Roll No. ....

O. M. R. Serial No. | | | | | | | |

Question Booklet Number

M. A./M. Sc. (Fourth Semester)
(NEP) EXAMINATION, 2025-26

MATHEMATICS

(Advanced Fluid Mechanics) (Elective)

Paper Code							
B	0	3	1	0	0	3	T

Questions Booklet Series
C

Time : 1:30 Hours] [*Maximum Marks : 75*

Instructions to the Examinee :

1. Do not open the booklet unless you are asked to do so.
2. The booklet contains 100 questions. Examinee is required to answer 75 questions in the OMR Answer-Sheet provided and not in the question booklet. All questions carry equal marks.
3. Examine the Booklet and the OMR Answer-Sheet very carefully before you proceed. Faulty question booklet due to missing or duplicate pages/questions or having any other discrepancy should be got immediately replaced.

परीक्षार्थियों के लिए निर्देश :

1. प्रश्न-पुस्तिका को तब तक न खोलें जब तक आपसे कहा न जाए।
2. प्रश्न-पुस्तिका में 100 प्रश्न हैं। परीक्षार्थी को 75 प्रश्नों को केवल दी गई OMR आन्सर-शीट पर ही हल करना है, प्रश्न-पुस्तिका पर नहीं। सभी प्रश्नों के अंक समान हैं।
3. प्रश्नों के उत्तर अंकित करने से पूर्व प्रश्न-पुस्तिका तथा OMR आन्सर-शीट को सावधानीपूर्वक देख लें। दोषपूर्ण प्रश्न-पुस्तिका जिसमें कुछ भाग छपने से छूट गए हों या प्रश्न एक से अधिक बार छप गए हों या उसमें किसी अन्य प्रकार की कमी हो, तो उसे तुरन्त बदल लें।

(Remaining instructions on the last page)

(शेष निर्देश अन्तिम पृष्ठ पर)

(Only for Rough Work)

1. A solid octant of a sphere is immersed with one plane face in the surface. The resultant pressure on the curved surface reduces to a single force of magnitude :

(A) $\frac{1}{5}g\rho a^3\sqrt{\pi^2+8}$

(B) $\frac{1}{6}\rho g a^3\sqrt{\pi^2+8}$

(C) $\frac{1}{7}\rho g a^3\sqrt{\pi^2+8}$

(D) None of the above

2. The pitch of the wrench (X, Y, Z; L, M, N) is :

(A) $\frac{LX-MY-NZ}{\sqrt{X^2+Y^2+Z^2}}$

(B) $\frac{LX-MY+NZ}{\sqrt{X^2+Y^2+Z^2}}$

(C) $\frac{LX+MY+NZ}{X^2+Y^2+Z^2}$

(D) None of the above

3. A system of forces (X, Y, Z; L, M, N) can be reduced to a single force if :

(A) $LX + MY + NZ = 0$

(B) $LX + MY + NZ \neq 0$

(C) $LX + MY + NZ > 0$

(D) None of the above

4. A hemisphere of radius a is immersed in a liquid of density σ. The plane of the base is vertical and its centre is at a depth $a\sqrt{5}$ below the surface. Then the resultant force on the curved surface is :

(A) $\frac{7}{6}\pi\sigma g a^3$

(B) $\frac{7}{5}\pi\sigma g a^3$

(C) $\frac{7}{4}\pi\sigma g a^3$

(D) $\frac{7}{3}\pi\sigma g a^3$

5. If an elliptic lamina just immersed in water in any position as let major axis of length Q and minor axis of length b and supposing it turned in the same vertical plane so as to be always just immersed in the depth h, then the locus of the center of pressure with respect to its axes is :

(A) $\frac{x^2}{a^2} - \frac{y^2}{b^2} = \frac{1}{16}$

(B) $\frac{x^2}{a^2} + \frac{y^2}{b^2} = \frac{1}{16}$

(C) $\frac{x^2}{a^2} + \frac{y^2}{b^2} = \frac{3}{16}$

(D) None of the above

6. The depth of the centre of pressure of a plane area immersed in a fluid is :

(A) Less than the depth of its centre of gravity

(B) Greater than the depth of its centre of gravity

(C) Equal to the depth of its centre of gravity

(D) None of the above

7. An ellipse is completely immersed with its minor axis horizontal and at a depth h. The position of the centre of pressure is :

(A) (0, 0)

(B) $\left(0, \frac{a^2}{2h}\right)$

(C) $\left(\frac{a^2}{4h}, 0\right)$

(D) $\left(\frac{a^2}{4h}, \frac{a^2}{2h}\right)$

8. A system of coaxial circular areas is immersed in water with the lines of centre at a given dept. The locus of the centres of pressure of the circular areas which are completely immersed is a :

(A) Parabola

(B) Ellipse

(C) Hyperbola

(D) Circle

9. The resultant fluid pressure on a curved surface is not always reducible to a :

(A) Single pressure

(B) Single velocity

(C) Single force

(D) None of the above

10. In polar co-ordinates, the total resultant pressure on the whole area is :

(A) $\iint p\, dr\, d\theta$

(B) $\iint pr\, d\theta\, dr$

(C) $\iint r\, d\theta\, dr$

(D) None of the above

11. A rigid spherical shell is just filled with homogeneous gravitating liquid and the whole rotates with uniform angular velocity ω about a diameter. The total pressure on the upper half is :

