



Third Semester B.E. Degree Examination, June/July 2019 Unit Operations

Time: 3 hrs.

Max. Marks: 80

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

- 1 a. State and derive the Bernoulli's equation. (08 Marks)
- b. How do you classify fluids? Explain in detail. (08 Marks)

OR

- 2 a. Derive Kozney-Karman equation for fluid flowing in packed beds. (08 Marks)
- b. A falling ball viscometer operates by time with respect to the fall of a steel ball which has the diameter of 0.625 cm and a density of 7.9 g/c.c steel ball falls at a distance of 25 cm. What is the viscosity of oil, if the time of fall is 4.6s? Justify the selection of equation. Assume the specific gravity of medium as 0.9. (08 Marks)

Module-2

- 3 a. With a neat sketch, explain the working of reciprocating pump. (08 Marks)
- b. An orificemeter with orifice diameter of 10 cm is inserted in a pipe of 20 cm diameter. Pressure gauges fitted in upstream and downstream of the orificemeter gives the readings of 19.62 N/cm² and 9.81 N/cm² respectively. Coefficient of discharge of orificemeter is 0.6. Find the discharge of water through pipe. (08 Marks)

OR

- 4 a. Explain the crushing laws. Define work index. (08 Marks)
- b. Explain the working principle of ball mill with neat sketch. (08 Marks)

Module-3

- 5 a. Derive the expression for heat transfer by conduction through a composite plane wall. (Assume three layers) (08 Marks)
- b. A 50 mm diameter pipe of circular cross section and with wall of 3 mm thick is covered with two concentric layers of lagging. Inner lagging is having thickness of 25 mm (K = 0.08 W/mK) and outer layer is having a thickness of 40 mm (K = 0.04 W/mK). Estimate the rate of heat loss/metre length of pipe, if temperature inside pipe is 550 K and outside surface temperature is 330K. Thermal conductivity of pipe is 45 W/mK. (08 Marks)

OR

- 6 a. Derive the expression $Q = U_o A_o \Delta T$ for forced convection in pipes. (12 Marks)
- b. Explain film wise and drop wise condensation. (04 Marks)

Module-4

- 7 a. Calculate inside heat transfer coefficient for fluid flowing at a rate of 300 cm³/s through a 20 mm inside diameter tube of heat exchanger.
 Viscosity of flowing fluid = 0.8 Ns/m² Density of flowing fluid = 1.1 g/cm³
 Specific heat of fluid = 1.26 kJ/kgK Thermal conductivity of fluid = 0.384 W/mK
 Viscosity at wall temperature = 1.0 Ns/m² Length of tube = 5 m (08 Marks)

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Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

- b. Draw a neat sketch of 1-2 shell and tube heat exchanger and list the parts. Give the function of (i) baffles (ii) tube sheet (iii) arrangement of tubes in triangular and square pitch. (08 Marks)

OR

- 8 a. Define Fick's law of diffusion. Also derive the expression for steady state equimolar counter current diffusion. (08 Marks)
- b. In an O₂-N₂ gas mixture at 101.3kPa and 298K, the concentrations of oxygen at two phases 2 mm apart are 10% and 20% by volume respectively. Calculate the flux of diffusion of oxygen for the cases where
- Nitrogen is non-diffusing
 - There is equimolar counter diffusion of the two gases
- Data: Diffusivity of O₂ in N₂ is $1.81 \times 10^{-5} \text{ m}^2/\text{s}$. (08 Marks)

Module-5

- 9 a. A distillation column is fed with 100 Kmol/h of a mixture containing 50 mol% hexane and 50 mol% octane at 101.325 kPa. Feed is at its boiling point. The distillate contains 90% (mole) hexane and the residue contains 10% (mole) hexane. Reflux ratio is 3:1. Calculate the flow rate of distillate and residue. Also find the number of theoretical plates needed for this operation vapour-liquid equilibrium data:

Mole fraction of hexane in liquid (X)	1.0	0.69	0.4	0.192	0.045	0
Mole fraction of hexane in vapour (Y)	1.0	0.93	0.78	0.54	0.177	0

- b. Explain the different types of distillation. (10 Marks)
(06 Marks)

OR

- 10 a. Explain the factors considered for the selection of solvent used in extraction. (10 Marks)
- b. Draw the rate of drying curve and explain the various zones of drying. (06 Marks)
