Roll. No. ....

Question Booklet Number

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

M.A./M.Sc. (SEM.-III) (NEP) (SUPPLE.) EXAMINATION, 2024-25

MATHEMATICS

(Fluid Dynamics)

Paper Code							
B	0	3	0	9	0	3	T

Question Booklet Series

A

Time : 1 : 30 Hours **Max. 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.
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 :

(Remaining instructions on last page)

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, उसे तुरन्त बदल लें।
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 उत्तर-पत्रक में सम्बन्धित प्रश्न संख्या में निम्न प्रकार भरना है :

(शेष निर्देश अन्तिम पृष्ठ पर)

1. Which of the following is a Newtonian fluid?
   (A) Blood
   (B) Air
   (C) Toothpaste
   (D) Soap solution

2. The relation between shear stress and velocity gradient is linear in:
   (A) Newtonian fluids
   (B) Non-Newtonian fluids
   (C) Bingham plastics
   (D) All fluids

3. Which of the following behaves as a non-Newtonian fluid?
   (A) Water
   (B) Air
   (C) Molasses
   (D) Mercury

4. Continuum hypothesis assumes:
   (A) Fluids are made up of discrete molecules
   (B) Fluid properties vary continuously without molecular discreteness
   (C) Fluids cannot be compressed
   (D) Fluids have no viscosity

5. Continuum hypothesis is valid if:
   (A) Knudsen number $<< 1$
   (B) Knudsen number ≈ 1
   (C) Knudsen number $>> 1$
   (D) None of these

6. Which field depends on continuum hypothesis?
   (A) Classical fluid mechanics
   (B) Quantum mechanics
   (C) Molecular dynamics
   (D) Nuclear physics

7. In Lagrangian description, fluid motion is described by:
   (A) Tracing each fluid particle
   (B) Considering a fixed point in space
   (C) Average velocity at control volume
   (D) Pressure field only

8. Eulerian method describes fluid motion with respect to:
   (A) Moving particles
   (B) Control volume (fixed in space)
   (C) Individual molecule
   (D) Random path lines

9. Which approach is easier for solving Navier-Stokes equations?
   (A) Lagrangian
   (B) Eulerian
   (C) Both are same
   (D) Neither

10. The continuity equation represents:
(A) Conservation of energy
(B) Conservation of momentum
(C) Conservation of mass
(D) Conservation of entropy

11. Continuity equation in Cartesian coordinates is:
(A) $\partial u / \partial x + \partial v / \partial y + \partial w / \partial z = 0$
(B) $u\, dv / dx + v\, du / dy = 0$
(C) $\partial p / \partial x + \partial p / \partial y = 0$
(D) $\nabla^2 \varphi = 0$

12. In cylindrical polar coordinates, continuity equation is:
(A) $(1/r)\partial(ru)/\partial r + \partial v/\partial\theta + \partial w/\partial z = 0$
(B) $(1/r)\, \partial u / \partial r + \partial v / \partial \theta = 0$
(C) $\partial u / \partial \theta + \partial w / \partial z = 0$
(D) None of these

13. Continuity equation in spherical polar coordinates includes:
(A) $(1/r^2)\, \partial\, (r^2 u) / \partial r$ *term*
(B) $(1/r)\, \partial v / \partial \theta$ *term*
(C) $(1/r \sin \theta)\, \partial w / \partial \phi$ *term*
(D) All of these

14. Vorticity vector is defined as:
(A) Curl of velocity vector
(B) Divergence of velocity vector
(C) Gradient of velocity potential
(D) Laplacian of velocity vector

15. Vorticity is zero in:
(A) Rotational flow
(B) Irrotational flow
(C) Turbulent flow
(D) Viscous flow

16. Velocity potential function satisfies:
(A) Laplace equation
(B) Poisson equation
(C) Bernoulli equation
(D) None of these

17. Streamline represents:
(A) Path traced by a particle
(B) Instantaneous direction of velocity field
(C) Locus of all particles passed through a point
(D) None of these

18. Pathline represents:
(A) Path traced by a fluid particle over time
(B) Direction of velocity vector
(C) Pressure distribution
(D) Mass flux