(A) $\frac{1}{2}\pi\rho a^4\omega^2$

(B) $\frac{1}{3}\pi\rho a^2\omega^2$

(C) $\frac{1}{4}\pi\rho a^2\omega$

(D) $\frac{1}{4}\pi\rho a^4\omega^2$

12. A sphere of fluid, whose density ρ at a distance r from its centre varies as $\frac{\sin kr}{kr}$, is self attracting according to the law of gravitation. If ρ_1 is the surface density of the sphere and Y is the constant of gravitation, the pressure at a distance r from the centre is :

(A) $\frac{2\pi r}{kr}(\rho^2 + \rho_1^2)$

(B) $\frac{2\pi r}{kr}(\rho^2 - \rho_1^2)$

(C) $\frac{3\pi r}{kr}(\rho^2 - \rho_1^2)$

(D) None of the above

13. If a conical cup be filled with liquid, the mean pressure at a point in the volume of the liquid is to the mean pressure at a point in the surface of the cup is :

(A) $\frac{3}{4}$

(B) $\frac{1}{4}$

(C) $\frac{5}{4}$

(D) $\frac{7}{4}$

14. If the forces tend to fixed centres and vary as the distance from those centres, then the surface of equal pressure are :

(A) Circles

(B) Rectangles

(C) Spheres

(D) Cylinders

15. A mass of fluid is at rest under the forces

$$X = (y + z)^2 - x^2$$

$$Y = (z + x)^2 - y^2$$

$$Z = (x + y)^2 - z^2$$

The surface of equal pressure are :

(A) Ellipsoids of revolution

(B) Hyperboloids of revolution

(C) Paraboloids of revolution

(D) None of the above

16. A hollow sphere of radius a, half filled with liquid is made to rotate with angular velocity ω about its vertical diameter. If the lowest point of the sphere is just exposed, then :

(A) $g = a\omega^2\left(2 - 3\sqrt{4}\right)$

(B) $g = a\omega^2\left(2 + 3\sqrt{4}\right)$

(C) $2g = a\omega^2\left(2 + 3\sqrt{4}\right)$

(D) $2g = a\omega^2\left(2 - 3\sqrt{4}\right)$

17. A mass of a homogeneous liquid contained in a vessel, revolves uniformly about a vertical axis. The pressure at any point is :

(A) $\rho\left[\frac{1}{2}\omega^2(x^2 + y^2) - gz\right] + C$

(B) $\rho\left[\frac{1}{2}\omega^2(x^2 - y^2) - gz\right] + C$

(C) $\rho\left[\frac{1}{2}\omega^2(x^2 - y^2) + gz\right] + C$

(D) None of the above

18. The density of a gravitating liquid sphere of radius a at any point increases uniformly as the point approaches the centre. The surface density is ρ_0 and the mean density is ρ. The pressure at the centre is :

(A) $\frac{2}{9}\pi a^2\left\{10\rho(\rho-\rho_0)+3\rho_0^2\right\}$

(B) $\frac{4}{9}\pi a^2\left\{10\rho(\rho-\rho_0)+3\rho_0^2\right\}$

(C) $\frac{2}{9}\pi a^3\left\{10\rho(\rho-\rho_0)+3\rho_0^2\right\}$

(D) None of the above

19. A mass of liquid rests up on a plane subject to a central attractive force $\frac{\mu}{r^2}$, situated at a distance C from the plane on the side opposite to that on which is the fluid, the pressure on the plane is :

(A) $\frac{\pi\rho\mu(a-c)}{a}$

(B) $\frac{\pi\rho\mu(a-c)^2}{a}$

(C) $\frac{\pi\rho\mu(a-c)^3}{a}$

(D) None of the above

20. A fluid rests in equilibrium in a field of force $X = y^2 + z^2 - xy - xz$, $Y = z^2 + x^2 - yz - yx$ and $Z = x^2 + y^2 - xz - zy$. Then the curves of equal pressure and density are a set of :

(A) Ellipses

(B) Parabola

(C) Circles

(D) Hyperbola

21. If the force per unit of mass at x, y, z parallel to the axes are $y(a - z)$, $x(a - z)$, x, y, the surfaces of equal pressure and equal density are :

(A) Elliptic

(B) Rectangular hyperbolas

(C) Parabola

(D) None of the above

22. The surfaces of equal pressure and the line of force are intersected at an angle :

(A) 30°

(B) 45°

(C) 60°

(D) 90°

23. A surface of (x, y, z) is called a free surface if external pressure is :

(A) 0

(B) 1

(C) 2

(D) 3

24. A mass of a fluid is at rest under the action of given force. The pressure at any point of the fluid is :

(A) $dp = \rho(Xdx - Ydy + Zdz)$

(B) $dp = \rho(Xdx + Ydy + Zdz)$

(C) $dp = \rho(Xdx - Ydy - Zdz)$

(D) None of the above

25. If ρ be the density and p, the pressure, the mass $m = v\rho$ and the temperature remains constant, then :

(A) $p = K\rho T$

(B) $p \neq K\rho T$

(C) $p = K\rho$

(D) $p \neq K\rho$

26. The viscosity of an ideal fluid is :

(A) 0

(B) 1

(C) 2

(D) None of the above

27. The Navier-Stokes equations are primarily based on the conservation of :

(A) Mass

(B) Momentum

(C) Energy

(D) Angular momentum

28. Which dimensionless number represents the ratio of inertial forces to viscous forces ?

(A) Mach Number

(B) Prandtl Number

(C) Froude Number

(D) Reynolds Number

29. In Hagan-Poiseville flow through a circular pipe, the velocity profile is :

(A) Linear

(B) Hyperbolic

(C) Parabolic

(D) None of the above

30. Water at 20°C flows between two large parallel plates at a distance 30. 5 mm apart. If the average velocity is 0.15 m/sec, the maximum velocity is :

