EML 4421 Fundamentals of IC Engines and Propulsion Systems Fall 2001

Homework 4 Due October 3

1. Please download the Stanford Engine Simulation Program (ESP) from http://esp.stanford.edu/. This is a simulation program for engine performance developed by Professor W. C. Reynolds at Stanford University. Detailed information of the program can be found in chapter 8 of our textbook. Please read and understand the basic function of the program. The following assignments should be completed using Stanford ESP program:
   (a) Working with ESP, using no manifold and any convenient configuration, and vary the point of ignition to 30, 25, 20, 15, 10, 5, and 0 CAD BTC, and plot the peak pressure and the CAD at which peak pressure occurs as a function of ignition CAD (on separate graphs). Discuss implications for knock. (This is essentially the problem 1.2 in the textbook.)
   (b) Working with ESP, using no manifold and any convenient configuration, vary the inlet pressure from 0.37 atm (corresponding to idle) to a maximum of 1.5 atm (corresponding to the case of either supercharged or turbocharged). Plot the peak pressure and volumetric efficiency (on separate graphs) as a function of the inlet pressure. Discuss your results. (This is essentially the problem 2.1 in the text)

2. Show that the mass flow through a valve can be given by using isentropic relation and mass conservation:

$$\dot{m}_{is} = \rho A_v U = \rho A_v \left\{ 2\frac{\gamma}{\gamma-1}\frac{P_o}{\rho_o}\left[1-\left(\frac{P}{P_o}\right)^{(\gamma-1)/\gamma}\right]\right\}^{1/2},$$

where P_o & ρ_o are stagnation pressure and density, respectively. p is the valve static pressure, A_v is a representative area of the valve.

3. Show that, for a choked valve, the volumetric efficiency can be related to the inlet Mach index (Z) by:

$$(\eta_v)_{choked} = 0.58\left(\frac{\theta_{io} - \theta_{io}}{\pi}\right)\frac{1}{Z},$$

This expression is derived based on γ=1.4 and terminology defined in the lecture notes.