Reg. No. : | | | | | | | | | | | | |

Question Paper Code:R3C05

B.E./B.Tech. DEGREE EXAMINATION, NOV 2024

Third Semester

Biotechnology

R21UBT305-FLUID MECHANICS AND HEAT TRANSFER OPERATIONS

(Regulations R2021)

Duration: Three hours Maximum: 100 Marks

Answer All Questions

PART A - (10 x 2 = 20 Marks)

1.	What is Bernoulli's equation in fluid mechanics?	CO1 U
2.	Write notes on specific gravity and specific weight of the fluid	CO1U
3.	What is the equation for the Reynolds number and write its significance?	CO1U
4.	Which is the heart of the centrifugal pump? Justify.	CO1U
5.	State Fourier's Law of conduction	CO2U
6.	What is critical radius of insulation (or) critical thickness?	CO2 U
7.	Draw a Wilson plot	CO1 U
8.	Differentiate conduction and convection	CO1 U
9.	State Kirchhoff's law of radiation.	CO1 U
10.	Calculate the loss of heat per unit area from a steam pipe to the surrounding air by radiation mode. Take emissivity of 0.90.	CO3 App

PART – B (5 x 16= 80 Marks)

11.	(a)	(i) An open reservoir contains a liquid having a density of 1250 kg/m2. at a certain point the gauge pressure is 32.424 kN/m2g. What height above the given point is the liquid level? (ii) The pressure difference over a manometer is 2452 N/m2. If the manometric fluid is carbon tetra-chloride and water is flowing through the pipeline and fills the manometer leads, what will be the manometer reading?	CO3 - App	(8+8)

Or

	(b)	Draw a neat sketch of venturi meter and explain its construction, working principle, advantages and disadvantages	CO3 - App	(16)
12.	(a)	Draw a sketch and explain briefly the working construction, advantage and limitations of centrifugal pump	CO1 - U	(16)
		Or		
	(b)	Derive the equation of Pressure drop and bed heights v/s superficial velocity for fluidized bed of solids with neat sketch	CO1 - U	(16)
13.	(a)	Derive a relation for critical radius of insulation for a circular cross-section having length L, r1 and r2 are the inside and outside radii of the pipe and r3 as outer radius of insulation. k1 and k2 be the thermal conductivities of the pipe material and insulating material respectively. Inner temperature is T1 and the outer temperature is T2 (T1 > T2)	CO5- Ana	(16)
		Or		
	(b)	A furnace is constructed with 230 mm thick of fire brick, 115 mm of insulating brick and then 230 mm of building brick. The inside temperature of the furnace is1213 K (940oC) and the outside temperature is 318 K (45oC). The thermal conductivities of fire brick, insulating brick and building brick are 6.047, 0.581 and 2.33 W/(m•K). Find the heat lost per unit area and the temperature at the interfaces.	CO5- Ana	(16)
14.	(a)	Give the Sieder-Tate equation used to calculate the film coefficient in case of turbulent flow.	CO4- App	(16)
		Or		
	(b)	To derive a relationship for heat transfer coefficient, h for forced convection heat transfer on the assumption that the coefficient h is a function of the following variables : l – linear dimension of the surface Cp – specific heat of the fluid ρ – density of the fluid μ – viscosity of the fluid k – thermal conductivity of the fluid and u – velocity of the fluid. h = A (ρaubLcμdCpekf) By dimensional analysis, prove that, Nu = f(Re, Pr) for forced convective heat transfer operation. Explain the physical significance of the above mentioned dimensionless groups.	CO4- App	(16)

15. (a) A chemical plant produces 300 metric tons of sulphuric acid per day. The acid is to be cooled from 333 K to 313 K by 500 metric tons of water per day, which has a initial temperature of 288 K. A counter flow cooler consisting of concentric pipes 12.5 mm thick is to be used. The inner pipe through which the acid flow is 75 mm bore and the outer one 125 mm bore. The outside diameter of the inner pipe is 100 mm. The physical properties of the fluid at the mean temperature are as follows: CO6 - Ana (16)

Properties	Acid	Water
Density, kg/m^3	1800	998.2
Heat Capacity, kJ/kg.K	1.465	4.187
Thermal Conductivity, W/m K	0.302	0.6669
Viscosity, kg/m.s	0.0112	0.0011

Thermal conductivity of pipe material is 46.52 W/m.K. Use Dittus-Boelter equation for calculation of h. Also calculate the length of pipe required.

Or

(b) (i) Explain parallel flow and counter flow heat exchanger. CO6 - Ana (8+8)

(ii) Steam at a pressure of 1.2 atm absolute is condensed in a 1-4 vertical condenser at the rate of 8000 kg/hr using water at 300 K with flow rate of 6500 kg/hr. Find out heat load, outlet temperature of water and area of heat transfer. Take Uo = 600 W/m^{2}K.