(A) 0.225

(B) 0.325

(C) 0.125

(D) None of the above

31. τ_{xz} in terms of velocity gradients :

(A) $\tau_{xz} = \frac{\partial w}{\partial x} - \frac{\partial u}{\partial z}$

(B) $\tau_{xz} = \frac{\partial w}{\partial x} + \frac{\partial u}{\partial z}$

(C) $\tau_{xz} = \frac{\partial w}{\partial y} + \frac{\partial v}{\partial z}$

(D) $\tau_{xz} = \frac{\partial u}{\partial z} + \frac{\partial v}{\partial x}$

32. In the laminar flow, if the upper plate is moving in the X-direction with coustant velocity UV and the lower plate is fixed, both parallel plates are at a distance y_0 apart, then the velocity profile is :

(A) $u(y) = \frac{U y}{y_0}$

(B) $u(y) = Uy \cdot y_0$

(C) $u(y) = \frac{U y^2}{y_0}$

(D) $u(y) = Uy^2 \cdot y_0$

33. $\frac{dp}{dx} = 0$ is taken in :

(A) Harmonic flow

(B) Plane-Poiseuille flow

(C) Generalised plane Coutte flow

(D) Plane Couette flow

34. Let X, Y be the impressed force per unit area. Then the slow steady motion of a viscous fluid in two dimensions as :

(A) $\upsilon\nabla^4\psi = \frac{\partial Y}{\partial z} - \frac{\partial Z}{\partial y}$

(B) $\frac{\partial Z}{\partial x} - \frac{\partial X}{\partial z} = \upsilon\nabla^4\psi$

(C) $\upsilon\nabla^4\psi = \frac{\partial X}{\partial y} - \frac{\partial Y}{\partial x}$

(D) None of the above

35. Let Γ be the circulation round a closed path, the :

(A) $\frac{D\Gamma}{Dt} = -\upsilon\nabla^2\Gamma$

(B) $\frac{D\Gamma}{Dt} = \upsilon\nabla^2\Gamma$

(C) $\frac{D\Gamma}{Dt} = \frac{1}{2}\upsilon\nabla^2\Gamma$

(D) None of the above

36. Reynolds' number Re is :

(A) $\frac{\rho V^2 L}{\mu}$

(B) $\frac{\rho V L^2}{\mu}$

(C) $\frac{\rho V L}{\mu}$

(D) None of the above

37. Navier-Stokes' equation for viscous incompressible fluid is :

(A) $\frac{dq}{dt} = F - \frac{1}{\rho}\nabla p + \upsilon\nabla^2 q$

(B) $\frac{dq}{dt} = F + \frac{1}{\rho}\nabla p + \upsilon\nabla^2 q$

(C) $\frac{dq}{dt} = F - \frac{1}{\rho}\nabla p - \upsilon\nabla^2 q$

(D) None of the above

38. How many components are sufficient to determine the state of stress at a point ?

(A) 4

(B) 6

(C) 8

(D) 9

39. A fluid is said to be non-Newtonian if its viscosity :

(A) Varies with the rate of deformation

(B) Does not vary with the rate of deformation

(C) Both (A) and (B) are false

(D) None of the above

40. If the stress tensor is given by $T_{ij} = \begin{pmatrix} 5 & 2 & 2 \\ 2 & 2 & 1 \\ 2 & 1 & 2 \end{pmatrix}$, then principal stress value is :

(A) 1, 1, 1

(B) 1, –1, 4

(C) 1, –1, 7

(D) 1, 1, 7

41. Newtonian fluid is represented by :

(A) Circle

(B) Parabola

(C) Straight line

(D) None of the above

42. If the velocity field defined at a point P by $a + by - cz, d - bx + ez, f + cx - ey$, where a, b, c, d, e, f are arbitrary constants, then it represents :

(A) Rigid body motion

(B) Rigid body flow

(C) Rigid body rotation

(D) None of the above

43. The components τ_{xx}, τ_{yy}, τ_{zz} of the stress τ are called :

(A) Shear stress

(B) Normal stress

(C) Complex stress

(D) None of the above

44. A plate at a distance of 0.2 cm. from the fixed plate moves at 2 m/sec. and requires a force of 40 dyne/cm^2 to maintain this speed. The coefficient of viscosity of the fluid between the plates is :

(A) 2×10^{-2} poise

(B) 3×10^{-2} poise

(C) 4×10^{-2} poise

(D) 4×10^{2} poise

45. Coefficient of kinematic viscosity *v* is :

(A) $\frac{2\mu}{e}$

(B) $\frac{-2\mu}{e}$

(C) $\frac{-\mu}{e}$

(D) $\frac{\mu}{e}$

46. Bulk modulus of water is 2.2×10^{10} dyne/cm^2. When 100 cc. of water is subjected to an increase of pressure by 7.7×10^6 dyne/cm^2, then the change in volume is :

(A) 0.035

(B) 0.030

(C) 0.034

(D) 0.032

47. The shear strain for the fluid flow described by the velocity field

$$\vec{q} = 8x^2\,\hat{i} - 17x^2 yj$$

is :

