KATHMANDU UNIVERSITY
End Semester Examination
March, 2025

Marks Scored:

Level : B.Sc.
Year : II

Course : PHYS 202
Semester : I

Exam Roll No. :

Time: 30 mins.

17 MAR 2025

F. M. : 20

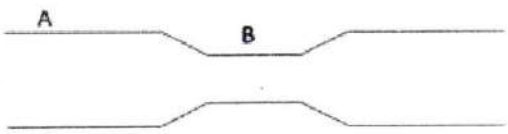
Registration No.:

Date : 17 MAR

SECTION "A"
[20Q. × 1 = 20 marks]

Choose and tick the most appropriate answer. The symbols, unless mentioned otherwise, have their usual meanings.

1. Water flows in a horizontal tube as shown in Figure.The pressure of water change by 600 N/m^2 between A and B where the areas of cross section are 30cm^2 and 15 cm^2. The rate of flow of water through the tube is equal to



a. 1890 cm^3/s b. 945 cm^3/s c.945 m^3/s d. 600 cm^3/s

2. A fluid motion is said to be irrotational if
a. $\nabla^2 V = 0$ b. $\nabla \times V = 0$ c. $\nabla . V = 0$ d. $\nabla \times V^2 = 0$

3. Which of the following statement is **TRUE**?
a. a free vortex is irrotational except at the origin
b. a free vortex is always irrotational
c. a forced vortex is irrotational
d. a thermodynamically isentropic flow is rotational

4. Water is flowing through a pipe of non-uniform cross-section. At the extreme narrow portion of the pipe, the water will have
a. maximum pressure and minimum velocity
b. minimum pressure and maximum velocity
c. both pressure and velocity maximum
d. both pressure and velocity minimum

5. In inertial flows, transition from laminar to turbulent does not take place until
a. Re >1000 b. Re <1500 c. Re >2000 d. Re >3000

6. Bernoulli's theorem is based on the conservation of
a. momentum b. mass
c. angular momentum d. energy

7. Which one of the following statements is true?
a. circulation is defined as $\Gamma = \int \vec{V}.\vec{ds}$
b. circulation is defined as $\Gamma = \int \vec{V}\vec{dv}$
c. circulation per unit length equals vorticity
d. circulation per unit volume equals vorticity

8. The apparent modulus of normal stress in incompressible Newtonian fluid of coefficient of viscosity (μ) is equal to

a. μ b. 2μ c. $\mu/2$ d. zero

9. In a flow over a flat plate, the boundary layer thickness is expressed as

a. $\frac{\delta(x)}{x} = \frac{5}{\sqrt{Rex}}$ b. $\frac{\delta(x)}{x} = \text{constant}$ c. $\frac{\delta(x)}{x} = \frac{5}{Rex}$ d. $\frac{\delta(x)}{x} = \frac{5}{R^2_{ex}}$

10. A large cylindrical tank has a whole of area A at its bottom. Water is poured in to the tank by a tube of equal cross-sectional area A ejecting water at the speed v.

a. The water level in the tank will keep on rising
b. No water can be stored in the tank
c. The water level will rise to a height $v^2/2g$ and then stop
d. The water level will oscillate

11. A velocity field in an incompressible fluid medium is given by $V = 3y^2\hat{i} - 6x\hat{j}$, the expression for stream function is

a. $\psi = yx^3$ b. $\psi = 0$ c. $c = -xy$ d. $\psi = 3x^2 - y^3$

12. In practice frictional effects in the flows of fluid are accounted by

a. adding a head loss to Bernoulli's equation at a downstream location
b. adding a head loss to Bernoulli's equation at an upstream location
c. subtracting a head loss to Bernoulli's equation at a downstream location
d. multiplying a head loss to Bernoulli's equation at a downstream location

