

Technical College - Baghdad
Dept.: Mechatronics
Class: Third Year

Date: 4/16/2018

2017-2018



Final Exam.

Subject: Thermodynamics & Heat transfer

Time: 3-Houres

Examiner: Dr. Kifah H. Hilal

(A)

Note: Answer only Five questions.

Q1/ Air initially at (60 kPa) pressure, (800K) temperature and (0.1m³) volume is compressed isothermally until volume is halved, and subsequently the air is cooled at constant pressure till volume is halved again. Sketch the process on a P-V plane and determine total work done and total heat transfer. Assume for air $C_p=1.005 \text{ kJ/kg.K}$ & $R=0.287 \text{ kJ/kg.K}$.

(20Marks)

Q2/ In an SI engine working on the Otto cycle, the compression ratio is (5.5). The pressure and temperature at the beginning of compression are (1 bar) and (27 °C) respectively. The peak pressure is (30 bar). Determine the pressure, temperature at the other points, the air standard efficiency and mean effective pressure. Assume for air $C_v=0.717 \text{ kJ/kg.K}$, $C_p=1.005 \text{ kJ/kg.K}$ & $R=0.287 \text{ kJ/kg.K}$.

(20Marks)

Q3/ In a steady flow system, a substance flows at a rate of (5 kg/s). It enters the system at a pressure of (6 bar), velocity (300 m/s), internal energy (2000 kJ/kg) and specific volume of (0.38 m³/kg). It leaves the system at a pressure of (1.5 bar), velocity (150 m/s), internal energy (1600 kJ/kg) and specific volume of (1.26 m³/kg). During its passage through the system, the substance losses (80kJ/kg) of heat to the surrounding. Determine work done by the system. Stating whether it is from or to the system. Neglect any changes in the potential energy.

(20Marks)

Q4/ Consider a hemispherical furnace of diameter (D=5m) with a flat base. The dome of the furnace is black, and the base has an emissivity of (0.7). The base and the dome of the furnace are maintained at uniform temperatures of (400 K) and (1000 K) respectively. Determine the net rate of radiation heat transfer from the dome to the base surface during steady operation.

(20Marks)

Q5/ Cold water ($C_p = 4180 \text{ J/kg. } ^\circ\text{C}$) enters a double pipe counter flow heat exchanger at (15 °C) at a rate of (0.25 kg/s) is heated to (45 °C) by hot water ($C_p = 4190 \text{ J/kg. } ^\circ\text{C}$) that enters at (100 °C) at a rate of (3 kg/s). If the overall heat transfer coefficient is (950 W/m². °C). Determine the rate of heat transfer and the heat transfer surface area of heat exchanger.

(20Marks)

Q6/ Air is heated as it flows through a tube with bulk temperature (177°C) and diameter (2.54 cm). Calculate the heat transfer per unit length of tube at air velocity (10 m/s) and wall temperature is (20°C) above the air temperature.

$$Nu = 0.023 Re^{0.8} Pr^{0.4}$$

(20Marks)

Properties of air

Temp. (K)	ρ (kg/m^3)	K ($\text{W/m}^{\circ}\text{C}$)	μ (kg/m.s)	ν (m^2/s)	Pr
340	1.043	0.0290	2.03×10^{-5}	1.96×10^{-5}	0.707
350	1.009	0.0297	2.08×10^{-5}	2.06×10^{-5}	0.706
400	0.883	0.0331	2.29×10^{-5}	2.60×10^{-5}	0.703
450	0.785	0.0363	2.49×10^{-5}	3.18×10^{-5}	0.700
500	0.706	0.0395	2.68×10^{-5}	3.80×10^{-5}	0.699

Good Luck

Kifah

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