

BTECH
(SEM III) THEORY EXAMINATION 2018-19
CHEMICAL ENGINEERING FLUID MECHANICS

Time: 3 Hours

Total Marks: 100

Notes: Assume any Missing Data.

1 Attempt **all** parts of the following:

7x2=14

- a. Explain Newton's Law of viscosity.
- b. What is Weber number with its physical significance?
- c. Explain Pascal's Law.
- d. Explain vacuum & absolute Pressure.
- e. Define stream lines & Path Lines.
- f. What is NPSH?
- g. Define irrotational and incompressible flows.

2 Attempt any **three** parts of the following :

3x7=21

- a. What size of the orifice meter would give a pressure difference of 41 cm water column for the flow liquid styrene of sp. gr. 0.9 at flow rate of 0.055 m³/s in a 25 cm diameter pipe?
- b. Describe the various types of flow meters. Describe with neat sketch the working of rotameter.
- c. State the Buckingham's Pi theorem. A fluid is steadily flowing through a straight circular tube. The pressure drop P is a function of ρ , μ , v of fluid, D and L of the tube. Develop the dimensionless group using Pi theorem.
- d. Determine the continuity equation is satisfied by the following velocity components for an incompressible fluid: $u=x^2y$, $v=2xz-xy^2$, $w=x^2-z^2$.
- e. What is the relationship among the impeller diameter D (inches), the head developed, H (in ft of liquid pumped), and speed of the centrifugal pump (rpm)?

3 Attempt any **one** of the following :

1x7=7

- a. For sudden expansion in a pipe flow, work out the optimum ratio between the diameter of the pipe before expansion and the diameter of the pipe after expansion so that pressure rise is maximum?

b. Derive the Bernoulli's equation for both ideal and real fluids. Explain its applications in the fluid flow operations.

4 Attempt any **one** of the following : **1x7=7**

a. Determine the rate of flow of water through a pipe 300 mm diameter placed in an inclined position where a venturimeter is inserted, having a throat diameter of 150 mm. The difference of pressure between the main throats is measured by a liquid of specific gravity 0.7 in an inverted U-tube which gives a reading of 260 mm. The loss of head between the main and throat is 0.3 times the kinetic head of the pipe.

b. Derive the Navier-Stokes equation of motion and so how it can be converted to Euler's equation for non viscous flow.

5 Attempt any **one** of the following : **1x7=7**

a. Define surface tension. Establish the relationship among surface tension (σ), pressure within the droplet of liquid in excess of outside pressure (p) and diameter of droplet d .

b. Given that $u = -4ax(x^2 - 3y^2)$, $v = 4ay(3x^2 - y^2)$. Examine whether these velocity components represent a physically possible two-dimensional flow; if so whether the flow is rotational or irrotational?

6 Attempt any **one** of the following : **1x7=7**

a. What is fluid? Give the classification of fluids. Explain difference between fluid static and fluid dynamics?

b. A rotameter tube is 0.3 long with an internal diameter of 25 mm at the top and 20 mm at the bottom. The diameter of the float is 20 mm, its specific gravity is 4.80 and its volume is 6.0 cm^3 . If the coefficient of discharge is 0.7, what will be the flow rate of water when the float is halfway up the tube? Density of water is assumed to be 1000 kg/m^3 .

7 Attempt any **one** of the following : **1x7=7**

a. Give the classification of pumps. Explain the working and operation of a centrifugal pump with the help of a neat diagram.

b. The axial velocity profile in a pipe is given by $u = u_m(1 - r/R)^n$ where R = radius of the pipe and u_m = maximum velocity at $r = R$. Calculate the average velocity for $n = 1/15$ and $n = 1/2$.