

GUJARAT TECHNOLOGICAL UNIVERSITY**BE - SEMESTER-VII (NEW) EXAMINATION – WINTER 2022****Subject Code:3170502****Date:05-01-2023****Subject Name:Process Equipment Design****Time:10:30 AM TO 01:00 PM****Total Marks:70****Instructions:**

1. Attempt all questions.
2. Make suitable assumptions wherever necessary.
3. Figures to the right indicate full marks.
4. Simple and non-programmable scientific calculators are allowed.

Marks

- Q.1**
- (a) Define NPSH and give its importance for pump design. **03**
- (b) Explain in brief about the equivalent length of pipes. **04**
- (c) Find out the power required for a turbo blower for the following duty. **07**
- Fluid= Atmospheric air,
Capacity = 1000 Nm³/h,
Discharge pressure = 2 atm a
Ratio of specific heat $C_p/C_v = 1.395$
Also find the discharge temperature of air.

- Q.2**
- (a) How baffle cut and baffle spacing affect tube outside heat transfer coefficient. **03**
- (b) Discuss in brief about fluid allocation for shell and tube heat exchange. **04**
- (c) Discuss the process design of kettle type reboiler. **07**

OR

- (c) 1-2 shell and tube heat exchanger is used to cool methanol condensate from 95 °C to 40°C. Flow rate of methanol is 100000 kg/h. Brackish water is used as coolant with temperature rise from 25 °C to 40 °C. **07**

Property	Methanol	Brackish Water
Heat Capacity, kJ/kg °C	2.84	4.2
Density, kg/m ³	750	995
Viscosity, mN.s/m	0.34	0.8
Thermal conductivity, W/m °C	0.19	0.59

Choose 20 mm od, 16 mm id, 4.88 m long cupro-nickle tubes with triangular pitch $P_t = 1.25d_o$. Based on overall heat transfer coefficient 600 W/m² °C

Calculate (1) Number of tubes (2) Shell Diameter

K_1 and n_1 for tube bundle diameter: (For triangular pitch $P_t = 1.25d_o$). Take bundle diameter clearance 68 mm.

N_p	1	2	4	6	8
K_1	0.319	0.249	0.175	0.0743	0.0365
n_1	2.142	2.207	2.285	2.499	2.675

Consider the value of $F(t) = 0.95$, $R = 3.61$ and $S = 0.21$

- Q.3**
- (a) How reflux ratio affects distillation column design. **03**
- (b) Explain FUG method for multicomponent distillation. **04**
- (c) Discuss the advantages and disadvantages of vacuum distillation in detail. **07**

OR

- Q.3** (a) Discuss in details the various factors considered for the selection of tray. **03**
(b) Describe determination of optimum reflux ratio **04**
(c) Continuous rectifying column handles a mixture consisting of 40 per cent of benzene by mass and 60 per cent of toluene at the rate of 4 kg/s and separates it into a product containing 97 per cent of benzene and a liquid containing 98 per cent toluene. The feed is liquid at its boiling-point. **07**
(a) Calculate the mass flows of distillate and waste liquor.
(b) If a reflux ratio of 3.5 is employed, how many plates are required in the rectifying part of the column?

Mole fraction of benzene in liquid	Mole fraction of benzene in vapor
0.0	0.0
0.1	0.22
0.2	0.38
0.3	0.51
0.4	0.63
0.5	0.70
0.6	0.78
0.7	0.85
0.8	0.91
0.9	0.96
1.0	1.0

- Q.4** (a) List the steps for determination of minimum amount of solvent for absorber. **03**
(b) With neat sketch discuss any two types of random packing material used for packed **04**
(c) Discuss the steps for the design of packed tower type absorber. **07**

OR

- Q.4** (a) List out various equipment used as an absorber/ scrubber. **03**
(b) State process design steps for vertical spray tower. **04**
(c) Discuss the criteria for the selection of different types of absorption column in industries. **07**

- Q.5** (a) Discuss welding joint efficiency factor. **03**
(b) With neat sketch state various types of welding joints. **04**
(c) Derive equation for longitudinal and circumferential, stress and discuss design stress. **07**

OR

- Q.5** (a) Explain selection of material of construction. **03**
(b) Discuss the use of jackets and coils in the industry. **04**
(c) A nozzle having 400 mm ID is fabricated from SA-516 Gr 70 plate, attached to shell by welding which having same MOC. Check whether this nozzle requires reinforcement pad or not. If required decide its dimension. **07**

Shell ID is 1500 mm

Shell Internal design pressure is 10 kgf/cm²

Design temperature 300 °C

Use Max. Allowable stress = 612.4 kgf/cm²

Joint efficiency = 0.85 for both nozzle and shell

CA = 1.5 mm
