Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/B.TECH (BT)-NEW/SEM-4/CH-402/2012

2012

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) Dimension of absolute viscosity is

a) $ML^{-1}T^{-1}$ b) MLT^{-1}

c) $ML^{-1}T$ d) MLT.

ii) Froude number is the ratio of

a) inertial force to viscous force

b) inertial force to gravitational force

c) inertial force to surface force

d) viscous force to inertial force.

iii) Prandtl number is given by

a) $C_p \mu / D$ b) hD/k

c) $C_p \mu / k$ d) $\mu / h C_p$.

iv) The unit of heat transfer coefficient is

a) BTU/hr. ft ^{2}. °F b) BTU/hr. °F.ft

c) BTU/hr.°F d) BTU/hr.ft.

v) For a packed bed with increasing superficial velocity of fluid (up to the minimum fluidization velocity) the pressure drop against the bed

a) decreases b) increases

c) remains constant d) non-predictable.

vi) Head developed by a centrifugal pump depends on its

a) speed b) impeller diameter

c) both (a) and (b) d) neither (a) nor (b).

vii) Continuity equation is another form of

a) conservation of energy

b) conservation of volume

c) conservaion of mass

d) none of these.

viii) Flow of jet of fluid in a stagnant layer of fluid is an example of

a) wall turbulence b) free turbulence

c) both (a) and (b) d) none of these.

ix) $f = 16/NRe$ is valid for

a) Turbulent flow

b) Laminar flow through circular pipe

c) Laminar flow through open channel

d) none of these.

x) Which of the following equations is correct for laminar flow through pipe ?

a) $U/U_{max} = 0{\cdot}5$

b) $U/U_{max} = 2{\cdot}0$

c) $U_{ave}/U_{max} = 0{\cdot}5$

d) $U_{ave}/U_{max} = 2{\cdot}0.$

xi) Heat transfer by conduction is governed by

a) Fourier's law b) Stefen-Boltzmann law

c) Joule's law d) None of these.

xii) When rapid and instantaneous heat transfer is required ..... type flow is preferred.

a) countercurrent b) cocurrent

c) cross flow d) all of these.

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following. 3 × 5 = 15

2. Check the dimensional consistency of the following equation for a heat-transfer coefficient

   $h_i = 0{\cdot}023\ G^{0{\cdot}8}\ k^{0{\cdot}67}\ C_p^{0{\cdot}33}\ D^{-0{\cdot}2}\ \mu^{-0{\cdot}47}$, where the symbols have their usual meanings.

3. Show by dimensional analysis that in case of forced convection $N_{sh} = f\left(N_{Re}, N_{Sc}\right)$.

4. A packed bed is composed of cylinders having a diameter $D = 0{\cdot}02$ m and a length $h = D$. The bulk density of the overall packed bed is 962 kg/m^3 and the density of the solid cylinder is 1600 kg/m^3. Calculate (a) the void fraction and (b) the effective diameter of the particles.

5. Briefly state the criteria for settling of a particle in a fluid, which defines the settling regime like Stokes law region or Newton's law region.

6. Derive the velocity profile of a fluid flowing in laminar flow through a pipe.

GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following. 3 × 15 = 45

7. a) What is overall heat transfer coefficient ? Derive a relation between overall heat transfer coefficient and individual heat transfer coefficient.

   b) What is logarithmic mean temperature difference ? Derive its formula. 10 + 5

8. a) A flat furnace wall is constructed of a 4·5 inch layer of refractory brick, with a thermal conductivity of 0·08 Btu/ft *h* °F backed by a 9 inch layer of common brick, of conductivity 0·8 Btu/ft *h* °F. The temperature of the inner face of the wall is 1400°F, and that of the outer face is 170°F.

      i) What is the heat loss through the wall ?

      ii) What is the temperature of the interface between the refractory brick and the common brick ?

      iii) Supporting that the contact between the two brick layers is poor and that a contact resistance of 0·50°F *h* ft ^{2}/Btu is present, what would be the heat loss ?

   b) A tube 60 mm OD is insulated with a 50 mm layer of silica foam, for which the conductivity is 0·055 W/m°C, followed with a 40 mm layer of cork with a conductivity of 0·05 W/m°C. If the temperature of the outer surface of the pipe is 150°C and the temperature of the outer surface of the cork is 30°C, calculate the heat loss in watts per meter of pipe. 10 + 5

9. a) At the end of the filtration cycle, a total filtrate volume of $3{\cdot}37\ m^3$ is collected in a total time of 269·7 seconds. The cake is to be washed by thorough washing in the plate and frame press using a volume of wash water equal to 10% of the filtrate volume. Calculate the time of washing and the filter cycle time if cleaning the filter takes 20 minutes.

   b) What do you mean by screen effectiveness ? Derive an expression for overall screen effectiveness in terms of mass fraction of feed, underflow and overflow.

   c) What is blinding of screens ? 8 + (2 + 4) + 1

10. a) State Bond's Law of crushing.

   b) What are the different methods of size reduction ?

   c) A certain set of crushing rolls has rolls of 150 cm diameter by 30 cm width face. They are set so that the crushing surfaces are 1·25 cm apart at the narrowest point. The manufacturer recommends that they may be run at 50 to 100 rpm. They are to crush a rock having a specific gravity of 2·35 and the angle of nip is 30°. What are the maximum permissible size of feed and the maximum actual capacity in tons/hr, if the actual capacity is 20% of the theoretical ? 2 + 4 + 9

11. a) What are the different types of pumps used in industries ? Mention their principal uses.

b) Benzene at 100°F is pumped at the rate of 40 gal/min. The reservoir is at atmospheric pressure. The gauge pressure at the end of the dischasrge line is $50\ lb_f/in^2$. The discharge is 10 ft and the pump suction 4 ft above the level in the reservoir. The discharge line is $1\frac{1}{2}$ in. Schedule 40 pipe. The friction in the suction line is known to be $0{\cdot}5\ lb_f/in^2$, and that in the discharge line is $5{\cdot}5\ lb_f/in^2$. The mechanical efficiency of the pump is 0·60. The density of benzene is $54\ lb/ft^3$, and its vapour pressure at 100°F is $3{\cdot}8\ lb_f/in^2$. Calculate (i) the developed head of the pump and (ii) the total power input, (iii) if the pump manufacturer specifies a required NPSH of 10 ft, will the pump be suitable for this service ?

Given, for a $1\frac{1}{2}$ in. Schedule 40 pipe, a velocity of 1 ft/s corresponds to a flow rate of 6·34 gal/min. 5 + 10