

**TRANSFER OPERATION I
(BIOT 2202)**

Time Allotted : 2½ hrs

Full Marks : 60

Figures out of the right margin indicate full marks.

*Candidates are required to answer Group A and
any 4 (four) from Group B to E, taking one from each group.*

Candidates are required to give answer in their own words as far as practicable.

Group – A

1. Answer any twelve:

12 × 1 = 12

Choose the correct alternative for the following

- (i) Which among the following is an assumption of Hagen-Poiseuille equation?
(a) Fluid is nonviscous (b) Fluid is laminar
(c) Fluid is turbulent (d) Fluid is compressible.
- (ii) What causes cavitation in centrifugal pump?
(a) Low barometric pressure (b) High suction pressure
(c) Low suction pressure (d) High suction velocity.
- (iii) Boundary layer thickness is the distance from the boundary to the point where velocity of the fluid is
(a) equal to 10% of free stream velocity
(b) equal to 50% of free stream velocity
(c) equal to 90% of free stream velocity
(d) equal to 99% of free stream velocity
- (iv) If a liquid enters a pipe of diameter d with a velocity v , what will it's velocity at the exit if the diameter reduces to $0.5d$?
(a) v (b) $0.5v$ (c) $2v$ (d) $4v$.
- (v) Which of the following is a shear-thinning fluid?
(a) Bingham plastic (b) Rheopectic
(c) Dilatant (d) Pseudoplastic.
- (vi) STHE stands for
(a) Straight Tube Heat Exchanger (b) Shell and Tank Heat Exchanger
(c) Shell and Tube Heat Exchanger (d) None of the above.
- (vii) Nusselt Number is equal to
(a) $C_p \mu / k$ (b) $Dv\rho/\mu$
(c) $h_i D / k$ (d) None of the above.

- (viii) Parallel flow heat exchanger is preferred for
 (a) rapid initial cooling (b) uniform cooling
 (c) gradual cooling (d) none of the above.
- (ix) Heating up of the earth's surface by the Sun is by
 (a) Radiation (b) Conduction
 (c) Convection (d) Convection and conduction
- (x) Bond's constant is
 (a) $0.3162W_i$ (b) $3.163W_i$
 (c) $1/0.3162W_i$ (d) inversely proportional to work index

Fill in the blanks with the correct word

- (xi) Value of Stefan Boltzmann's constant is _____.
- (xii) An example of pseudoplastic fluid is _____.
- (xiii) Pressure drop in a packed bed reactor is predicted by _____ equation.
- (xiv) Medium is not required for this type of heat transfer _____.
- (xv) Rheology of a fluid is related to shear stress on fluid with _____.

Group - B

2. (a) Define the following
 (i) Friction factor
 (ii) Sphericity of a non-spherical particle
 (iii) Boundary layer in fluid flowing through pipe. [[CO1](Remember/LOCQ)]
- (b) Derive the expression of terminal settling velocity of a spherical particle in gravitational settling chamber. [[CO1](Understand/IOCQ)]
3 + 9 = 12
3. (a) Derive Bernoulli's equation for fluid flowing through a rough pipe. [[CO3](Derive/HOCQ)]
- (b) A patient who is recovering from surgery is being given fluid intravenously. The fluid has a density of 1030 kg/m^3 . If $9.5 \times 10^{-4} \text{ m}^3$ of fluid flows into the patient in every six hours, find the mass flow rate in kg/sec. [[CO2](Compute/IOCQ)]
8 + 4 = 12

Group - C

4. (a) Describe the working principle of centrifugal pump. [[CO3](Understand/LOCQ)]
- (b) Water at 15°C is flowing through 500 m of horizontal pipe at a rate of 454.5 litre/min. A friction head of 10 m is available. What must be the pipe diameter, given that the value of friction factor (f) = 0.0048. [[CO4](Compute/HOCQ)]
5 + 7 = 12
5. (a) Venturimeter is used to measure liquid flowrate 7500 litre/min. The difference in pressure across the venturimeter is equivalent to 8 m of flowing fluid. The

pipe diameter is 19 cm. Calculate the throat diameter of the venturimeter. Assume discharge coefficient = 0.96. [[C03](Analyse/HOCQ)]

- (b) What should be the range of values of coefficient of discharge for venturimeter and why? [[C04](Remember/LOCQ)]

7 + 5 = 12

Group - D

6. The heat transfer rate to the jacket of an agitated polymerization kettle is 7.4 kW/m² when the polymerization temperature is 50°C and the water in the jacket is at 20°C. The kettle is made of stainless steel with a wall 12 mm thick, and there is a thin layer of polymer left on the wall from previous runs.

- (i) What is the temperature drop across the metal wall?
 (ii) How thick would the polymer deposit have to be to account for the rest of the temperature difference?
 (iii) By what factor could the heat flux be increased by using a stainless steel clad reactor with a 3 mm stainless steel layer bonded to a 9 mm mild steel shell?

Thermal conductivity (W/(m.°C))	Material
0.16	Polymer
17	Stainless steel
44.2	Mild steel

[[C04](Analyse/HOCQ)]

12

7. (a) Derive an expression for heat transfer through a composite wall of three different layers. [[C04](Derive/LOCQ)]

- (b) Derive a mathematical expression for overall heat transfer coefficient based on outside heat transfer area? [[C04](Remember/LOCQ)]

6 + 6 = 12

Group - E

8. (a) Derive Ruth's equation for constant pressure filtration. [[C03](Analyse/HOCQ)]

- (b) Define the following terms: blinding of screen, comminution, filter aids? [[C05,C06](Remember/LOCQ)]

6 + (2 + 2 + 2) = 12

9. A material is crushed in a Blake Jaw crusher and the average size of particles is reduced from 5 cm to 1.3 cm, with consumption of energy at the rate of 37 watt.h/ton. What will be the consumption of energy necessary to crush the same material of average size of 8 cm to an average size of 3 cm? The mechanical efficiency remains unchanged.

- (i) Using Rittinger's law
 (ii) Using Kick's law
 (iii) Using Bond's law.

[[C05](Evaluate/HOCQ)]

(4 + 4 + 4) = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	32.3	13.5	54.2

Course Outcome (CO):

After completion of this course, the students will be able to:

1. Understand the physical properties of fluid, flow behavior and their consequence on fluid flow.
2. Apply the basic laws and equations to analyze fluid dynamics and solve numerical problems related to them.
3. Understand the importance of fluid flow measurement by various devices in industries.
4. Analyze and calculate various parameters involved in heat transfer by conduction, convection and thermal radiation.
5. Develop and design various equipment's associated with heat transfer and evaluate heat exchanger performance.
6. Develop the knowledge of principles of communiton, mechanical separation aspects, working of equipments used in mechanical operation and calculate various parameters for energy requirement related to size reduction of solid.

**LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question; HOCQ: Higher Order Cognitive Question.*