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

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

1-a) Show that entropy increases in adiabatic process. [*15*]

b) For a perfect gas show that horizontal intercepts between two constant pressure lines on the T-s diagram are equal.

c) An inventor claims a heat engine that can produce 9 KW, working between temperature limits of 130 C and -40 C. The engine receives 1050 KJ/min of heat. Discuss the possibility of this claim.

2-a) Show that it is impossible to attain absolute zero. [*20*]

b) Show that enthalpy of ideal gas is only a function of temperature.

c) In a steam power plant operating on a Rankine cycle, the steam at the turbine inlet is 80 bar and 600 C. The steam enters the condenser in a dry saturated state at 0.1 bar. Neglecting the pump work, calculate:

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

iii- The steam flow rate (Ton/hr) if the power is 21.4 MW.

3-a) Show that simple Brayton cycle efficiency increases with pressure ratio. [*20*]

b) For the same heat rejection and compression ratio,

Show 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 work done.

4-a) Steam at a pressure of 3.6 bar and a temperature of 210 C, is moving with a velocity of 350 m/s. Determine the stagnation enthalpy of the steam. [*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, to the atmosphere (1 bar). Neglecting the approach velocity:

i- Calculate the exit velocity and Mach number if nozzle efficiency is 0.80.

ii- Determine the stagnation temperature.

c) A wall with 10.5 cm thickness and thermal conductivity 0.7 W/m.K is covered from both sides with a 3.2 cm layer of cement and sand with a thermal conductivity of 0.45 W/m. K. What is the thermal resistance of the wall per square meter? Calculate the heat transfer per unit area through the wall if both sides are at 40 and 20 C.

P. T. O

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

5- Write the answer <u>between brackets</u> : [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 0 C and 273 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 300 C, is compressed to 5 bar and 300 C, Δh = …. (KJ/Kg) ( )

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

g- In a Dual cycle $v_1 = 1.2$, $v_2 = 0.2$ and $v_4 = 0.4$ m^3/Kg. The cut off ratio of the cycle is …… ( )

h- Air with a temperature 150 C is moving with a velocity 200 m/s, The total temperature is = ….. C ( )

i- Air enters a nozzle with a negligible velocity. If the enthalpy drop of air in the nozzle is 20 KJ/kg, the exit velocity = …. m/s ( )

j- If the heat transfer coefficient between a surface and air is 2 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 = 0 ( )

b- Heat added is equal to the area under the process in T-s diagram ( )

c- In saturation condition, if the temperature is const. the pressure is cost. ( )

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 Diesel cycle is at constant pressure process. ( )

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

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

i- Temperature distribution in a cylindrical wall is linear. ( )

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

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GOOD LUCK ,,, Dr. Helmy Gad