Register No.: …… Name: ……..

SAINTGITS COLLEGE OF ENGINEERING (AUTONOMOUS)

(AFFILIATED TO APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY, THIRUVANANTHAPURAM)

FOURTH SEMESTERB.TECH DEGREE EXAMINATION (Regular), JULY 2022
CHEMICAL ENGINEERING
(2020 SCHEME)

Course Code: **20CHT204**

Course Name: **Heat Transfer Operations**

Max. Marks: **100** **Duration: 3 Hours**

PART A

(Answer all questions. Each question carries 3 marks)

1. List the modes of heat transfer with its applications
2. Write one dimensional heat conduction equation without generation of heat.
3. State Buckingham's pi theorem
4. Explain the mechanism of natural convection.
5. Differentiate Black body and Gray body.
6. State Stefan Boltzmann law.
7. Classify the various types of heat exchanger.
8. Draw the diagrammatic representation of shell and tube heat exchanger.
9. Define economy and capacity for an evaporator.
10. Compare the performance of single effect and multiple effect evaporator .

PART B

(Answer one full question from each module, each question carries 14marks)

MODULE I

11. Derive the heat conduction equation for a plane wall and obtain the same for a composite wall. (14)

OR

12. Define the following: 1. Biot Number 2. Fourier number 3. Critical Radius of Insulation 4. Application of Heisler chart (14)

MODULE II

13. Derive the relation of dimensionless numbers of Re,Pr and Gr for natural convection. (14)

OR

14. Explain the various analogies of heat, mass and momentum transfer. (14)

MODULE III

15. a) Discuss in detail the various regimes of Boiling. (10)
    b) List the various types of condensation. (4)

OR

16. Derive the expression for Laminar film condensation on a vertical plate. (14)

MODULE IV

17. A counter flow heat exchanger is used to cool 2200 kg/hr of oil (Cp=2.5 kJ/kg· K), from 100 °C to 35 °C by the use of water (Cp= 4.18 kJ/kg· K) entering at 17 °C. If the overall heat transfer coefficient is expected to be 1.5 kW/m^2 K, make calculations for the water flow rate, the surface area required and the effectiveness of heat exchanger. Presume that the exit temperature of water is not to exceed 85 °C. Use NTU-effectiveness approach. (14)

OR

18. Obtain the expression for LMTD in a Parallel flow heat exchanger (14)

MODULE V

19. a) Discuss in detail the various types of feeding of multiple effect evaporator with a neat sketch. (12)
    b) State Duhring's rule. (2)

OR

20. A single effect evaporator is to be used to concentrate a food solution containing 15% (by mass) dissolved solids to 50% solids. The feed stream enters the evaporator at 291 K with a feed rate of 1.0 kg s^{-1}. Steam is available at a pressure of 2.4 bar and an absolute pressure of 0.07 bar is maintained in the evaporator. Assuming that the properties of the solution are the same as those of water, and taking the overall heat transfer coefficient to be 2300 W m^{-2} K^{-1}, calculate the rate of steam consumption and the necessary heat transfer surface area. (14)

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