Reg.No.									

INTERNATIONAL CENTRE FOR APPLIED SCIENCES

(Manipal University)

III SEMESTER B.S. DEGREE EXAMINATION – OCT. / NOV. 2017

SUBJECT: Fluid Flow Operations in Biotechnology

(BRANCH: INDUSTRIAL BIOTECHNOLOGY)

Saturday, 4 November 2017

Time: 3 Hours **Max. Marks: 100**

- ✓ **Answer ANY FIVE full Questions.**
- ✓ **Missing data, if any, may be suitably assumed**

1A. Determine the pressure exerted on the surface of a submarine cruising 300ft below the free surface of the sea. Assume that the barometric pressure is 14.7psia and the specific gravity if sea water is 1.03. (5)

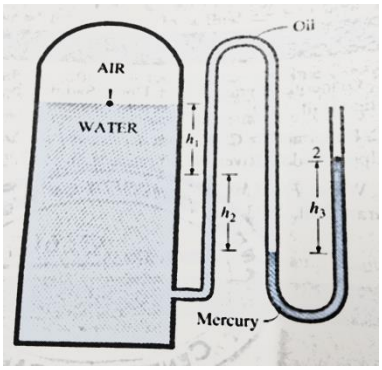
1B. Explain the following i) viscous and inviscid flow ii) laminar and turbulent flow (5)

1C. Explain the Newton's law of viscosity (5)

1D.The velocity distribution for flow over a flat plate is given by $u=3/4y-y^2$ in which u is the velocity in meter per second at a distance y meter above the plate. Determine the shear stress at y=0.15m. Take the dynamic viscosity of the fluid as 8.6 poise. (5)

2A. A square metal plate 1.8m side and 1.8mm thick weighing 60N is to be lifted through a vertical gap of 30mm of infinite extent. The oil in the gap has a specific gravity of 0.95 and a viscosity of $3Ns/m^2$. If the metal plate is to be lifted with a constant speed of 0.12m/s, find the force required? (5)

2B. The water tank is pressurized by air, and the pressure is measured by multifluid manometer as shown. Determine the guage pressure of air in the tank if h1=0.2m , h2=0.3m and h3=0.46m. take the densities of water, oil and mercury to be $1000kg/m^3$, $850kg/m^3$, $13600 kg/m^3$ respectively. (5)



2C. Determine the atmospheric pressure at a location where the barometric reading is 750mm Hg. Take the density of mercury to be $13600kg/m^3$. (5)

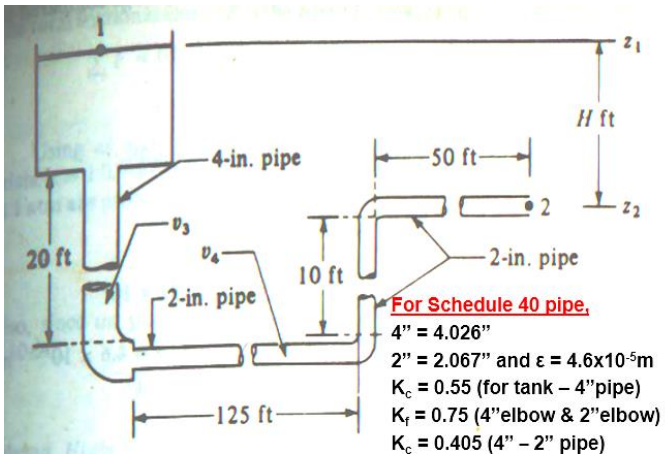
2D. State the relation between guage, atmospheric and absolute pressure and explain. (5)

3A. Air enters a nozzle steadily at $2.21kg/m^3$ and 30m/s and leaves at $0.762kg/m^3$ and 180m/s. If the inlet area of the nozzle is $80cm^2$, determine (i) the mass flow rate through the nozzle (ii) the exit area of the nozzle. Comment on the answer. (10)