(A) $8xy$

(B) $17xy$

(C) $-34xy$

(D) $-17xy$

48. The dimension of coefficient of viscosity is :

(A) $\frac{M}{LT^2}$

(B) $\frac{L^2}{T}$

(C) $\frac{ML}{T}$

(D) $\frac{M}{LT}$

49. Which of these fluids has the highest viscosity ?

(A) Water

(B) Honey

(C) Blood

(D) Air

50. The viscosity of the air at 30°C is :

(A) 0.019

(B) 1.295

(C) 0.514

(D) 2.564

51. Let the vortex of strength k be situated at A (OA = f) outside the circular cylinder of radius a with axis parallel to axis of cylinder the velocity at A is :

(A) $\frac{f}{2\pi(f^2 - a^2)}$

(B) $\frac{kf}{2\pi(a^2 - f^2)}$

(C) $\frac{kf}{2\pi(f^2 - a^2)}$

(D) None of the above

52. A vortex is in an infinite liquid occupying the upper half of the z-plane bounded by a circle of radius a, centre O and parts of the x-axis outside the circle, the path of the vortex is :

(A) $(x^2 - y^2 - a^2)^2 + 4a^2y^2 = Ay^2 (x^2 + y^2 - a^2)^2$

(B) $(x^2 + y^2 - a^2)^2 - 4a^2y^2 = Ay^2 (x^2 + y - a^2)^2$

(C) $(x^2 + y^2 - a^2)^2 + 4a^2y^2 = Ay^2 (x^2 + y^2 - a^2)^2$

(D) None of the above

53. If the section be a circle of radius a is in an incompressible inviscid liquid in a direction perpendicular of XY-plane, let the vorticity vector is ξ uniform throughtout the whole section, then for constant A and C, the equation of the stream function Ψ is :

(A) $A \log r + \frac{1}{2} \zeta r^2 + C$ when $r < a$

(B) $A \log r + \frac{1}{2} \zeta r^3 + C$ when $r > a$

(C) $A \log r + \frac{1}{2} \zeta r^3 + C$ when $r < a$

(D) None of the above

54. A long fixed cylinder of radius a is surrounded by infinite incompressible liquid and there is in the liquid a vortex filament of strength k which is parallel to the axis of the cylinder at a distance $c(c > a)$ from this axis. Given that there is no circulation round any circuit enclosing the cylinder but not the filament and r is the distance of the point from the filament, then the speed q of the fluid at the surface of the cylinder is :

(A) $\frac{k}{2\pi a}\left[1 + \left(\frac{c^2 - a^2}{r^2}\right)\right]$

(B) $\frac{k}{2\pi a}\left[1 - \left(\frac{c^2 - a^2}{r^2}\right)\right]$

(C) $\frac{k}{2\pi a}\left[1 + \left(\frac{c^2 + a^2}{r^2}\right)\right]$

(D) None of the above

55. If $u = \dfrac{(ax - by)}{x^2 + y^2}$, $v = \dfrac{bx + ay}{x^2 + y^2}$ and $\omega = 0$, then the velocity potential is :

(A) $\log (x^2 + y^2) + b \tan^{-1}\left(\dfrac{y}{x}\right)$

(B) $\log (x^2 + y^2) - b \tan^{-1}\left(\dfrac{y}{x}\right)$

(C) $\dfrac{a}{2} \log (x^2 + y^2) + b \tan^{-1}\left(\dfrac{y}{x}\right)$

(D) $-\left[\dfrac{a}{2}\log(x^2 + y^2) + b\tan^{-1}\left(\dfrac{y}{x}\right)\right]$

56. An infinite liquid contains two parallel, equal and opposite rectilinear vortex filaments at a distance $2b$. Then the paths of the fluid particles relative to the vortices are represented by the equation :

(A) $\log\left[\dfrac{(x-b)^2 - y^2}{(x+b)^2 + y^2}\right] + \dfrac{x}{b} = C$

(B) $\log\left[\dfrac{(x-b)^2 + y^2}{(x+b)^2 + y^2}\right] + \dfrac{x}{b} = C$

(C) $\log\left[\dfrac{(x-b)^2 + y^2}{(x+b)^2 - y^2}\right] - \dfrac{x}{b} = C$

(D) None of the above

57. The equation of Cote's spiral is :

(A) $r \sin \theta = a$

(B) $r \sin 2\theta = a$

(C) $r \sin 2\theta = 2a$

(D) None of the above

58. An elliptic cylinder is filled with liquid which has molecular rotation ω at every point and whose particles move in a plane perpendicular to the axis. The stream lines are similar ellipses described in periodic time :

(A) $\dfrac{\pi}{\omega}\dfrac{a^2 + b^2}{ab}$

(B) $\dfrac{2\pi}{\omega}\dfrac{a^2 + b^2}{ab}$

(C) $\dfrac{\pi}{\omega}\dfrac{a^2 - b^2}{ab}$

(D) None of the above

59. If components of spin are all zero, the motion is called :

(A) Rotational

(B) Irrotatioal

(C) Conditional

(D) None of the above

60. The vortex in which the fluid rotates as a forced vortex at the centre and as a free vortex is known as :

(A) Free spiral vortex

(B) Forced vortex

(C) Free cylindrical vortex

(D) Compound vortex

61. In Routh's theorem, the value of $\psi_2(x, y)$ is :

(A) $\psi_1(\xi_1, \eta_1) - \frac{k}{4\pi}\log\left|\frac{d\zeta}{dz}\right|$

(B) $\psi_1(\xi_1, \eta_1) - \frac{k}{2\pi}\log\left|\frac{d\zeta}{dz}\right|$

(C) $\psi_1(\xi_1, \eta_1) + \frac{k}{4\pi}\log\left|\frac{d\zeta}{dz}\right|$

(D) None of the above

62. If (r_1, θ_1), (r_2, θ_2), ..., (r_n, θ_n), ... are the polar coordinates of number of rectilinear vortices of strength k_1, k_2, ..., k_n, ... then :

