2.61 Internal Combustion Engines
Spring 2008

**2.61: Internal Combustion Engine - Engine Laboratory Exercise Spring, 2008**
**(Lab report due 4/24/08)**

OBJECTIVE

The objective of the laboratory is to provide the students with some familiarity to how does a real engine behave, to operate the engine and the exhaust gas emissions measurement system, and to acquire and explain the engine data.

ORGANIZATION

The class will be divided into a Tuesday (4/15/08) group and a Thursday (4/17/08) group. Each group will work on the engine for one afternoon from 1 to 2:30 pm. The data gathering is a team effort, with the raw data to be shared by all members of the group. Each student, however, has to write a lab report individually based on independent analysis of the raw data.

The report title will be **"The Load/ Speed Dependence of SI Engine Emission Behaviors"**. The data presented in the report should have been reduced to meaningful results. It is important that the results be explained according to your understanding of the physical phenomena involved.

LABORATORY MEASUREMENTS

The engine is a 4-cylinder, 4-valve per cylinder production spark ignition engine. (The engine is the DaimlerChrysler (DCX) 2.4L engine, which powers the Minivan. The specifications are:

| | | | |
|---|---|---|---|
| Bore | 87.5 mm | IVO | $1^o$ BTC |
| Stroke | 101.0 mm | IVC | $51^o$ ABC |
| Compression Ratio | 9.4 | EVO | $52^o$ BBC |
| Connecting Rod Length | 136.5 mm | EVC | $8^o$ ATC |
| Rated Power: | 117 KW @ 5000 rpm | | |
| Peak Torque | 227 n-m @4000 rpm | | |
| Firing Order | 1-3-4-2 | | |

The fuel used is Certification gasoline HF437; the fuel properties can be found on the course web site. The fuel is injected in the intake port. The equivalence ratio is changed by varying the injection duration which is controlled by the DaimlerChrysler ECU using the information from the Exhaust Gas Oxygen (EGO) sensor at the exhaust. Note that this sensor gives only an ‘on-off’ type of signal; therefore, an additional Universal Exhaust Gas Oxygen (UEGO) sensor is used to read the air fuel ratio. Also note that the ECU modulates the equivalence ratio at 2 Hz, in the range of $\lambda = 0.975$ to 1.025; the UEGO displays the averaged value.

(a) At 1600 rpm, 46 N-m brake torque operation, check that the emission measurements are consistent by determining the equivalence ratio from a carbon balance and compare that with the UEGO sensor output. (Note that this is the standard light load condition employed by DaimlerChrysler to check out all their engines.)

(b) Produce the Engine-Out emission maps for the engine for the following and explain the observed trends. (You should use brake- specific values which are the values normalized by the energy output of the engine.)

Brake- specific CO emission
Brake- specific HC emissions
Brake- specific NO emission
Brake- specific fuel consumption (based on carbon balance)

Note: the map is a contour plot of the specific quantities as a function of the engine brake torque and rpm. It should include points on the WOT line and have data points reasonably spaced. Roughly a 4x4 data matrix will suffice. You could plot the contours by hand, using interpolation. It is not necessary to use a computer program to plot these contours. Point out the features on these plots and explain why the engine exhibits such behaviors.