A slurry of this material giving 1.5 kg of cake solid/m^3 of filtrate is to be filte
a constant pressure drop of 50 kg/cm^2 and a temperature of 20°C. Experime
this sludge and the filter cloth to be used gave a value of
$R_m = 1.2 \times 10^{10}$ m^{-1}.
A plate and frame filter is to be used. Calculate the total no of frames requir
give 2000 lit of filtrate in 1 hr. The viscosity of the water at 20°C is 1 cp and
of one frame is 300 cm^2.

6 + 6

Fluid Mechanics
(CHEN 2102)

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.

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

Group – A
(Multiple Choice Type Questions)

Choose the correct alternatives for the following: 10 x 1=10

i) The ratio of inertial forces to gravitational forces is called ---------- number
(a) Froude (b) Euler (c) Reynolds (d) Mach.

ii) The ---------- is measured by piezometric opening.
(a) Dynamic pressure (b) Static pressure
(c) Total pressure (d) Point pressure

iii) For an ideal fluid the Reynolds number is
(a) infinity (b) zero (c) one (d) 2100.

iv) For turbulent flow of the Newtonian fluid in a circular cross-section pipe, the ratio of maximum to average fluid velocity is
(a) 0.5 (b) 1 (c) 0.66 (d) < 0.5.

v) The velocity profile for a Bingham plastic fluid flowing in laminar conditions in a pipe is
(a) Flat (b) Parabolic
(c) Flat near the wall and parabolic in the middle
(d) Parabolic near the wall and flat in the middle.

vi) The operation of a venturimeter is based on
(a) Variable flow area (b) Pressure at a stagnation point
(c) Pressure drop across a nozzle (d) None of the above.

vii) The average velocity during pressure driven laminar flow through a rectangular channel is
(a) ½ maximum velocity (b) 2/3 maximum velocity
(c) 1/3 maximum velocity (d) ¼ maximum velocity.

(viii) A pipe of I.D. 4 m is bifurcated into two pipes of I.D. 2 m each. The average ve of water flowing through the main pipe is 5 m/s. Assuming equal flow through of the bifurcated section, the average velocity through the bifurcated pipe in m
(a) 5 (b) 10 (c) 20 (d) 45.

(ix) A pathline in a flow field is defined as
(a) Trajectory of a fluid particle of fixed identity
(b) A line or curve such that tangent at any point represents direction of velo that point
(c) Locus of temporary locations of all particles that passed through a fixed po a flow field at any instant of time
(d) A line such that at every point of it, the fluid velocity remains constant

(x) Toothpaste is a type of
(a) Pseudoplastic fluid (b) Dilatant fluid
(c) Bingham plastic (d) Newtonian fluid.

Group – B

2.(a) A conical funnel of half angle Φ drains through a small hole of diameter d a vertex. The speed of liquid leaving the funnel is $v = \sqrt[2]{gy}$ where y = height of l free surface above the hole. The funnel is initially filled to height y_0. Obta expression for time required to drain the funnel. Calculate the time required so if the initial height is 1 m and Φ is 30°.

(b) Given velocity field of fluid as $V = 2x(1 + 0.5t)\hat{i} + y\hat{j}$, plot the streakline fo by particles that passed through the point (1,1,0) during t= 0 to t= 3 s. Com with streamlines through the point at t = 0,1,2 s (Rectangular graph p required)

(c) Explain the concept of continuum hypothesis mentioning the significan Knudsen number

5 +5 +

3.(a) Classify the devices used for measurement of fluid pressure and expres relation between Absolute pressure, Gauge pressure and vacuum pressure. What are the gauge pressure and absolute pressure at a point 3 metre belo free surface of a liquid having a density of 1.53 x 10 ^{3} kg/m^3 if the atmos pressure is 760 mm of Hg? [Given, specific gravity of Hg is 13.6 and density of is 1000 kg/m^3].

(b) For a laminar flow of a Newtonian fluid, show that the velocity distributio circular channel with respect to its radius is a parabola.

(1+2+3)

Group – C

Considering the average velocity distribution in streamline flow through a tube for a Newtonian fluid flow, show that the relation between friction factor(f) and Reynolds No.(Re) is f= $\frac{16}{R_e}$.

) At a sudden enlargement of water main pipe diameter from 350 mm to 700 mm the hydraulic gradient rises by 10 mm. Estimate the rate of flow.

7+ 5=12

a) For laminar flow over a flat plate with zero pressure gradient, obtain an expression for boundary layer thickness (nominal) in terms of Reynolds number and wall shear stress. Assume a parabolic velocity profile over the plate.

(b) Water at 20 °C is pumped at a constant rate 10 m^3/h from a large reservoir resting on a floor to the open top of an absorption tower. The point of discharge is 5 m above the floor, and frictional losses in the 50 mm pipe from the reservoir to the tower amount to 3 J/kg. At what height from the reservoir must the water level be kept if the pump can deliver only 0.1 kW?

