

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL (A constituent unit of MAHE, Manipal)

IV SEMESTER B.TECH. MAKEUP EXAMINATIONS JUN 2018

SUBJECT: HEAT TRANSFER OPERATION [CHE 2202]

REVISED CREDIT SYSTEM

Time: 3 Hours

MAX. MARKS: 50

Instructions to Candidates:

- ✤ Answer ALL the questions.
- ✤ Missing data may be suitable assumed.

1A.	The wall of cold storage consists of three layers- an outer layer of ordinary bricks 25cm thick, a middle layer of cork 10cm thick and an inner layer of cement 6cm thick, the thermal conductivities of the materials are brick: 0.7 cork: 0.043 and cement : 0.72 W/m °C. The temperature of the outer surface of the wall is 30°C, and the inner is -15°C. Calculate a) the steady state rate of heat gain per unit area of the wall b) the temperature at the interfaces of the composite wall and c) the percentage of the total heat transfer resistance offered by the individual layers, what additional thickness of cork should be provided to make the rate of heat transfer 30% less than the present value ?.	05
1B.	Derive an expression for the rate of heat flow through a composite spherical wall made of several resistances in series, stating the necessary assumptions.	05
2A.	Determine the coefficient of water flowing in a tube of 16mm diameter at a velocity of 3 m/s. the temperature of the tube is 297K and water enters at 353K and leaves at 309K.Use (i) Dittus- Boelter equation and (ii) Sieder-Tate equation. Data : Properties of water at 331K i.e at the arithmetic mean bulk temperature are Density = 984.1 Kg/m ³ , Specific heat = 4187 J/(kg.k), Viscosity = 485×10^{-6} Pa.s, Thermal conductivity = 0.657 W/(m.K), Viscosity of water at 297 K = 920 x 10^{-6} Pa.s.	04
2B.	Determine the individual thermal resistance to calculate overall heat transfer coefficient in plane wall.	06
3A.	Derive the expression for temperature profile in the rectangular fin. State all the assumptions made.	07
3B.	A 3 inch schedule 40 carbon steel pipe (actual i.d = 78 mm, wall thickness = 5.5 mm) has eight longitudinal fins of 1.5mm thickness, each fin extends 30mm from the pipe wall, the thermal conductivity of the fin	03

	material is 45 W/m °C. If the wall temperature, the ambient temperature and the surface heat transfer co-efficient are 150°C, 28°C and 75 W/m ² °C respectively. Calculate the percentage increase in the rate of heat transfer for the finned tube over the plain tube.	
4A.	 A double pipe parallel flow heat exchanger use oil (Cp = 1.88 KJ/kg.k) at an initial temperature of 205°C to heat water, flowing at 225 kg/hr from 16°C to 44°C, the oil flow rate is 270 kg/hr (Cp water = 4.18KJ/kg.k). a. What is the heat transfer area required for an overall heat transfer co-efficient of 340W/m².K b. Determine the number of transfer unit (NTU) Calculate the effectiveness of heat exchanger. 	05
4B.	Explain working principle of draft tube baffle crystallizer with neat sketch.	05
5A.	2000 kg/hr of an aqueous solution of sodium nitrate containing 57.6% NaNO ₃ is being cooled in a continuous crystallizer from 90 to 40°C. Cooling water flows counter currently and its temperature rises from 16 to 21°C. Water amounting to 2% by weight of the initial solution is being evaporated during cooling. Using the given data i) Estimate the cooling water rate to be used and ii) Heat transfer area to be provided. Given:- A saturated solution of NaNO ₃ at 40°C contains 1.045 kg NaNO ₃ per kg water, the average specific heat of NaNO ₃ solution is 0.59 Kcal/kg.°C, and that of solid NaNO ₃ is 0.287 Kcal/kg. °C. Heat of crystallization of NaNO ₃ is 59.17 Kcal /Kg. the average latent heat of vaporization of water may be taken as 575 Kcal/kg. the overall heat transfer co-efficient has been estimated to be 120 Kcal/hr.m ² . °C	05
5B.	Write the possible Material and Energy Balance equations for triple effect evaporator arranged under feed forward conditions.	05