Roll No. .....

Question Booklet Number

O. M. R. Serial No.

M. Sc. (Second Semester)
(NEP) EXAMINATION, 2025-26
PHYSICS
(Mathematical Physics–II)

Paper Code							
B	0	1	0	8	0	1	T

Questions Booklet Series
A

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 partial differential equation contains :

(A) Only two partial independent variable

(B) Partial derivatives of a function of several variables

(C) Only ordinary derivatives variable

(D) None of the above

2. The order of a PDE is determined by :

(A) Highest order partial derivative

(B) Number of independent variables

(C) Degree of equation

(D) None of the above

3. The method of separation of variables is mainly used for :

(A) First-order PDEs

(B) Ordinary independent derivative

(C) Linear PDEs with boundary conditions

(D) None of the above

4. The method of characteristics is used for :

(A) First-order PDE

(B) Laplace equation

(C) Heat conduction equation

(D) None of the above

5. In the Lagrange's equation, if $c = 0$, the PDE is called :

(A) Homogeneous

(B) Linear inhomogeneous

(C) Nonlinear

(D) None of the above

6. The method of multipliers is mainly used to :

(A) Solve nonlinear PDE

(B) Addition of equations randomly

(C) Solve homogeneous boundary value problems

(D) None of the above

7. The identity element of a group G is :

(A) Unique

(B) Depends on the operation

(C) Can be more than one

(D) None of the above

8. In spherical coordinates, the radial part of Laplace equation includes :

(A) $r^2 u_r$

(B) $\frac{1}{r^2}\frac{\partial}{\partial r}\left(r^2 u_r\right)$

(C) $\sin r$

(D) None of the above

9. The set of integers under addition is :

(A) Abelian group

(B) Non-abelian group

(C) Monoid only

(D) None of the above

10. The operator ∇^2 in Cartesian coordinates equals :

(A) $\frac{\partial}{\partial x} + \frac{\partial}{\partial y} + \frac{\partial}{\partial z}$

(B) $\frac{\partial^2}{\partial t^2}$

(C) $\frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2} + \frac{\partial^2}{\partial z^2}$

