Reg. No.																

Question Paper Code	13594

B.E. / B.Tech. - DEGREE EXAMINATIONS, APRIL / MAY 2025

Sixth Semester

Mechanical Engineering

20MEPC602 - HEAT TRANSFER

Regulations - 2020

(Use of Heat Transfer Data Book and Steam Tables is permitted)

Duration: 3 Hours Max. Marks: 100

PART - A (MCQ) (10 × 1 = 10 Marks)

Answer ALL Questions

	Question	*Marks*	*K – Level*	*CO*
1.	The primary mode of heat transfer in solids is (a) Convection (b) Radiation (c) Conduction (d) All of the above	*1*	*K1*	*CO1*
2.	If the radius of a pipe is less than the critical radius of insulation, interpret what will happen when adding more insulation (a) Increase heat transfer (b) Decrease heat transfer (c) Not affect heat transfer (d) First increase, then decrease heat transfer	*1*	*K2*	*CO1*
3.	The Stefan-Boltzmann law states that the total energy radiated by a black body is proportional to (a) The absolute temperature (b) The square of the absolute temperature (c) The cube of the absolute temperature (d) The fourth power of the absolute temperature	*1*	*K1*	*CO2*
4.	Radiation shields are used to (a) Increase radiation heat transfer (b) Reduce radiation heat transfer (c) Maintain a constant temperature (d) Increase the emissivity of surfaces	*1*	*K1*	*CO2*
5.	Forced convection occurs when fluid motion is caused by (a) Buoyancy forces (b) External means like a pump or fan (c) Temperature gradients within the fluid (d) Surface tension effects	*1*	*K1*	*CO3*
6.	The hydrodynamic boundary layer is the region where (a) Temperature gradients are significant (b) Velocity gradients are significant (c) Both temperature and velocity gradients are negligible (d) Heat transfer is primarily by conduction	*1*	*K1*	*CO3*
7.	In film condensation, the heat transfer coefficient is generally (a) Higher than dropwise condensation (b) Lower than dropwise condensation (c) Equal to dropwise condensation (d) Independent of the type of condensation	*1*	*K1*	*CO4*
8.	Which of the following boiling regimes offers the highest heat transfer coefficient? (a) Film boiling (b) Nucleate boiling (c) Transition boiling (d) Forced convection boiling	*1*	*K1*	*CO4*
9.	The NTU method is preferred over the LMTD method when (a) The heat exchanger geometry is simple (b) The flow rates are unknown (c) The outlet temperatures are unknown (d) The phase change is involved	*1*	*K2*	*CO5*
10.	Which of the following is a type of direct contact heat exchanger? (a) Shell and tube (b) Plate (c) Cooling tower (d) Finned tube	*1*	*K1*	*CO6*

PART - B (12 × 2 = 24 Marks)

Answer ALL Questions

11.	Define thermal conductivity.	*2*	*K1*	*CO1*
12.	Compare steady state and unsteady state heat transfer.	*2*	*K2*	*CO1*
13.	Define emissivity.	*2*	*K1*	*CO2*

14.	State Wien's displacement Law.	*2*	*K1*	*CO2*
15.	Compare natural and forced convection heat transfer.	*2*	*K2*	*CO3*
16.	What is the difference between the local and average heat transfer coefficients?	*2*	*K1*	*CO3*
17.	Interpret the differences between film wise condensation and drop wise condensation.	*2*	*K2*	*CO4*
18.	List out the applications of boiling and condensation process.	*2*	*K1*	*CO4*
19.	In a schematic show the flow configuration of cross flow heat exchanger.	*2*	*K2*	*CO5*
20.	What are indirect contact heat exchangers?	*2*	*K1*	*CO5*
21.	Differentiate between the heat transfer processes in boilers and condensers.	*2*	*K2*	*CO6*
22.	Compare Counter flow and cross flow heat exchanger.	*2*	*K2*	*CO6*

PART - C (6 × 11 = 66 Marks)

Answer ALL Questions

23. a) A composite wall is formed of a 2.5 cm copper plate (k = 355 W/mK), a 3.2 mm layer of asbestos (k = 0.110 W/mK) and a 5 cm layer of fibre plate (k = 0.049 W/m.K). The wall is subjected to an overall temperature difference of 560°C (560°C on the Cu plate side and O°C on the fibre plate side). Estimate the heat flux through this composite wall and the interface temperature between asbestos and fibre plate. *11 K3 CO1*

