TRANSFER OPERATION – I
(BTC2201)

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) According to Archimede's principle, if a body is immersed partially or fully in a fluid then the buoyancy force is _____ the weight of fluid displaced by the body.
(a) Less than (b) More than
(c) Equal (d) unpredictable

(ii) At high Reynolds number
(a) Inertial forces control and viscous forces are unimportant
(b) Viscous forces predominate
(c) Inertial forces are unimportant and viscous forces control
(d) None of these

(iii) What causes cavitation in centrifugal pump
(a) low suction pressure (b) low barometric pressure
(c) high suction pressure (d) high suction velocity

(iv) The length of the divergent portion of venturimeter in comparison to the convergent portion is
(a) more (b) less
(c) equal (d) more or less depending on capacity

(v) Heating up of the earth's surface by the Sun is by
(a) Conduction (b) Convection
(c) Radiation (d) both (a) and (c)

(vi) Nusselt's Number is equal to
(a) h_iD/k (b) mC_P/kL
(c) $C_P\mu/k$ (d) $Dv\rho/\mu$

(vii) Mechanism of size reduction in jaw crusher is
(a) Compression (b) Cutting
(c) Impact (d) Attrition

(viii) Mechanism of size reduction in ball mill is
(a) impact (b) attrition
(c) compression (d) cutting

(ix) The Ruth equation is valid for which of the following?
(a) Constant rate filtration only
(b) Constant pressure filtration only
(c) Both constant rate and constant pressure filtration
(d) None of the above

(x) Orificemeter is used to measure
(a) Flowrate in a pipe (b) static pressure in flowing fluid
(c) barometric fluid (d) flow pressure in the pipe

Fill in the blanks with the correct word

(xi) For a non-circular cross section of a pipe the hydraulic radius is given by _____

(xii) STHE stands for _____

(xiii) Dimension of specific gravity of a liquid_____

(xiv) Continuity equation is a law of conservation of _____

(xv) The coefficient of discharge for an orifice meter is generally _____ than that of a venturimeter (less/more).

Group - B

2. (a) The velocity distribution of a viscous liquid (μ=0.9Ns/m^2) flowing over a fixed plate is given by U=0.42y-y^2 (U is the velocity in m/sec and y is the distance from plate in m). What are the shear stresses at the plate surface and at y=0.21 m. *[(CO1)(Evaluate/IOCQ)]*

(b) Differentiate between Bingham plastic and dilatants fluid with examples? *[(CO2)(Remember/LOCQ)]*

6 + (4 + 2) = 12

3. (a) Write and explain continuity equation in fluid mechanics. *[(CO2)(Understand/IOCQ)]*
(b) State any two application of fluidised bed reactor in biotechnology? *[(CO1)(Remember/LOCQ)]*
(c) Mathematically show how does shear stress on a fluid varies along radial direction of a pipe. *[(CO2)(Analyse/IOCQ)]*

4 + 2 + 6 = 12

Group - C

4. It is planned to install a steel pipe with an ID 20 cm to transfer 1000 kg/min molasses having viscosity 500cP and density 1.6 gm/cc. The line is to be 1000 m long and delivery end is to be 5 m higher than the intake. (i) Calculate pressure drop due to friction (Kg/Cm^2). If the overall efficiency of pump is 80%, what is the power required by the pump. *[(CO2)(Compute/HOCQ)]*

12

5. (a) State the working principle of venturimeter. *[(CO3)(Understand/IOCQ)]*

(b) Derive the working equation to calculate the volumetric flow rate of fluid flowing through venturimeter. *[(CO3)(Apply/IOCQ)]*

6 + 6 = 12

Group - D

6. (a) A furnace wall consists of 200mm of refractory fireclay brick, 100mm of kaolin brick, and 6mm of steel plate. The fireside of the refractory is at 1150˚C, and the outside of the steel is at 30˚C. An accurate heat balance over the furnace shows the heat loss from the wall to be 300W/m^2. It is known that there may be this layers of air between the layers of brick and steel. To how many millimetres of kaolin are these air layers equivalent? (thermal conductivity of fire clay bricks is 1.73W/m˚C, kaolin brick is 0.195W/m˚C, steel is 45W/m˚C, air is 0.0318W/m˚C). *[(CO4)(Calculate, Apply/HOCQ)]*

(b) Derive an equation for logarithmic mean temperature difference (LMTD). *[(CO4)(Remember/LOCQ)]*

7 + 5 = 12

7. (a) Derive an expression for heat transfer through a composite wall of three different layers. *[(CO4)(Remember/LOCQ)]*

(b) Oil is flowing through a 75mm ID iron pipe at 1m/s. It is being heated by steam outside the pipe and the steam film coefficient is 11,000W/(m2.°C). At the particular point along the pipe, the oil is at 50°C, its density is 880kg/m3, viscosity is 2.1 cP, thermal conductivity, k, is 0.135W/(m.°C), specific heat, Cp,=217J/(g°C). What is the value of Ui, based on the inside area of the pipe? Given: (h/(Cp.v.ρ)(Pr)2/3 =0.023(Re)-0.2. *[(CO4)(Calculate/IOCQ)]*

5 + 7 = 12

Group - E

8. (a) A material is crushed in a Blake Jaw crusher and the average size of particles is reduced from 5cmto 1.3cm, with consumption of energy at the rate of 37watt.h/ton. What will be the consumption of energy necessary to crush the same material of average size of 8cm to an average size of 3cm? The mechanical efficiency remains unchanged.
(i) Using Rittinger's Law.
(ii) Using Bond's Law.
(iii) Using Kick's law. *[(CO6)(Calculate/IOCQ)]*

(b) What is comminution? What are the different mechanisms of comminution? *[(CO6)(Remember/LOCQ)]*

(3 + 3 + 3) + (1 + 2) = 12

9. (a) Derive Ruth's equation. *[(CO6)(Remember/LOCQ)]*

(b) Define the following terms: (i) Filter aid, (ii) Comminution, (iii) Constant pressure filtration, (iv) work index, (v) crushing efficiency and (vi) blinded screen.

[(CO5)(Remember/LOCQ)]

6 + (1 × 6) = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	34.4	45.8	19.8