# B.TECH/ BT/4TH SEM/ BIOT 2202/2018
# 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) Newton's law of viscosity states that
(a) the shear stress applied to the fluid is directly proportional to the velocity gradient (du/dy)
(b) the shear stress applied to the fluid is inversely proportional to the velocity gradient (du/dy)
(c) the shear stress applied to the fluid is directly proportional to the specific weight of the fluid
(d) the shear stress applied to the fluid is inversely proportional to the specific weight of the fluid.

(ii) Shear stress in static fluid is
(a) always zero (b) always maximum
(c) between zero to one (d) unpredictable.

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

(iv) Colburn j factor is given by
(a) $0.023(Re)^{-0.2}$ (b) $0.046(Re)^{-0.2}$
(c) $J_H = f$ (d) $0.046(Re)^{0.8}$.

(v) Equivalent diameter for an annular cross section will be
(a) $\pi (d_0 - d_i)$ (b) $(d_0 - d_i)$
(c) $\pi (d_0 - d_i)/4$ (d) $(d_0 - d_i)/4$.





(vi) 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.

(vii) What is the effect of change in Reynold's number on friction factor in laminar flow?
(a) As the Reynold's number increases the friction factor increases in laminar flow
(b) As the Reynold's number increases the friction factor decreases in laminar flow
(c) change in Reynold's number does not affect the friction factor in laminar flow
(d) unpredictable.

(viii) Which of the following devices does not use Bernoulli's equation as its working principle?
(a) Venturimeter (b) Orifice-meter
(c) Pitot tube (d) None of the above.

(ix) Nusselt Number is equal to
(a) $C_P\mu/k$ (b) $Dv\rho/\mu$ (c) $h_iD/k$ (d) None of the above.

(x) Individual heat transfer coefficient is present in
(a) Reynolds Number (b) Sherwood Number
(c) Nusselt Number (d) Graetz Number.

## Group – B

2. A pump draws a solution of sp. gr. 1.84 from a storage tank through a pipe having an ID of 75 mm. The efficiency of the pump is 60%. The velocity in the suction line is 0.914m/sec. The pump discharges through a pipe of ID 50 mm to an overhead tank which is 15.2m above the level of the liquid in the feed tank. Frictional losses in the entire pipeline are 29.9 J/kg.
(i) What pressure must the pump develop?
(ii) What is the power of the pump?

**8 + 4 = 12**

3. Water flows through a pipe AB 1.0 m diameter at 3 m/sec and passes through a pipe BC which is 1.2 m in diameter. At C the pipe forks. Branch CD is 0.6 m in diameter and carries one third of the flow in AB. The velocity of the other branch CE is 2.5 m/sec. Find
i) volumetric flow rate of flow in AB, ii) the velocity in BC
iii) the velocity in CD and iv) the diameter of CE.

**4+ 4 + 4+ 4 = 12**

## Group – C

4. (a) What is meant by discharge coefficient in venturi type flowmeter?

(b) A rotameter designed to measure the flow rate of water is used to measure the flow rate of *brine* (specific gravity 1.15), without altering the scale. Would the reading be more or less than actual? Justify.

**6 + 6 =12**

5. (a) A pitot static tube is used to measure the velocity of air flowing through a duct. The manometer shows a difference in head of 5 cm of water. If the density of air and water are 1.13 kg/m$^3$ and 1000 kg/m$^3$ determine the velocity of air. Assume the coefficient of the pitot tube as 0.98.

(b) A venturimeter of 150 mm × 75 mm size is used to measure the flow rate of oil having specific gravity of 0.9. The reading shown by the U tube manometer connected to the venturimeter is 150 mm of mercury column. Calculate the coefficient of discharge for the venturimeter if the flow rate is 1.7 m$^3$/min.

**5 + 7 = 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/m$^2$, specific heat= 2.44 KJ/kg.K, and thermal conductivity =0.151 W/m.K. The tubes are low carbon steel 0.75 inch ID and 0.80 OD. The heat transfer coefficient on the shell side is 1703.5 W/m$^2$.K. Calculate the overall coefficient based on outside area of the tube.(1 inch= 2.54cm).

(b) Derive an expression for heat transfer by conduction at steady state through a two layered composite walled hollow cylinder.

**6 + 6 = 12**

7. (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 thin layer of air between 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).

(b) 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.

**6 + 6 = 12**





## Group – E

8. 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. using (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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9. 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 was A= 0.0439m$^2$ and the slurry concentration was $C_s$ = 23.74kg/m$^3$. Calculate the constants $\alpha$ 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 $8.937\times10^{-4}$ kg/m.s)

| t (s) | 9.5 | 16.3 | 24.6 | 34.7 | 46.1 | 59.0 | 73.6 | 89.4 | 107.3 |
|---|---|---|---|---|---|---|---|---|---|
| $Vx10^3$(m$^3$) | 0.498 | 1.00 | 1.501 | 2.0 | 2.498 | 3.002 | 3.506 | 4.004 | 4.502 |
| $t/Vx10^{-3}$ (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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