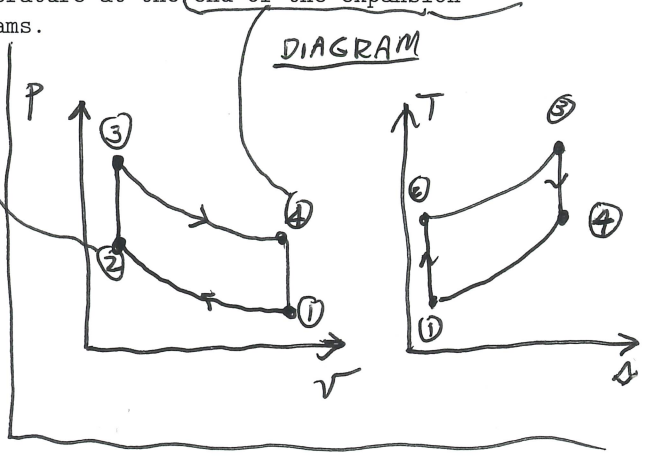
ANNOUNCED QUIZ #6 – ME 3030 — Section 002 – Spring 2024

SOLUTION

NAME: _____

This is an open book quiz. You may use a four function calculator. An unsigned honors pledge will result in a zero.

1. Compute the work produced by an air-standard Otto cycle during a minute of operation when it operates at 5,000 cycles/min. The compression ratio for the cycle is 9.5, the temperature at the end of the compression is 397°C and the temperature at the end of the expansion is 767°C. The mass of air in the cylinder is 4.3 grams.



GIVEN: $r = 9.5$; T_2, T_4, m, $\omega = 5000$ cycles/min

FIND: W for 5000 cycles

ASSUME: Standard Otto cycle assumptions

ANALYSIS: $\frac{W_{net}}{m} = W_{34} - W_{12} = (u_3 - u_4) - (u_2 - u_1)$

$W_{net/cycle} = m[(u_3 - u_4) - (u_2 - u_1)]$

(2) $T_2 = 397°C = 670K$; $u_2 = 488.81$ kJ/kg; $v_{r2} = 78.61$

(4) $T_4 = 767°C = 1040K$; $u_4 = 793.36$ kJ/kg; $v_{r4} = 22.39$

(1→2) and (3→4) are isentropic. So

$\frac{v_1}{v_2} = \frac{v_{r1}}{v_{r2}} = \frac{v_{r1}}{78.61} = 9.5 \Rightarrow v_{r1} = 746.80$ interpolating in A-22

$\frac{738.0 - 746.8}{738.0 - 808.0} = \frac{199.75 \text{ kJ/kg} - u_1}{199.75 \text{ kJ/kg} - 192.60 \text{ kJ/kg}}$

$u_1 = 198.85$ kJ/kg

$\frac{v_4}{v_3} = \frac{v_{r4}}{v_{r3}} = \frac{22.39}{v_{r3}} = 9.5$, $v_{r3} = 2.356$ looking up in A-22 → $u_3 = 1775.3$ kJ/kg

$\frac{W_{net}}{cycle} = (0.0043 kg)[(1775.3 \frac{kJ}{kg} - 793.36 \frac{kJ}{kg}) - (488.81 \frac{kJ}{kg} - 198.85 \frac{kJ}{kg})]$

$\frac{W_{net}}{cyc} = 2.975$ kJ/cyc so, for one minute $W_{net} = 14,875$ kJ ← ANS.

I HAVE NEITHER PROVIDED OR RECEIVED HELP DURING THIS QUIZ.

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SIGNATURE