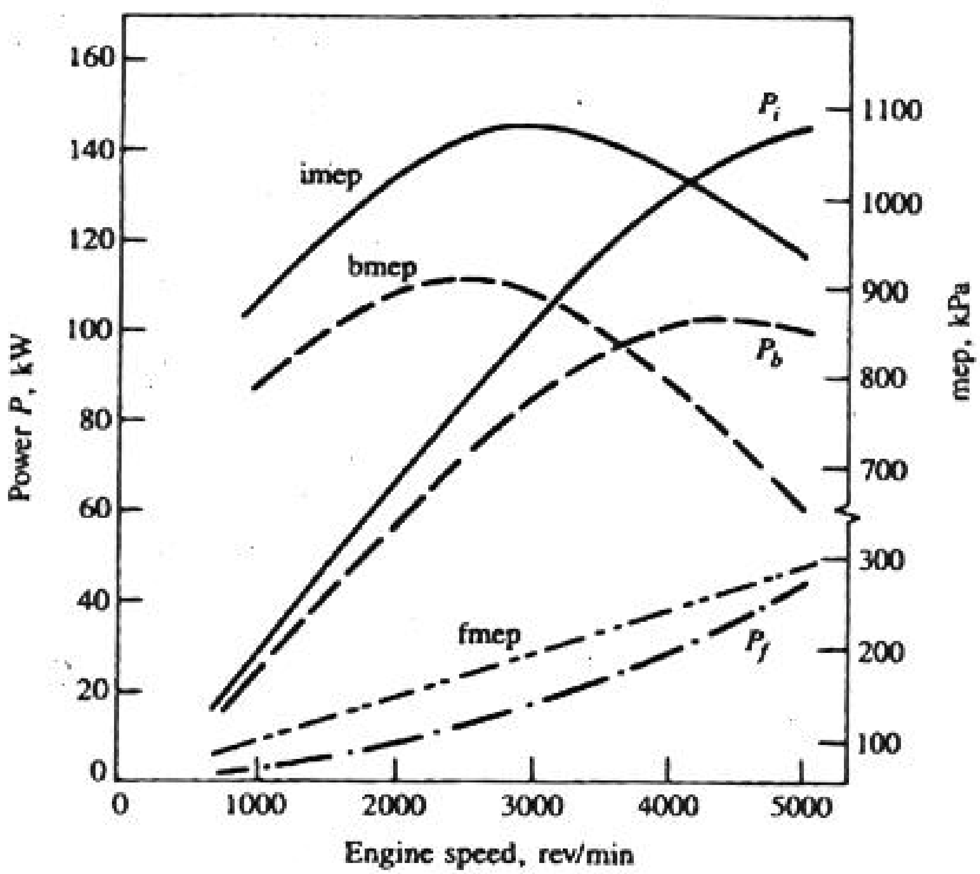
1. Make general contrasts between the following two engines: SI, 4 cylinder naturally aspirated engine in a Honda Civic, and CI, 6 cylinder turbocharged heavy duty truck engine. Assume both engines are operating at highway speed. Put CI or SI in the blanks as needed.

a) __C__ the engine with the largest displacement
b) __C__ the engine with the largest stroke
c) __S__ the engine with the lowest bmep
d) __C__ the engine with the largest compression ratio
e) __C__ the engine operating with the lowest F/A ratio
f) __C__ the engine developing the largest road load power

The following questions, 2-8, apply to the 4-stroke engine described below.

Parameter	Value
number of cylinders	6
bore (m)	.0968
stroke (m)	.0860
compression ratio	8.6



2. Calculate the total engine displacement in liters (1 liter = .001 m^3) and the clearance volume of ONE cylinder in m^3.

$$V_{cyl\text{-}d} = \frac{\pi}{4} b^2 L = \frac{\pi}{4}(.0968)^2(.860) = 6.329 \times 10^{-4}\ m^3$$

$$V_d = 6 V_{cyl\text{-}d} = .003797\ m^3 = \underline{3.8 \text{ Liters}}$$

$$r_c = \frac{V_c + V_{cyl\text{-}d}}{V_c} \quad 8.6 = \frac{V_c + 6.329 \times 10^{-4}}{V_c} = \underline{8.328 \times 10^{-5}\ m^3}$$

