**ME 433 Combustion Engine Systems**

## Catalog Data:

Theory and characteristics of combustion engines; combustion process analysis; fuels, exhaust emissions and controls; system analysis and modeling. Prereq: ME 345 or permission.

## Textbook:

Heywood, J., Internal Combustion Engine Fundamentals. 1st or 2nd edition. Hard copy or electronic copy are acceptable.

## Meeting Times:

Monday, Wednesday, Friday 1:30 – 2:20 am EPB 205

## Course Web Page:

<https://www.webpages.uidaho.edu/mindworks/ic_engines.htm>

## Instructor Contact Information:

Dan Cordon, GJ 234H, (208) 885-7948, dcordon@uidaho.edu

Office Hours: TBD with class input – see course website

## Prerequisites by Topic:

1. Creating, editing, and transforming tables.
2. Producing graphs following engineering guidelines.
3. Functional and comparative graphing; determining best-fit coefficients for experimental data; evaluating curve fits using residual plots.
4. Documenting engineering calculations with a word processor.
5. Running Matlab m-files.
6. Solving systems of ordinary differential equations that describe dynamic systems.
7. Finding roots of scalar and vector equations that describe engineering phenomena.
8. Preparing, delivering, and evaluating technical presentations.
9. Ability to determine stoichiometric coefficients for chemical reactions.
10. Application of the first and second laws of thermodynamics to engineering systems.
11. Representing and interpreting thermodynamic cycles on PV and TS diagrams.
12. Fundamentals of conduction and convection heat transfer.

## Course Outcomes:

1. Become familiar with common engine components and test equipment.
2. Apply the first and second laws of thermodynamics along with balanced chemical reactions to estimate performance of ideal air cycles.
3. Specify and interpret engine design parameters and performance characteristics for a variety of combustion engine systems.
4. Predict heats of reaction and species concentrations using equilibrium thermodynamics for common and alternative fuels.
5. Predict instantaneous heat release and associated work output as well as a pollutant formation for real fuel-air cycles.
6. Work on an engine-related project or create a short in-class presentation on a specialty topic. Topics will be chosen by the class early in the semester.

## Professional Behaviors:

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

Learning Skills:\*\* Indicates high priority skills for this course

**Cognitive:**

* Identifying assumptions\*\*
* Inquiring\*\*
* Diagramming\*\*
* Validating\*\*
* Reasoning with theory\*\*
* Systematizing
* Integrating
* Simplifying
* Linear thinking
* Identifying constraints
* Selecting tools
* Generalizing solutions
* Locating relevant literature

**Social:**

* Collaborating\*\*
* Assessing performance\*\*
* Sharing knowledge
* Persuading
* Initiating interaction
* Being non-judgmental

**Affective:**

* Preparing\*\*
* Being proactive\*\*
* Persisting
* Accepting help
* Seeking assessment
* Accepting outcomes

## Course Topics:

1. Review of chemical, thermodynamic, and fluid fundamentals.
2. Representing cycle processes on a PV and TS diagram
3. Identification and inspection of typical engine components.
4. Differences between SI and CI engines from the standpoint of load control, air/fuel mixture control, ignition control, and pollutant formation.
5. Engine control systems, including MBT timing, carburetion, fuel injection, and emissions abatement.
6. Calculation of brake power, brake torque, arbitrary efficiency, and specific fuel consumption.
7. Relation between engine design specifications and performance parameters, including different service classifications.
8. Engine sizing guidelines and selection of engine type
9. Road load power calculations and acceleration models
10. Concept of Mean Effective Pressure
11. Premixed and diffusion flames as well as associated burning velocities.
12. Chemical equation balancing for common combustion scenarios
13. Classification of hydrocarbon fuels, measuring heating values, computing heats of reaction, estimating flame temperatures, and determining chemical equilibrium.
14. Researching, writing, and presenting a literature review on a combustion topic.
15. Alternative fuel production and emissions, including a tour through the Agricultural Engineering fuels laboratory.
16. Engine cycle modeling and analysis, including finite combustion time, cylinder heat transfer, crevice effects, and blowdown.
17. Estimating Wiebe function parameters from instantaneous in-cylinder pressure data.
18. Conducting and analyzing performance data from an engine on a test-stand and a vehicle on a chassis dynamometer.

## Grade Weighting:

Thermodynamics Pre-Test 5%

Homework 40%

Course Project 20%

Exams 15%

Name 20%

## Homework:

Almost every homework assignment requires some use of applications software for functional graphing, data analysis, and non-linear equation solving. Analysis tools used may be determined by the students. Working in teams is encouraged, however, when coding is required, only two people at most will be allowed to turn in a shared code (and only if it was written together).

Homework will be assigned weekly, and unless noted in the schedule will be due by class time the following Monday. You may turn in hard copies of your homework in class, or turn in digital submissions via Canvas.