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P.E.S. College of Engineering, Mandya - 571 401

(An Autonomous Institution affiliated to VTU, Belagavi)

Fourth Semester, B.E. - Automobile Engineering

Semester End Examination; August - 2023

Heat Transfer

Time: 3 hrs *Max. Marks: 100*

Course Outcomes

The Students will be able to:

CO1: Able to formulate to solve problems in fundamentals of heat transfer modes.

CO2: Able to apply basic equations of heat conduction in steady one dimensional problems and design of fins.

CO3: Able to formulate, solve transient conduction and forced convection problems.

CO4: Able to formulate, solve in free convection problems .design of heat exchangers.

CO5: Able to apply the concepts of radiation heat transfer to solve problems.

***Note**: I) **PART - A** is compulsory. **Two** marks for each question.*

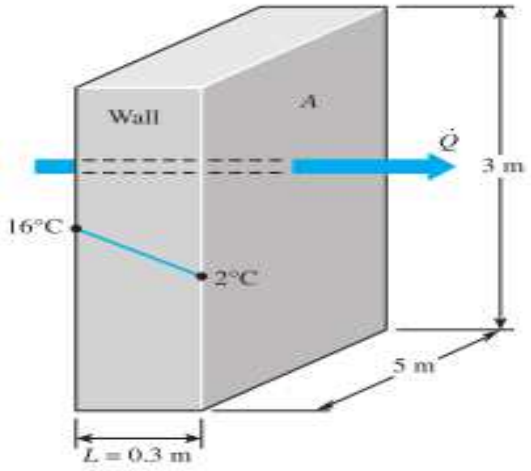
*II) **PART - B**: Answer any **Two** sub questions (from a, b, c) for a Maximum of **18 marks** from each unit.*

III) Heat transfer DATA handbook is allowed.

Q. No.	Questions	Marks	BLs	COs	POs
	I : PART - A	**10**			
1 a.	State Fourier's law of conduction.	2	L1	CO1	PO1
b.	Define Fin effectiveness.	2	L1	CO2	PO1
c.	What is lumped system analysis? When is it applicable?	2	L1	CO3	PO1
d.	Explain fouling factor.	2	L1	CO4	PO1
e.	What is meant by gray body?	2	L1	CO5	PO1
	II : PART - B	**90**			
	UNIT - I	**18**			
2 a.	What is heat transfer? Briefly explain three modes of heat transfer.	9	L1	CO1	PO1
b.	A Surface having an area of 1.5 m^2 and maintained at 300°C exchanges heat by radiation with another surface at 40°C. The value of the fraction due to the geometric location and emissivity is 0.52. Determine; i) Heat loss by radiation ii) The value of thermal resistance iii) The value of the equivalent convective coefficient	9	L3	CO1	PO2
c.	What do you mean by boundary condition of 1^{st}, 2^{nd} and 3^{rd} kind?	9	L1	CO1	PO1
	UNIT - II	**18**			
3 a.	What is a fin? What are the different types of fins? Where is fin used?	9	L1	CO2	PO1
b.	Derive an expression for critical thickness of insulation of a cylinder and state its importance.	9	L2	CO2	PO2

Contd… 2

c. Consider a 3-m-high, 5-m-wide, and 0.3-m-thick wall whose thermal conductivity is k = 0.9 W/m·K (Figure). On a certain day, the temperatures of the inner and the outer surfaces of the wall are measured to be 16°C and 2°C, respectively. Determine the rate of heat loss through the wall on that day.



9 L3 CO2 PO2

UNIT - III **18**

4 a. Define the following dimensionless numbers. Also give their physical significance:
i) Reynolds ii) Prandtl number iii) Nusselt number

9 L1 CO3 PO1

b. Derive the expression for lumped system by considering negligible internal resistance.

9 L2 CO3 PO1

c. A flat plate 1 m wide and 1.5 m long is maintained at 90°C in air with free stream temperature of 10°C flowing along 1.5 m side rate of energy dissipation as 3.75 kW.

Use correlations :

$Nu_z = 0.664Re^{1/2} Pr^{1/3}$ for laminar flow

$Nu_z = (0.036\ Re^{0.8} - 836)\ Pr^{1/3}$ For turbulent flow

Take properties of air: ρ = 1.0877 kg/^{m3}, μ = 2.029×10^{-5} kg/ms, k_f = 0.028 W/mK, C_p = 1.007 kJ/kgK

9 L3 CO3 PO2

UNIT - IV **18**

5 a. Derive an expression for LMTD for counter flow heat exchanger.

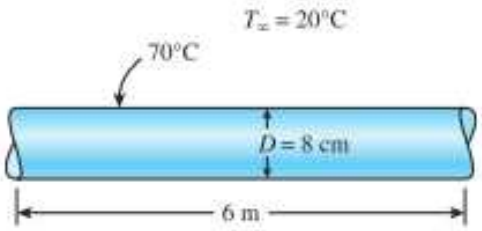
9 L2 CO4 PO1,2

b. Briefly explain the classification of heat exchangers by flow arrangement.

9 L2 CO4 PO1,2

Contd… 3

c.	A 6-m-long section of an 8-cm-diameter horizontal hot-water pipe shown in figure passes through a large room whose temperature is 208C. If the outer surface temperature of the pipe is 708C, determine the rate of heat loss from the pipe by natural convection.	9	L3	CO4	PO1,2



UNIT - V **18**

6 a.	Explain the following: i) Kirchhoff's law ii) Stefan Boltzmann law iii) Wein's displacement law	9	L2	CO5	PO1
b.	Define the following: i) Reflectivity ii) Transmissivity iii) Absorptivity	9	L1	CO5	PO1
c.	Two parallel, infinite gray surfaces are maintained at temperature of 127°C and 227°C respectively. If the temperature of the hot surface is increased to 327°C, by what factor is the net radiation exchange per unit area increased? Assume the emissivities of colder and hotter surfaces to be 0.9 and 0.7 respectively also calculate same if both surfaces are black.	9	L3	CO5	PO1,2

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