Hall Ticket Number:

Code No. : 15537 S

VASAVI COLLEGE OF ENGINEERING *(AUTONOMOUS)*, HYDERABAD

Accredited by NAAC with A−+ Grade

B.E. (Mech. Engg.) V-Semester Supplementary Examinations, July-2022

Heat Transfer

Time: **3 hours** Max. Marks: **60**

*Note: Answer all questions from **Part-A** and any **FIVE** from **Part-B***

Part-A (10 × 2 = 20 Marks)

Q. No.	Stem of the question	M	L	CO	PO
1.	Give two engineering applications for Conduction Heat Transfer and two engineering applications for Radiation Heat Transfer.	2	2	1	1
2.	State and explain the Newton's Law of Convection Heat Transfer.	2	2	1	1
3.	Define "Fin Efficiency" and "Fin Effectiveness".	2	2	2	1
4.	Define "Response Time" and "Sensitivity" for a temperature measuring instrument.	2	1	2	1
5.	Give two examples for "Very Low Prandtl Number Fluids" and two examples for "Very High Prandtl Number Fluids".	2	2	3	1
6.	Define (i) hydrodynamic and (ii) thermal entrance lengths as referred to internal forced convection flow through a tube.	2	1	3	1
7.	List the relative advantages and disadvantages of (i) Direct-contact type heat exchangers as against (ii) Surface heat exchangers.	2	1	4	1
8.	Define Drop-wise and Film-wise Condensation.	2	2	4	1
9.	Define Spectral Emissive Power and give its SI unit.	2	1	5	1
10.	Define "View Factor". What are its lower and upper limiting values?	2	2	5	1
	Part-B (5 × 8 = 40 Marks)				
11. a)	Derive an expression, in non-dimensional form, for the steady-state radial temperature distribution in a solid sphere with uniform volumetric heat generation subjected to convective cooling on its surface.	4	1	1	1, 2
b)	It is proposed to cover a 30 mm O.D. steam carrying pipe with two layers of insulation, each having a thickness of 25 mm. The thermal conductivity of one insulating material is 5 times that of the other. Calculate the percentage change in heat transfer, if better insulating material is put immediately next to the pipe than that where it forms the outer layer. Assume that the outer and inner surface temperatures of the composite insulation are held fixed in both the cases.	4	4	1	1, 2
12. a)	A 1.6 mm diameter steel rod [k = 16.3 W/m K] protrudes from an object maintained at 49°C. The rod is 12.5 mm long and it is exposed to an environment at 25°C that offers a convection heat transfer coefficient of 570 W/m^2 K. Calculate (i) rod tip temperature, (ii) rate of heat dissipation from the rod, (iii) efficiency of the rod and (iv) effectiveness of the rod.	4	4	2	1, 2
b)	A cylindrical bar [diameter 10 cm, thermal conductivity 50 W/m K and thermal diffusivity 2×10^{-5} m^2/s] is heated in a blacksmith's furnace to a uniform temperature 200°C. It is then suddenly dipped into an oil tank at a temperature 40°C that offers a surface heat transfer coefficient 150 W/m^2 K. (i) Calculate the time needed to cool the centre of the bar to a temperature 50°C. (ii) Find the temperature of the surface of the bar at this instant of time.	4	4	2	1, 2

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13. a)	With the help of neat sketches, narrate the development of velocity boundary layer and thermal boundary layer pertaining to forced convection external flow past an isothermal flat plate.	4	2	3	1, 2
b)	An ice block, modeled as a vertical cylinder and at a temperature 0°C, is in an apparently quiescent (stationary) air at 30°C. The ice block is 0.8 m in diameter and 1.2 m in height. Find the rate of convection heat transfer from the quiescent air to the ice block [assume that there is no melting of ice during the above heat transfer].	4	4	3	1, 2
14. a)	Define (i) Pool Boiling, (ii) Flow Boiling, (iii) Local Boiling and (iv) Bulk Boiling.	4	2	4	1, 2
b)	A counter-flow heat exchanger serving as an oil cooler is being designed to cool 2000 kg/h of an oil of specific heat 2.5 kJ/kg K from 105°C to 30°C making use of water that enters the heat exchanger at a temperature 15°C. The overall heat transfer coefficient is expected to be 1.5 kW/m^2 K. Calculate (i) the mass flow rate of water, (ii) the effectiveness of the heat exchanger and (iii) the design surface area needed. Consider the exit temperature of water to be equal to 80°C. Solve the problem using the ε - NTU method.	4	4	4	1, 2
15. a)	Define (i) White Body, (ii) Opaque Body, (iii) Transparent Body and (iv) Black Body. Give one pertinent example for each of them.	4	2	5	1, 2
b)	A room, measuring 4.5 m × 6 m × 3 m (height), is heated by means of heater panels under the floor, which is of surface emissivity 0.6 and is at a temperature 67°C, while the walls are at 27°C, with a surface emissivity 0.9. Calculate the rate of direct radiation heat exchange between the floor and the wall that is adjacent to the side of length 6 m, by neglecting the effect of presence of all other walls of the room.	4	4	5	1, 2
16. a)	Heat is generated uniformly in a stainless steel plate [k = 19.1 W/m K] of thickness 1 cm at a rate of 500 MW/m^3. The two boundaries of the plate are held at prescribed temperatures 100°C and 200°C, respectively. Calculate the steady-state temperature at the central plane of the plate.	4	4	1	1, 2
b)	Define Lumped Body and Semi-Infinite Body. Give relevant examples for	4	2	2	1, 2
17.	Answer any ***two*** of the following:				
a)	Water at 50°C enters a tube of 1.5 cm diameter and 3 m in length at a mean velocity of 1 m/s. The tube wall is maintained at a temperature 90°C, while the exit water temperature is 64°C. Calculate (i) the mean convection heat transfer coefficient and (ii) the net rate of convection heat transfer.	4	4	3	1, 2
b)	The heat transfer surface of a steam boiler is modeled as a pan of Copper of heat transfer surface area 0.05 m^2. It is required to boil saturated water at 100°C and at atmospheric pressure using the above boiler. The heating surface is maintained at a uniform temperature 110°C. Calculate the boiling heat flux for the above boiler.	4	4	4	1, 2
c)	Calculate all the view factors pertaining to the following configurations: (i) A duct of equilateral triangle cross-section and (ii) A hemi spherical surface resting on a circular plane surface.	4	1	5	1, 2

M : Marks; L: Bloom's Taxonomy Level; CO; Course Outcome; PO: Programme Outcome

i)	Blooms Taxonomy Level – 1	20%
ii)	Blooms Taxonomy Level – 2	35%
iii)	Blooms Taxonomy Level – 3 & 4	45%

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