(A) $\sum_{n=1}^{\infty} k_n (r_n)^2 (\theta_n)^{-1} = \text{constant}$

(B) $\sum_{n=1}^{\infty} k_n (r_n)^{-2} \theta_n = \text{constant}$

(C) $\sum_{n=1}^{\infty} k_n (r_n)^2 \theta_n = \text{constant}$

(D) $\sum_{n=1}^{\infty} k_n (r_n)^2 = \text{constant}$

63. In case of rectilinear vortex with elliptic section, the value of periodic time T is :

(A) $\frac{\pi(a+b)}{\zeta ab}$

(B) $\frac{\pi(a+b)^2}{\zeta ab}$

(C) $\frac{2\pi(a+b)}{\zeta ab}$

(D) None of the above

64. A spiral vortex is the combination of :

(A) source and sink

(B) sink and vortex

(C) source and vortex

(D) None of the above

65. Let μ be the strength of doublet. Consider vortices of strength $+k$ and $-k$ at $z = ae^{i\alpha}$ and $z = -ae^{i\alpha}$. Then the complex potential W at any point $p(z)$ is :

(A) $-i\mu\frac{e^{i\alpha}}{z}$

(B) $\frac{i\mu e^{i\alpha}}{z}$

(C) $-i\mu\frac{e^{-i\alpha}}{z}$

(D) None of the above

66. Consider the fluid motion due to two vertices of equal and opposite strength *i.e.*, k and $-k$ at A_1 $(-a, 0)$ and A_2 $(a, 0)$. Then the stream function is :

(A) $\frac{k}{\pi}\log\left(\frac{r_1}{r_2}\right)$

(B) $\frac{k}{2\pi}\log\left(\frac{r_1}{r_2}\right)$

(C) $\frac{k}{2\pi}\log(r_1 r_2)$

(D) None of the above

67. Consider two rectilinear vortices of strength k_1 and k_2 at $A_1(z = z_1)$ and $A_2(z = z_2)$. Vortices situated at A_1 and A_2 would start moving due to presence of each other. If u_2, v_2 be the components of velocity q_2 of A_2 which is due to A_1 alone, then :

(A) $q_2 = \frac{k_2}{2\pi(A_1A_2)}$

(B) $q_2 = \frac{k_1k_2}{2\pi(A_1A_2)}$

(C) $q_2 = \frac{k_1}{2\pi(A_1A_2)}$

(D) None of the above

68. In usual notation to velocity potential of vortex doublet is :

(A) $\phi = \frac{\mu}{r}\sin(\alpha - \theta)$

(B) $\phi = \frac{\mu}{r}\sin(\theta - \alpha)$

(C) $\phi = \frac{\mu}{r}\cos(\alpha - \theta)$

(D) None of the above

69. The motion due to a set of line vortices of strength k at point $z = \pm na$ ($n = 0$, 1, 2, 3, ...) is given by the relation :

(A) $w = \frac{ik}{2\pi}\log\cos\left(\frac{\pi z}{a}\right)$

(B) $w = \frac{k}{2\pi}\log\cos\left(\frac{\pi z}{a}\right)$

(C) $w = \frac{k}{2\pi}\log\sin\left(\frac{\pi z}{a}\right)$

(D) $w = \frac{ik}{2\pi}\log\sin\left(\frac{\pi z}{a}\right)$

70. The strength k of the curve is :

(A) $\int_S \bar{\omega}.nds = \text{variable}$

(B) $\int_S \bar{\omega}.nds = \text{constant}$

(C) $\frac{1}{2\pi}\int_S \bar{\omega}.nds = \text{variable}$

(D) None of the above

71. In the two-dimensional cartesian coordinates, the vorticity is given by :

(A) $\frac{\partial w}{\partial y} - \frac{\partial v}{\partial z}$

(B) $\frac{\partial u}{\partial z} - \frac{\partial w}{\partial x}$

(C) $\frac{\partial v}{\partial x} - \frac{\partial u}{\partial y}$

(D) None of the above

72. The complex potential W due to a rectilinear vortex of strength k is :

(A) $-\frac{ik}{2\pi}\log z$

(B) $-\frac{k}{2\pi i}\log z$

(C) $\frac{ik}{\pi}\log z$

(D) $\frac{ik}{2\pi}\log z$

73. The necessary and sufficient condition that vortex lines may be at right angles to the :

(A) Stream lines

(B) Path lines

(C) Streak lines

(D) None of the above

74. If $\omega(\xi, \eta, \zeta)$, then the components ξ, η, ζ are called :

(A) components of spin

(B) components of velocity

(C) components of acceleration

(D) None of the above

75. If q is the velocity of the fluid motion, then the curl of q is called :

(A) Negative vorticity

(B) Vorticity

(C) Fast vorticity

(D) Velocity

76. A doublet of strength μ is placed at the point (0, a, 0) with its axis parallel to z-axis, then the velocity potential ϕ of the doublet close to the origin is :

