(v) Shear stress in a fluid flowing in a round pipe
(a) is zero at the wall and increases linearly to the centre
(b) varies parabolically across the cross-section
(c) is zero at the centre and varies linearly with the radius
(d) remains constant over the cross-section.

(vi) Counter flow heat exchanger is preferred for
(a) rapid initial cooling (b) uniform cooling
(c) gradual cooling (d) none of the above.

(vii) Bond's constant is
(a) $0.3162W_i$
(b) $3.163W_i$
(c) $1/0.3162W_i$
(d) inversely proportional to work index.

(viii) Rate of filtration depends on
(a) Pressure drop (b) Viscosity of filtrate
(c) Cake resistance (d) all the above.

(ix) Which of the following crushing laws is most accurately applicable to the grinding of stones?
(a) Bond's Law (b) Kick's Law
(c) Rittinger's Law (d) none of these.

(x) Regime of flow is determined by
(a) Reynolds Number (b) Sherwood Number
(c) Nusselt Number (d) Graetz Number.

Group – B

2. (a) Derive Bernoulii's equation for a fluid flowing through a channel of variable area.

(b) Water is to be pumped from a pond to the top of a tower 1829 cm above the water level in the pond. It is desired to deliver 0.34 cum/min of water at a pressure of 2.08 kg/cm^2 absolute. The absolute pressure on the top of surface of pond is 1.033 kg/cm^2. The pipe line consists of 122 m length of straight pipe 7.62 cm ID with 8 elbows and 4 gate valves. Calculate the power required for the pump having an efficiency of 80%.

ii. By what factor would the area be increased if parallel flow was used to get more rapid initial cooling of CCL_4?

4 + 3 + 5 = 12

Group - E

8. Data for the laboratory filtration of $CaCO_3$ slurry in water at 298K are reported as follows at a constant pressure drop of 338KN/m^2. The filter area of the plate and frame press is 0.0439m^2 and the slurry concentration is 23.74kg/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 298K is 8.937×10^{-4} kg/m.s).

t (s) 4.4	9.5	16.3	24.6	34.7	46.1	59.0	73.6	89.4	107.3
$V \times 10^3$ (m^3)	0.498	1.00	1.501	2.0	2.498	3.002	3.506	4.004	4.502
$t/V \times 10^{-3}$ (s/m^3)	8.83	9.5	10.86	12.3	13.9	15.35	16.83	18.38	19.85

12

9. (a) A roll mill is available with rolls of 400mm diameter and capable of milling to an average product particle diameter of 0.05mm. If the coefficient of friction for the material of the roll is 0.12, what is the largest available diameter of the feed particle which could be fed to the mill?

(b) Write short notes on the following:
i. Operation of a jaw crusher
ii. Differential and cumulative screen analysis

5 + (3 + 4) =12

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2016

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 alternatives for the following: **10×1=10**

   (i) The terminal velocity of a small sphere settling in a viscous fluid varies as the
   (a) inverse of the fluid viscosity
   (b) inverse square of the diameter
   (c) first power of its dimeter
   (d) square of the difference in specific weights of solid & fluid.

   (ii) Power loss in an orificemeter is _____ that in a venturimeter.
   (a) more than (b) less than
   (c) same as (d) data insufficient.

   (iii) 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.

   (iv) Which of the following is not a dimension-less parameter?
   (a) Euler number (b) Specific gravity
   (c) Fanning friction factor (d) none of these.

Data given,
For elbow joint, L/D =32
For Gate valve, L/D = 7
and $f = \frac{0.046}{Re^{0.32}}$ for turbulent flow

5 + 7 = 12

3. (a) Derive the relationship between friction factor and frictional energy loss when a fluid is flowing through a pipe of diameter D and length L with a velocity V.

(b) What is power law fluid? Prove that effective viscosity will decrease with increase in shear rate for a pseudo-plastic fluid.

(c) The velocity distribution of a viscous liquid (μ=0.9Ns/m^2) flow 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.

3 + 3 + 6 = 12

Group - C

4. (a) A properly designed venturimeter has a throat diameter of 30 cm and inlet opening diameter of 60 cm. If it is inserted in a pipe line of 60 cm through which dry chlorine gas is flowing, the reading of the venturimeter connected to a U tube mercury manometer is 1.3 cm of Hg. Calculate the rate of flow of chlorine gas in Kg/hr. Assume the density of mercury to be 13.6 g/cc and that of chlorine gas at the conditions involved as 0.009 g/cc. The coefficient of discharge of venturimeter can be taken as 0.98

(b) What is cavitation and how this can be avoided.

8 + 4 = 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 a centrifugal pump with a diagram.

6 + 6 = 12

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Group – D

6. (a) 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/ (m^2°C). At the particular point along the pipe, the oil is at 50°C, its density is 880kg/m^3, viscosity is 2.1 cP, thermal conductivity is 0.135W/(m°C), specific heat, C_p,=217J/(g°C). What is the value of U_i, based on the inside area of the pipe? Given: $(h/(C_p.v.\rho)(Pr)^{2/3}=0.023(Re)^{-0.2}$.

   (b) The door of cold storage plant is made from two 6mm thick glass sheets separated by a uniform air gap of 2mm. The temperature of the air inside the room is -20°C and ambient air temperature is 3°C. Assume the heat transfer co-efficient between the glass and air to be 23.26W/m^2K. Determine the rate of heat leaking into the room per unit area of the door. Neglect convection effect in the air gap. K_{glass}=0.75W/mK and K_{air}=0.02W/mK.

6 + 6 = 12

7. (a) A flat furnace wall is constructed of a 114mm layer of Sil-o-cel brick, with a thermal conductivity of 0.138W/m°C backed by a 229mm layer of common brick, of conductivity 1.38 W/m°C. The temperature of the inner face of the wall is 760°C and that of the outer face is 76.6°C.
   i. What is the temperature of the interface between the refractory brick and the common brick?
   ii. Supposing that the contact between the two brick layers is poor and that a contact resistance of 0.088°Cm^2/W is present, what would be the heat loss?

   (b) Derive an expression for LMTD

   (c) CCl_4 flowing at 19,000kg/h is to be cooled from 85◦C to 40◦C using 13,500kg/h of cooling water at 20°C. The film coefficient of CCL_4 outside the tubes is 1700W/m^2°C. The wall resistance is negligible, but h_i on the water side, including fouling factors is 11,000W/m^2°C.C_p of CCl_4= 852.6J/kg°C and C_p of water = 4184J/kg°C.
   i. What area is needed for a counter current heat exchanger?

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