KATHMANDU UNIVERSITY
End Semester Examination [C]
July, 2017

Marks Scored:

JUL 06 2017

Level: B.Sc.
Year : II

Course : PHYS 202
Semester: I

Exam Roll No. :
Registration No:

Time: 30 mins.

F. M. : 20
Date :

SECTION "A"
[20Q ×1 = 20 marks]

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

1. Newtons's law of viscosity for a fluid states that the shear stress is :
[a] proportional to the angular deformation.
[b] proportional to the rate of angular deformation.
[c] inversely proportional to the angular deformation.
[d] inversely proportional to the angular deformation.

2. The velocity distribution in a viscous flow over a plate is given by $u = 4y\text{-}y^2$, y is a distance from the plate. If the coefficient of viscosity is 1.5 Pa.s, the shear stress at the plate surface is
[a] 0 N/m^2 [b] 6.0 dyne/cm^2 [c] 6.0 N/m^2 [d] 6.0 N

3. The Bernoulli equation is applicable between
[a] in any rotational flow of an incompressible fluid.
[b] in any type of irrotational flow of a fluid.
[c] in steady rotational flow of an incompressible fluid.
[d] in steady, irrotational flow of an incompressible fluid.

4. A sharp edged orifice of 4 cm diameter is fitted on the vertical face of a reservoir. The level of water in the reservoir is 2 meters, and $g = 9.7\text{m/s}^2$. If the measured value of $C_c = 0.625$ and $C_d = 0.61$, the velocity of the jet at vena-contracta is
[a] 7.854 m/s [b] 4.774 m/s [c] 60.8 m/s [d] 6.08 m/s

5. Two capillary tubes of same radii but different lengths l_1 and l_2 are connected in parallel. The equivalent length of single tube having same flow rate is
[a] $l_1 + l_2$ [b] $l_1 l_2$ [c] $\frac{l_1 l_2}{l_1 + l_2}$ [d] $\frac{l_1 + l_2}{l_1 l_2}$

6. The velocity field in an incompressible fluid medium is given by $\vec{V} = -3y^2\hat{i} - 6x\hat{j}$. The stream function for this fluid motion is
[a] $3x^2 - y^3$ [b] $3x^2 + y^3$ [c] $-3x^2 - y^3$ [d] $-3x^2 + y^3$

7. The continuity equation in polar form is
[a] $\frac{1}{r}\frac{\partial u}{\partial \theta} + \frac{1}{r}\frac{\partial}{\partial r}(v)$ [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] $\frac{\partial u}{\partial r} + \frac{1}{r}\frac{\partial}{\partial \theta}(rv)$

8. An irrotational flow is characterized by
[a] $\iint (\nabla \times \vec{V}).\, d\vec{A} = 0$ [b] $\iint \vec{V}.\, d\vec{s} = 0$ [c] $\nabla \times \vec{V} \neq 0$ [d] $\vec{V} = \nabla\phi$

9. The stream function for the fluid flow is given by $\psi = \frac{\Lambda}{2\pi}\theta$, where Λ is flow strength. This represents

[a] a vortex flow [b] a source flow [c] a uniform flow [d] a doublet flow

10. If the maximum velocity in a laminar flow through two parallel static plates is 9 m/s, then the average velocity of the flow will be

[a] 6.0 m/s [b] 3.0 m/s [c] 4.5 m/s [d] 7.5 m/s

11. For a flow past sphere, the drag coefficient C_D is defined on the basis of the projected area and the velocity head. Then it is equal to

[a] $\frac{R_e}{24}$ [b] $\frac{\mu}{\rho U_\infty R}$ [c] $\frac{\rho U_\infty R}{\mu}$ [d] $\frac{24}{R_e}$

12. For two dimensional viscous flow, the average value of normal stress at a point is

[a] P [b] –P [c] μ [d] 2 μ

13. The ratio of displacement thickness to momentum thickness for linear velocity distribution in a laminar boundary layer along a flat plate is almost

