Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

A Constituent Institution of Manipal University

III SEMESTER B.TECH. (MECHATRONICS ENGINEERING)

END SEMESTER EXAMINATIONS, NOV /DEC 2016

SUBJECT: ENGINEERING THERMODYNAMICS AND HEAT TRANSFER

[MTE 2103]

REVISED CREDIT SYSTEM

Time: 3 Hours **MAX. MARKS: 50**

Instructions to Candidates:

- Answer **ALL** the questions.
- Missing data may be suitable assumed.
- Draw neat labeled diagram ***(using scale and pencil)*** wherever necessary.

1A. Explain intensive properties and extensive properties with three examples for each and also prove that Internal energy is a point function and a property of a system by using first law. **(05)**

1B. Starting with an energy balance on a rectangular volume element, derive the one-dimensional transient heat conduction equation for a plane wall with constant thermal conductivity and no heat generation. **(05)**

2A. Consider the base plate of a 1200-W household iron that has a thickness of L= 0.005 m, base area of A= 300 cm^2, and thermal conductivity of k= 15 W/m °C. The inner surface of the base plate is subjected to uniform heat flux generated by the resistance heaters inside, and the outer surface loses heat to the surroundings at T_∞= 20°C by convection. Taking the convection heat transfer coefficient to be h = 80 W/m^2 °C and disregarding heat loss by radiation, neglecting heat generation and assuming heat flow to be steady, obtain an expression for the variation of temperature in the base plate, and evaluate the temperatures at the inner and the outer surfaces. **(04)**

2B. Why do we place Fan at the inlet instead of placing it at the outlet of an electronic equipment for air cooling through forced convection? **(02)**

2C. 10 kg of fluid per minute goes through a reversible steady flow process. The properties of fluid at the inlet are: P_1 = 1.5 bar, ρ_1 = 26 kg/m^3, C_1 = 110 m/s and u_1 = 910 kJ/kg and at the exit are P_2 = 5.5 bar, ρ_2 = 5.5 kg/m^3, C_2 = 190 m/s and u_2 = 710 kJ/kg. During the passage, the fluid rejects 55kJ/s and rises through 55 meters. Determine: - (i) The change in enthalpy (Δ h) of the fluid. (ii) Work done during the process (W). **(04)**

3A. Derive a relationship between COP of heat pump and COP of refrigerator when both are working in a reversible cycle exchanging heat with same temperature reservoirs at T_L (Lower) and T_H (Higher). **(02)**

3B. A piston allows air to expand from 6MPa to 200kPa. The initial volume and **(02)**

temperatures are 500 cm^3 and 800^o C. If the process is isothermal, calculate the heat transfer and entropy change.

3C. What do you understand by critical radius of insulation? A 2-mm-diameter and 10-m-long electric wire is tightly wrapped with a 1-mm-thick plastic cover whose thermal conductivity is k=0.15 W/m°C. Electrical measurements indicate that a current of 10 A passes through the wire and there is a voltage drop of 8 V along the wire. If the insulated wire is exposed to a medium at T_∞=30°C with a heat transfer coefficient of h = 12 W/m^2 °C. Determine the temperature at the interface of the wire and the plastic cover in steady operation. Also determine if doubling the thickness of the plastic cover will increase or decrease this interface temperature with reason. **(06)**

4A. Explain the Ideal Vapour Compression cycle with the help of plant flow diagram, T-s diagram and p-h diagram. **(04)**

4B. A piston cylinder arrangement shown in the fig.Q4 initially contains air at 150kPa and 400 ^{o}C. The setup is allowed to cool at ambient temperatures of 20^o C. **(02)**

Is the piston resting on the stops at the final state? What is the final pressure?

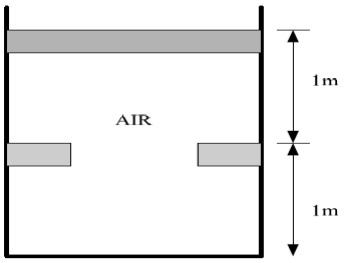

Fig. Q4B

4C. The turbine plate is mounted to a rotating disc in a gas turbine are exposed to gas stream that is at T_∞= 1200^o C and maintains a convection coefficient of h= 250W/m^2 ^{o}C over the blade. The blades are fabricated from Inconel (K=20W/m ^{o}C), have a length of 50 mm, the blade has a uniform cross sectional area of 6 cm^2 and perimeter 110mm. The base of the plate is maintained at T_b= 300 ^{o}C by using additional cooling system. Calculate temperature at the tip of the blade if it is adiabatic in nature and efficiency of the fin. What is the rate at which heat is transferred from each blade to the coolant? **(04)**

5A. A refrigeration circuit is to cool a room at 0°C using outside air at 30°C to reject the heat. The refrigerant R134a flowing at 1kg/sec. The temperature difference at the evaporator and room is 4o C and the temperature difference at condenser and outside air is 5.5oC. **(05)**

Calculate :- The Carnot COP for the refrigeration cycle
The cooling capacity in tons of refrigeration
The dryness fraction of refrigerant entering evaporator.
The ideal vapour compression cycle COP when using R134a.

5B. A counter-flow double-pipe heat exchanger is to heat water from 20°C to 80°C at a rate of 1.2 kg/s. The heating is to be accomplished by geothermal water available at 160°C at a mass flow rate of 2 kg/s. Calculate temperature of geothermal water at outlet and logarithmic mean temperature difference of the heat exchanger. **(02)**

5C. Draw a neat labelled diagram of Chip carrier. What are its functions? Why lead frame is manufactured from copper instead of easily available and cost effective plastic? **(03)**