Model Question Paper-1 with effect from 2019-20 (CBCS Scheme)

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Fourth Semester B.E. Degree Examination
Subject Title Process Heat Transfer

TIME: 03 Hours **Max. Marks: 100**

Note: 01. Answer any **FIVE** full questions, choosing at least **ONE** question from each **MODULE**.

		Module -1	***Bloom's Taxonomy Level**	**Marks**
Q.01	a	Derive an expression to determine temperature distribution and rate of heat transfer through a hollow cylinder	L3	10
	b	A 15 cm schedule 40 steam main carries saturated steam at 10.7 bar (gage), and the temperature is 190°C. The inside and outside diameters of the pipe are 15.4 cm and 16.8 cm, respectively. The thermal conductivity of the pipe wall is 51 W/m°C. The pipe is insulated with a 10 cm thick fiber glass blanket (k = 0.072 W/m°C). If the outer surface temperature of the insulation is 41°C, calculate the rate of heat loss over a 10 m section of the pipe.	L3	10
		OR		
Q.02	a	Derive an expression to determine temperature distribution and rate of heat transfer through a hollow sphere	L3	10
	b	What is critical and optimum insulation thickness? Show that the critical outer radius (r_o) of an insulated pipe is k_c/h_o and for insulated sphere is $2k_c/h_o$ where k_c is thermal conductivity of insulating material and h_o is the convective heat transfer coefficient outside the insulation.	L2	10
		Module-2		
Q. 03	a	Derive an expression to determine the temperature distribution and efficiency of a fin with an insulated tip.	L3	10
	b	A solid copper sphere of 10 cm diameter (ρ = 8954 kg/m^3, C_p = 383 J/kg°C, k = 386 W/m°C) initially at a uniform temperature of 250°C, is suddenly immersed in a well stirred fluid which is maintained at a uniform temperature of 50°C. The heat transfer coefficient between the sphere and the fluid is 200 W/m^2°C. (a) Check whether the lumped system analysis is suitable? (b) If it is possible, determine the temperature of the copper block at t = 7, 12, & 20 minutes after the immersion.	L3	10
		OR		
Q.04	a	Taking an example of a double pipe heat exchanger, derive an expression to determine the LMTD.	L3	10
	b	The convection heat transfer coefficients for flow of a fluid through a tube have been experimentally determined. Using dimensional analysis develop an expression for correlating the experimental data. The physical quantities likely to influence the convection heat transfer coefficient are: Tube diameter (D), thermal conductivity of fluid (k), velocity of fluid (u), density of fluid (ρ), viscosity of fluid (μ), and specific heat of fluid (C_p).	L3	10
		Module-3		
Q. 05	a	Explain different regimes of pool boiling	L2	10
	b	Starting from the basic, derive the equation for Reynolds analogy	L3	10
		OR		
Q. 06	a	Draw 1-2 pass Shell and tube heat exchanger and explain the major components of the same.	L2	15
	b	Differentiate between dropwise and film condensation.	L2	05

Module-4				
Q. 07	a	Explain the step-by-step design procedure for the design of a condenser.	L2	12
	b	A light lubricating oil (C_p = 2090 J/kgK) is cooled by allowing it to exchange energy with water in a small heat exchanger. The oil enters & leaves the heat exchanger at 375 K & 350 K, respectively and flows at a rate of 0.5 kg/s. Water (C_p = 4177 J/kgK) at 280 K is available in sufficient quantity to allow 0.201 kg/s to be used for cooling purposes. Determine the required heat transfer area for counter flow operation. The overall heat transfer coefficient may be taken as 250 W/m^2K.	L3	08
OR				
Q. 08	a	Explain the step-by-step design procedure for the design of a double pipe heat exchanger	L2	12
	b	A vertical square plate 0.3 by 0.3 is exposed to steam at atmospheric pressure. The plate temperature is 370 K. Estimate the heat transfer and the mass of steam condensed per hour. The physical properties of the condensate at average film temperature are as follows: Latent heat of vaporization, λ = 2250 kJ/kg, density, ρ = 960 kg/m^3, Thermal conductivity, k = 0.68 W/m.K and viscosity, $\mu = 0.282\times10^{-3}$ kg/m.s	L3	08
Module-5				
Q. 09	a	With neat diagrams explain the working of a multiple effect evaporator of (a) forward feed arrangement, (b) backward feed arrangement, and (c) mixed feed arrangement	L2	15
	b	An evaporator operating at atmospheric pressure is fed at the rate of 10000 kg/h of weak liquor containing 4% caustic soda. Thick liquor leaving the evaporator contains 25% caustic soda. Find the capacity of the evaporator.	L2	05
OR				
Q. 10	a	Define the following terms: (i) radiation, (ii) Absorptivity, (iii) Emissivity, (iv) Opaque material, and (v) Grey body	L1	10
	b	Explain is Stefan – Boltzmann law and Weins displacement law	L1	05
	c	Calculate the rate of heat transfer by radiation from an unlagged steam pipe 50 mm outside diameter at 393 K to air at 293 K. Take emissivity = 0.9.	L1	05

*Bloom's Taxonomy Level: Indicate as L1, L2, L3, L4, etc. It is also desirable to indicate the COs and POs to be attained by every bit of questions.