

**TRANSFER OPERATION I
(BIOT 2202)**

Time Allotted : 3 hrs

Full Marks : 70

Figures out of the right margin indicate full marks.

*Candidates are required to answer Group A and
any 5 (five) from Group B to E, taking at least one from each group.*

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

**Group – A
(Multiple Choice Type Questions)**

1. Choose the correct alternative for the following: **10 × 1 = 10**
- (i) What causes cavitation in centrifugal pump?
(a) Low barometric pressure (b) High suction pressure
(c) Low suction pressure (d) High suction velocity
 - (ii) 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
 - (iii) The fluid in which the shearing stress within it is proportional to the velocity gradient across the sheared section, is called a _____ fluid.
(a) Newtonian (b) none of these
(c) perfect (d) Bingham
 - (iv) Which one of the following is the dimension of specific gravity of a liquid?
(a) $[M^1 L^{-3} T^0]$ (b) $[M^1 L^0 T^0]$ (c) $[M^0 L^{-3} T^0]$ (d) $[M^0 L^0 T^0]$
 - (v) Which of the following is not a dimension-less parameter?
(a) Euler number (b) Specific gravity
(c) Fanning friction factor (d) none of these
 - (vi) Mechanism of size reduction in jar crusher is
(a) Cutting (b) Compression
(c) Impact (d) Attrition
 - (vii) Nusselt Number is equal to
(a) $C_P \mu / k$ (b) $D \nu \rho / \mu$
(c) $h_i D / k$ (d) None of the above.

- (viii) The operating speed of the ball mill should be
(a) Less than the critical speed (b) Much more than the critical speed
(c) At least equal to the critical speed (d) None of these
- (ix) Parallel flow heat exchanger is preferred for
(a) rapid initial cooling (b) uniform cooling
(c) gradual cooling (d) None of the above
- (x) Equivalent diameter for an annular cross section will be
(a) $\Pi(d_o - d_i)$ (b) $(d_o - d_i)$
(c) $(d_o - d_i)/4$ (d) $\Pi(d_o - d_i)/4$

Group – B

2. (a) Prove that for laminar flow through pipe $V_{ave}/V_{max}=0.5$, where V_{ave} is the average velocity of the fluid and V_{max} is the maximum velocity of the fluid through the pipe.
- (b) Define the following
(i) Drag coefficient
(ii) Sphericity of a non-spherical particle
(iii) Boundary layer in fluid flowing through pipe

9 + 3 = 12

3. (a) Explain continuity equation for fluid flow.
- (b) The velocity distribution of a viscous liquid ($\mu=0.9\text{Ns/m}^2$) flowing over a fixed plate is given by $U=0.68y-y^2$ (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 $y=0.34$ m.

4 + 8 = 12

Group – C

4. (a) Sulphuric acid of sp gr. 1.3 is flowing through a pipe ID 5 cm. A thin tipped orifice of 1 cm diameter ID fitted in the pipe and the differential pressure shown by mercury manometer is 10 cm. Assuming that the leads to the manometer are filled with acid, calculate the weight of acid flowing through pipe per hour. Assume that the value of C_o as 0.61.
- (b) Define 'coefficient of discharge' of orifice meter. What should be the range of value of this parameter and why?

8 + (2 + 2) = 12

5. (a) What is NPSH? Write the equation to calculate NPSH required for suction lift system and suction head system.
- (b) Describe the working principle of centrifugal pump.

(2 + 2 + 2) + 6 = 12

Group – D

6. (a) Kerosene is heated by hot water in a shell and tube heater. The kerosene is inside the tubes, and the water is outside. The flow is counter current. The average temperature of the kerosene is 43.3°C, and the average linear velocity is 8ft/s. The properties of kerosene at 43.3°C are sp.gravity= 0.805, viscosity =0.0015 Ns/m², specific heat= 2.44 KJ/kg.K, and thermal conductivity =0.151 W/m.K. The tubes are low carbon steel $\frac{3}{4}$ inch ID. The heat transfer coefficient on the shell side is 1703.5 W/m².K. Calculate the overall coefficient based on outside area of the tube.(1 inch= 2.54cm).
- (b) Derive an expression for logarithmic temperature difference for heat transfer by convection at steady.

6 + 6 = 12

7. (a) A small oxidized horizontal metal tube with an OD of 0.0254m and being 0.61m long with a surface temperature at 588K is in a very large furnace enclosure with fire-brick walls and the surrounding air at 1088K. The emissivity of the metal tube is 0.6 and 0.46 at 588K. Calculate the heat transfer to the tube by radiation.
- (b) Derive an expression for overall heat transfer coefficient based on outside heat exchange area.

6 + 6 = 12**Group – E**

8. Data for the laboratory filtration of CaCO₃ slurry in water at 298K are reported as follows at a constant pressure drop of 338KN/m². The filter area of the plate and frame press was A= 0.0439m² and the slurry concentration was C_s = 23.74kg/m³. 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 m³. Given: viscosity of water at 298K is 8.937×10⁻⁴ kg/m.s

t (s)	9.5	16.3	24.6	34.7	46.1	59.0	73.6	89.4	107.3
V×10 ³ (m ³)	0.498	1.00	1.501	2.0	2.498	3.002	3.506	4.004	4.502
t/V×10 ⁻³ (s/m ³)	8.83	9.5	10.86	12.3	13.9	15.35	16.83	18.38	19.85

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9. Trap rock is crushed in a gyratory crusher. The feed is nearly uniform 2-in spheres. The differential screen analysis of the product is given in column(1) of the table. The power required to crush this material is 400kW/ton. Of this 10kW is needed to operate the empty mill. By reducing the clearance between the crushing head and the cone, the differential screen analysis of the product becomes that given in column(2) in the table.

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From(a) Rittinger's law and (b) Kick's law, calculate the power required for the second operation. The feed rate is 110ton/h.

Mesh	First grind(1)	Second grind(2)	D _{pi} , mm
4/6	3.1	-	4.013
6/8	10.3	3.3	2.845
10	20	8.2	2.007
14	18.6	11.2	1.409
14/20	15.2	12.3	1.001
20/28	12	13	0.711
28/35	9.5	19.5	0.503
35/48	6.5	13.5	0.356
48/65	4.3	8.5	0.252
65/pan	0.5	-	0.178
65/100	-	6.2	0.178
100/150	-	4	0.126
150/pan	-	0.3	0.089
Total	100	100	

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Department & Section	Submission Link
BT	https://classroom.google.com/c/MzI4MzQ3OTkyMjM2/a/Mzc0MjY0MzQ4OTE0/details