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# B.M.S. College of Engineering, Bengaluru-560019

**Autonomous Institute Affiliated to VTU**

## September / October 2023 Semester End Main Examinations

**Programme: B.E.** **Semester: IV**
**Branch: Chemical Engineering** **Duration: 3 hrs.**
**Course Code: 22CH4PCHTR** **Max Marks: 100**
**Course: Process Heat Transfer**

**Instructions**: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may be suitably assumed.
3. Use of steam tables is allowed.

**Important Note:** Completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages. Revealing of identification, appeal to evaluator will be treated as malpractice.

| | | UNIT - I | CO | PO | Marks |
|---|---|---|---|---|---|
| 1 | a) | Compare the various modes of heat transfer with suitable examples. | CO 1 | PO 1 | **08** |
| | b) | A duralumin rod is enclosed with three different materials of insulation X, Y& Z. Develop an expression for heat transfer by conduction through the composite material assuming constant thermal conductivity. | CO3 | PO2 | **12** |
| | | **UNIT - II** | | | |
| 2 | a) | Define Critical radius of insulation. Derive an equation to find the critical radius of insulation for a sphere. | CO4 | PO2 | **10** |
| | b) | A steel pipe of 146 mm I.D. and 168mm O.D. is covered with a 202 mm layer of insulation. The temperature of inner surface of the pipe is 519 K and the temperature of the outer surface of insulation is 310.8 K. Determine the rate of heat loss per meter length of the pipe and the insulation. Also, calculate the temperature of interface Data: k = 44.81W/mK for steel and K=0.658W/m K for insulation. | CO3 | PO 2 | **10** |
| | | **OR** | | | |
| 3 | a) | List any four applications of fins, sketch the different types of fins. | CO4 | PO2 | **06** |
| | b) | A rectangular fin is attached to a base plate which is at a temperature $T_o$. The surrounding air temperature is $T_\infty$. Deduce an equation to determine the temperature profile when the tip of the fin is insulated. | CO4 | PO2 | **14** |

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| | | | **UNIT - III** | | | |
| | 4 | a) | Derive the relation between overall and individual heat transfer coefficient based on the outside area. | *CO5* | *PO3* | **12** |
| | | b) | Liquid A is flowing at a rate of 1900 kg/h inside the tubes in a heat exchanger and is to be cooled from 358 K to 318 K using water. Water flows outside tube at a rate of 13500 kg/h and enters at 293 K. The film coefficient for liquid A is 1700 $W/m^2K$. The wall resistance is negligible. The water side coefficients including the fouling factors are 11000 $W/m^2K$. Enumerate the area required for counter current flow in an exchanger.<br>Cp of liquid A = 0.88 kJ/kg°C and Cp of water = 4.2 kJ/kg°C | *CO5* | *PO3* | **08** |
| | | | **OR** | | | |
| | 5 | a) | Analyze the various regimes in the pool boiling of a saturated liquid with the labeled plot of heat flux verses excess temperature. | *CO1* | *PO1* | **12** |
| | | b) | Compare the different condensation mechanisms with neat sketches. | *CO5* | *PO3* | **08** |
| | | | **UNIT - IV** | | | |
| | 6 | a) | Explain the working of any one single effect natural circulation evaporator with a neat sketch. | *CO5* | *PO3* | **10** |
| | | b) | A Single effect evaporator operates at 13 $kN/m^2$. Estimate the heat transfer area required to concentrate 5000 kg/h of Caustic Soda solution from 10% to 40% solution. Saturated steam is available at 390 K. The overall heat transfer coefficient may be considered as 1.25 $kW/m^2K$. The feed enters the evaporator at 300 K. The Boiling point elevation is 3.2°F. The specific heats of feed and product are 3.768 kJ/kg and 3.14 kJ/kg, respectively.<br>Data: Enthalpy of vapor =2376.108 kJ/kg; enthalpy of liquid = 221.08 kJ/kg | *CO5* | *PO3* | **10** |
| | | | **UNIT - V** | | | |
| | 7 | a) | Illustrate the following laws of radiation:<br>i. Stefan Boltzmann law<br>ii. Kirchoff's law<br>iii. Wien's displacement law | *CO1* | *PO1* | **12** |
| | | b) | Expound the significance of radiation shields and view factors in radiation problems. | *CO2* | *PO2* | **08** |

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