(D) None of the above

11. The image of a homomorphism $\phi : G \rightarrow H$:

(A) is can be empty

(B) is always G

(C) is a subgroup of H

(D) None of the above

12. A practical application of the diffusion equation is :

(A) Heat conduction in a rod

(B) Sound propagation in air

(C) Vibrations of a string

(D) None of the above

13. The one-dimensional wave equation is :

(A) $\frac{\partial u}{\partial t} = \frac{c^2 \partial^2 u}{\partial x^2}$

(B) $\frac{\partial^2 u}{\partial t^2} = \frac{c^2 \partial^2 u}{\partial x^2}$

(C) $\frac{\partial u}{\partial x} = \frac{c^2 \partial^2 u}{\partial t^2} = 0$

(D) None of the above

14. The SI unit of diffusion coefficient (D) is :

(A) m

(B) m^2/s

(C) s/m^2

(D) None of the above

15. Which phenomenon is modeled by the wave equation ?

(A) Vibrations of a stretched string

(B) Diffusion of gas

(C) Cooling of metal

(D) None of the above

16. In cylindrical coordinates, θ represents :

(A) Radial distance from origin

(B) Height above *xy* plane

(C) Angle measured from the positive x-axis in *xy* plane

(D) None of the above

17. Which is always a normal subgroup ?

(A) Kernel

(B) Conjugacy class

(C) Matrices

(D) None of the above

18. The general form of wave equation in spherical coordinates is :

(A) $\nabla^2\psi = \frac{\partial\psi}{dt}$

(B) $\nabla^2\psi = \frac{\left(1/c^2\right)\partial^2\psi}{\partial t^2}$

(C) $\frac{\partial\psi}{dt} = c\nabla\psi$

(D) None of the above

19. The Helmholtz equation is obtained from the wave equation by :

(A) Removing Laplacian equations

(B) Assuming time-harmonic Laplacian

(C) Removing time independence

(D) None of the above

20. A Green's function is primarily used to solve :

(A) Nonlinear differential equations

(B) Algebraic equations

(C) Inhomogeneous linear differential equations

(D) None of the above

21. If the operator is self-adjoint, then the Green's function satisfies :

(A) $G(x, x') = -G(x', x)$

(B) $G(x, x') = G(x', x)$

(C) $G(x, x') = 0$

(D) None of the above

22. The central difference δ is given by :

(A) $f(x+h) - f(x)$

(B) $f(x+h) - f(x-h)$

(C) $\left[f(x+h) - f(x-h) \right] / 2$

(D) None of the above

23. Inverse Laplace transform recovers :

(A) Derivative

(B) Original time domain function

(C) Frequency domain function

(D) None of the above

24. The Green's function is discontinuous in :

(A) Value at $x = x' = 0$

(B) First derivative at $x = x'$

(C) Second derivative everywhere

(D) None of the above

25. The Green's function helps in solving :

(A) Homogeneous equations

(B) Only algebraic derivative equations

(C) Inhomogeneous differential equations.

(D) None of the above

26. Parseval's identity is equivalent to :

(A) Conservation of momentum

(B) Conservation of energy in frequency and time domain

(C) $\frac{1}{2}mv^2$

(D) None of the above

27. The Green's function is symmetric in space for :

(A) Non-Hermitian Hamiltonians

(B) Time-dependent potentials

(C) Hermitian Hamiltonians

(D) None of the above

28. The Fourier series of a periodic function is a sum of :

(A) Exponential functions only

(B) Sine and cosine functions

(C) Polynomial

(D) None of the above

29. Fourier series is applicable to functions that are :

(A) Periodic

(B) Non- Periodic

(C) Constant only

(D) None of the above

30. The Fourier coefficient a_0 represents :

(A) Amplitude of sine term

(B) Average value of the function

(C) Frequency of the function

(D) None of the above

31. Fourier coefficient a_n is :

(A) $a_n = \int f(x)\,dx$

(B) $a_n = \frac{1}{\mathrm{L}}\int_{-\mathrm{L}}^{\mathrm{L}} f(x)\cos(n\pi x/\mathrm{L})\,dx$