13. Water flows through a tube of larger diameter (A) to a tube of smaller one (B). If V_1 and V_2 be the velocities of the fluid in tube A and B respectively, the head loss due to contraction is expressed as

a. $h_L = 0.5\frac{v_2^2}{2g}$ b. $h_L = 0.5\frac{v_1^2}{2g}$ c. $h_L = \frac{v_1^2}{2g}$ d. $h_L = \frac{v_1^2 - v_2^2}{2g}$

14. The velocity of efflux of a liquid from an orifice is equal to

a. $\sqrt{gH}$ b. gH/2 c. $\sqrt{2gH}$ d. $2\sqrt{gH}$

15. Euler's equation in three dimension is expressed as

a. $\rho\frac{D\bar{V}}{Dt} = -\nabla p - \rho g\hat{k}$ b. $\rho\frac{D\bar{V}}{Dt} = -\rho g\hat{k}$

c. $\rho\frac{D\bar{V}}{Dt} = -\nabla p$ d. $\frac{D\bar{V}}{Dt} = -\nabla p - \rho g\hat{k}$

16. Which one of the following statement is **TRUE**?

a. a streamline represents the trajectory of a fluid particle in steady motion.
b. a streamline represents the trajectory of a fluid particle in unsteady motion
c. streamline is always normal to the velocity at a every point
d. the concept of stream function is common only to an irrotational flow

17. In a flat plate flow, the pressure gradient is

a. negative b. zero c. positive d. either (a) or (b)

18. A square plate of side 0.1m moves parallel to another plate with velocity of 0.1 m/s, both plates immersed in water. If the viscous force is 0.02 N and coefficient of viscosity of water is 0.01 poise, the separation between the plates is

a. 2.5 mm b. 5 cm c. 0.05 mm d. 0.5 mm

19. The turbulence in a fluid flow is said to be isentropic when

a. $\overline{u'^2} = \overline{v'^2} = \overline{w'^2}$ b. $\overline{u'} = \overline{v'} = \overline{w'}$

c. $u = v = w$ d. u= constant

20. The ratio of average to maximum velocity of fluid flowing through a pipe of radius R is equal to

a. 1 b. 2 c. 1/2 d. 4

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SECTION "B"
[5Q × 4 = 20 marks]

Attempt *ALL* questions.

1. Derive an expression for the energy loss due to sudden contraction in a fluid flow.

2. Explain the terms stream line and stream function. Prove that stream functions satisfy the continuity equation.

3. The x and y components of velocity in a two dimensional incompressible flow are given by u=3x+y, v= 2x-3y. Derive an expression for the stream function, and hence show that the flow is not irrotational.

4. Deduce an expression for the discharge through an orifice at the side of a large tank.

5. What is Reynolds number? Discuss its significance in fluid dynamics.

SECTION "C"
[5Q × 7 = 35 marks]

Attempt *ALL* questions.

6. Describe flow potential and flow resistance of a fluid and also show the analogy with electrical potential and resistance

7. Give a thermodynamic interpretation of Bernoulli's equation.

8. Describe the solution of Navier-Stokes equation for the flow of a fluid in a channel formed by two parallel plates and also explain the velocity profile.

OR

Find the expressions for the displacement thickness and momentum thickness and hence establish the relation $\delta > \delta_1 > \delta_2$.

9. The pressure field in a steady flow of an ideal fluid is given by $p = 10\text{-}6x^2\text{-}3yz^2$ Pa. If the fluid has a mass density of 1000kg/m^3, evaluate the acceleration of the fluid element at a location $r = 6\hat{i} + 2\hat{j} + 10\hat{k}$ m. Assume the body force to be absent.

10. Water flows out of tank through a small orifice on a vertical wall, under a constant head of 2 meters. The orifice diameter is 2 cm. The water jet issuing out of the orifice drops downward due to the action of gravity. It is seen that the vertical fall is 10 cm, for a horizontal displacement of 85 cm from the vena-contracta. Calculate
    a. coefficient of velocity
    b. discharge per unit time, if $C_c = 0.62$, and
    c. horizontal thrust on the container due to the issue of water jet.