Question Paper Code: 94903

B.E. / B.Tech. DEGREE EXAMINATION, DEC 2021

Fourth Semester

Chemical Engineering

19UCH403-Heat Transfer

(Regulation 2019)

Duration: Three hours | Maximum: 100 Marks

PART – A (10 X 2 =20 Marks)
ANSWER ANY TEN QUESTIONS

1.	State Fourier's law of heat conduction.	R	CO1
2.	Define specific Heat capacity.	R	CO2
3.	Calculate the rate of heat transfer per unit area through a copper plate 45mm thick. Which one face is maintained at 380°C and other face at 60°C. take thermal conductivity of copper as 370 W/m°C	U	CO1
4.	State Newton's Law of cooling.	R	CO2
5.	What do you mean by Sider-Tate Correction factor?	U	C01
6.	What is Nusselt number and write its significance,	AN	CO1
7.	What are the properties of radiative heat transfer and explain it.	R	CO2
8.	Define Plancks Law for blackbody radiation	U	CO2
9.	Calculate the rate of heat transfer by radiation from an unlagged steam pipe, 50 mm O.D. at 393 K to air at 293 K. Assume emissivity of 0.9.	AN	CO3
10.	Mention the difference between film wise and drop wise condensation.	AN	CO2
11.	What is film boiling? And what is the risk of attaining film boiling?	AP	CO1
12.	What are the advantages of forced circulation evaporators?	AN	CO5
13.	What is the purpose of chiller in heat exchangers?	R	CO3
14.	What are the two type of tube pitch? Draw a sketch	R	CO4

15.	What is the purpose of using baffles in a shell & tube heat exchanger?	U	CO3

PART - B (5X 16 =80 Marks)

ANSWER ANY THREE QUESTIONS

1	A young engineer is asked to design a thermal protection barrier for a sensitive electronic device that mightbe exposed to irradiation from a high-powered infraredlaser. Having learned as a student that a low thermalconductivity material provides good insulating characteristics, the engineer specifies use of a nanostructuredaerogel, characterized by a thermal conductivity of *ka*0.005 W/m K, for the protective barrier. The engineer's boss questions the wisdom of selecting the aerogel *because* it has a low thermal conductivity. Considerthe sudden laser irradiation of (a) pure aluminum,(b) glass, and (c) aerogel. The laser provides irradiationof *G* 10 106 W/m2. The absorptivities of the materials are 0.2, 0.9, and 0.8 for the aluminum, glass,and aerogel, respectively, and the initial temperature ofthe barrier is *Ti* 300 K. Explain why the boss is concerned. *Hint:* All materials experience thermal expansion (or contraction), and local stresses that developwithin a material are, to a first approximation, proportional to the local temperature gradient	E	CO1
2	A heat exchanger is to be designed to heat 1720 kg/h of water from 293K to 318 K with steam condensing on the outside surface of brass tubes of o.d 25mm and id 22.5mm and 4 m long. The water velocity is 1.02 m/s, find the number of tubes. $K_{\text{tube material}}$ = 111.65 W/ (m.K) Weight of steam condensed = 4500 kg/h Latent heat of vaporization of water = 2230 kJ/kg temperature of steam = 383 K steam side film coefficient = 4650 W/(m^2 K). Physical properties of water at mean temperature as given below Density = 995.7 kg/m^2 C_p = 4.174 kJ/kg.K) Kinematic viscosity v =0.659 *10^{-6} m^2/s.	App	CO2
3	Calculate the following for an industrial furnace in the form of a black body and emitting radiation at 3000ºC. 1. Monochromatic emissive power at λ = 1.6 μm length 2. Wavelength at which the emission is maximum. 3. Maximum emissive power 4. Total emissive power 5. Total emissive power of the furnace if it is assumed of a real surface with emissivity equal to 0.9	AP	CO3
4	A heat exchanger is designed to heat 1720 kg/h of water from 293 K (20 ºC) to 318 K (45 ºC) with saturated steam condensing on the outside surface of the brass tubes of 25mm O.D and 22.5 I.D. Tube length is 4 m. Assuming water velocity is eing constant at 1.2m/s. determine the number of tubes required in the heat exchanger. Data: Thermal conductivity of brass = 460kJ/(h.m.K) Latent heat of vaporization of steam = 2230 kJ/kg Steam side coefficient = 19200kJ/(h.m^2.K)	AP	CO4

Physical properties of water at mean fluid temperature are as follows:
Density = 995.7 kg/m^3, Specific heat = 4.28 kJ.(kg.K)
Thermal conductivity = 2.54 kJ/(h.m.K)

Kinematic viscosity = 0.659 x $10^{-6}$$m^2$/s

5	Discuss in detail about the design calculations of evaporator	AN	CO5