(A) $\frac{\mu z}{a^4} + \frac{3\mu yz}{a^5}$

(B) $\frac{\mu z}{a^3} + \frac{5\mu yz}{a^5}$

(C) $\frac{\mu z}{a^3} + \frac{3\mu yz}{a^4}$

(D) None of the above

77. A solid of revolution is moving along its axis in an infinite liquid. If ψ is the Stokes' stream function, *w* the distance of a point from the axis and the integral is taken round a meridian curve of the solid. The kinetic energy of the liquid is :

(A) $\frac{1}{2}\pi\rho\int\frac{\psi}{\omega}\frac{\partial\psi}{\partial n}dS$

(B) $\frac{2}{3}\pi\rho\int\frac{\psi}{\omega}\frac{\partial\psi}{\partial n}dS$

(C) $-\frac{2}{3}\pi\rho\int\frac{\psi}{\omega}\frac{\partial\psi}{\partial n}dS$

(D) $-\frac{1}{2}\pi\rho\int\frac{\psi}{\omega}\frac{\partial\psi}{\partial n}dS$

78. The image of radial doublet in a sphere of radius *a* of strength μ placed at a point A, where OA = *f* and the inverse point B directed towards the centre, a doublet is situated at B of strength μ' is :

(A) $\frac{\mu a^2}{f^2}$

(B) $\frac{\mu a^3}{f^2}$

(C) $\frac{\mu a^3}{f}$

(D) $\frac{\mu a^3}{f^3}$

79. If AB be a uniform line source and A, B equal sinks of such strength that there is no total gain or loss of fluid, the Stokes' stream function ψ at any point is :

(A) $C\,[(r_1+r_2)^2-c^2]\left(\frac{1}{r_1}-\frac{1}{r_2}\right)$

(B) $C\,[(r_1-r_2)^2-c^2]\left(\frac{1}{r_1}-\frac{1}{r_2}\right)$

(C) $C\,[(r_1-r_2)^2-c^2]\left(\frac{1}{r_1}+\frac{1}{r_2}\right)$

(D) None of the above

80. If the Stokes' function is $\psi=\frac{1}{2}V(a^4r^{-2}\cos\theta-r^2)\sin^2\theta$, where *r* is the distance from a fixed point and θ is the angle, this distance makes with a fixed direction, then a meridian curve, along which ψ is constant, is :

(A) $r^4 = a^4 \cos\theta$

(B) $r^4 = -a^4 \cos\theta$

(C) $r^2 = a^4 \cos\theta$

(D) $r^3 = a^4 \cos\theta$

81. An ellipsoidal cavity (semiaxes a, b, c) initially at rest is filled with liquid initially at rest. If the solid be moved with velocities u, v, w parallel to the axes of the cavity and be rotated with angular velocities $\omega_x, \omega_y, \omega_z$ round the semi axes, the angular momentum of the fluid round the axis of x at any instant is :

(A) $\frac{2}{15}\pi\rho abc\frac{(b^2+c^2)^2}{(b^2-c^2)^2}\omega_x$

(B) $\frac{4}{15}\pi\rho abc\frac{(b^2+c^2)^2}{(b^2-c^2)^2}\omega_x$

(C) $\frac{4}{15}\pi\rho abc\frac{(b^2-c^2)^2}{(b^2+c^2)^2}\omega_x$

(D) None of the above

82. When the motion is symmetrical about z-axis the equation of continuity in cylindrical coordinates for the incompressible fluid is :

(A) $\frac{1}{r}\frac{\partial}{\partial r}(ru)+\frac{\partial v}{\partial z}=0$

(B) $\frac{1}{r}\frac{\partial v}{\partial \theta}+\frac{\partial w}{\partial z}=0$

(C) $\frac{1}{r}\frac{\partial}{\partial r}(rv)+\frac{\partial u}{\partial z}=0$

(D) $\frac{1}{r}\frac{\partial}{\partial r}(ru)+\frac{\partial w}{\partial z}=0$

83. A doublet of strength μ placed at A outside the sphere, where OA = f, O is the centre of the sphere of radius a and B is the inverse point of A, then the image of a doublet is :

(A) A doublet of strength μ' at B

(B) A doublet of strength μ at B

(C) A doublet of strength μ' at O

(D) A doublet of strength μ at O

84. If ϕ is velocity potential due to a sink of strength $-m$, then with usual notations :

(A) $\phi=\frac{m}{r}$

(B) $\phi=-\frac{m}{r}$

(C) $\phi=\frac{m}{r^2}$

(D) $\phi=-\frac{m}{r^2}$

85. A three-dimensional source of strength $+m$ is placed at the origin. Then the Stokes' function ψ is :

(A) $+m\sin\theta$

(B) $-m\sin\theta$

(C) $+m\cos 2\theta$

(D) $+m\cos\theta$

86. A three dimensional doublet is of strength μ, then the velocity potential ϕ is :

(A) $\frac{\mu}{r}\cos\theta$

(B) $-\frac{\mu}{r}\cos\theta$

(C) $\frac{\mu}{r^2}\cos\theta$

(D) $-\frac{\mu}{r^2}\cos\theta$

87. If the total flow across a small surface surrounding the point is $4\pi m$, then the strength of the sink is :

(A) $+m$

(B) $-m$

(C) $2\pi m$

(D) $-2\pi m$

88. If the liquid flows with velocity U in the negative direction of x-axis in presence of fixed sphere and the sphere moves with velocity U in a liquid at rest at infinity, then the Stokes' function ψ is given by :