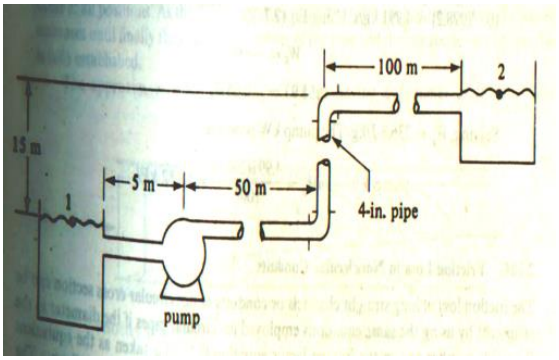
3B. A pitot static probe is used to measure the velocity of an aircraft flying at 3000m. If the differential pressure reading is 3kPa, determine the velocity of the aircraft. List the assumptions. (5)

3C. Explain the conservation of mass principle. (5)

4A. An elevated storage tank contains water at 82.2°C as shown in Fig. It is desired to have a discharge rate at point 2 of $0.223ft^3/s$. What must be the height H in ft of the surface of the water in the tank relative to the discharge point? The pipe used is commercial steel pipe, schedule 40, and the lengths of the straight portions of pipe are shown. Density = 0.97 g/cc ; viscosity = 0.347 cP, friction factor, f (both for 4 and 2 inch pipe)=0.0047 (10)



4B. Water at 20ºC is being pumped from a tank at the rate of $5x10^{-3}$ m^3/s. All of the piping is 4" schedule 40 pipe. The pump has an efficiency of 65%. Calculate the kW power needed for the pump.
Given that for 4" Schedule 40 pipe, D=0.1023m, Kc=0.55, Density = 998.2 kg/m^3, K_f=0.75, Viscosity=1.005 cP, Kex=1.0, f=0.0051. Mention the assumptions if any. (10)



5A. Explain why streamlined bodies experience less pressure drag. (5)
5B. Explain the separation of boundary layer in a flow over a sphere. (5)
5C. A lubricating oil of viscosity 1 poise and specific gravity 0.9 is pumped through a 30mm diameter pipe. If the pressure drop per meter length of the pipe is $20kN/m^2$, determine (i) the mass flow rate in kg/min (ii) the shear stress at the pipe wall (iii) The Reynolds number (iv) the power required per 50m length of the pipe to maintain the flow. (10)

6A. Solid particles having a size of 0.12mm, a shape factor of 0.88 and a density of $1000kg/m^3$ are to be fluidized using air at 2 atm abs and 25ºC. The voidage at min. fluidization is 0.42. a) If the cross section of the empty bed is $0.3m^2$ and the bed contains 300kg of solid, calculate the minimum height of the fluidized bed. b) Calculate the pressure drop at min. fluidization conditions. c) Calculate the min. velocity for fluidization. Air properties at 2 atm abs and 25ºC are Viscosity=$1.845x10^{-5}$ Pas; density = 2.374 kg/m^3 (10)
6B. Explain the terms fluidization, minimum fluidization velocity and free settling. (5)
6C. Calculate the settling velocity of dust particles of (a) 60 mm and (b)10 mm diameter in air at 21°C and 100 kPa pressure. Assume that the particles are spherical and of density 1280 kg/m^3, and that the viscosity of air = 1.8×10^{-5} Ns/m^2 and density of air = 1.2 kg/m^3. (5)

7A. Explain the working principle of a venturimeter and a rotameter. (10)
7B. A horizontal venturimeter with inlet and throat diameters 300mm and 100mm respectively is used to measure the flow of water. The pressure intensity at the inlet is $130kN/m^2$ while the vaccum pressure head at the throat is 350mm mercury. Assuming that 3 % of head is lost in between the inlet and the throat, find (i) coefficient of discharge of venturimeter and (ii) rate of flow. (10)

8A. Explain the terms hydraulic radius and roughness factor and their importance in fluid flow. (5)
8B. In a pipe 300mm diameter the maximum velocity of flow is found to be 2m/s. If the flow in the pipe is laminar find (i) the average velocity and the radius at which it occurs (ii) the velocity at 50mm from the wall of the pipe. (10)
8C. For a laminar flow, the ratio of average velocity to maximum velocity is 0.5. Prove this statement.(5)