19. Streakline is the locus of particles that:
(A) Pass through a given point continuously
(B) Trace a velocity vector
(C) Travel in streamline direction
(D) Remain stationary

20. A flow is rotational when:

(A) Vorticity $\neq 0$

(B) Vorticity = 0

(C) Velocity potential exists

(D) Laplace equation holds

21. In irrotational flow:

(A) Circulation = 0

(B) Vorticity = 0

(C) Velocity potential exists

(D) All of these

22. Condition of irrotational flow is:

(A) $\nabla \times V = 0$

(B) $\nabla \bullet V = 0$

(C) $\nabla V = 0$

(D) $\nabla^2 V = 0$

23. Boundary surface is the surface that:

(A) Separates two immiscible fluids

(B) Separates streamline and pathline

(C) Has no velocity

(D) Has infinite vorticity

24. On solid boundaries, the boundary condition is:

(A) Velocity normal = 0 (no penetration)

(B) Velocity tangential = 0 (no slip)

(C) Both (A) and (B)

(D) Only pressure is continuous

25. Across fluid-fluid interface, which condition holds?

(A) Pressure continuity

(B) Velocity tangential continuity

(C) Velocity normal continuity

(D) All of these

26. Kinematic boundary condition refers to:

(A) Continuity of normal velocity across boundary

(B) Continuity of tangential velocity across boundary

(C) Stress distribution at boundary

(D) None of these

27. Dynamic boundary condition refers to:

(A) Continuity of pressure and stresses

(B) Continuity of velocity

(C) No slip

(D) Only tangential stresses

28. Which function can simultaneously define both streamlines and equipotential lines?

(A) Stream function

(B) Velocity potential

(C) Complex potential

(D) Vorticity function

29. Stream function in 2D satisfies:

(A) Continuity equation automatically

(B) Euler's equation

(C) Laplace's equation always

(D) Bernoulli's theorem

30. Euler's equation of motion is derived from:

(A) Conservation of mass

(B) Conservation of momentum

(C) Conservation of energy

(D) Conservation of entropy

31. Euler's equation of motion is valid for:

(A) Viscous and compressible flow

(B) Inviscid and incompressible flow

(C) Only laminar flow

(D) Only turbulent flow

32. Euler's equation in vector form is:

(A) $\rho\,(dV/dt) = -\nabla\rho + \rho g$

(B) $\nabla \bullet V = 0$

(C) $\nabla \times V = 0$

(D) $dp/dx = \rho g$

33. Bernoulli's equation is obtained by integrating:

(A) Navier-Stokes equation

(B) Continuity equation

(C) Euler's equation of motion

(D) Energy equation

34. Bernoulli's equation represents:

(A) Conservation of momentum

(B) Conservation of energy

(C) Continuity of mass

(D) Vorticity equation

35. In Bernoulli's equation, the term $\rho/\rho g$ is called:

(A) Pressure head

(B) Velocity head

(C) Elevation head

(D) Dynamic head

36. Bernoulli's equation is applicable to:

(A) Viscous, unsteady, compressible flow

(B) Inviscid, incompressible, steady flow along streamline

(C) Only rotational flows

(D) Turbulent flow

37. Which of the following is an application of Bernoulli's principle?

(A) Venturimeter

(B) Pitot tube

(C) Orifice meter

(D) All of these

38. Lagrange's equation of motion is a reformulation of:

(A) Newton's second law

(B) Continuity equation

(C) Navier-Stokes equation

(D) Bernoulli's equation

39. In Lagrangian formulation, the equation of motion is expressed in terms of:

(A) Generalized coordinates

(B) Stream function

(C) Velocity potential

(D) Pressure function

40. The principle used to derive Lagrange's equation is:

(A) Principle of least action

