

KATHMANDU UNIVERSITY
End Semester Examination
February/March, 2018

Marks Scored:

Level : B.Sc.

Year : II

Exam Roll No. :

Time: 30 mins.

Course : PHYS 202

Semester: I

F. M. : 20

Registration No.:

Date MAR: 07 2018

SECTION "A"

[20Q × 1 = 20 marks]

Choose and tick the most appropriate answer. The symbols have their usual meanings.

- Under a constant pressure head, the volume of a liquid flowing per second through a capillary tube of radius 1 mm and length 16 cm is 4cm^3 . If another tube of radius 0.5 mm and length 8 cm is connected in series with it and the same pressure head is applied across the combination, the volume of liquid flowing per second will be (in cm^3)
[a] 5/3 [b] 5/6 [c] 4/5 [d] 4/9
- A real fluid is any fluid which
[a] has surface tension and is incompressible [b] has zero shear stress
[c] has constant viscosity and density [d] has viscosity
- The stream line is a line
[a] which is normal to the velocity vector at every point.
[b] which represents lines of constant velocity potential.
[c] which is normal to lines of constant stream function.
[d] which is tangential to the velocity vector everywhere at a given instant.
- Vorticity in z-direction is given by
[a] $\left[\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y}\right]$ [b] $\left[\frac{\partial u}{\partial x} - \frac{\partial v}{\partial y}\right]$ [c] $\left[\frac{\partial v}{\partial x} + \frac{\partial u}{\partial y}\right]$ [d] $\left[\frac{\partial v}{\partial x} - \frac{\partial u}{\partial y}\right]$
- The unknown velocity component for $u = Ae^x$, so that the equation of continuity is satisfied is
[a] $-Ae^xy + f(x)$ [b] $Ae^xy + f(x)$ [c] $-Ae^xx + f(x)$ [d] $Ae^xx + f(x)$
- For incompressible fluids, density being constant the Bernoulli's equation can be written as $\frac{P}{\rho} + \frac{v^2}{2} + gz = E_s$. Where E_s is constant which can differ from stream line to stream line. Then flow is
[a] irrotational [b] rotational [c] Turbulent [d] Couette
- A tank has a hole at its bottom. The time needed to empty the tank from level h_1 to h_2 will be proportional to
[a] $h_1 - h_2$ [b] $h_1 + h_2$ [c] $\sqrt{h_1} - \sqrt{h_2}$ [d] $\sqrt{h_1} + \sqrt{h_2}$
- The irrotational flow is characterized by
[a] $\int (\nabla \times \vec{V}) \cdot d\vec{A} = 0$ [b] $\nabla \cdot \vec{V} = 0$ [c] $\vec{V} = \nabla \phi$ [d] $\nabla \times \vec{V} \neq 0$

9. Two-dimensional flow field is represented by $\phi = 2xy - x$. The value of the velocity V at the point $(2, 1)$ is
 [a] 4.12 units [b] 2.2 units [c] 1.73 units [d] 17 units
10. Which of the following functions does not represent the possible irrotational flow?
 [a] $\psi = xy$ [b] $\phi = m \ln x$ [c] $\psi = A(x^2 - y^2)$ [d] $\phi = 2x + 5y$
11. In Couette flow with zero pressure gradient parameter, the shear stress at the boundary is given by
 [a] $\Gamma = \frac{U_\infty h}{\mu}$ [b] $\Gamma = \frac{\mu h}{U_\infty}$ [c] $\Gamma = \frac{\mu U_\infty}{h}$ [d] $\Gamma = \frac{U_\infty}{\mu}$
 Where, h is the gap between the plates.
12. Very low Reynolds number (i.e. $Re \ll 1$) renders the
 [a] viscous terms significantly higher than the inertial terms.
 [b] inertial terms significantly higher than the viscous terms.
 [c] equal viscous terms and inertial terms.
 [d] flow between parallel channels.
13. A laminar boundary layer has a velocity distribution given by $\frac{u}{U_\infty} = \frac{y}{\delta}$, The displacement thickness ' δ_1 ' for this boundary layer is
 [a] δ [b] $\delta/2$ [c] $\delta/6$ [d] $\delta/4$
14. At the point of separation (i.e. beyond boundary layer)
 [a] velocity is negative [b] shear stress is zero
 [c] shear stress is maximum [d] pressure gradient is zero
15. At $Re \ll Re(\text{critical})$, the laminar condition persists because
 [a] the flow K.E. is enough to sustain the disturbances against the viscous damping.
 [b] the flow K.E. is not enough to sustain the disturbances against the viscous damping.
 [c] at certain axial location, the laminar boundary layer become unstable.
 [d] of the thorough mixing of the fluid layers.

