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Question Paper Code	14450

B.E. / B.Tech. - DEGREE EXAMINATIONS, APRIL / MAY 2026

Sixth Semester

Mechanical Engineering

20MEPC602 - HEAT TRANSFER

Regulations - 2020

(Use of HMT *Data Books* & Steam tables is permitted)

Duration: 3 Hours | Max. Marks: 100

PART – A (i) (MCQ)
(16 × 1 = 16 Marks)
Answer ALL Questions

		Marks	*K – Level*	*CO*
1.	Your finger sticks to an ice tray just taken from refrigerator. Which factor have more effect on this phenomenon a) The inside temperature of the freezer b) The humidity of the air c) The heat capacity of your finger and the tray d) The thermal conductivity of the tray	*1*	*K1*	*CO1*
2.	From a metallic wall at 100℃, a metallic rod protrudes to an ambient air. The temperature at the tip will be minimum when the rod is made up of a) Aluminum b) Steel c) Copper d) Silver	*1*	*K3*	*CO1*
3.	In a long cylindrical rod of radius R and the surface heat flux of q_0, the uniform internal heat generation rate is a) $2\ q_0/R$ b) $2\ q_0$ c) q_0/R d) q_0/R^2	*1*	*K2*	*CO1*
4.	A perfect black body is a) Black in color b) Reflect all the incident radiation c) Absorbs all the incident radiation d) Transmit all the incident radiation	*1*	*K1*	*CO2*
5.	Absorptivity and reflectivity of a white body respectively are a) 0 and 0 b) 1 and 0 c) 0 and 1 d) 1 and 1	*1*	*K2*	*CO2*
6.	Radiation from flame contain a) Continious radiation from burning shoot particles of microscopic and submicroscopic dimensions b) Radiation from suspended larger particles of coal trash causing flame luminosity c) Infrared radiation from water vapor and carbon dioxide d) All of the above	*1*	*K3*	*CO2*
7.	If a body has large thermal conductivity and a corresponding low film heat transfer coefficient, the heat flow to or from the body is controlled principally by a) Conductive resistance b) Convective resistance c) Radiation resistance d) Temperature gradient	*1*	*K2*	*CO3*
8.	Forced convection is caused due to difference in a) density b) pressure c) viscosity d) none of these	*1*	*K1*	*CO3*
9.	A finned tube hot water radiator with a fan blowing over it is kept in room during winter. The major portion of heat transfer from radiator is due to a) Combined conduction and radiation b) Radiation to the surrounding c) Better conduction d) Convection to the air	*1*	*K3*	*CO3*

10.	The boiling process has wide-spread applications in (i) Production of steam in nuclear and steam power plants for generation and for industrial processes and space heating (ii) Absorption of heat in refrigeration and air-conditioning systems (iii) Concentration, dehydration and drying of foods and materials Identify the correct statements a) i and ii b) ii and iii c) i, ii and iii d) i and iii	*1*	*K3*	*CO4*
11.	The phenomenon of stable film boiling is referred to as a) Nucleate effect b) Boiling regimes c) Leiden frost effect d) Von karma effect	*1*	*K1*	*CO4*
12.	Drop wise condensation usually occurs on a) Oily surface b) Glazed surface c) Smooth surface d) Coated surface	*1*	*K2*	*CO4*
13.	In a parallel flow gas turbine recuperator, the maximum effectiveness is a) 100 % b) 75 % c) 50 % d) Between 25 % and 45 %	*1*	*K3*	*CO5*
14.	Heat exchanger are used in a) Condensers and boilers in steam plant b) Intercooler and preheater c) Condenser and evaporator in refrigerator d) All of these	*1*	*K1*	*CO5*
15.	€-NTU method is practically useful in thermal design heat exchanger when a) Outlet temperature of fluid stream is not called priori b) Outlet temperature of fluid stream is called priori c) Outlet temperature of hot fluid stream is known but that of cold stream is not called a priori d) Inlet temperature of fluid stream is called priori	*1*	*K2*	*CO6*
16.	Why do we use counter flow operation on gasketed type heat exchanger a) It provide better ease of operation b) Applied pressure difference required is low c) A large and uniform temperature difference is achieved d) It reduces corrosion	*1*	*K3*	*CO6*

PART – A (ii) (Short Answer Questions)
(6 × 3 = 18 Marks)
Answer ALL Questions

17.	Define critical thickness of insulation with its significance.	*3*	*K3*	*CO1*
18.	Write down the heat transfer equation for Radiant exchange between infinite parallel gray planes.	*3*	*K3*	*CO2*
19.	A square plate 40 x 40 cm maintained at 400 K is suspended vertically in atmospheric air at 300 K. Determine the boundary layer thickness at trailing edge of the plate.	*3*	*K3*	*CO3*
20.	Show the temperature distribution graph for condensers & evaporators.	*3*	*K4*	*CO4*
21.	Analyze the relation for overall heat transfer coefficient in heat exchanger without fouling factor.	*3*	*K4*	*CO5*
22.	Compare the advantage does NTU method have over the LMTD method.	*3*	*K4*	*CO6*