(B) D'Alembert's principle

(C) Continuum hypothesis

(D) Bernoulli's theorem

41. The energy equation is obtained by applying:

(A) First law of thermodynamics

(B) Second law of thermodynamics

(C) Newton's law

(D) Continuity equation

42. Energy equation for fluid motion includes:

(A) Internal energy

(B) Kinetic energy

(C) Potential energy

(D) All of these

43. In the absence of viscous dissipation and heat transfer, the energy equation reduces to:

(A) Continuity equation

(B) Bernoulli's equation

(C) Euler's equation

(D) Navier-Stokes equation

44. An impulsive force acts for:

(A) A very long duration

(B) An infinitely short time

(C) Only in rotational motion

(D) Only in steady flow

45. Impulsive effects are studied using:

(A) Momentum equation

(B) Impulse-momentum equation

(C) Energy equation

(D) Continuity equation

46. In impulsive motion, change in momentum is equal to:

(A) Force × distance

(B) Force × velocity

(C) Impulse

(D) Energy transfer

47. Helmholtz's first theorem states:

(A) Circulation around a material curve remains constant

(B) Vorticity is always zero

(C) Stream function is constant

(D) Energy is conserved

48. Helmholtz's vorticity theorem is applicable for:

(A) Viscous flow

(B) Inviscid flow

(C) Compressible flow only

(D) Turbulent flow

49. According to Helmholtz, vortex lines:

(A) Cannot begin or end in fluid

(B) Always end on solid boundaries

(C) Disappear suddenly

(D) Can terminate in space

50. In an ideal fluid, vortex filaments move:

(A) With the fluid

(B) Against the fluid

(C) Stationary

(D) Randomly

51. Vorticity is mathematically defined as:

(A) $\nabla \times V$

(B) $\nabla \bullet V$

(C) ∇V

(D) $\nabla^2 V$

52. Vorticity equation is obtained by taking the curl of:

(A) Continuity equation

(B) Euler's equation of motion

(C) Energy equation

(D) Lagrange's equation

53. The device used to measure velocity of fluid using Bernoulli's principle is:

(A) Manometer

(B) Pitot tube

(C) Bourdon gauge

(D) Rotameter

54. For two-dimensional incompressible flow, the condition of irrotationality is:

(A) $\partial u / \partial x + \partial v / \partial y = 0$

(B) $\partial v / \partial x - \partial u / \partial y = 0$

(C) $\partial u / \partial x = \partial v / \partial y$

(D) $\partial u / \partial y = \partial v / \partial x$

55. In 2D irrotational flow, the velocity potential φ satisfies:

(A) Poisson equation

(B) Laplace equation

(C) Continuity equation only

(D) Navier–Stokes equation

56. Irrotational flow implies:

(A) Circulation is zero

(B) Vorticity = 0

(C) Potential function exists

(D) All of these

57. The stream function ψ is defined such that:

(A) $u = \partial\psi / \partial y, v = -\partial\psi / \partial x$

(B) $u = \partial\psi / \partial x, v = \partial\psi / \partial y$

(C) $u = \partial\psi / \partial z, v = \partial\psi / \partial x$

(D) None of these

58. Streamlines are lines of:

(A) Constant potential function

(B) Constant stream function

(C) Zero velocity

(D) Maximum vorticity

59. For incompressible flow, stream function ψ satisfies:

(A) Poisson's equation

(B) Laplace's equation

(C) Euler's equation

(D) None of these

60. Physical significance of stream function is:

(A) Difference of ψ gives flow rate between streamlines

(B) ψ = velocity potential

(C) ψ = circulation always

(D) ψ is dimensionless

61. In 2D, velocity potential of a source at origin is:

(A) $(Q / 2\pi) \log r$

(B) $(Q / 2\pi r)$

(C) $(Q / 4\pi r^2)$

(D) (Q/r)

