Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

M.E. SEMESTER I (old course)–EXAMINATION (Remedial) – WINTER 2015

Subject code: 713904 Date: 15/12/2015

Subject Name: Advanced Thermal Engineering

Time: 10:30 AM to 1:00 PM Total Marks: 70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Use of Steam table is permitted.**

Q.1 **(a)** What is dead state? Explain concept of dead state in context to availability. **07**

(b) Discuss different types of processes for condensation of vapours on a solid surface. **07**

Q.2 **(a)** What are the objectives of conduction analysis? List the factors which influence the thermal conductivity of a substance. In what way the conductivity is affected by the solid, liquid and gaseous phases of the substance? **07**

(b) A standard cast iron pipe having inner diameter = 50mm and outer diameter = 55 mm is insulated with 85 percent magnesium insulation (k = 0.02 W/m^0C). temperature at the interface between the pipe and insulation is 300^0C.The allowable heat loss through the pipe is 600 W/m length of pipe and for the safety, the temperature of the outside surface of insulation must not exceed 100^0C. Determine i) Minimum thickness of insulation required and ii) The temperature of inside surface of the pipe assuming its thermal conductivity as 20 W/m^0C. **07**

OR

(b) A square plate heater (15 * 15) cm^2 is inserted between two slabs. Slab is 2 cm thick (k = 50 W/m^0C) and slab B is 1 cm thick (k = 0.2 W/m^0C). The outside heat transfer coefficients on side A and side B are 200 $W/m^2\ ^0C$and 50 $W/m^2\ ^0C$ respectively.The temperature of surrounding air is 25^0C. If rating of heater is 1 kW, find: (a) Maximum temperature in the system (b) Outer surface temperature of two slabs. Draw the equivalent electrical circuit also. **07**

Q.3 **(a)** What are Helmholtz function and Gibbs function? Discuss their importance in study of heat and work. **07**

(b) A closed system contains 2 kg of air and during an adiabatic expansion process, there occurs a change in its pressure from 500 kPa to 100 kPa and in its temperature from 350 K to 320K. if the volume doubles during the process, make calculations for the maximum work, the change in availability and the irreversibility. **07**

OR

Q.3 **(a)** Write a short note on stoichiometry. **07**

(b) A reversible heat pump is required to maintain a temperature of 0^0C in a refrigerator while rejecting heat to the surroundings at 300 K. If the heat removal rate from the refrigerator is 25 kW, determine the coefficient of performance of the machine and the work input required.Also find the overall COP of the system if the power required to run the machine is developed by a reversible engine which operates between higher and lower temperature limits of 650 K and 300 K respectively. **07**

Q.4 **(a)** Sketch and explain pool boiling curve. **07**

(b) A vertical plate 500 mm high and maintained at 30^0C is exposed to saturated steam at atmospheric pressure. Calculate the following : **07**

i. The rate of heat transfer and

ii. The condensate rate per hour per metre of the plate width for film condensation.

The properties of water film at the mean temperature are
$\Lambda = 980.3$ kg/m^3. ; k= 66.4 X 10^{-2} W/m^{0}C ; μ = 434 X 10^{-6} kg/ms and hg = 2257 kJ/kg. assume vapour density is small compared to that of the condensate.

OR

Q.4 **(a)** Derive the expression for LMTD for the counter flow heat exchangers. **07**

(b) The tube of an oil cooler is submerged in a large pool of stagnant water at temperature of 25^0C. The inside diameter of the tube is 25 mm and its length is 35 m. Estimate the overall heat transfer coefficient of this system if the temperature of oil drops from 85^0C to 35^0C and the average velocity of oil is 0.6 m/s. Assume for oil specific heat =2.51 KJ/kg K and specific gravity = 0.8. **07**

Q.5 **(a)** Derive the expression for the radiant heat exchange between the two non-black infinite parallel planes. **07**

(b) In a certain double pipe heat exchanger, hot water flows at a rate of 5000 kg/h and gets cooled from 95^0C to 65^0C. At the same time 50000Kg/h of cooling water at 30^0C enters the heat exchanger. The overall heat transfer co-efficient remains constant at 2270 W/m^{2}K. Determine the heat transfer area required and the effectiveness, assuming parallel flow streams. Assume for both the streams Cp = 4.2 KJ/KgK **07**

OR

Q.5 **(a)** Write a short note on Gas radiation. **07**

(b) A boiler furnace is laid from fire clay brick with outside lagging from plate steel; the distance between the two is quite small compared with the size of the furnace. The brick setting is at an average temperature of 380 K while the steel lagging is at 300 K. The emissivity values are : $\mathring{U}_{(brick)} = 0.84$ $\mathring{U}_{(steel)} = 0.64$. **07**

Determine :

1) The radiant flux.
2) The reduction in heat loss if a steel screen having an emissivity value of 0.62 on both sides is placed between the brick and steel setting. Also calculate the desired emissivity of screen if the radiation loss is to be limited to 90 W/m^2.

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