REV-01
MSM/23/28

2023/06

SET A

M.Sc. MATHEMATICS
FOURTH SEMESTER
FLUID DYNAMICS
MSM - 403A

[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. An example of non-Newtonian fluid is
   a. Air b. Blood
   c. Gas d. None

2. The ratio of inertia force to viscous force is called
   a. Prandtl number b. Reynolds number
   c. Hartman number d. None

3. Fluid is a substance which offers no resistance to change of
   a. Pressure b. Flow
   c. Shape d. Volume

4. The Group velocity and wave velocity for shallow water is
   a. Equal b. Equivalent
   c. Zero d. None

5. Bernoulli's theorem deals with the principles of
   a. Momentum b. Energy
   c. Mass d. Force

6. 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

7. A one-dimensional flow is one which
   a. Uniform flow b. Steady uniform flow
   c. Takes place in straight lines d. Involves zero transverse component of flow

8. Navier Stoke's equation is
   a. Linear b. Parabolic
   c. Hyperbolic d. Non-linear

9. According to the equation of continuity, when water falls its speed increases, while its cross-sectional area
   a. Increase b. Decrease
   c. Same d. Different

10. A fluid in equilibrium can't sustain
    a. Tensile stress
    b. Compressive stress
    c. Shear stress
    d. Bending stress

11. Surface tension
    a. Acts in the plane of the interface
    b. Known as capillarity
    c. Has no units
    d. None

12. The loss of pressure head in case of laminar flow is proportional to
    a. Velocity
    b. Velocity^2
    c. Velocity^3
    d. Velocity^4

13. Raindrops are spherical because of
    a. Viscosity
    b. Atmospheric pressure
    c. Surface tension
    d. None

14. The unit of viscosity is
    a. M^2/sec
    b. Kg-sec/M
    c. Newton-sec/M^2
    d. None

15. The equation of continuity holds good when the flow is
    a. Steady
    b. One dimensional
    c. Velocity is uniform at all cross sections
    d. All

16. 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

17. Dimension of surface tension is
    a. ML^0T^2
    b. ML^0T
    c. MLT^2
    d. ML^2T^2

18. Liquids
    a. Cannot be compressed
    b. Occupy definite volume
    c. Are not viscous
    d. None

19. The Continuity equation is connected with
    a. Viscous fluid
    b. Compressibility of fluids
    c. Conservation of mass
    d. None

20. The ratio of absolute viscosity to mass density is known as
    a. Specific viscosity
    b. Viscosity index
    c. Kinematic viscosity
    d. None

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Descriptive

Time : 2 hrs. 30 mins. **Marks : 50**

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

1. Show that **3+3+4 =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 $\delta, \delta_1, \delta_2, \delta_3$ respectively boundary layer thickness, displacement thickness, momentum thickness, and energy thickness.

2. Define group velocity. Show that the group velocity for deep water is half the wave velocity whereas for shallow water the group velocity and wave velocity are equal. **2+8=10**

3. Find the velocity c of propagation of waves of length $\frac{2\pi}{m}$ at the common surface of two liquids when surface tension is considered, and show that if the liquids are deep compared to the wavelength and are undisturbed save for the wave motion then **10**

   $$c^2 = \frac{Tm}{\rho + \rho'} + \frac{g}{m}\left(\frac{\rho - \rho'}{\rho + \rho'}\right)$$ where T is the surface tension.

4. A velocity field is given by $\vec{q} = \frac{-y\hat{i} + x\hat{j}}{x^2 + y^2}$ .Determine whether the flow is irrotational. Calculate the circulation round **5+2+3 =10**

a. A square with its corners at (1,0), (2,0), (2,1), (1,1).
b. A unit circle with center at the origin.
c. Find the circulation about the square enclosed by the lines $x = \pm 2, y = \pm 2$ for the flow $u = x + y, v = x^2 - y$.

5. Derive the velocity distribution for laminar steady flow between two coaxial circular cylinders. Also determine the volumetric rate of flow. **7+3=10**

6. A liquid occupying the space between two co-axial circular cylinders is acted upon by a force $\frac{c}{r}$ per unit mass, where r is the distance from the axis, the lines of force being circles around the axis. Prove that in the steady motion the velocity at any point is given by $\frac{c}{2\upsilon}\left[\frac{b^2}{r}\left(\frac{r^2 - a^2}{b^2 - a^2}\right)\log\frac{b}{a} - r\log\left(\frac{r}{a}\right)\right]$ where a, b are the two radii and υ is the co-efficient of kinematic viscosity. **10**

7. Derive the Karman's momentum integral equation for two-dimensional flow of incompressible fluid. **10**

8. Derive the Navier Stokes's equation for viscous fluid. Also deduce the cartesian form of the equations. **7+3=10**

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