PART - B (Descriptive Answer Questions)
(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 =0.110W/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) Circumferential aluminum fins of rectangular profile (1.5 cm wide and 1 mm thick) are fitted to a 90 mm engine cylinder with a pitch of 10 mm. The height of the cylinder is 120 mm. The cylinder base temperatures before and after fitting the fins are 200°C and 150°C respectively. Take ambient at 30°C and h (average) = 100 W/m2K. Estimate the heat dissipated from the finned and the unfinned surface areas of cylinder body. *11 K3 CO1*

24. a) Two parallel plates of size 1.0 m × 1.0 m spaced 0.5 m apart are located in very large room; the walls are maintained at a temperature of 27°C. One plate is maintained at a temperature of 900°C and other at 400°C. The emissivity's are the 0.2 and 0.5 respectively. If the plates exchange heat between themselves and surroundings, find the heat transfer to each plate and to them. Consider only the plate surfaces facing each other. *11 K3 CO2*

OR

b) Two large parallel plates are maintained at a temperature of 600 K and 900 K and emissivities of 0.4 and 0.7 respectively. Determine the heat transfer by radiation and also calculate the percentage of reduction in heat transfer when a radiation shield of emissivity 0.05 is introduced in between them. Also find the shield temperature. *11 K3 CO2*

25. a) Air at 20^oC and a pressure of 1 bar is flowing over a flat plate at a velocity of 3 m/s. If the plate is 280 mm wide and at 56^oC, estimate the following quantities at x= 280 mm, given that the properties of air at the bulk mean temperature of 38^oC are : $\rho = 1.1374$ kg/m^3, k =0.02732 W/m K, cp= 1.005 kJ/Kg K, and v = 16.768 x 10^{-6} m^2/s: (i) boundary layer thickness, (ii) local friction coefficient, (iii) average friction coefficient, (iv) shearing stress due to friction, (v) thickness of thermal boundary layer, (vi) local convective heat transfer coefficient, (vii) average convective heat transfer coefficient, (viii) rate of heat transfer by convection, (ix) total drag force on the plate, and (x) local mass flow rate through the boundary. *11 K3 CO3*

OR

b) Air at 20°C, at a pressure of 1 bar is flowing over a flat plate at a velocity of 3 m/s. if the plate maintained at $60°^OC$, calculate the heat transfer per unit width of the plate. Assuming the length of the plate along the flow of air is 2m. Analyze how the heat transfer rate would change if the air velocity increases, while all other conditions remain the same. *11 K3 CO3*

26. a) (i) What is flow boiling and pool boiling? Describe how heat transfer coefficient various in regimes of pool boiling *5 K3 CO4*

(ii) Water is boiled at atmospheric pressure by horizontal polished copper heating element of diameter D=5mm and emissivity 0.05 immersed in water. If the surface temperature of the heating element is 350°C. Determine the rate of heat transfer from the wire to the water per unit length of the wire. *6 K3 CO4*

OR

b) A condenser is to be designed to condense 600kg/h of dry saturated steam at a pressure of 0.12 bar. A square array of 400 tubes, each of 8mm diameter is to be used. The tube surface is maintained at 30°C. Calculate the heat transfer coefficient and the length of each tube. *11 K3 CO4*

27. a) In a counter flow double pipe heat exchanger oil is cooled from 200°C to 120°C with water available at 25°C. The exit temperature of water is 70°C. Specific heat of oil is 1.5 kJ/kg K and mass flow rate of oil is 0.8 kg/s. If the overall heat transfer coefficient is 400 W/m^2K, find the rate of heat transfer and the heat exchanger area. *11 K4 CO5*

OR

	b)	Hot oil with a capacity rate of 2500 W/K flows through the double pipe heat exchanger. It enters at 360°C and leaves at 300°C.cold fluid enters at 30°C and leaves at 200°C. If the overall heat transfer coefficient is 800 W/m^2K. Compare the heat exchanger area required for (1) parallel flow and (2) counter flow	*11*	*K4*	*CO5*
28.	a)	Analyze for the following cases, the surface area required for the heat exchanger which is required to cool 3200 kg/hr of benzene (Cp=1.74 kJ/kg K) from 72°C to 42°C. The cooling water (CP=4.18 kJ/kg °C) at 15°C has a flow rate of 2200 kg/hr. (i) single pass counter flow (ii) 1-4 heat exchanger (one-shell pass and four -tube passes) and (iii) Cross flow single pass with water mixed and benzene unmixed. Assume all the cases U=0.28 kW/m2K	*11*	*K4*	*CO6*

OR

	b)	In a counter flow double pipe heat exchanger, Water is heated from 50°C to 75°C by oil entering at 115°C and leaving at 70°C. The specific heat of oil is 1780J/Kg K. The mass flow rate of water is 65Kg/min and specific heat of water is 4186J/Kg K. Determine the heat exchanger area and heat transfer rate for an overall heat transfer coefficient of $340W/m^2K$,	*11*	*K4*	*CO6*