Final Examination in
THERMAL ENGINEERING
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Time : 3 hours [110] marks

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Answer the following questions: R = 8.3144 KJ / Mol. K For air $\gamma = 1.4$

1-a) Show that in a closed system performing adiabatic process, work added to the system increases its internal energy. [15]

b) For a perfect gas, shows that horizontal intercepts between two isochoric lines on the T-s diagram are equal.

c) In a reversible heat engine, the work done in a certain period is 100 KJ, and the heat added to the engine from a high temperature heat reservoir is 280 KJ. Determine the thermal efficiency and amount of heat transferred from the engine to the surroundings during this period. Calculate the coefficients of performance of this engine when it works as a refrigerator and as a heat pump.

2-a) Show that enthalpy of ideal gas is only a function of temperature. [20]

b) Show that it is impossible to attain absolute zero.

c) In a Rankine cycle, steam enters the turbine at 90 bar and 650 C, and exit at 0.1 bar with a quality of 0.95. Neglecting the pump work, calculate:

i- The cycle thermal efficiency. ii- The turbine isentropic efficiency.

iii- S.S.C of the cycle.

3-a) Steam power plant with reheater, OFWH and one feed pump operating on Rankine cycle. Draw the plant flow diagram and the corresponding cycle on T-s chart. [20]

b) For the same r and Q_R, show graphically that: $\eta_{Otto} > \eta_{Dual} > \eta_{Diesel}$

c) A simple Brayton cycle working at optimum pressure ratio, the temperature and pressure at the beginning of compression are 27 C and 1 bar. If the maximum temperature is 627 C, calculate the cycle thermal efficiency and cycle work done.

4-a) Calculate the critical pressure ratio of air flowing through a convergent nozzle. [25]

b) Air discharges adiabatically from a reservoir where the pressure and temperature are 5 bar and 127 C respectively, through a convergent-divergent nozzle with efficiency of 80%, to the atmosphere (1 bar). Neglecting the approach velocity:

i- Calculate the exit velocity and Mach number.

ii- Determine the stagnation temperature.

c) A steam pipe of inner and outer radiuses 2 and 3 cm respectively is covered with an insulation layer of 2 cm thickness. The thermal conductivities of the pipe and insulation are 20 and 4 W/m K respectively. The temperature of the inner surface of the steam pipe is 300 C, and that of the outer surface of insulation layer is 50 C. calculate the thermal resistance heat loss per meter and the interface temperature.

P.T. 0

أجب 5 و 6 هنا (بدون خطوات) وديس ورقة الأسئلة فى كراسة الإجابة (بدون كتابة إسم الطالب عليها)

5- Write the answer between brackets: **[20]**

a- If no work and heat transfer in a closed system, Δe = ... (KJ/Kg) ( )

b- Dry saturated steam executes a throttling process from 4 to 1 bar, Δh = ... (KJ/Kg) ( )

c- A Carnot cycle working between temperatures 30 C and 333 C, the thermal efficiency = ... % ( )

d- A reversible heat engine with an efficiency of 40% is reversed to work as a heat pump, the COP will be ... ( )

e- Ideal gas at a pressure 1 bar and 250 C, is compressed to 5 bar and 250 C, Δh = ... (KJ/Kg) ( )

f- The efficiency of Otto cycle with a compression ratio of 6 is ..... % ( )

g- The cooling capacity of a refrigerator is 35.16 kW = ... TR ( )

h- In a parallel flow heat exchanger, if $m_A cp_A = m_B cp_B$ and the inlet temperatures of fluids A and B are 20 and 100 C, the LMTD is = ... C ( )

i- In a condenser, the steam temperature is 250 C, the water temperature increases from 20 and 60 C, the LMTD = ... C ( )

j- If the heat transfer coefficient between a surface and air is 0.5 W/m^2 C, the thermal resistance per unit area is = ... C/W. ( )

6- Put a sign (✓) on the right statement and (X) on the wrong one. **[10]**

a- In a closed system performing isochoric process, W = Δh ( )

b- Heat added in open system = Area under the process in T-s diagram. ( )

c- In adiabatic flow, the total temperature increases downstream. ( )

d- Reheating decreases the thermal efficiency of Brayton cycle. ( )

e- In a Dual cycle, the heat rejected is at constant pressure process. ( )

f- Heat rejected in a Carnot cycle is at a constant pressure process. ( )

g- Stagnation pressure increases downstream the isentropic flow. ( )

h- Using heat exchanger in refrigeration cycle decreases the cooling effect. ( )

i- Counter flow heat exchanger needs larger area for the same heat transfer.( )

j- For forced convection laminar flow, the Reynolds number Re >2000 ( )

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GOOD LUCK ,,,, Dr. Helmy Gad