

KATHMANDU UNIVERSITY
End Semester Examination [C]
May/June, 2019

Marks Scored:

Level : B.Sc.

Year : II

Exam Roll No. :

Time: 30 mins.

Course : PHYS 202

Semester: I

F. M. : 20

Registration No.:

Date 02 JUN 2019

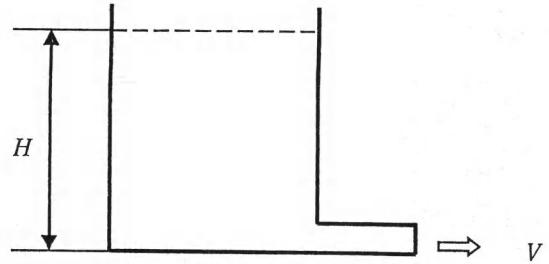
SECTION "A"

[20Q. × 1 = 20 marks]

Choose and the most appropriate answer among the given options and **encircle** the letter of your choice. The symbols have their usual meanings.

- A liquid can easily change its shape but a solid cannot because
[a] the density of liquid is smaller than that of solid
[b] the force between the molecules is stronger in solid than in liquid
[c] the atoms combine to form bigger molecules in a solid
[d] the average separation between the molecules is larger in solids
- A fluid in motion is said to be irrotational when
[a] $\nabla \cdot \vec{V} = 0$ [b] $\nabla \times \vec{V} = 0$ [c] $\nabla \times \vec{V} = \text{constant}$ [d] $\omega_x = \omega_y$
- What is the most common assumption while dealing with fluid flow problems using continuity equation?
[a] Flow is assumed to be compressible [b] Flow is assumed to be unsteady
[c] Flow is assumed to be steady [d] Flow is assumed to be turbulent
- The diameters of the pipe at the sections 1 and 2 are 8 cm and 13 cm respectively. If the discharge through the pipe at section 1 is 6 m/s then the velocity at section 2 is
[a] 2.27 m/s [b] 4.54 m/s [c] 1.13 m/s [d] 3.32 m/s
- The total head loss for the system of a fluid flow is equal to
[a] pipe length [b] pipe diameter
[c] width of the reservoir [d] height difference of reservoir
- The continuity equation in polar form is
[a] $\frac{1}{r} \frac{\partial u}{\partial \theta} + \frac{1}{r} \frac{\partial}{\partial r} (rv)$ [b] $\frac{1}{r} \frac{\partial (ru)}{\partial r} + \frac{1}{r} \frac{\partial v}{\partial \theta}$
[c] $\frac{1}{r} \frac{\partial u}{\partial \theta} + \frac{1}{r} \frac{\partial}{\partial r} (rv)$ [d] $\frac{\partial u}{\partial r} + \frac{1}{r} \frac{\partial}{\partial \theta} (rv)$
- The x-component of acceleration of the velocity field $\vec{V} = 10x^2y\hat{i} + 15yz\hat{j} + -3xy\hat{k} + 25t\hat{k}$ at a point (1, 2, -1) at time $t = 0.5$ is equal to
[a] 300 units [b] 400 units [c] 500 units [d] 600 units
- What is the magnitude of vorticity?
[a] Twice the angular velocity [b] Three times the angular velocity
[c] two and half times the angular rotation [d] Same as angular rotation

9. A beaker contains water up to certain height H as shown. If the water is allowed to get discharged through a small pipe of uniform diameter. What type of flow will it be in the pipe?



- [a] steady and uniform
 [b] unsteady and uniform
 [c] steady and non-uniform
 [d] unsteady and non-uniform

10. For the situation of plane Couette flow in the absence of pressure gradient the linear velocity profile as $\frac{u}{U_\infty} = \frac{y}{h}$, the shear stress is constant all along the fluid thickness.

- [a] $\tau = \mu \frac{U_\infty}{h}$ [b] $\tau = \frac{U_\infty}{\mu h}$ [c] $\tau = \mu \frac{h}{U_\infty}$ [d] $\tau = \mu h U_\infty$

11. In an isotropic turbulence, which of the following is untrue?
 [a] fluctuations are independent of the direction of preference
 [b] the gradient of mean velocity is either zero or constant throughout
 [c] perfect disorder persists
 [d] it is always inhomogeneous

12. Let \vec{V} is the velocity of fluid element then circulation Γ is defined as

- [a] $\Gamma = \frac{1}{2} \iint \vec{V} \cdot d\vec{V}$ [b] $\Gamma = \frac{1}{A} \oint \vec{V} \cdot d\vec{S}$ [c] $\Gamma = \iint \vec{V} \cdot d\vec{V}$ [d] $\Gamma = \oint \vec{V} \cdot d\vec{S}$

