, road load modeling/fuel consumption prediction, exploration of engine simulation software, engine electronics and control systems, use of fuel additives, emissions modeling, or another approved topic of personal interest

### Deliverables include:

10 minute Powerpoint Presentation (for class review)

5 page technical paper in SAE format

## **Homework Ground rules:**

Many homework assignments require use of applications software for functional graphing, data analysis, and non-linear equation solving. The analysis tools you select to use are up to you but EES, MATLab, and ChemKin will be the ones supported by on-line resources associated with the course (via V-lab). These are available for home use through the UI VLab system. EXCEL should be workable for all problems, but in some cases you may need to apply additional engineering assumptions/judgement to obtain credible answers. Working in teams is encouraged, especially in resolving conceptual questions and in validating results. However, when calculations and coding are required, you should implement and annotate your own solutions. Homework is to be submitted at the day specified, unless special arrangements are made ahead of time. Homework assignments will receive grades based on consideration to your problem formulation, assumptions, identification of governing equations/concepts, appropriate and documented use of equation solving software, solution validation, and reflection/discussion. A general purpose rubric will be provided for assessing and improving homework performance.