Fill in the blanks:

16. When shear stress is applied to a substance it is found to resist it by continuous deformation. The substance is
17. The pressure at any location has both hydrodynamic and hydrostatic components, the gravitational body force at that location is balanced by
18. In case of a forced vortex of angular velocity ' ω ', the velocity at radius ' r ' is $u = \omega r$. Then the circulation per unit area is equal to
19. In a laminar flow between two parallel plates with a separation distance of 6 mm, the center line velocity is 1.8 m/s. The velocity at a distance of 1 mm from the boundary is equal to
20. For turbulent flow over flat plate, the distance between the point of instability and fully developed turbulent condition is known as

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Semester: I

F. M. : 55

SECTION "B"

[5Q × 4 = 20 marks]

1. Explain how Bernoulli's equation can be modified for its application in gases.
2. Define turbulent flow. Discuss the kinematically different condition existing below and above the critical Reynolds number.
3. The Bernoulli equation being an equation of conservation of energy, explain how it can be obtained by purely thermodynamic consideration?

OR

Show that head loss due to sudden expansion is $h_L = \frac{(v_1 - v_2)^2}{2g}$.

4. The potential function for the source flow is given by relation $\phi = -\frac{\Lambda}{2\pi} \ln r$. Determine the corresponding stream function and draw the flow net for this flow.
5. A rectangular plate of 1m × 1.5m face area is drawn over a horizontal layer of fluid 5 mm thick and supported by a solid plate at rest. The force required for drawing the upper plate at a steady speed of 0.5 m/s is 20 Newton. Estimate the value of the dynamic viscosity of the fluid.

OR

The velocity field in a fluid medium is given by $\vec{V} = 3xy^2 \hat{i} + 2xy \hat{j} + (2zy + 3t) \hat{k}$. Find the magnitudes and direction of: (i) translational velocity, (ii) rotational velocity, (iii) acceleration and (iv) the vorticity of a fluid element at (1, 2, 1) at time $t = 3$ sec.

SECTION "C"

[5Q × 7 = 35 marks]

6. Discuss the analogy between current flow and fluid flow. Derive the expression for the flow rate through pipes when they are in (a) series combination and (b) parallel combination.
7. For an incompressible fluid where the density neither changes with time nor with space, show that the continuity equation reduces to $\nabla \cdot \vec{V} = 0$. For unit control volume, show that the total momentum change is given by $\frac{DM}{Dt} = \rho \frac{D\vec{V}}{Dt}$.

OR

Show that frictional effect in the diverging portion of Venturimeter cause differential pressure reading less than the ideal, in contrast to a higher reading for the converging portion.

8. Show that the velocity profile for the flow between two parallel plates is parabolic using Navier-Stokes equation for two-dimensional viscous flow. Also estimate the average velocity of the flow.

9. For flow over flat plate, estimate the displacement thickness and momentum thickness in terms of boundary layer thickness.
10. A source of strength $10 \text{ m}^2/\text{sec}$ is located at $(-1, 0)$ and a sink of strength $20 \text{ m}^2/\text{sec}$ is located at $(1, 0)$. Find the velocity and stream function at point $(1, 1)$.

OR

Water issues out of a conical tank whose radius of cross-section varies linearly with the height from 10 cm at the bottom of the tank as shown in figure below. The slope of tank wall with the vertical is 30° . A short pipe of 2 cm diameter is fitted at the bottom for discharging the water. Calculate the time taken for the tank to be emptied from an initial water level of 70 cm. Assume that the pipe entry loss coefficient is 0.5, and is constant at all time.

