EES Solution to Practice Exam #3

ME410 Fall 2002

Part I DATA SECTION

$u_1 = 218$ [kJ/kg]

$h_1 = 306$ [kJ/kg]

$s_1 = 5.715$ [kJ/kg-K]

$u_2 = 638$ [kJ/kg]

$h_2 = 884$ [kJ/kg]

$u_{3a} = 1624$ [kJ/kg]

$h_{3a} = 2182$ [kJ/kg]

$s_{3a} = 6.45$ [kJ/kg-K]

$u_{3b} = 2386$ [kJ/kg]

$h_{3b} = 3167$ [kJ/kg]

$s_{3b} = 6.876$ [kJ/kg-K]

$u_4 = 1053$ [kJ/kg]

$h_4 = 1436$ [kJ/kg]

Part I Answers

1. Specific entropy at 2 is same as 1 since process 1 to 2 is adiabatic and reversible.

$s_2 = s_1$

2. The total equivalent heat release comes in two parts. First the constant volume part. To this we add the constant pressure part.

$q_{cv} = u_{3a} - u_2$

$q_{cp} = h_{3b} - h_{3a}$

$q = q_{cv} + q_{cp}$

3. The work of compression done is, by the first law, the internal energy change in the fluid as is goes from state 1 to state 2.

$w_{12} = u_2 - u_1$

4. The specific entropy at 4 is the same as at 3b.

$s_4 = s_{3b}$

5. The work done per unit mass of the power stroke from 3a to 3b.

$w_{3a3b} = q_{cp} - [u_{3b} - u_{3a}]$

6. Work done from 3b to 4.

$w_{3b4} = u_{3b} - u_4$

7. Net specific work per cycle

$w_{cycle} = w_{3a3b} + w_{3b4} - w_{12}$

8. Gross indicated fuel conversion efficiency

$$\eta_{fg} = \frac{w_{cycle}}{q}$$

9. What is the imep? Assume it processes 0.001 kg/cycle. We base this on one cylinder.

$$V_d = 1.5 \cdot \left[0.001 \cdot \frac{m^3}{liter} \right]$$

$m_{cycle} = 0.001$ [kg]

$W_c = w_{cycle} \cdot m_{cycle}$ [kJ]

$$imep = \frac{W_c}{V_d} \text{ [kPa]}$$

10. Indicate Gross Power at 3500 rpm.

$$N = \frac{3500}{60} \text{ [1/s]}$$

$$P_{ind} = 6 \cdot W_c \cdot \frac{N}{2}$$

Unit Settings: [kJ]/[K]/[kPa]/[kmol]/[radians]

η_{fg} = 0.5764	h_1 = 306 [kJ/kg]	h_2 = 884 [kJ/kg]	h_{3a} = 2182 [kJ/kg]	h_{3b} = 3167 [kJ/kg]
h_4 = 1436 [kJ/kg]	imep = 757.3 [kPa]	m_{cycle} = 0.001 [kg]	N = 58.33 [1/s]	P_{ind} = 198.8
q = 1971	q_{cp} = 985	q_{cv} = 986	s_1 = 5.715 [kJ/kg-K]	s_2 = 5.715 [kJ/kg-K]
s_{3a} = 6.45 [kJ/kg-K]	s_{3b} = 6.876 [kJ/kg-K]	s_4 = 6.876 [kJ/kg-K]	u_1 = 218 [kJ/kg]	u_2 = 638 [kJ/kg]
u_{3a} = 1624 [kJ/kg]	u_{3b} = 2386 [kJ/kg]	u_4 = 1053 [kJ/kg]	V_d = 0.0015 [m^3]	w_{12} = 420
w_{3a3b} = 223	w_{3b4} = 1333	W_c = 1.136 [kJ]	w_{cycle} = 1136 [kJ/kg]	