Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/B.Tech/BT/NEW/SEM-4/CH-402/2013

2013

TRANSFER OPERATION - I

Time Allotted : 3 Hours *Full Marks :* 70

The figures in the margin indicate full marks.

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

GROUP – A

(Multiple Choice Type Questions)

1. Choose the correct alternatives for any *ten* of the following : $10 \times 1 = 10$

i) The sphericity (ϕs) of a particle having surface area Sp and volume Vp is defined as

a) $Sp/Vp = 6 / (\phi s.dp)$

b) $Vp/Sp = 6 / (\phi s.dp)$

c) $Sp/Vp = 6\ dp/\ \phi s$

d) $Sp/Vp = 6\ \phi s/\ dp.$

ii) Blood is an example of

a) Newtonian fluid

b) Bingham plastic

c) Pseudoplastic fluid

d) Dilatant fluid.

iii) Pitot tube is used to measure

a) average velocity of fluid flowing through horizontal pipe

b) average velocity of fluid flowing through vertical pipe

c) point velicity

d) pressure drop between two points of pipe carrying fluid.

iv) Bernoulli's equation is the mathematical statement of conservation of

a) Momentum

b) Mass

c) Energy

d) Mass and energy.

v) The threee forces which are used for comminution of particles are

a) impact, shear and compression

b) viscous, shear and tear

c) impact, compression, tensile.

vi) Head developed by centrifugal pump depends on its

a) speed

b) impeller diameter

c) both (a) and (b)

d) neither (a) nor (b).

vii) For the same flow rate of a fluid the pressure drop is the least for

a) venturimeter

b) orifice meter

c) flow nozzle

d) ΔP is same for all.

viii) The operating speed of a ball mill should be

a) less than the critical

b) much more than the critical

c) at least equal to the critical

d) none of these.

ix) Which of the following crushing laws is most accurately applicable to the grinding of materials ?

a) Bond's law

b) Kick's law

c) Rittinger's law

d) None of these.

x) Which of the following is directly concerned with heat trnsfer ?

a) Sherwood number

b) Grashoff number

c) Euler number

d) Reynolds number.

xi) The maximum rate of heat transfer is achieved by

a) co-current flow

b) counter-current flow

c) turbulent flow

d) laminar flow.

xii) The heat transfer co-efficient in film type condensation is

a) greater than that for dropwise condensation

b) less than that for dropwise condensation

c) same as for dropwise condensation

d) half of that for dropwise condensation.

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following. $3 \times 5 = 15$

2. Calculate the power requirement by a pump of 70% efficiency in order to send 60 kg/min 98% sulphuric acid at 25°C from a tank at atmospheric pressure through 300 m of 5 cm ID steel pipe to a tank of 2.0 kg/cm ^{2} pressure, where the level is 3 m above that in the lower tank. Density and viscosity of the acid may be taken as 1.8 g/c.c. and 26 cp respectively. 5

3. Draw a neat sketch of centrifugal pump and briefly explain its operation. 3 + 2

4. Define the following :
   i) Rheopectic fluid
   ii) Pseudoplastic fluid
   iii) Boundary layer separation
   iv) Drag coefficient
   v) N.P.S.H.
5. Derive an equation for heat flow through a composite wall made of three different layers.
6. Derive Hagen-Poiseuille equation.

GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following. $3 \times 15 = 45$

7. a) Water at a rate of 200 tons/hr has to be pumped from a river to a factory overhead tank placed at a height of 25 m from the river bed, the total length of pipeline being 1.5 killometres. Pipe dia is 30 cm. Viscosity of water is 0.764 cP. Calculate
   i) the Reynolds number
   ii) the head loss due to friction.

   Provided $f = 0.0014 + 0.125/(\text{Re})^{0.32}$.

   b) Define friction factor. Derive the expression to show, how energy loss in a pipe due to friction is related with friction factor, if length and diameter of pipe and velocity of fluid through pipe are known factors.

   c) Write and explain Bernoulli's equation including frictional energy loss and pump work. 6 + 6 + 3

8. a) A sharp edge orifice, connected to a manometer is used for measuring the flow rate of brine (Sp. gravity = 1.20) flowing through a 7.5 cm ID pipe. The maximum flow rate not to exceed 750 lit/min and maximum manometer reading is not to exceed 400 mm Hg. Calculate the size of the orifice.

   b) Define sphericity. Write the Kozeny-Karman equation and Burke-Plummer equation and state their applications.

   c) Write a short note on Globe valve and Gate valve.

6 + (1 + 2 + 1) + 5

9. A heavy hydrocarbon oil which has a C_{pm} = 2. 30 kJ/kg. K is being cooled in a heat exchanger from 371.9 K to 349.7 K and flows inside the tube at a rate of 3630 kg/h. A flow of 1450 kg water/h enters at 288.6 K for cooling and flows outside the tube.

   Calculate the water output temperature and the heat transfer area, if overall U_i = 340 W/m ^{2}. K and the streams are counter-current. Given C_{pm_2} of water = 4.187 kJ/Kg. K.

10. a) What is fluidization ?

    If a fluidized bed has void fractions ε_1 and ε_2, corresponding bed heights are L_1 and L_2 respectively, establish the relation among ε_1 , ε_2, L_1 and L_2 .

b) Solid particles having a size of 0.12 mm and density of 1000 kg/m^3 are to be fluidized using air at 2.0 atm abs and 25°C. The voidage at minimum fluidization condition is 0.42. Density of air at 2.0 atm abs. is 2.374 kg/m^3 and viscosity is 1.845×10^{-5} Pa–s.

i) If the cross-section of the empty bed is 0.30 m^2 and the bed contains 300 kg of solid, calculate the minimum height of the fluidized bed.

ii) Calculate the pressure drop at minimum fluidized condition. 2 + 3 + 5 + 5

11. Data for the laboratory filtration of $CaCO_3$ slurry in water at 298 k are reported as follows at a constant pressure drop of 338 kN/m^2 . The filter area of the plate and frame press was A = 0.0439 m^2 and the slurry concentration was C_s = 23.74 kg/m^3. Calculate the constants α and r_m from the experimental data given, where t is time in s and V is filtrate volume collected in m^3 . (Given : viscosity of water at 298 K is 8.937×10^{-4} kg/m.s)

t (s) 4.4	9.5	16.3	24.6	34.7	46.1
$V \times 10^3$ (m^3)	0.498	1.00	1.501	2.0	2.498
$t/V \times 10^{-3}$ (s/m^3)	8.83	9.5	10.86	12.3	13.9

59.0	73.6	89.4	107.3	
3.002	3.506	4.004	4.502	5.009
15.35	16.83	18.38	19.85	21.42