

GUJARAT TECHNOLOGICAL UNIVERSITY

BACHELOR OF ENGINEERING – SEMESTER 4 – EXAMINATION – SUMMER 2026

Subject Code: BE04000161

Date: 21/05/2026

Subject Name: Fluid Mechanics

Time: 10:30 AM TO 01:00 PM

Total Marks: 70

Instructions:

1. Attempt all questions.
2. Make suitable assumptions wherever necessary.
3. Figures to the right indicate full marks.
4. Simple and non-programmable scientific calculators are allowed.

- Q.1**
- (a) The surface tension of water in contact with air at 20°C is 0.0725 N/m. The pressure inside a droplet of water is to be 0.02 N/cm² greater than the outside pressure. Calculate the diameter of the water droplet. 03
 - (b) Explain the terms: Compressibility and Bulk Modulus. 04
 - (c) Find the magnitude and direction of the resultant force due to water acting on a roller gate of cylindrical form of 4.0 m diameter, when the gate is placed on the dam in such a way that water is just going to spill. Take the length of gate as 8 m. 07
- Q.2**
- (a) Differentiate between: (i) Uniform and Non-Uniform flow (ii) Compressible and incompressible flow (iii) Rotational and Irrotational flow. 03
 - (b) A fluid flow field is given by $V = x^2y\mathbf{i} + y^2z\mathbf{j} - (2xyz + y^2z)\mathbf{k}$. Prove that it is a case of possible steady incompressible fluid flow. Calculate the velocity at the point (2, 1, 3). 04
 - (c) State Euler's equation. Derive Bernoulli's equation from Euler's equation. What are the limitations of Bernoulli's equations? 07
- OR
- Q.2**
- (c) Derive continuity equation in three dimensional Cartesian coordinates with usual notation and reduce it for steady incompressible flow. 07
- Q.3**
- (a) Explain Hydraulic Grade Line and Total Energy Line. State their physical significance. 03
 - (b) Show that the value of co-efficient of friction for viscous flow through a circular pipe is given by, $\lambda = 64/Re$ where Re = Reynolds number. 04
 - (c) Derive Hagen–Poiseuille equation for laminar flow through a pipe. A pipe of diameter 150 mm carries oil ($\mu = 0.9 \text{ Ns/m}^2$). Calculate discharge when pressure drop over 10 m length is 50 kPa. 07
- OR
- Q.3**
- (a) Explain Darcy–Weisbach equation for head loss due to friction in pipes. 03
 - (b) Explain Moody diagram and its practical importance. 04
 - (c) An oil of viscosity 0.1 Ns/m² and relative density 0.9 is flowing through a circular pipe of diameter 50 mm and of length 300 m. The rate of flow of fluid through the pipe is 3.5 liter/s. Find the pressure drop in the length of 300 m and also the shear stress at the pipe wall. 07
- Q.4**
- (a) Explain Reynolds, Froude and Mach numbers with physical significance 03

- (b) If power P required to transport a fluid through a pipe depends on length of pipe L, diameter D, surface roughness K, discharge Q, density ρ and coefficient of dynamic viscosity μ . Using Buckingham-Pi method, find the desired expression. **04**
- (c) The inlet and throat diameter of the horizontal venturi meter is 30 cm and 10 cm respectively. The water is flowing through the meter. The pressure at the inlet is 13.734 N/cm^2 while the vacuum pressure head at throat is 37 cm of mercury. If the 4% of the differential head is lost between inlet and throat, find coefficient of discharge and volume flow rate. **07**

OR

- Q.4** (a) Differentiate the term dimensional analysis and model analysis **03**
- (b) Using Buckingham's π -theorem, show that the velocity through a circular orifice is given by

$$V = \sqrt{2gH} \phi[D/H, \mu/\rho V H]$$
Where, H = Head causing flow, D = Diameter of the orifice, μ = Co-efficient of viscosity, ρ = Mass density, and g = Acceleration due to gravity. **04**
- (c) A nozzle of diameter 20 mm is fitted with the pipe of diameter 40 mm. find the force exerted by the nozzle on the water which is flowing through the pipe at rate of $1.2 \text{ m}^3/\text{min}$. **07**

- Q.5** (a) Explain laminar and turbulent flow with velocity distribution diagrams. **03**
- (b) Explain surface tension and capillarity with two engineering applications each. **04**
- (c) Derive an expression for velocity for the sound wave in a compressible fluid in terms of change of pressure and change of density. **07**

OR

- Q.5** (a) Explain the term co-efficient of friction. On what factors does this co-efficient depends? **03**
- (b) Differentiate between stable, unstable, and neutral equilibrium of floating bodies with neat sketches. **04**
- (c) Prove that the velocity of sound wave in compressible fluid is given by $c = \sqrt{\frac{K}{\rho}}$, where K = Bulk modulus of fluid and ρ = Density of fluid. **07**