[a] 1.5 [b] 2.0 [c] 2.6 [d] 3.0

14. A flat plate with a sharp leading edge is placed along a free stream of fluid flow. The local Reynolds number at 3 cm from the leading edge is 10^5. The thickness of the boundary layer is

[a] 0.35 mm [b] 0.44 mm [c] 0.23 mm [d] 0.12 mm

15. In a boundary layer developed along the flow, the pressure decreases along the downstream direction. The boundary layer thickness would

[a] increases gradually along the flow.
[b] increases rapidly along the flow.
[c] tend to decrease along the flow.
[d] remains constant.

16. The loss of head arising due to the presence of shear stress between a solid surface and the fluid flowing past it is known as ....

17. Acceleration of the fluid element is given by $\frac{D\vec{V}}{Dt} = \frac{\partial \vec{V}}{\partial t} + \vec{V}.\nabla\vec{V}$. The second term $\vec{V}.\nabla\vec{V}$ represents....................................

18. At the centre of the vortex flow, the circulation (τ) is equal to ....

19. The average value of skin friction coefficient over a flat plate of given length L is proportional to ....

20. The distance between the point of instability and fully turbulent condition is known as the ....

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F.M. : 55

SECTION "B"
[5Q × 4 = 20 marks]

Attempt *ALL* questions.

1. Why should Poiseulli's formula be modified for gas? Deduce the Mayer's formula for gas.

2. Define stream lines, stream tubes and stream function. Show that the stream function satisfies the continuity equation.

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

OR

Show that Bernoulli's equation being an equation of conservation of energy, can also be obtained by purely thermodynamic approach.

4. For flow over flat plate, the third degree velocity profile is given by $\frac{u}{U_\alpha} = \frac{3}{2}\left(\frac{y}{\delta}\right) - \frac{1}{2}\left(\frac{y}{\delta}\right)^3$.

Estimate the momentum thickness.

5. The Reynolds number for flow of oil through a 5cm diameter pipe is 1800. If the kinematic viscosity of oil is $\mu = 0.75\text{cm}^2/\text{s}$, estimate the velocity at the pipe center and at a radius of 1.25cm.

OR

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 the fluid velocity is given by

$$u = x^2y^2 + 2xy,$$

Obtain the velocity field, and the acceleration at a point (2, 1).

SECTION "C"
[5Q × 7 = 35 marks]

Attempt *ALL* questions.

6. Derive an expression for the head loss due to sudden enlargement in pipe flow and hence deduce the head loss due to sudden contraction.

OR

With well label diagram of venturimeter, show that the coefficient of discharge $'C_d'$ at conversing section is less than unity and that at diverging section is greater than unity.

7. Derive Euler's equation in three dimensional flow of an ideal fluid. Show that the Euler's equation takes the form $\rho V\frac{dV}{dS} = -\frac{dp}{ds} - \rho g\frac{dz}{ds}$ when the three velocity components in the x, y and z direction are conversed to one in the direction of tangent.

8. Define fluid mechanical doublet. Obtain the expression for potential function and stream function for doublet flow and also sketch the flow net for this flow.

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

10. A fluid of kinematic viscosity (ν) = 20×10^{-6} m^2/s and density (ρ) = 800 kg/m^3 is contained between two parallel plates 15cm apart. The lower plate is fixed and the upper plate moveable. A positive pressure gradient of 12.5 N/m^2 exists in the direction of motion of the upper plate. Estimate the force required to move the upper plate at an uniform speed of 4.5 m/s, if the plate surface cross-section is 60cm × 130cm and also sketch the velocity profile in the fluid.

OR

Show that $\psi = A(r)^{\pi/\alpha}\sin(\pi\theta/\alpha)$ satisfies Laplace equation. Derive the potential function for the corresponding irrotational flow. Generate and sketch the flow net when $\alpha = \frac{\pi}{2}$. For what value of α, the given stream function may represent an uniform flow.