62. Stream function for a 2D source at origin is:

(A) $(Q / 2\pi)\, \theta$

(B) $(Q / 2\pi)\, r$

(C) $(Q / 2\pi r) \cos\theta$

(D) None of these

63. A doublet is formed by:

(A) Source and sink of equal strength placed very close

(B) Two sinks of equal strength

(C) Two sources at same point

(D) Source at infinity

64. Velocity potential of a doublet at origin is:

(A) $-(\mu \cos\theta) / (2\pi r)$

(B) $(\mu \sin\theta) / (2\pi r^2)$

(C) μ / r^2

(D) $\mu \log r$

65. The complex potential is written as:

(A) $W = \varphi - i\psi$

(B) $W = \varphi + i\psi$

(C) $W = \psi - i\varphi$

(D) $W = \psi + i\varphi$

66. In complex potential, derivative dW/dz gives:

(A) Pressure

(B) Velocity

(C) Stream function

(D) Circulation

67. Complex potential automatically satisfies:

(A) Navier–Stokes equation

(B) Euler's equation

(C) Cauchy–Riemann conditions

(D) Reynolds equation

68. The Milne-Thomson circle theorem is used to obtain:

(A) Flow around a cylinder

(B) Flow over a flat plate

(C) Flow in a pipe

(D) Flow over airfoil

69. Milne-Thomson theorem ensures that:

(A) The boundary condition on a cylinder is satisfied

(B) Continuity holds

(C) Energy is conserved

(D) Flow is rotational

70. Blasius theorem is used to calculate:

(A) Velocity distribution

(B) Lift and drag forces

(C) Circulation

(D) Energy dissipation

71. In Blasius theorem, force components are expressed as integrals of:

(A) Pressure only

(B) Complex potential derivative

(C) Stream function

(D) Circulation

72. Blasius theorem is applicable in:

(A) Potential flow theory

(B) Viscous boundary layers

(C) Turbulent wakes

(D) Shock waves

73. Circulation " is defined as:

(A) $\oint V . dl$

(B) $\oint \nabla \times V . dA$

(C) $\int V^2 \, dA$

(D) $\nabla . V$

74. For irrotational flow, circulation around any closed path is:

(A) Maximum

(B) Minimum

(C) Zero

(D) Infinite

75. Circulation is mathematically equal to:

(A) Vorticity × area

(B) Velocity × distance

(C) Pressure × length

(D) Energy × mass

76. Kelvin's theorem is based on:

(A) Conservation of mass

(B) Conservation of energy

(C) Conservation of circulation

(D) Vorticity transport equation

77. The permanence of irrotational motion states:

(A) Once irrotational, always irrotational in ideal fluid

(B) Flow cannot remain irrotational

(C) Irrotational motion becomes rotational after time

(D) Irrotational motion exists only in viscous fluid

78. This principle follows from:

(A) Kelvin's circulation theorem

(B) Bernoulli's theorem

(C) Continuity equation

(D) Helmholtz's theorem

79. Kelvin's minimum kinetic energy theorem states:

(A) Irrotational flow has minimum kinetic energy among all possible flows

(B) Viscous flow always has less energy

(C) Circulation minimizes kinetic energy

(D) Stream function minimizes kinetic energy

80. The general motion of a cylinder in 2D includes:

(A) Translation only

(B) Rotation only

(C) Both translation and rotation

(D) Vibrations only

81. The kinetic energy of a cylinder in potential flow is expressed in terms of:

(A) Mass and velocity only

(B) Added mass and velocity

(C) Pressure difference

(D) Circulation only

82. In 2D flow, the concept of added mass refers to:

(A) Mass of cylinder itself

(B) Virtual mass of displaced fluid accelerating with the body

(C) Total kinetic energy of flow

(D) Weight of fluid displaced

83. The added mass per unit length of a circular cylinder in 2D is:

(A) $\rho\pi a^2$

(B) ρa^2

(C) $2\rho\pi a^2$

(D) $\rho / \pi a^2$

84. The stream function for uniform flow past a circular cylinder of radius a is:

(A) $U(r - a^2/r) \sin\theta$

(B) $U(r + a^2/r) \cos\theta$

(C) $U(r - a^2/r) \cos\theta$

(D) $U(r^2 + a^2) \sin\theta$

85. In potential flow, the drag force on a circular cylinder is:

(A) Very high

(B) Equal to lift force

(C) Zero (d'Alembert's paradox)