(C) $a_n = f(n)$

(D) None of the above

32. The Fourier coefficient b_n is associated with :

(A) Sine terms

(B) Cosine terms

(C) Constant terms

(D) None of the above

33. The term 'harmonic' in Fourier series refers to :

(A) Contant frequency

(B) Integer multiples of fundamental frequency

(C) Zero frequency

(D) None of the above

34. For a square wave, the Fourier coefficients are proportional to :

(A) $1/n^2$

(B) $1/n^3$

(C) $1/n$

(D) Constant

35. If $f(x)$ is periodic and even, then :

(A) $a_n = 1$

(B) $b_n = 0$

(C) $a_n = b_n$

(D) None of the above

36. If Fourier coefficients a_n and b_n decay as $1/n^2$ the function is :

(A) Differentiable once

(B) Continuous

(C) Discontinuous

(D) None of the above

37. Parseval's theorem in complex form is :

(A) $\Sigma|C_n|^2 = \int |f(x)|^2 \, dx$

(B) $\Sigma|C_n|^2 = \frac{1}{T}\int |f(x)|^2 \, dx$

(C) Depends on normalization

(D) None of the above

38. Dirichlet's conditions apply to functions that are :

(A) Non-periodic

(B) Periodic

(C) Constant only

(D) Polynomial only

39. Which property is essential in Dirichlet's conditions ?

(A) Integrability

(B) Continuity everywhere

(C) Differentiability

(D) None of the above

40. The Dirac delta function $\delta(x)$ is defined as :

(A) A continuous function

(B) Zero everywhere except at $x = 0$

(C) Infinite everywhere

(D) None of the above

41. The value of $\int_{-\infty}^{\infty} \delta(x)\, dx$ is :

(A) 0

(B) ∞

(C) 1

(D) None of the above

42. The sifting property of delta function is :

(A) $\int f(x)\, dx = 0$

(B) $\int f(x)\delta(x-a)\, dx = f(a)$

(C) $\int \delta(x)\, dx = f(x)$

(D) None of the above

43. The relation $\delta(-x)=\delta(x)$ shows that delta function is :

(A) Even

(B) Odd

(C) Neither

(D) None of the above

44. The Fourier transform of $\delta(t)$ is :

(A) 0

(B) Undefined

(C) 1

(D) None of the above

45. The Dirac delta can be expressed as Fourier integral :

(A) $\delta(x)=\sum e^{inx}$

(B) $\delta(x)=\frac{1}{2\pi}\int e^{ikx}dk$

(C) $\delta(x)=x$

(D) None of the above

46. The Fourier transform converts a function from :

(A) Time domain to frequency domain

(B) Space domain to frequency domain

(C) Frequency to time only

(D) None of the above

47. Laplace transform converts differential equations into :

(A) Algebraic equations

(B) Matrices

(C) Integral equations

(D) None of the above

48. The Fourier transform of an even function is :

(A) Odd

(B) Complex

(C) Even

(D) Zero

49. Convolution in time domain corresponds to :

(A) Differetiation in frequency domain

(B) Multiplication in frequency domain

(C) Addition in frequency domain

(D) None of the above

50. Time shift property : $f(t-t_0)$

(A) $\mathrm{F}(\omega)e^{i\omega t_0}$

(B) $\mathrm{F}(\omega)e^{-i\omega t_0}$

(C) $\mathrm{F}(\omega)$

(D) None of the above

51. Fourier transform helps to convert PDEs into :

(A) Algebraic equations

(B) Integral equations

(C) Higher random equations

(D) None of the above

52. If a group has order 2, it must be :

(A) Abelian

(B) Cyclic

(C) Both (A) and (B)

(D) None of the above

53. Laplace transform of e^{at} is :

(A) $1/(s-a)$

(B) $1/(s+a)$

(C) $s/(s-a)$

(D) a/s

54. Laplace transform is especially useful for :

(A) Equilibrium states

(B) Transient phenomena

(C) Infinite series

(D) None of the above

55. Laplace transform helps to solve :

(A) Initial value problems

(B) Boundary value problems

(C) Both (A) and (B)

(D) None of the above

56. Final value theorem gives :

(A) $f(0)=0$

(B) $\lim_{t\to\infty} f(t)$

(C) $\lim_{s\to\infty} sF(s)$

(D) None of the above

57. Laplace transform of t^n is :

(A) $\frac{n!}{s^{n+1}}$

(B) 0

(C) $\frac{t^n}{s}$

(D) None of the above

58. Laplace transform of $f'(t)$ is :

(A) $sF(s)-f(0)$

(B) $sF(s)$

(C) $F(s)/s$

(D) None of the above

59. Final value theorem fails when :

(A) Poles are on the left

(B) Poles are in the right- half plane

(C) Zeros are in the right- half plane

(D) None of the above

60. The Dirac delta function $\delta(x)$ is defined such that :

(A) $\delta(x) = 1$ for all x

(B) $\delta(x) = x$

(C) $\delta(x) = 0$ for $x \neq 0$ and $\int_{-\infty}^{\infty} \delta(x)\, dx = 1$

(D) None of the above

61. The backward difference operator ∇ is defined as :

(A) $f(x) - f(x-h)$

(B) $f(x-h) - f(x)$

(C) $f(x+h) - f(x)$

(D) None of the above

62. For unequal intervals, which interpolation is used ?

(A) Newton forward

(B) Newton divided difference

(C) Gauss forward

(D) None of the above

63. Finite differences are mainly applied to :

(A) Continuous functions only

(B) Discrete tabulated data

(C) Analytical integration

(D) None of the above

64. Relation between shift and forward difference is :

(A) $E = 1 + \Delta$

(B) $E = 1 - \Delta$

(C) $E = 1/\Delta$

(D) None of the above

65. Finite difference method is used to :

(A) Solve matrices only Solve

(B) Solve algebraic equations only

(C) Solve differential equations

(D) None of the above

66. Interpolation is a method to :

(A) Estimate unknown values between known data points

(B) Integrate a function

(C) Both (A) and (B)

(D) None of the above

67. $\Delta f(x+h)$ equals :

(A) $f(x+h) - f(x)$

(B) $f(x+2h) - f(x+h)$

(C) $f(x) - f(x-h)$

(D) None of the above

68. Delta function is useful in solving :

(A) Polynomials

(B) Differential equations with point sources

(C) Both (A) and (B)

(D) None of the above

69. Absolute error is :

(A) | True value – Approximate value |

(B) Approximate / true

(C) (True – Approximate) / True

(D) None of the above

70. Absolute error is fixed, relative error will :

(A) Decrease for small true value

(B) Increase when true value is small

(C) Remain constant

(D) None of the above

71. Iterative methods are used to solve :

(A) Algebraic equations

(B) Transcendental equations

(C) Both (A) and (B)

