Basavarajeswari Group of Institutions

BALLARI INSTITUTE OF TECHNOLOGY & MANAGEMENT

(Autonomous Institute under Visvesvaraya Technological University, Belagavi)

USN											Course Code	2	1	M	E	6	3

Sixth Semester B.E. Degree Examinations, September/October 2024

HEAT TRANSFER

Duration: 3 hrs **Max. Marks: 100**

Note:* 1. *Answer any* FIVE *full questions choosing ONE full Question from each Module.
2. Use of Heat Transfer Data Handbook is permitted
3. Missing data, if any, may be suitably assumed

Q. No		Question	Marks	(RBTL:CO:PI)
		Module-1		
1.	**a.**	State the following with respective equations: (i) Fourier's Law of Heat Conduction (ii) Newton's law of heating or cooling (iii) Stefan's Boltzmann Law	**06**	(1 :1 : 1.6.1)
	b.	Derive an expression for general three dimensional heat conduction equation in Cartesian coordinate.	**10**	(3 :1 : 1.6.1)
	c.	A surface of 1.6 m^2 area which is maintained at 250 ºC exchanges heat by radiation with another surface at 45 ºC, having ε=0.45. Calculate the heat lost by radiation.	**04**	(3 :1 : 1.7.1)
		(OR)		
2.	**a.**	Explain the three types of boundary conditions with neat sketches.	**08**	(1 :1 : 1.6.1)
	b.	A composite wall is made up of external thickness of brick work 110 mm and inside layer of fibre glass of 75 mm thick. The fibre is covered internally by an insulating board 25 mm thick. The coefficient of thermal conductivity for three materials are as follows: Brick work = 1.5 W/mK; Fibre glass = 0.04 W/mK Insulating Board = 0.06 W/mK; Surface Heat Transfer coefficient of inside wall is 2.5 W/m^2K while that of outside wall is 3.1 $W/m^2 K$. Determine the average heat transfer coefficient for the wall and using the same. Also, determine the heat loss per hour through such a wall. The wall is 4 m high and 10 m long. Take inside wall temperature as 27^0C and external ambient temperature as 10^0C.	**12**	(3 :1 : 1.7.1)
		Module-2		
3.	**a.**	Define fin and state its applications.	**05**	(1 :2 : 1.6.1)
	b.	Define fin efficiency and fin effectiveness with equation.	**05**	(1 :2 : 1.6.1)
	c.	A steel rod (k=32W/m ºC), 12 mm in diameter and 60 mm long, with an insulated end, is used to be as a spine. It is exposed to the surroundings with a temperature of 60 ºC and a heat transfer coefficient of 55 W/m^2 ºC. The temperature at the base of fin is 95 ºC. Determine the (i) Fin Efficiency (ii) The Temperature at the edge of the Spine (iii) The heat dissipation	**10**	(3 :2 : 1.7.1)

Note: (RBTL - Revised Bloom's Taxonomy Level: CO - Course Outcome: PI– Performance Indicator)

(OR)

4.	**a.**	Define (i) unsteady state heat transfer (ii) Thermal time constant (iii) Biot number (iv) Fourier number (v) characteristic length	**05**	(1 :2 : 1.6.1)
	b.	Obtain an expression for an instantaneous heat flow rate.	**05**	(3 :2 : 1.6.1)
	c.	A 130 mm diameter orange (ρ = 990 kg/m^3,c = 4166J/kg ºC, k = 0.6W/m ºC), approximately spherical in shape is taken from a 22 ºC atmospheric conditions and placed in a freezer where temperature is 5ºC and heat transfer coefficient over the apple surface is 13.2 W/m^2 ºC. Determine the temperature at the centre of the orange after a duration of 1.5 hours.	**10**	(3 :2 : 1.7.1)

Module-3

5.	**a.**	Briefly explain the use of numerical techniques to solve heat transfer problems. Explain the process of discretization based on finite difference methodology.	**10**	(2 :3 : 1.6.1)
	b.	Explain explicit scheme of a solution to one–dimensional transient heat conduction problem without heat generation.	**10**	(2 :3 : 1.6.1)

(OR)

6.	**a.**	Define (i) Total Emissive Power (ii) Monochromatic Emissive Power (iii) Emissivity (iv) Regular Reflection (v) Diffuse Reflection	**05**	(1 :3 : 1.6.1)
	b.	State the following laws with respective equations (i) Wien`s law (ii) Kirchhoff's law	**05**	(1 :3 : 1.6.1)
	c.	Calculate the following for an Industrial furnace in the form of a black body and emitting radiation at 2500 ºC (i) Monochromatic Emissive Power at 1.2 μm length (ii)Wavelength at which the emission is maximum (iii)Maximum emissive power (iv)Total Emissive Power (v)Total emissive power of the furnace if it is assumed as real surface with emissivity equal to 0.9	**10**	(3 :3 : 1.7.1)

Module-4

7.	**a.**	With a neat sketch of boundary layer for a fluid flow over flat plate define (i) Boundary layer thickness (ii) Free stream Velocity (iii) Drag force (iv) Leading edge (v)Transition Zone	**10**	(1 :4: 1.6.1)
	b.	Lubricating oil at a temperature of 60 ºC enters at 1 cm diameter tube with a velocity of 3.5 m/s and a tube surface is maintained at 30 ºC. Calculate the tube length required to cool the oil to 45 ºC. Assume the oil has following average properties. ρ = 865kg/m^3, k = 0.14W/m K, c_p = 1.78kJ/kg ºC	**10**	(3 :4 : 1.7.1)

(OR)

8.	**a.**	Using Buckingham's π- theorem, prove that Nu=hL/k	**05**	(3:4 : 1.6.1)
	b.	Explain the physical significance of Reynolds number.	**05**	(3 :4 : 1.6.1)
	c.	A square plate of 15 cm ×15 cm is maintained at 160 ºC in atmospheric air at 20 ºC. Calculate the convection heat loss from both surface of plate, when the upper surface is heated and lower surface cooled and plate kept in horizontal position.	**10**	(3 :4 : 1.7.1)

Note: (RBTL - Revised Bloom's Taxonomy Level: CO - Course Outcome: PI– Performance Indicator)

<u>**Module-5**</u>

9.	**a.**	Define heat exchanger Explain classification of heat exchangers?	**10**	(3 :5 : 1.6.1)
	b.	Exhaust gases (c_p =1.12 kJ/kg K) flowing through a tubular heat exchanger at the rate of 1200 kg/hr are cooled from 400 ºC to 120 ºC. This cooling is affected by water (c_P = 4.18 k J/kg K) that enters the system at 10 ºC at the rate of 1500 kg/hr. If the overall heat transfer coefficient is 500 kJ/m^2 hr º C. What heat exchanger areas is required to handle the load for parallel flow and counter flow arrangement?	**10**	(3 :5 : 1.7.1)

(OR)

10	**a.**	Explain boiling regimes with neat sketch of boiling curve of water.	**10**	(3 :5 : 1.6.1)
	b.	Saturated steam at t_{sat}=90 ºC (p = 70.14 kPa)the condenses on outer surface of a 1.5 m long 2.5 m OD vertical tube maintained at a uniform temperature t_a = 70ºC (ambient). Assuming film wise condensation, calculate (i) Local heat transfer coefficient at the bottom of tube (ii) The average heat transfer coefficient over the entire length of the tube	**10**	(3 :5 : 1.7.1)

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