

JK LAKSHMIPAT UNIVERSITY, JAIPUR
INSTITUTE OF ENGINEERING AND TECHNOLOGY

End Term Examination (Backlog), November 2017
B. Tech/ M. Tech (as applicable) in Chemical Engineering, Semester Third

Roll No.....

COURSE CODE: CHE302

Time: 3 hours

Max. Marks: 100

COURSE TITLE: Fluid Flow Operations

Instructions to students:

1. Do not write anything other than your roll number on question paper.
 2. **Assume suitable data wherever required and mention it clearly.**
 3. Writing appropriate **units, nomenclature, and drawing neat sketches/ schematics/ flow chart** wherever, required are an integral part of the answer.
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Q.1A Objective type multiple choice questions (10 questions @ 1 mark) 10

- i. Newton's law of viscosity relates:
 - (a) Pressure, Velocity, and viscosity
 - (b) shear stress and rate of angular deformation in a fluid
 - (c) Temperature, viscosity, and velocity
 - (d) Pressure, temperature, viscosity, and rate of angular deformation in a fluid
- ii. The resistance of a fluid to shear depends:
 - (a) upon cohesion only
 - (b) upon its rate of transfer of molecular momentum only
 - (c) upon its cohesion and rate of transfer of molecular momentum
 - (d) upon other factors than its cohesion and rate of transfer of molecular momentum
- iii. The viscosity of the liquid
 - (a) Remains unaffected with change in temperature
 - (b) Decreases with increases in temperature
 - (c) Increases with increase in temperature
 - (d) Is dependent on pressure only
- iv. Mercury is used in barometers due to
 - (a) Its very low vapour pressure
 - (b) Its high density
 - (c) Its low compressibility
 - (d) Negligible capillary effect
- v. Vapour pressure of a liquid is due to
 - (a) The existence of free surface
 - (b) The fluid pressure
 - (c) The pressure of air above the free surface
 - (d) The molecules of liquid which hang over the free surface
- vi. The pressure at a point in a static or uniformly moving fluid is equal in all direction. This statement is known as
 - (a) Newton's law of gravitation
 - (b) Archimedes principle
 - (c) Pascal law
 - (d) Toricelli's theorem.
- vii. The device which may be used for measuring small differences in pressure is
 - (a) U-tube manometer
 - (b) Inclined manometer
 - (c) Mercury barometer
 - (d) Hydrometer
- viii. A floating body displaces a volume of liquid equal to

- (a) Its own weight
 - (b) Its submerged weight
 - (c) Its own volume
 - (d) Its submerged volume
- ix. A hydrometer
- (a) is used to measure the absolute pressure
 - (b) use the principle of buoyant force to determine specific gravities of liquids
 - (c) is used to determine viscosities of liquids
 - (d) is used to measure the local atmospheric pressure
- x. A stream line
- (a) is always the path of a particle
 - (b) is a line drawn in the flow region such that the tangent drawn at any point on the line indicates the direction of velocity
 - (c) is a line drawn in the flow region such that there is mass flow across the line
 - (d) is not fixed in steady flow

- Q.2 Short answer type questions (4 questions @ 2.5 marks) 10
- A. Explain the classification of fluids on the basis of density and viscosity.
 - B. Define the buoyancy force with suitable example.
 - C. Explain the Darcy's law with suitable example.
 - D. Derive the correlation for Newton's law of viscosity.
- Q.3A Define the pascal's law and derive the correlation for the state of rest. 5
- Q.3B A flat plate 0.1 m^2 area is pulled at 30 cm/s relative to another plate located at a distance of 0.01 cm from it, the fluid separating them being water with viscosity as 0.001 Ns/m^2 . Find the force and power required to maintain the velocity. 5
- Q.4A Derive the correlation to determination the location of the hydrostatic force on submerged horizontal surface. 5
- Q.4B A tank contains water of density 1000 kg/m^3 upto a height 3 m above the base. An immiscible liquid of specific gravity 0.8 is filled on top of that over 2 m depth. Calculate the pressure at a point 1.5 m below the free surface, at the interface and at another point 2.5 m below the free surface. Calculate also the force on a vertical wall, 6 m wide. 5
- Q.5A Define the piezo metric heads. 5
- Q.5B The velocity of an incompressible fluid in a pipeline must be halved by providing a diverging pieces only one diameter long. Determine the cone angle of the piece. 5
- Q.6A Derive the correlation to determine the pressure in Upright U-tube manometers. 5
- Q.6B1 A fireman must reach a window 40 m above the ground with a water jet, from a nozzle 3 cm diameter discharging 30 kg/s . assuming the nozzle height of 2 m , determine the greatest distance from the building where the fireman can stand and still reach the jet into the window. 5
- OR
- Q.6B2 A 300 mm diameter pipe carries water under a head of 20 m with a velocity of 3.5 m/s . if the axis of the pipe turns through 45 degree in the horizontal plane, find the magnitude and direction of the force at the bend. 5
- Q.7A Define and derive the Bernoulli's theorem with suitable diagram. 5
- Q.7B1 A centrifugal pump has an impeller with inner and outer diameters 15 cm and 5

25cm respectively. Effective outlet area is 180 cm^2 and discharge $0.03 \text{ m}^3/\text{s}$. the blades are curved backward with 40° . Suction and delivery diameter are 5 cm each and pressure heads at suction and delivery are -5 m and $+15 \text{ m}$ respectively with respect to atmospheric pressure. The motor delivers 8 kW at 1450 r.p.m. assume that the true outlet whirl velocity is 70% of ideal. Determine the manometric efficiency and the overall efficiency for medium as water.

OR

- Q.7B2 Water discharge freely at a rate of 98 liters/second through a 120 mm diameter vertical sharp edged orifice under a constant load of 10 m of water. A point on the jet measured from the vena contracta has the coordinates $(+4.5\text{m}, -0.54\text{m})$. Find the hydraulic coefficient of discharge, velocity and contraction for the flow through the orifice. 5
- Q.8A A venturimeter with 7 cm throat diameter is fitted in a 15cm diameter vertical pipeline with upward discharge. The absolute pressure at a point 6 m below the throat is 5 atmospheres which the pressure at the throat is such that it supports a column of 20 cm water gauge. (i) Estimate the discharge through the pipe. (ii) Find the pressure at a point 6 m above the throat. 10
- Q.9A Derive the correlation to determine the velocity in laminar flow through an annulus geometry. 10
- Q.9B1 Is the flow expressed by the velocity potential, $\phi = Ux + K \log r$, possible for all U and K ? Sketch the flow if $U=10 \text{ m/s}$ and $K=5 \text{ m}^2/\text{s}$. 10

OR

- Q.9B2 An oil having a viscosity of $0.0098 \text{ kgf second per square meter}$ and a specific gravity of 1.59 flows through a horizontal pipe of 5 centimeter diameter with a pressure drop of $0.06 \text{ kg per square centimeter per meter length}$ of the pipe. Determine (i) the rate of flow in kilograms per minute, (ii) the shear stress at the pipe wall, (iii) the total drag for 100-meter length of the pipe and (iv) the power required for the 100-meter length of the pipe to maintain the flow. 10

*****Good Luck*****