Exam #3

Open Text Book

One 8.5” x 11” Equation Sheet (one side only)
[No Worked Examples, ALEs or HW allowed]

Laptops Permitted for Calculations & Music Only
[EES is NOT permitted; music must not disturb others.]

NAME_________________  BOX              .

SCORE

Problem 1  _____  / 60

Problem 2  _______  / 40

Total  _______  /100

PLEASE NOTE:

The problems are printed on the inside of this folder. You may start your
solution there and/or continue them on the blank paper provided. Please answer
the short answer questions on the question sheet.

Please put your name and CM box on each sheet.

Submit your equation sheet and solutions in the folder before you leave.

DO NOT INTERPOLATE! Use the closest value in the tables.
Problem 1 (60 pts)
Consider the following reaction of 2 kmols/s of GASEOUS ETHANOL \((C_2H_5OH, M = 46.07\ \text{kg/kmol})\) and OXYGEN.

\[2C_2H_5OH(g) + 5.5O_2 \rightarrow 2CO_2 + 2CO + 6H_2O(l) + 0.5O_2\]

Treat the combustor as an open system without accumulation. The fuel enters at 25 °C and the oxygen \((O_2)\) at 400 K. The products exit at 25 °C and 1 bar. Assume all of the water in the products condenses.

(a) For the reaction above:

1. Did complete combustion occur? Yes No
2. Determine the percent excess or deficient \(O_2\).
3. Determine the dew point temperature of the products.
4. Calculate the rate of heat transfer output, \(Q_{\text{out}}\), in kW for the reaction. Recall all of the water in the products condenses.

(b) Modify the reaction so combustion occurs with 400 K AIR and answer questions about the consequences of the change.

1. Rewrite the above reaction using AIR as the oxidizer.
2. Calculate the molar air to fuel ratio, \(AF\), of the new reaction.
3. Will the heat transfer output? Increase Decrease Stay Same.
4. Will the adiabatic flame \(T\)? Increase Decrease Stay Same.
5. Will the dewpoint \(T\)? Increase Decrease Stay Same.
Problem 2 (40 pts)

An air standard Otto cycle has a heat input of 600 kJ/kg and state data shown in the table below.

(a) Given the state data at the right, compute the following properties and parameters. Use variable specific heat data.

<table>
<thead>
<tr>
<th></th>
<th>T [K]</th>
<th>v [m³/kg]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>300</td>
<td>0.82</td>
</tr>
<tr>
<td>2</td>
<td>700</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(1) (8 pts) the compression ratio, r.
(2) (13 pts) $T_3$ and $T_4$
(3) (8 pts) net work output per kg
(4) (6 pts) mean effective pressure of the cycle

(b) (2 pts) Circle the more appropriate T-s.

(b) (3 pts) Using a dashed line, alter the chosen T-s diagrams to show the case where:
the heat transfer input decreases AND the compression ratio remains constant.