INSTITUTE OF CHEMICAL TECHNOLOGY

(University under Section – 3 of UGC Act 1956)(formerly UDCT/UICT, Mumbai)
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Matunga, Mumbai – 400019, India

THIRD YEAR BACHELOR OF CHEMICAL ENGINEERING (SEMESTER – V) EXAMINATION NOVEMBER 2022

CET1102 – HEAT TRANSFER

DATE : NOVEMBER 07, 2022 **TIME : 1:30 P.M TO 4:30 P.M**
DAY : MONDAY **MARKS : 50**

Note All questions are compulsory
The formulae are attached with the question paper.
Use well-labeled figures/schematics for explanation/problem solutions.
Make suitable assumptions wherever necessary and state them clearly

Q 1. 12000 kg/hr of water available at 93°C, which is to be cooled to 50°C in a shell and tube heat exchanger. This heat is to be used for preheating water from 15°C to 45°C. Cold water is circulated from the tube, and hot water is circulated on the shell side. Tubes of inside diameter 20 mm are to be used, and the maximum velocity through the tubes should not be more than 0.5 m.s. Due to space limitations, the tube length is restricted to 3.2 m. Overall heat transfer coefficient for the heat exchanger is 1450 W/m^{2}k. Fouling resistance and metal wall resistance may be neglected. Suggest a suitable design of shell and tube heat exchanger. The pressure drop should be below 50 kN/m^2

(15)

Q2. Can we design gasketed plate heat exchanger for the system mentioned in Problem 1 (Q 1)? If possible, give design for the same. If not possible, justify your answer with proper calculations.

(20)

Q3. A glass-lined reactor contains 9000 kg of water. It is to be heated from 20°C to 70°C by circulating steam in the jacket. Saturated steam having a temperature 135°C is available. The dimensions of vessel **i.** diameter 2.1 m **ii.** agitation speed 60 rpm **iii.** diameter of agitator 40% of vessel diameter **iv.** Mean fluid temperature 45 °C **v.** wall temperature 90°C **vi.** film temperature 67.5°C, **vii.** Heat transfer coefficient for condensing steam 8500 W/m^{2}k. **viii.** Thickness of vessel 10 mm **ix.** Fouling resistance on the waterside 0.00026 m^{2}k/w & on the steam side 0.00005 m^{2}k/w. The properties of water thermal conductivity 0.66 W/mk viscosity 0.45 x 10^{-3} N-s/m^2 viscosity at wall temperature 0.28 x 10^{-3} N-s/m^2. Thermal conductivity of steel 45 W/mk, and glass 1.09 W/mk. Determine the time required for heating (6)

ii. Compare Bell Delaware, Kern, and flow stream analysis method.

(4)

Q4. Carbon steel sphere 0.3 m in diameter and at 800 K, cools down by radioactive heat loss to ambient at 30^{0}C. If other modes of heat transfer are neglected, and if the ball and the ambient are assumed to be black, calculate the time required for the ball to cool down to 70^{0}C. The density and specific heat of carbon steel are 7801 kg/m^3 and 0.473kj/kg^{0}C, respectively (5)