13. For a very low Reynold's number i.e. $R_e \ll 1$ the simplified Navier-Stokes equation becomes similar to those for a

- [a] turbulent flow [b] parallel flow [c] vortex flow [d] Couette flow

14. Which of the flowing is not an example of forced vortex flow?

- [a] Liquid contained in cylindrical rotated about its axis
 [b] Flow of liquid inside impeller of centrifugal pump
 [c] Flow of water through runner of a turbine
 [d] Flow of the liquid around a circular bend in a pipe

15. If a smooth flat plate 1.5 m long, 30 cm wide is placed in a stream of air at 8 m/s then the boundary layer thickness is

- [a] 5.58 mm [b] 7.78 mm [c] 2.92 mm [d] 5.18×10^{-3} mm

Fill in the blanks.

16. The circumference velocity $u = \frac{\Lambda}{2\pi r}$ for vortex flow becomes infinity at $r = 0$. This indicates the existence of _____ at the origin.

17. The flow of fluid along curvilinear or curved path is known as _____.

18. The flow is said to be _____ when the value of the critical Reynolds number is exceeded.

19. The loss of head arises due to viscous effects on the presence of shear stress between a solid surface and the fluid flowing through it is technically called _____.

20. The intensity of turbulence is given by $Tu = \sqrt{\frac{1}{3}(\bar{u}^2 + \bar{v}^2 + \bar{w}^2)} / U_\infty$. The turbulent is isotropic when _____.

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SECTION "B"

[5Q. × 4 = 20 marks]

Attempt *ALL* questions.

1. What do you mean by velocity field? Considering a physical model of the velocity field, write down the expression for velocity of a fluid element and also discuss the local and convective accelerations.
2. If the rotation of a fluid element is estimated from the average angular displacement between two straight lines mutually perpendicular in the beginning, show that average angular velocity vector $\bar{\omega} = \frac{1}{2}(\nabla \times \vec{V})$.
3. Obtain the Bernoulli equation for irrotational flow.

OR

Deduce an expression of time of discharge for the fluid flow through an orifice at the side or bottom of the large tank.

4. Obtain the relation between stream function ψ and potential function ϕ in polar co-ordinate system.
5. Given the velocity field $\vec{V} = 10x^2y\hat{i} + 15yz\hat{j} - 3xy\hat{k} + 25t\hat{k}$. Find the acceleration of a fluid element at a point (1, 2, -1) at time $t = 0.5$ s. Identify the local and convective components of acceleration in each of the three directions.

OR

Evaluate the values of boundary layer thickness δ and skin friction coefficient C_f for flow over a

flat plate by using velocity profile $\frac{u}{U_\infty} = \frac{y}{\delta}$

SECTION "C"

[5Q. × 7 = 35 marks]

6. Derive the momentum integral equation for uniform flow over flat plate in terms of displacement and momentum thicknesses.

OR

On the basis of conservation of energy of fluid in curvilinear motion, estimate the energy change in the radial direction and normal to the stream line.

7. Obtain the expressions for energy losses due to sudden expansion and sudden contraction.

8. Derive Navier-Stokes equation for two dimensional viscous flows. And also write at what condition Navier-Stokes equation become similar for parallel flow.
9. An incompressible fluid flows past a solid plate. The x and y coordinates are measured respectively from the leading edge and the surface of the plate. If the x component of fluid velocity is given by $u = x^2 y^2 + 2xy$, obtain the velocity field, and the acceleration at a point $(2, 1)$.
10. Water flows out of a tank through a small orifice on a vertical wall, under a constant head of 2 meters. The orifice diameter is 2cm. The water jet issuing out of the orifice drops downward due to the action of gravity. It is seen the vertical fall is 10cm, for a horizontal displacement of 85 cm from the vena-contracta. Calculate
- coefficient of velocity,
 - discharge per unit time, if $C_c = 0.62$, and
 - the horizontal thrust on the container due to the issue of water jet.
- Take $g = 9.8ms^{-2}$.

OR

A fluid of kinematic viscosity $\nu = 20 \times 10^{-6} m^2 / s$ and $\rho = 800 kg / m^3$ is contained between two parallel plates 15cm apart. The lower plate is fixed and the upper movable. A positive pressure gradient of $12.5N / m^3$ exists in the direction of motion of the upper plate. Estimate the force required to move the upper plate at an uniform speed of $4.5m / s$.