REV-01
MSM/01/05

2023/06

SET A

M.Sc. MATHEMATICS
FOURTH SEMESTER
FLUID DYNAMICS
MSM - 403A [SPECIAL REPEAT]
[USE OMR FOR OBJECTIVE PART]

Duration: 3 hrs. Full Marks:70

Objective

Time: 30 min. Marks:20

Choose the correct answer from the following: ***1X20=20***

1. Fluid is a substance which offers no resistance to change of
   a. Pressure b. Shape
   c. Flow d. Volume
2. If every particle of the fluid has irregular flow, then the flow is said to be
   a. Laminar b. Turbulent
   c. Fluid flow d. Both a and b
3. According to the equation of continuity, when water falls its speed increases, while its cross-sectional area
   a. Decreases b. Increases
   c. Remain same d. Different
4. Surface tension
   a. Acts in the plane of the interface normal to any line in the surface b. Is also known as capillary
   c. Has no unit d. None
5. Raindrops are spherical because of
   a. Viscosity b. Atmospheric pressure
   c. Surface tension forces d. None
6. Newton's law of viscosity is a relationship between
   a. Shear stress of angular distortion b Shear stress and viscosity
   c. Pressure, velocity, and viscosity D None
7. Liquids
   a Cannot be compressed B Occupy definite volume
   c Are not viscous D None
8. The Continuity equation is connected with
   a. Viscous fluid b. Compressibility of fluids
   c. Conservation of mass d. All the above
9. The ratio of absolute viscosity to mass density is known as
   a. Specific viscosity b. Viscosity index
   c. Kinematic viscosity d. None

10. Navier Stoke's equation is
    a. linear
    b. Non - linear
    c. Parabolic
    d. None

11. Group velocity is equal to the wave velocity for
    a. Normal water
    b. Deep water
    c. Shallow water
    d. None

12. An example of Newtonian fluid is
    a. Mercury
    b. Blood
    c. Polymer
    d. None

13. Rate of work done per unit mass of the fluid is
    a. Time X Velocity
    b. Force X Velocity
    c. Energy X Time
    d. None

14. Reynolds number is the ratio of Inertia force to
    a. Viscous force
    b. Energy force
    c. Drag force
    d. None

15. For very slow motion the pressure is a
    a. Harmonic function
    b. Modulus function
    c. Signum function
    d. None

16. In Blasius boundary condition at $\eta \to \infty$ is
    a. $F' = 0$
    b. $F' = 1$
    c. $F' = 2$
    d. None

17. Displacement thickness for $u = U\left(1 - e^{-\eta}\right), \eta = \frac{y}{\delta}$ is
    a. $\delta\left(1 - \frac{1}{e}\right)$
    b. $\delta\left(1 - e\right)$
    c. $\delta\left(1 - \frac{1}{e^2}\right)$
    d. $\delta\left(1 - e^2\right)$

18. In a static fluid
    a. Resistance to shear stress is small
    b. Fluid pressure is zero
    c. Linear deformation is small
    d. Only normal stress can exist

19. The property of fluid by virtue of which it offers resistance to shear is called
    a. Surface tension
    b. Adhesion
    c. Cohesion
    d. Viscosity

20. The pressure at a point in a fluid will not be same in all directions when the fluid is
    a. Moving
    b. Viscous
    c. Viscous and static
    d. Both a and b

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Descriptive

Time : 2 hrs. 30 mins. Marks : 50

[Answer question no.1 & any four (4) from the rest]

1. Prove that the velocity of propagation c of surface waves of length λ in a rectangular canal of depth h is given by the formula 10

$$c^2 = \frac{g\lambda}{2\pi}\tanh\frac{2\pi h}{\lambda}$$

2. Show that the total energy of a progressive wave is half Kinetic Energy and half Potential Energy. 10

3. Express the rate of change of the circulation Γ for a viscous incompressible fluid in the form $\dot{\Gamma} = \upsilon\nabla^2\Gamma$ where '.' denotes differentiation w. r. t. t and υ is the kinematic viscosity. 10

4. Derive the Navier Stokes equations of motion for a viscous fluid in the cartesian form. 10

5. A viscous liquid flows steadily paralleled to the axis in the annular space between two coaxial cylinders of radii a and na (n>1), show that the rate of discharge is $\frac{\pi Pa^4}{8\mu}\left\{n^4 - 1 - \frac{\left(n^2-1\right)^2}{\log n}\right\}$. 10

6. Show that at a distance x from the leading edge of a flat plate parallel to the stream of unbounded fluid moving outside the boundary layer with velocity U, the tangential stress on the plate is $\frac{1}{4}\infty\left(\rho\mu U^3/x\right)^{1/2}$, where $2\infty^{-2/3} = \lim_{\eta\to\infty} F'(\eta)$ and $F(\eta)$ is the solution of the equation $F''' + FF'' = 0$ for which $F(0) = F'(0) = 0, F''(0) = 1$. 10

7. Derive the Karman's momentum integral equation and hence evaluate the shear stress for steady flow. 10

8. Show that 10

i. $\int_0^{\delta} \frac{u}{U} dy = \delta - \delta_1$

ii. $\int_0^{\delta} \left(\frac{u}{U}\right)^2 dy = \delta - \delta_1 - \delta_2$

iii. $\int_0^{\delta} \left(\frac{u}{U}\right)^3 dy = \delta - \delta_1 - \delta_3$

Where the symbols have their usual meanings.

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