(A) $\frac{1}{2}Ur^2\sin^2\theta\left(1+\frac{a^3}{r^3}\right)$

(B) $\frac{1}{2}Ur^2\sin^2\theta\left(1-\frac{a^3}{r^3}\right)$

(C) $-\frac{1}{2}Ur^2\sin^2\theta\left(1+\frac{a^3}{r^3}\right)$

(D) None of the above

89. If ψ is the Stokes' function, then the velocity components u and v are given by :

(A) $u=-\frac{1}{\varpi}\frac{\partial\psi}{\partial\varpi}, v=\frac{1}{\varpi}\frac{\partial\psi}{\partial x}$

(B) $u=\frac{1}{\varpi}\frac{\partial\psi}{\partial\varpi}, v=\frac{1}{\varpi}\frac{\partial\psi}{\partial x}$

(C) $u=-\frac{1}{\varpi}\frac{\partial\psi}{\partial\varpi}, v=-\frac{1}{\varpi}\frac{\partial\psi}{\partial x}$

(D) None of the above

90. A sphere of radius a is made to move to incompressible perfect fluid with non-uniform velocity U along the x-axis. If the pressure at infinity is zero, then q^2 is :

(A) $\frac{U^2a^2}{r^6}(4\cos^2\theta+\sin^2\theta)$

(B) $\frac{U^2a^6}{4r^6}(3\cos^2\theta+\sin^2\theta)$

(C) $\frac{U^2a^6}{4r^6}(4\cos^2\theta+\sin^2\theta)$

(D) None of the above

91. A spherical shell of internal radius a contains a concentric sphere of radius λa and density σ, the intervening space being filled with water and the whole system is at rest. If a velocity V is communicated to the shell, the initial velocity to the sphere is :

(A) $\frac{2V}{2\sigma(1-\lambda^3)+(1+2\lambda^3)}$

(B) $\frac{2V}{2\sigma(1+\lambda^3)-(1+2\lambda^3)}$

(C) $\frac{3V}{2\sigma(1-\lambda^3)+1-2\lambda^3}$

(D) $\frac{3V}{2\sigma(1-\lambda^3)+1+2\lambda^3}$

92. Liquid of density ρ fills the space between a solid sphere of radius *a* and density σ and a fixed concentric spherical envelope of radius *b*. The work done by an impulse which starts the solid sphere with the velocity V is :

(A) $\frac{1}{3}\pi a^3 V^2\left(2\sigma + \frac{2a^3+b^3}{a^3-b^3}\rho\right)$

(B) $\frac{1}{3}\pi a^3 V^2\left(2\sigma + \frac{2a^3+b^3}{b^3-a^3}\rho\right)$

(C) $\frac{1}{3}\pi a^3 V^3\left(2\sigma + \frac{2a^3+b^3}{b^3-a^3}\rho\right)$

(D) None of the above

93. The space between two spherical shells of radii 2*a* and *a* is filled with an incompressible fluid of density ρ. If the shell suddenly begins to move with velocity V and 2V in the same direction, the resultant impulsive pressure on the inner shell is :

(A) $\frac{2}{3}\pi\rho V a^3$

(B) $\frac{4}{7}\pi\rho V a^2$

(C) $\frac{8}{19}\pi\rho V a^3$

(D) $\frac{8}{21}\pi\rho V a^3$

94. A sphere is moving under no external forces with constant velocity U and the mean pressure over the sphere is in defect the pressure Π at a great distance by $\frac{1}{4}\rho U^2$, then the pressure at any point of a liquid, of infinite extent and at rest at a great distance is :

(A) $\Pi < \frac{5}{8}\rho U^2$

(B) $\Pi > \frac{5}{8}\rho U^2$

(C) $\Pi > \frac{7}{8}\rho U^2$

(D) None of the above

95. A infinite ocean of an incompressible perfect liquid of density ρ is streaming past a fixed spherical obstacle of radius *a*. The velocity V is uniform except in so far as it's disturbed by the sphere and the pressure in the liquid at a great distance from the obstacle is Π. Then the thrust on that half of the sphere is :

(A) $\pi a^2\left[\Pi - \frac{\rho V^2}{16}\right]$

(B) $\pi a^2\left[\Pi + \frac{1}{16}\rho V^2\right]$

(C) $\pi a^2\left[\Pi - \frac{1}{6}\rho V^3\right]$

(D) None of the above

96. A sphere is moving in an infinite mass of liquid with velocity U in *z*-direction and the liquid being at rest at infinity, then liquid exerts a resistance of amount is :

(A) $2\text{M}'\dot{\text{U}}$

(B) $\frac{1}{2}\text{M}'\text{U}$

(C) $\frac{1}{2}\text{M}'\dot{\text{U}}$

(D) None of the above

97. A sphere of radius *a* is surrounded by a concentric spherical shell of radius *b*. The space between is filled with liquid. If sphere is moving with velocity U, then velocity potential ϕ is :

(A) $\frac{\text{U}a^3}{b^3 - a^3}\left(r + \frac{b^3}{2r^2}\right)\cos\theta$

(B) $\frac{\text{U}a^3}{a^3 - b^3}\left(r + \frac{b^3}{2r^2}\right)\cos\theta$

(C) $\frac{\text{U}b^3}{a^3 - b^3}\left(r + \frac{b^3}{2r^2}\right)\cos\theta$

(D) None of the above

98. Let the origin O at the centre of the sphere, moving along X-axis in the direction of the motion with velocity V and the velocity potential ϕ is defined by $q = -\nabla\phi$ with the boundary conditions :

(i) $\left(\frac{\partial\phi}{\partial r}\right)_{r\to\infty} = 0$

(ii) $\left(\frac{\partial\phi}{\partial r}\right)_{r=0} = \text{V}\cos\theta$

Then the equation of the lines of flow is :