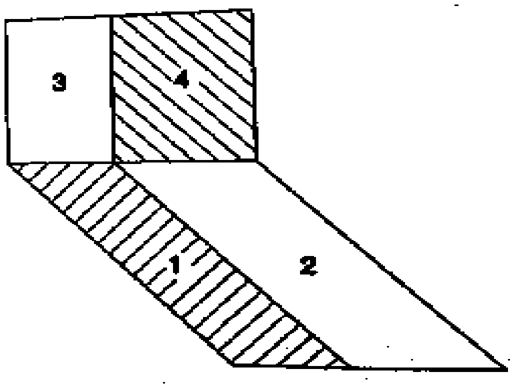
OR

b) A steam pipe 10 cm I.D and 11 cm O.D is covered with an insulating substance (k = 1 W/mK). The steam temperature and the ambient temperatures are 200^{o}C and 20^{o}C respectively. If the convective heat transfer coefficient between the insulating surface and the air is 8 W/m^{2}K, find the critical radius of insulation. For this value of r_o(outer Radii), Estimate the heat loss per meter length of pipe and outer surface temperature. Neglect the resistance of pipe material. *11 K3 CO1*

24. a) A gray surface is maintained at a temperature of 900^{o}C and maximum emissive power at that temperature is 1.4 x 10^{10} W/m^2. Calculate the emissivity of the body and the wave length corresponding to the maximum intensity of radiation. *11 K3 CO2*

OR

b) Find the shape factor, F_{14}, by shape factor algebra for rectangles perpendicular to each other but not in line (as shown in Fig.): *11 K3 CO2*



25. a) Air at 25^{o}C, flows over a flat plate at a velocity of 5 m/s and heated to 135^{0}C. The plate is 3 m long and 1.5 m wide. Calculate the local heat transfer coefficient at x = 0.5 m and the heat transferred from the first 0.5 m of the plate. *11 K3 CO3*

OR

b) Water at 50^{O}C flows through an automobile radiator tube 0.5 cm inner diameter, 50 cm long with a mean velocity of 1 m/s. The surface of the radiator tube is at 30^{O}C. Determine the heat transfer coefficient using Colburn analogy. *11 K3 CO3*

26. a) A nickel wire carrying electric current of 1.5 mm diameter and 50 cm long, is submerged in a water bath which is open to atmospheric pressure. Find the voltage at the burn out point, if at this point the wire carries a current of 200A. *11* *K2* *CO4*

OR

b) Dry saturated steam at a pressure of 2.45 bar condenses on the surface of a vertical tube of height 1m. The tube surface temperature is kept at 117°C. Find the thickness of the condensate film and the local heat transfer coefficient at a distance of 0.2 m from the upper end of the tube. *11* *K2* *CO4*

27. a) In a counter flow heat exchanger; oil is cooled from 85°C to 55°C by water entering at 25°C. The mass flow rate of oil is 9800 kg/h and specific heat of oil is 2000 J/kg K. The mass flow rate of water is 8000 kg/h and specific heat of water is 4180 J/kg K. Determine the heat exchanger area and heat transfer rate for an overall heat transfer coefficient of 280W/m^{2}K. *11* *K3* *CO5*

OR

b) In a parallel flow heat exchanger, hot liquid enters at 400°C and leaves at 250°C. Cold fluid enters at 50°C and leaves at 110°C. The inside and outside heat transfer coefficients are 120W/m^{2}K and 190W/m^{2}K respectively. Inside and outside diameters of the tube are 0.06m and 0.08m respectively. If the heat transferred per hour is 1.6x10^5 kJ, find the length of the tube required. *11* *K3* *CO5*

28. a) Saturated steam at 120°C is condensing on the outer surface of a single pass heat exchanger. The heat transfer coefficient is U_o = 1800 W/m^{2}K. Determine the surface area of the heat exchanger capable of heating 1000 kg/h of water from 20^{o}C to 90^{o}C. Also compute the rate of condensation of steam. Take h_{fg} = 2200 kJ/kg. *11* *K3* *CO6*

OR

b) In a counter flow heat exchanger, water at 20°C flowing at the rate of 1200 kg/hr. It is heated by oil of specific heat 2100 J/kgK flowing at the rate of 520 kg/h at inlet temperature of 95°C. Determine the Heat transfer, outlet temperature of water and oil. Take Heat exchanger area as 1m^2 and overall heat transfer coefficient as 1000 W/m^{2}K. *11* *K3* *CO6*

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