# II B.Tech I Semester Examinations,MAY 2011 PROCESS ENGINEERING PRINCIPLES Bio-Technology 

Time: 3 hours

## Answer any FIVE Questions

All Questions carry equal marks

1. Write short notes on :
(a) Streamlines
(b) Streamtubes
(c) Potential flow
(d) Fully developed flow.
2. (a) Differentiate between pitot tube and venturi meter.
(b) Explain the stuffing box and Mechanical seal
3. By taking an example Discuss the various unit operations you encounter in the bioprocess industry.
4. What is the relation between ep and c, derive it?
5. The following rheological data were obtained with a fermentation broth in the very initial stages of fermentation. Find out whether the fluid is Newtonian or non-Newtonian. If it a Newtonian fluid, find the rheological constants. It is a Newtonian fluid, find the viscosity of the fluid.
[15]
Rheologieal data:

| $\frac{d \mu}{d \gamma}\left(\mathrm{sec}^{-1}\right)$ | 5 | 10 | 15 | 20 | 32 | 50 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\mathrm{~T}\left(\mathrm{~N} / \mathrm{m}^{2}\right)$ | $1 \times 10^{-2}$ | $2.1 \times 10^{-2}$ | $2.96 \times 10^{-2}$ | $4.1 \times 10^{-2}$ | $6.2 \times 10^{-2}$ | 0.1 |

6. Write briefly on the following :
(a) Friction factor chart
(b) Velocity distribution in laminar flow
(c) Velocity distribution in turbulent flow
(d) Indicate the difference between skin friction and form friction. $[3+4+4+4]$
7. Catalyst pellets 5 mm in diameter are to be fluidized with $45000 \mathrm{~kg} / \mathrm{h}$ of air at 1 atm and 800 C in a vertical cylindrical vessel. The density of the catalyst particles is $960 \mathrm{~kg} / \mathrm{m}^{3}$ their sphericity is 0.86 . If the given quantity of air is just sufficient to fluidize the solids, what is the vessel diameter?
8. (a) Draw the characteristic curves for a centrifugal pump.
(b) What is a positive displacement pump? Describe the working of any one type with neat sketch.

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1. Explain drag and drag coefficient giving all equations and relations.
2. (a) An open tank contains 5.7 m of water covered with 2.8 m of kerosene $(\rho=8.0$ $\mathrm{kN} / \mathrm{m}^{3}$ ). Find the pressure at the interface and at the bottom of the tank.
(b) If air had a constant specific weight of $0.076 \mathrm{lb} / \mathrm{ft}^{3}$ and were incompressible, what would be the height of the atmosphere if sea leyel pressure were 14.92 psia.
[8+7]
3. With a neat diagram derive an equation to measure the mass flow rate using the Rotameter?
4. The capillary tube of diameter 2 mm and length 100 mm is used for measuring viscosity of liquid. The difference of pressure between the two ends of the tube is $0.6867 \mathrm{~N} / \mathrm{cm}^{2}$ and the viscosity of the liquids is 0.25 poise. Find the rate of flow of the fluid through the tube
5. (a) What is Mach number, Subsonic and supersonic?
(b) Derive equation for Mach number of an ideal gas in terms of its acoustic velocity. $\quad[10+5]$
6. (a) Define and explain briefly volumetric efficiency?
(b) Write the working procedure of peristaltic pumps.
7. (a) What is momeutum balance equation ? Explain about the driving force for momeutum balance.
(b) Why heat transfer take place from one point to the another point? Explain.

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[8+7]
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8. (a) Expalin how ideal gas law is used to evaluate PVT data.
(b) Define " Force "
$[11+4]$

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1. Sulfuric acid is pumped at $3 \mathrm{~kg} / \mathrm{sec}$ through a pipeline of 25 mm diameter and 60 m length. Calculate the drop in pressure. If the pressure drop falls one half, what will be the new flow rate?
2. What are the applications of fluidization? Explain.
3. Explain in detail about the unit operation and unit processes.
4. (a) How does a U-tube manometer function? Derive an expression for ( $P_{1}-P_{2}$ ) in terms of measurable quantities.
(b) What are the importance of check valves in process industries and explain its working?
5. Discuss about the compressibility factor for ideal gas.
6. Derive the relations between skin friction, Wall shear, Pressure drop and friction factor and give the equations? Explain the terms involved in it.
7. (a) Describe the working of an Airlift pump and explain on what factors its efficiency dependent.
(b) Write short notes on Selection of pumps for handling of liquids.
8. Write short notes on
(a) Newton's law of Viscosity
(b) Power law of fluids
(c) Effect of temperature on viscosity.

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1. (a) Differentiate between venture and orifice meters.
(b) Explain how pressure is recovered in the both meters? Explain.
2. 6 liters per min. of volume are flowing through a pipe of 1.2 cm .D. pipe. If the density of volume is $0.87 \mathrm{gm} / \mathrm{cm}^{3}$. calculate
(a) Volumetric flow rate $\mathrm{cm}^{3} / \mathrm{sec}$
(b) Mass flow rate gm / sec
(c) Average velocity $\mathrm{cm} / \mathrm{sec}$ and
(d) Mass velocity gm / sec $\mathrm{cm}^{2}$.

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[4+4+4+3]
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3. For turbulent flow in packed beds derive the pressure drop equation with suitable assumptions?
4. Discuss in detail about the virial equations of state and virial coefficients.
5. Write in detail about the various unit operations that are widely used in biotech industry.
6. An oil of density $917 \mathrm{~kg} / \mathrm{m}^{3}$ is being pumped in a pipe of diameter 15 cm . The discharge is measured as $850 \mathrm{~L} / \mathrm{min}$. The drop in the pressure in a stretch of 800 m pipe line, both end of which are at the same elevation, is measured as 95 kPa .Estimate the absolute viscosity of oil.
7. Find an expression for eddy viscosity from the formula for the logarithmic velocity profile in the turbulent core. Is the quantity, a function of $\mathrm{R}_{e}$ or position?
8. It is proposed to pump $10,000 \mathrm{~kg} / \mathrm{hr}$ of toluene at 1140 C and 1.1 atm absolute pressure from the re-boiler of a distillation tower to a second distillation unit without cooling the toluene before it enters the pump. If the friction loss in the line between reboiler and pump is $7 \mathrm{kN} / \mathrm{m}^{2}$ and the density of toluene is $866 \mathrm{~kg} / \mathrm{m}^{3}$, how far above the pump must the liquid level in the reboiler be maintained to give a net positive suction head of 2.5 m ?