(A) $\frac{dr}{\partial\phi/\partial r} = -\frac{rd\theta}{\partial\phi/r\partial\theta}$

(B) $\frac{dr}{\partial\phi/\partial r} = -\frac{rd\theta}{\partial\phi/r^2\partial\theta}$

(C) $\frac{dr}{\partial\phi/\partial r} = \frac{rd\theta}{\partial\phi/r\partial\theta}$

(D) None of the above

99. For a liquid streaming past a fixed sphere, the line of flow relative to the sphere is :

(A) $rc = \sin^2\theta(r^3 - a^3)$

(B) $rc = \sin^2\theta(a^2 - r^2)$

(C) $rc = \sin^2\theta(r^3 + a^3)$

(D) None of the above

100. For the motion of a sphere through an infinite mass of a liquid at rest at infinity, the stream function ψ is :

(A) $\frac{\text{U}a^3}{2r}\sin^2\theta$

(B) $-\frac{\text{U}a^3}{2r}\sin^2\theta$

(C) $-\frac{\text{U}a^3}{2r^2}\sin^2\theta$

(D) None of the above

(Only for Rough Work)

4. Four alternative answers are mentioned for each question as—A, B, C & D in the booklet. The candidate has to choose the correct answer and mark the same in the OMR Answer-Sheet as per the direction :

Example :

Question :

Q. 1 (A) ● (C) (D)
Q. 2 (A) (B) ● (D)
Q. 3 (A) ● (C) (D)

Illegible answers with cutting and over-writing or half filled circle will be cancelled.

5. Each question carries equal marks. Marks will be awarded according to the number of correct answers you have.
6. All answers are to be given on OMR Answer Sheet only. Answers given anywhere other than the place specified in the answer sheet will not be considered valid.
7. Before writing anything on the OMR Answer Sheet, all the instructions given in it should be read carefully.
8. After the completion of the examination candidates should leave the examination hall only after providing their OMR Answer Sheet to the invigilator. Candidate can carry their Question Booklet.
9. There will be no negative marking.
10. Rough work, if any, should be done on the blank pages provided for the purpose in the booklet.
11. To bring and use of log-book, calculator, pager and cellular phone in examination hall is prohibited.
12. In case of any difference found in English and Hindi version of the question, the English version of the question will be held authentic.

Impt. : On opening the question booklet, first check that all the pages of the question booklet are printed properly. If there is any discrepancy in the question Booklet, then after showing it to the invigilator, get another question Booklet of the same series.

4. प्रश्न-पुस्तिका में प्रत्येक प्रश्न के चार सम्भावित उत्तर–A, B, C एवं D हैं। परीक्षार्थी को उन चारों विकल्पों में से सही उत्तर छाँटना है। उत्तर को OMR आन्सर-शीट में सम्बन्धित प्रश्न संख्या में निम्न प्रकार भरना है :

उदाहरण :

प्रश्न :

प्रश्न 1 (A) ● (C) (D)
प्रश्न 2 (A) (B) ● (D)
प्रश्न 3 (A) ● (C) (D)

अपठनीय उत्तर या ऐसे उत्तर जिन्हें काटा या बदला गया है, या गोले में आधा भरकर दिया गया, उन्हें निरस्त कर दिया जाएगा।

5. प्रत्येक प्रश्न के अंक समान हैं। आपके जितने उत्तर सही होंगे, उन्हीं के अनुसार अंक प्रदान किये जायेंगे।
6. सभी उत्तर केवल ओ. एम. आर. उत्तर-पत्रक (OMR Answer Sheet) पर ही दिये जाने हैं। उत्तर-पत्रक में निर्धारित स्थान के अलावा अन्यत्र कहीं पर दिया गया उत्तर मान्य नहीं होगा।
7. ओ. एम. आर. उत्तर-पत्रक (OMR Answer Sheet) पर कुछ भी लिखने से पूर्व उसमें दिये गये सभी अनुदेशों को सावधानीपूर्वक पढ़ लिया जाये।
8. परीक्षा समाप्ति के उपरान्त परीक्षार्थी कक्ष निरीक्षक को अपनी OMR Answer Sheet उपलब्ध कराने के बाद ही परीक्षा कक्ष से प्रस्थान करें। परीक्षार्थी अपने साथ प्रश्न-पुस्तिका ले जा सकते हैं।
9. निगेटिव मार्किंग नहीं है।
10. कोई भी रफ कार्य, प्रश्न-पुस्तिका के अन्त में, रफ-कार्य के लिए दिए खाली पेज पर ही किया जाना चाहिए।
11. परीक्षा-कक्ष में लॉग-बुक, कैलकुलेटर, पेजर तथा सेल्युलर फोन ले जाना तथा उसका उपयोग करना वर्जित है।
12. प्रश्न के हिन्दी एवं अंग्रेजी रूपान्तरण में भिन्नता होने की दशा में प्रश्न का अंग्रेजी रूपान्तरण ही मान्य होगा।

महत्वपूर्ण : प्रश्नपुस्तिका खोलने पर प्रथमत: जाँच कर देख लें कि प्रश्न-पुस्तिका के सभी पृष्ठ भलीभाँति छपे हुए हैं। यदि प्रश्नपुस्तिका में कोई कमी हो, तो कक्षनिरीक्षक को दिखाकर उसी सिरीज की दूसरी प्रश्न-पुस्तिका प्राप्त कर लें।