

ME 410 FALL 2002
INTERNAL COMBUSTION ENGINES
TEST #4
November 2002

NAME _____

INSTRUCTIONS:

This test is open notes. The following formulas are also given with little explanation.

$$\bar{S}_p = 2LN \qquad r_c = \frac{V_d + V_c}{V_c} \qquad P_{ig} = P_b + P_f$$

$$\eta_m = \frac{P_b}{P_{ig}} \qquad mep = \frac{Pn_R}{V_d N} \qquad P = 2\pi NT$$

$$mep(kPa) = \frac{P(kW)n_R \times 10^3}{V_d(l)N(rev/s)} \qquad mep = \frac{P(hp)n_R \times 396000}{V_d(in^3)N(rev/min)}$$

$$\eta_f = \frac{1}{sfc \cdot Q_{HV}} \qquad \frac{F}{A} = \frac{\dot{m}_f}{\dot{m}_a} \qquad \eta_v = \frac{2\dot{m}_a}{\rho_{a,i} V_d N}$$

$$\eta_v = \frac{\dot{m}_a}{\rho_{a,i} V_d} \qquad P = \frac{\eta_f \eta_v N V_d Q_{HV} \rho_{a,i} (F/A)}{2} \qquad mep = \eta_f \eta_v Q_{HV} \rho_{a,i} (F/A)$$

$$T = (1/4\pi) \cdot mep \cdot V_d$$

Additional Ideal Gas Relations

$$\gamma = \frac{c_p}{c_v} \qquad PV = mRT \qquad R = c_p - c_v$$

1. A fuel-air cycle thermodynamic analysis of an SI engine is performed. It has been assumed that the engine is operating at full open throttle and the pumping work may be neglected.
 - $V_d = 3.1$ liters, 6 cylinders.
 - Work done on working fluid during compression is 410 J / cylinder.
 - Work done on piston by working fluid during expansion is 1110 J / cylinder.
 - Equivalent heat released into working fluid during combustion is 1450 J / cylinder.
 - Mechanical efficiency is estimated to be 65%.

a) Calculate the gross work done in each cylinder per cycle.

b) Calculate the fuel conversion efficiency based on this ideal cycle information.

c) Calculate the indicated gross power being developed at 4800 RPM.

d) What is your best estimate of the brake power developed by the engine model at 4800 RPM? Explain your estimate.

e) What is your best estimate of the brake power developed by the actual engine at 4800 RPM? Explain.

2. Give three reasons why the results of a fuel air cycle analysis must be reduced in order to agree with results from testing an actual engine.

3. The following phenomena affect the volumetric efficiency of internal combustion engines. In each case, describe the phenomena, and explain the effect it has on volumetric efficiency, including whether the effect is more noticeable at low engine speed or high engine speed.

a) ram effect

b) backflow

c) choking

d) tuning

4. Estimate an exhaust runner length which will produce tuning in an engine exhaust system.
 - The speed of sound in the exhaust gas is estimated to be about 2000 ft/s.
 - The crank turns through 230° between the exhaust pressure peak after EVO until the exhaust valve closes.
 - The desired RPM for tuning is 5000.