

## IME-3240 Automotive Power Systems

### Course Syllabus – Fall 2010

**Catalog Description:** The construction, disassembly/reassembly, manufacture, examination of design, simulation, operation, testing of performance and durability serviceability, emissions and reliability of current and contemporary power plants for automotive and truck use. Emphasis on current designs of SI and CI engines, ASTM tests of fuels and lubricants as well as evaluations of near-term alternatives such as synthetic diesel and fuel cells. Principles of mechanics, thermodynamics, applied to power systems.

**Starting Point:** The world is at a point where the fuel of choice is not only gasoline and diesel. The world now views any fuel that can be transported in a vehicle and for which an infrastructure is in place as a potential transportation fuel. This class is going to study methodology of conversion, energy transfer, energy storage starting with conventional fuel and combustion and characteristics. The class will use the first lab session to evaluate cyclic relationships of valves, piston and crankshaft positions. Reports will be due the following week at the Lab session. A digital camera ((camera phone)you provide) will be used to document components and procedures

#### **Prerequisite Topics:**

1. Mathematics that include the understanding of algebra, geometry and basic calculus
2. Physics that include the understanding and measurement of heat, heat transfer, electricity, light, sound, acceleration, speed, flow of fluids and mechanical mechanisms
3. Materials that include the understand of physical and thermal properties as well as manufacturing techniques used with different materials
4. Chemistry that includes the understanding of chemical relationships used in production and use of materials, fuels and lubricants
5. Computers that include the use of software packages for simulations and problem solving
6. Technical writing that includes the ability to report scientific observations and performance results
7. Technical illustration that includes the use of computers to report graphical information, manufacturing processes and records
8. Statistics and metrology for determination of manufacturing tolerances and accuracy of process control
9. IME-122 Automobile in Society, The sociological technological challenges of the automobile

#### **Textbook:**

Robert Bosch GmbH, Automotive Handbook, 6<sup>th</sup> Ed. ISBN: 0-7680-1513-6 or later (SAE International) **If you have a copy, use the copy you have. If you are purchasing for the first time get the latest edition available!**

#### **References:**

- Pulkrabek, Willard W. 2003, Engineering Fundamentals of the Internal Combustion Engine, 2<sup>nd</sup> Edition, New Jersey, Prentice Hall
- Bosch, Robert GmbH, 1999 Automotive Electrics and Electronics, Germany (Distributed by The Society of Automotive Engineers International)
- Bosch, Robert GmbH, 1999 Gasoline Engine Management, Germany (Distributed by the Society of Automotive Engineers International)
- Bosch, Robert GmbH, 1999, Diesel Engine Management, Germany (Distributed by the Society of Automotive Engineers)
- Plint, Michael and Martyr, Anthony, 1999, Engine Testing-Theory and Practice, England, SAE/Butterworth-Heinemann
- SAE Transactions, 1999, Fuel Cell Power For Transportation, Pennsylvania, Society of Automotive Engineers)
- Owen, Keith and Coley, Trevor, 1995, Automotive Fuels Reference Book, Pennsylvania, Society of Automotive Engineers)

Caines, Arthur J. and Haycock, Roger F. Automotive Lubricants Reference Book, Pennsylvania, Society of Automotive Engineers)  
2000, Guide to ASTM Test Methods for the “Analysis of Petroleum Products and Lubricants”.  
West Conshohocken, PA, Distributed by the American Society of Testing Materials

**Course Learning Objectives** – By the end of the semester the student should be able to:

1. Identify methods of manufacture, assembly, adjustment and tolerance of components and sub assemblies of SI and CI engines
2. Apply physics and thermodynamics to the operation of SI and CI engines
3. Test the performance of SI and CI engines using dynamometers and other engineering measurement equipment
4. Identify and explain the function of SI and CI electronic engine management systems and how they effect emissions and economy
5. Identify characteristics of modern power plant operation and construction
6. Identify characteristics of alternative power systems

## **Topics**

### Lectures

1. Operating characteristics and cycles of SI and CI engines
2. Thermochemistry and ASTM tests of SI and CI fuels
3. Air induction, combustion chamber fluid motion and the combustion process
4. Friction, lubrication and ASTM/SAE tests of lubricant characteristics
5. Forming, fabrication, assembly of SI and CI engines
6. Exhaust constituents and there control
7. SI and CI engine management systems
8. Heat transfer in SI and CI engines
9. Fuel cell and electric applications to power vehicles

### Labs

1. Study of cyclical relationships of valves. Crankshaft and pistons
2. Study of cylinder head, induction, exhaust system design and assembly
3. Study of piston, piston ring, and connecting rod design, dynamics and assembly
4. Study of cylinder block/head design, manufacturing and thermodynamics
5. Study of valve and valve train operation, design and dynamics
6. Study and tests of SI and CI fuel properties
7. Study and tests of lubricant properties
8. Study of electronic management systems
9. Study of engine performance measurements in a dynamometer cell monitoring exhaust constituents, fuel consumption and power variables, calculating brake specific fuel consumption, thermal efficiency and mechanical efficiency
10. Hybrid vehicle operational testing

### **Evaluation:**

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|----------------------|-----|
| 1. Exams and Quizzes | 30% |
| 2. Homework          | 10% |
| 3. Lab assignments   | 40% |
| 4. Attendance        | 20% |

**Performance Criteria (Learning Outcomes)**, Based on learning objectives above:

1. Identify material, manufacturing methods, assembly procedures, measurement and tolerances of SI and CI engines
2. Calculate and analyze loads on engine bearings and valve train components
3. Measure and calculate BSFC, Thermal Efficiency, Mechanical Efficiency, Horsepower (KW) of a modern power plant
4. Use dynamometers, flow meters, thermocouples and other engine test cell equipment to determine and analyze engine performance and efficiency characteristics
5. Use an electronic engine management development system to establish low emissions, driveability and economy
6. Explain the operation of contemporary power plants

**Computer Usage:**

Computers will be used with direct reading instrumentation, spread sheets of data, searching for information, printing digital pictures, making calculations, graphing data and with the use of engine design simulations

**Laboratory Projects:**

Laboratory projects include engine assembly and tolerancing. Measurement of engine performance of engine emissions.

**Oral and Written Communications**

Oral and written communication will be evaluated with each laboratory report and homework assignment. Proper grammar, correct technological terminology and format will be graded and will constitute a minimum of 25% of the grade.

**Calculus Usage:**

Basic use and understanding of calculus is used in thermodynamics of engines and dispersion of pollutants from the automobile

**Library Usage:**

Library usage is expected to accompany lab reports. Transactions of the Society of Automotive Engineers serve as a great source of information regarding powerplants both historically and contemporarily. I have been assured by Mr. Ed Eckles, Science Librarian at Waldo Library, WMU that these Transactions will be accessible from your personal computer.

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**Office Hours:**

M-W-F 10:30 to 11:30. Other hours by appointment