(c) Water flows by gravity from one reservoir to a lower one through a straight, inclined galvanized iron pipe. The pipe diameter is 50 mm, and total length is 250 m. Each reservoir is open to atmosphere. Calculate the elevation difference required to maintain a flowrate of 0.007 m^3/s. Also estimate the fraction of the total loss occupied by minor losses. The roughness factor of the pipe is 0.15 mm, minor loss coefficient at entrance is 0.5 and at exit is 1, viscosity of water is 10^{-3} m^2/s. What would be the modifications in the result obtained if the water was pumped through a smooth pipe? (Moody diagram required)

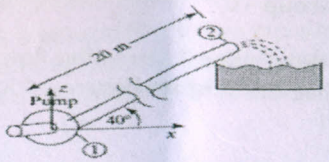
4 + 3 + 5 = 12

Group – D

(a) A vertical venturimeter has an area ratio of 5. It has a throat diameter of 1 cm. When oil of specific gravity 0.8 flows through it the mercury in the differential gauge indicates a difference in height of 15 cm. Find the discharge through the venturimeter if the coefficient of discharge is 0.98.

(b) Briefly describe the working principle of a sharp crested rectangular weir in measurement of flow in open channels. Obtain the relation between theoretical discharge and head of liquid above the crest in a triangular notch.

(c) Consider a 20 m long, 4 cm diameter pipe, discharging into an open container, as shown in Figure. The pipe inclination is 40°. The desirable flow rate is 8 L/s and the liquid properties are: density = 900 Kg/m^3 and viscosity = 0.18 Ns/m^2. Calculate the power required to pump the liquid. Neglect minor losses.



(d) Explain the working principle of a Pitot tube. What is meant by stag pressure?

3 + 4 + 3 + 2

7.(a) Write down the relations between pump head, capacity and rpm for centr pump.

(b) A centrifugal pump has the following dimensions: Inlet diameter =160 cm; o diameter = 320 cm; width of the impeller at the inlet = 5 cm; Vane angle at the (ϕ_1) = 0.45 radians; and vane angle at the outlet (ϕ_2) = 0.25 radians; width a inlet (B_1) = 5 cm; width at the outlet (B_2) = 5 cm.
Assuming shockless entry, determine the discharge and the head developed by pump when the impeller rotates at 850 r.p.m.

5 + 7 =

Group – E

8.(a) A water softener consists of a vertical tube of 100 mm diameter and packed to height of 0.5 m with ion-exchange resin particles. The particles may be consider spherical with a diameter of 1.3 mm. Water flows over the bed because of gravity well as a pressure difference at a rate of 200 mL/s. The bed has a porosity of Calculate the pressure gradient.

(b) Briefly describe the different types of fluidization. Explain what is meant minimum fluidization velocity. Mention the different applications of fluidization.

(c)Estimate the terminal velocity for limestone particles of diameter 0.08 mm(dens 2800 kg/m^3) falling in water at 30 ^{0}C. The viscosity of water is 10^{-3} Pascal sec.

(d) Explain the significance of void fraction during flow of fluid through packed bed.

3 + 4 + 3 + 2 =

9.(a) Explain the significance of the concept of Prandtl's mixing length theory in case turbulent flow and obtain an expression for the mixing length.

(b) The air is flowing over a cylinder of diameter 50 mm and infinite length with velocity of 0.1 m/s. Find the total drag, shear drag and pressure drag on 1 m leng of the cylinder if the total drag coefficient is equal to 1.5 and shear drag coefficie equal to 0.2. Take density of air as 1.25 kg/m^3.

6 + 6 =

2015

Energy Engineering
(CHEN 2103)

Full Marks : 70

Allotted : 3 hrs

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.

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

Group – A
(Multiple Choice Type Questions)

10 x 1=10

Choose the correct alternatives for the following:

(i) Coal with higher volatile matter content has
(a) Higher calorific value (b) Higher ignition temperature
(c) Higher tendency of spontaneous oxidation (d) None of these.

(ii) Coal demand in India is maximum for
(a) Thermal power Industry (b) Steel Industry
(c) Cement Industry (d) Brick Industry.

(iii) Which process among the following is a thermal cracking process?
(a) Hydrocracking (b) Catalytic reforming
(c) Hydrotreating (d) Visbreaking.

(iv) Which type of compound has the highest octane number?
(a) Paraffins (b) Olefins
(c) Aromatics (d) Napthenes.

(v) For a controlled nuclear reaction, the multiplication factor must be
(a) <1 (b) >1
(c) =1 (d) None of these.

(vi) Volatile matter in coal is determined by heating the coal sample in muffle furnace
(a) at 800°C for 10 min (b) at 850°C for 9 min
(c) at 900°C for 8 min (d) at 925°C for 7 min.

(vii) Cetane number is highest for
(a) Aromatics (b) Paraffins
(c) Napthenes (d) Olefins.

(viii) The cold weather performance of a fuel is indicated by its
(a) Calorific value (b) Pour point
(c) Flash point (d) Smoke point.