

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

Duration : 3 hrs.

Full Marks: 70

Time : 20 min.

( PART-A: Objective )

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  $\eta \rightarrow \infty$  is
- |             |             |
|-------------|-------------|
| a. $F' = 0$ | b. $F' = 1$ |
| c. $F' = 2$ | d. None     |
17. Displacement thickness for  $u = U(1 - e^{-\eta})$ ,  $\eta = \frac{y}{\delta}$  is
- |                                            |                      |
|--------------------------------------------|----------------------|
| a. $\delta \left(1 - \frac{1}{e}\right)$   | b. $\delta(1 - e)$   |
| c. $\delta \left(1 - \frac{1}{e^2}\right)$ | d. $\delta(1 - e^2)$ |
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

**( PART-B : Descriptive )**

Time: 2 HRS 40 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  $\lambda$  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  $\Gamma$  for a viscous incompressible fluid in the form  $\frac{d\Gamma}{dt} = \nu \nabla^2 \Gamma$  where ' $\nu$ ' denotes differentiation w. r. t.  $t$  and  $\nu$  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 parallel to the axis in the annular space between two coaxial cylinders of radii  $a$  and  $na$  ( $n > 1$ ), show 10

that the rate of discharge is 
$$\frac{\pi P a^4}{8\mu} \left\{ n^4 - 1 - \frac{(n^2 - 1)^2}{\log n} \right\}.$$

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 10

$$\frac{1}{4} \infty (\rho \mu U^3 / x)^{1/2}, \text{ where } 2\infty^{-2/3} = \lim_{\eta \rightarrow \infty} F'(\eta) \text{ and } F(\eta) \text{ is}$$

the solution of the equation  $F''' + FF'' = 0$  for which  $F(0) = F'(0) = 0, F''(0) = 1.$

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

8. Show that

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.

= = \*\*\* = =