Register No : ____________________

THE KAVERY ENGINEERING COLLEGE

(An Autonomous Institution)

UG/PG DEGREE END SEMESTER THEORY EXAMINATIONS, APRIL/MAY 2026

Fourth Semester

Chemical Engineering

UCHT24404 / CH3491 – HEAT TRANSFER

(HMT Data book & Steam Table Can be Permitted)

Regulations – 2024 & 2021

Duration : 3 Hrs *Maximum : 100 Marks*

*PART – A (ANSWER ALL QUESTIONS) (Marks 10*2=20)*

Q.No	*Questions*	*BLT*	*CO*	*Marks*
1.	State the importance of heat transfer in chemical engineering.	L2	1	2
2.	What is meant by thermal conductivity? and what are the factors affecting the thermal conductivity?	L1	1	2
3.	When thermal and hydrodynamic boundaries are equal? Explain.	L1	2	2
4.	Write various momentum and heat transfer analogies?	L1	2	2
5.	What is heat exchanger? How the heat exchangers are classified?	L1	3	2
6.	What is meant by LMTD and NTU method?	L1	3	2
7.	Compare drop wise condensation and film wise condensation.	L2	4	2
8.	Differentiate film boiling and nucleate boiling.	L2	4	2
9.	Define multiple effect evaporators.	L2	5	2
10.	State Stefan Bolzsmann's Law.	L2	5	2

*PART – B (ANSWER ALL QUESTIONS) (Marks 5*16 = 80)*

Q.No			*Questions*	*BLT*	*CO*	*Marks*
11.	a	i	A pipe consists of 100 mm internal diameter and 8 mm thickness carries steam at 170°C. The convective heat transfer coefficient on the inner surface of pipe is 75 W/m^{2}C. The pipe is insulated by two layers of insulation. The first layer of insulation is 46 mm in thickness having thermal conductivity of 0.14 W/m° C. The second layer of insulation is also 46 mm in thickness having thermal conductivity of 0.46 W/m°C. Ambient air temperature = 33°C. The convective heat transfer coefficient from the outer surface of pipe = 12 W/m^{2}C. Thermal conductivity of steam pipe = 46 W/m° C. Calculate (a) the heat loss per unit length of pipe (b) Overall heat transfer coefficient (c) Overall thermal resistance (d) Draw the equivalent electrical circuit. Suggest the materials used for insulation.	L3	1	8
		ii	A hollow sphere 1.2m inner diameter and 1.7m, outer diameter is having a thermal conductivity of 1 W/mK. The inner surface temperature is 70K and outer surface temperature is 300K. determine (i) heat transfer rate (ii) temperature at a radius of 650mm.	L3	1	8

Or

	b	i	A stainless steel cylindrical rod of 1.2cm diameter and 6cm height with thermal conductivity of 25 W/mK is exposed to surrounding with a temperature of 60°C. The heat transfer co-efficient is 45W/m^{2}K and the temperature at the base of the fin is 100°C. Determine (i) fin Efficiency (ii) Heat dissipation (iii) fin effectiveness. Assume fin end is insulated.	L3	1	8
		ii	A copper plate 2mm thick is heated up to 400°C and quenched into water at 30°C. find the time required for the plate to reach the temperature of 50°C. Heat transfer co-efficient is 100W/m^{2}K. Density of copper is 8800Kg/m^3. Specific heat of copper = 0.36KJ/kg K. Plate dimensions = 30 x 30cm.	L3	1	8
12.	a	i	Explain the concept of thermal and hydrodynamic boundary layer.	L2	2	8
		ii	Derive Reynolds analogy and colburn analogy and also mention their validity.	L2	2	8
			Or			
	b		Using the dimensional analysis in forced convection, Develop NNu = f (NRe, Npr).	L2	2	16
13.	a	i	In a parallel flow heat exchanger, hot liquid enters at 400°C and leaves at 250°C. Cold fluid enters at 50°C and leaves at 110°C. the inside and outside heat transfer coefficients are 120W/m^{2}K and 190 w/m^{2}K respectively. The inside and outside diameters of the tube are 0.06m and 0.08m respectively. If the heat transferred per heat is 1.6 x 10^5 KJ. Find the length of the tube required.	L3	3	8
		ii	In a cross flow heat exchanger, both fluid unmixed, Hot fluid with a specific heat of 2300J/kg K enters at 380°C and leaves at 300°C. Cold fluids enter at 25°C and leaves at 210°C. Calculate the required surface area of heat exchanger. Take overall heat transfer co-efficient is 750W/m^{2}K. Mass flow rate of hot fluid is 1Kg/s.	L3	3	8
			Or			
	b	i	Derive the relationship between individual and overall heat transfer coefficients.	L3	3	8
		ii	In a counter flow heat exchanger water at 20°C, flowing at the rate of 1200Kg/hr. it is heated by oil of specific heat 2100 J/g K flowing at the rate of 520Kg/hr. at inlet temperature of 95°C. Determine the following by using NTU method (i) total heat transfer (ii) outlet temperature of water. (iii) Outlet temperature of oil. Take overall heat transfer co-efficient is 1000 W/m^{2}K. Heat exchanger area is 1m^2.	L3	3	8
14.	a	i	A vertical tube of 65mm outside diameter and 1.5m long is exposed to steam at atmospheric pressure. The outer surface of the tube is maintained at a temperature of 60°C by circulating cold water through the tube. Calculate the following. (i) The rate of heat transfer to the coolant. (ii) the rate of condensation of steam.	L2	4	8
		ii	Explain the nusselt's theory for film condensation.	L2	4	8
			Or			

	b	i	An aluminium pan 15cm diameter is used to boil water and the water depth at the time boiling is 2.5cm. The pan is placed on an electric stove and heating element raises the temperature of the pan to 110°C. Calculate the power input for boiling and the rate of evaporation. Take Csf = 0.0132.	L2	4	8
		ii	Draw the neat sketch and discuss the various regimes of boiling.	L2	4	8
15.	a	i	A double effect evaporator is used to concentrate 11200 kg/hr of 5% solids to 50%. The feed enters at 33°C and saturated steam at 115°C enters the first effect for supplying the heat. The pressure in the second effect is 13.65 KPa absolute. The overall co-efficient are U_1 =2250 and U_2 = 1610 W/m^2 K. The specific heat of the solution is given by Cp(kJ/kg°C)=4.19-2.35X. where X is the solute fraction by weight? Find out the area of evaporation. Assume no BPE. Carry out the calculation for only one trial.	L4	5	8
		ii	Explain planck's distribution law and wien's displacement law.	L4	5	8
			Or			
	b	i	A gray surface is maintained at at temperature of 900 °C and maximum emissive poer at that temperature is 1.4 x 10^{10} W/m^2. Calculate the emissivity of the body and the wavelength corresponding to the maximum intensity of radiation.	L4	5	8
		ii	Two parallel plates 0.5 m by 1 m, spaced by 0.5 m apart. One plate is maintained at 1000°C and the other plate is at 500°C. The emissivities of the plates are 0.2 and 0.5respectively. The plates are located in a very large room whose walls are maintained at 27 °C. the plates exchange heat with each other and the room, but only the plate surface facing each other need to be considered in the analysis. Find the net transfer to each plate and to the room.	L4	5	8