3. What is the maximum brake torque at wide open throttle? Give your answers in N-m. At what RPM (rev/min) does the maximum torque occur?

max bmep = 910 Kpa = $910 \times 10^3 \frac{N}{m^2}$

@ $\approx$ 2500 rpm

$$T = \frac{1}{4\pi} \, bmep \, V_d$$

$$= \frac{1}{4\pi}\left(910 \times 10^3 \frac{N}{m^2}\right)(.003797\ m^3)$$

$$= 275\ N \cdot m$$

4. Estimate the mechanical efficiency of the engine at 4000 RPM.

$$\eta_m = \frac{P_b}{P_i} = \frac{100\ kW}{130\ kW} = .769$$

$$\doteq 77\%$$

5. With wide open throttle, the brake specific fuel consumption is 0.3 Kg/(kW-hr) at 4000 RPM. Estimate the flow rate of fuel to the engine in Kg/hr.

$$bsfc = \frac{\dot{m}_F}{P_b} \qquad \dot{m}_f = bsfc\ P_b$$

$$= \left(.3 \frac{Kg}{Kw\text{-}hr}\right)(100\ Kw)$$

$$= 30 \frac{Kg}{hr}$$

6. Using the information given in the previous problem, and assuming a heating value of 42×10^6 N-m/Kg, calculate the fuel conversion efficiency at 4000 RPM.

$$\eta_f = \frac{3600}{bsfc\left(\frac{g}{Kw\text{-}hr}\right) Q_{HV}\left(\frac{MJ}{Kg}\right)}$$

$$= \frac{3600}{(300)(42)}$$

$$= .286 \approx 29\%$$

7. The air/fuel ratio is 13/1. Assuming standard conditions, p=101,000 Pa, and T = 298K, in the intake, estimate the volumetric efficiency at 4000 RPM.

$$\dot{m}_f = \frac{30}{3600} \frac{Kg}{s} = .008333 \frac{Kg}{s}$$

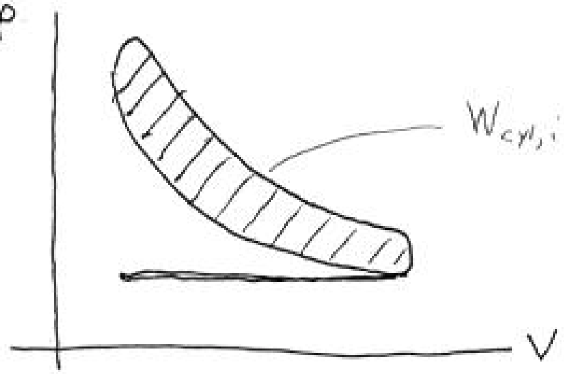
$$\dot{m}_a = 13\dot{m}_f = .108333 \frac{Kg}{s}$$

$$\rho_{a,i} = \frac{(3.483 \times 10^{-3})(101000)}{298} = 1.18 \frac{Kg}{m^3}$$

$$N = 4000 \frac{rev}{min} \frac{min}{60s} = 66.7\ rev/sec = 66.7/s$$

$$\eta_v = \frac{2\dot{m}_a}{\rho_{a,i} V_d N} = \frac{2\left(.108333 \frac{kg}{s}\right)}{\left(1.18 \frac{kg}{m^3}\right)(.003797\ m^3)\frac{66.7}{s}} = .725 = 73\%$$

8. The sketch below shows a p-V diagram of one of the cylinders in the engine at 4000 RPM. Estimate the shaded area.



$$P_{i,cyl} = \frac{W_{i,cyl}\, N}{n_R}$$

$$P_{i,cyl} = \frac{130\,kW}{6} = 21.7\,kW$$

$$W_{i,cyl} = \frac{P_{i,cyl}\, n_R}{N}$$

$$= \frac{\left(21.7\,\frac{N\cdot m}{s} \times 10^3\right)(2)}{\frac{66.7}{s}}$$

$$= \underline{650\ N\cdot m}$$