

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 (ϕ_s) of a particle having surface area S_p and volume V_p is defined as
- a) $S_p/V_p = 6 / (\phi_s \cdot dp)$
 - b) $V_p/S_p = 6 / (\phi_s \cdot dp)$
 - c) $S_p/V_p = 6 \, dp / \phi_s$
 - d) $S_p/V_p = 6 \, \phi_s / dp$.
- 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 velocity
 - 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 three 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 transfer ?
- a) Sherwood number
 - b) Grashoff number
 - c) Euler number
 - d) Reynolds number.



- xi) The maximum rate of heat transfer is achieved by
- co-current flow
 - counter-current flow
 - turbulent flow
 - laminar flow.
- xii) The heat transfer co-efficient in film type condensation is
- greater than that for dropwise condensation
 - less than that for dropwise condensation
 - same as for dropwise condensation
 - 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/cm² 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.

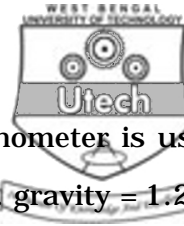
GROUP – C

(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 kilometres. 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.

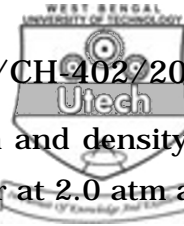
$$6 + (1 + 2 + 1) + 5$$

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/m². 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 $1.845 \times 10^{-5} \text{ Pa-s}$.

- 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 $A = 0.0439 \text{ m}^2$ and the slurry concentration was $C_s = 23.74 \text{ kg/m}^3$. 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 $8.937 \times 10^{-4} \text{ kg/m.s}$)

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

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