(D) Infinite

86. The pressure distribution around a circular cylinder is obtained from:

(A) Euler's equation

(B) Bernoulli's equation

(C) Continuity equation

(D) Navier–Stokes equation

87. For two coaxial cylinders, the added mass depends on:

(A) Inner cylinder radius only

(B) Outer cylinder radius only

(C) Both inner and outer radii

(D) None of these

88. In 2D flow, the added mass of an elliptic cylinder moving along its major axis is:

(A) Larger than that along minor axis

(B) Smaller than that along minor axis

(C) Same along both axes

(D) Zero

89. For elliptic cylinders, the added mass coefficients depend on:

(A) Density only

(B) Axis ratio (a/b)

(C) Circulation

(D) Stream function

90. The flow past a fixed circular cylinder is symmetric unless:

(A) Cylinder rotates

(B) Circulation is introduced

(C) Viscosity is considered

(D) All of these

91. Lift per unit length of a circular cylinder with circulation Γ is given by:

(A) $\rho U^2 \pi a^2$

(B) $\rho U \Gamma$

(C) $\frac{1}{2} \rho U^2$

(D) $\rho \Gamma^2$

92. For an elliptic cylinder, circulation causes:

(A) Zero lift

(B) Pressure imbalance $\rightarrow$ lift generation

(C) No effect on motion

(D) Only drag increase

93. The kinetic energy of a rotating elliptic cylinder includes:

(A) Rotational KE only

(B) Translational KE only

(C) Both translational KE and added mass effect

(D) Pressure energy only

94. The kinetic energy due to added mass for elliptic cylinder moving along its major axis is proportional to:

(A) a^2

(B) b^2

(C) ab

(D) a^3

95. The kinetic energy for rotation of an elliptic cylinder about its axis depends on:

(A) Axis lengths a and b

(B) Circulation Γ only

(C) Uniform velocity U only

(D) None of these

96. An aerofoil is designed to produce:

(A) Maximum drag

(B) Maximum lift with minimum drag

(C) Zero circulation

(D) Only turbulence

97. The circulation around an aerofoil is related to lift by:

(A) Blasius theorem

(B) Kutta–Joukowski theorem

(C) Bernoulli's equation

(D) Kelvin's theorem

98. The Kutta condition applied to aerofoils states:

(A) Flow leaves smoothly at trailing edge

(B) Circulation is maximum

(C) Pressure is minimum

(D) Velocity is uniform everywhere

99. The lift coefficient of an aerofoil in potential flow varies linearly with:

(A) Drag coefficient

(B) Angle of attack (α)

(C) Pressure coefficient

(D) Mach number

100. The lift per unit span of an aerofoil is:

(A) $L = \rho U^2 a^2$

(B) $L = \rho U \Gamma$

(C) $L = \rho \Gamma^2 / 2$

(D) $L = U / \Gamma$

Rough Work / रफ कार्य

Example :

Question :

Q.1 Ⓐ ● Ⓒ Ⓓ

Q.2 Ⓐ Ⓑ ● Ⓓ

Q.3 Ⓐ ● Ⓒ Ⓓ

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 & 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.

उदाहरण :

प्रश्न :

प्रश्न 1 Ⓐ ● Ⓒ Ⓓ

प्रश्न 2 Ⓐ Ⓑ ● Ⓓ

प्रश्न 3 Ⓐ ● Ⓒ Ⓓ

5. प्रत्येक प्रश्न के अंक समान हैं। आपके जितने उत्तर सही होंगे, उन्हीं के अनुसार अंक प्रदान किये जायेंगे।

6. सभी उत्तर केवल ओ०एम०आर० 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. ओ०एम०आर० 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 में, रफ-कार्य के लिए दिए खाली पेज पर ही किया जाना चाहिए।

11. परीक्षा-कक्ष में लॉग-बुक, कैल्कुलेटर, 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।

महत्वपूर्णः प्रश्नपुस्तिका खोलने पर प्रथमतः जाँच कर देख लें कि प्रश्नपुस्तिका के सभी पृष्ठ भलीभाँति छपे हुए हैं। यदि प्रश्नपुस्तिका में कोई कमी हो, तो कक्षनिरीक्षक को दिखाकर उसी सिरीज की दूसरी प्रश्नपुस्तिका प्राप्त कर लें।