(D) None of the above

72. Trapezoidal rule is used to approximate :

(A) Derivatives

(B) Integrals

(C) Limits

(D) None of the above

73. The trapezoid *vs*. Simpson's rule :

(A) Simpson's more accurate for same n values

(B) Trapezoid more accurate

(C) Same accuracy

(D) None of the above

74. Trapezoidal rule error term is proportional to :

(A) h^2

(B) h^3

(C) h^4

(D) None of the above

75. In numerical integration, h is called :

(A) Error size

(B) Step size

(C) Height

(D) None of the above

76. More the number of intervals :

(A) More error

(B) Unchanged

(C) Less error

(D) None of the above

77. The trapezoidal rule provides numerical integration by :

(A) Simple average rule

(B) Simpson's rule

(C) Linear approximation

(D) None of the above

78. If |G| = 12 and |H| = 4, order of G/H is :

(A) 3

(B) 8

(C) 6

(D) None of the above

79. The intersection of two subgroups is always :

(A) a subgroup

(B) not a subgroup

(C) a finite group

(D) None of the above

80. Simpson's rule error term is proportional to :

(A) h^2

(B) h^4

(C) h^5

(D) None of the above

81. For Simpson's rule, h is equal to :

(A) $(b-a)/n$

(B) $(b-a)/2n$

(C) $2(b-a)$

(D) None of the above

82. Using the Trapezoidal Rule, integrate $f(x) = x$ from 0 to 2 using 2 sub-intervals.

h = 1, Values : $f(0) = 0$, $f(1) = 1$, $f(2) = 2$

(A) 5

(B) 2

(C) 1.5

(D) None of the above

83. FFT is an algorithm to compute :

(A) Laplace Transform

(B) Discrete Fourier Transform (DFT) efficiently

(C) Continuous Fourier Transform

(D) None of the above

84. Cyclic groups of same order are always :

(A) Abelian only

(B) Isomorphic

(C) Homomorphic only

(D) None of the above

85. Newton-Raphson method is used to find :

(A) Roots of an equation

(B) Integration

(C) Derivatives

(D) None of the above

86. For finite groups, Schur's lemma gives :

(A) Matrix orthogonality

(B) Character orthogonality

(C) Both (A) and (B)

(D) None of the above

87. Runge-Kutta method is a/an :

(A) Multi-step method

(B) Exact solution method

(C) Single-step numerical method

(D) None of the above

88. Newton-Raphson iteration for $f(x) = x^2 - 2$ is :

(A) $x_{n+1} = \frac{x_n}{2}$

(B) $x_{n+1} = x_n - \frac{x_n^2 - 2}{2x_n}$

(C) $x_{n+1} = 2x_n - x_n^2$

(D) None of the above

89. DFT converts :

(A) Discrete time signal → Discrete frequency spectrum

(B) Frequency → Time

(C) Continuous signal → Discrete

(D) None of the above

90. In finite difference method, step size h must be :

(A) Always small

(B) Always integers

(C) Always constant

(D) None of the above

91. Stopping condition in bisection method for accuracy is :

(A) $|f(x_n)| < \in$

(B) $|x_{n+1} - x_n| < \in$

(C) Interval width $< \in$

(D) Any one of the above

92. Schur's lemma applies to :

(A) Reducible representation

(B) Irreducible representation

(C) Unitary representation only

(D) None of the above

93. A reducible representation can be reduced through :

(A) Change of basis

(B) Change of group

(C) Removing elements

(D) None of the above

94. A butterfly operation is used in :

(A) Bisection method

(B) Simpson rule

(C) FFT

(D) None of the above

95. A group with finite number of elements is called :

(A) Compact group

(B) Finite group

(C) Abelian group

(D) None of the above

96. A group is Abelian if :

(A) It has no identity

(B) Operation is commutative

(C) Every element has infinite order

(D) None of the above

97. If a group has only one element, it is called :

(A) Identity group Null group

(B) Identity group

(C) Trivial group

(D) None of the above

98. The special unitary group SU(2) is :

(A) Discrete group

(B) Real group only

(C) Lie group of 2 × 2 complex unitary matrices with determinant 1

(D) None of the above

99. Factor group describes symmetries after :

(A) Removing subgroup symmetries

(B) Combining symmetries

(C) Breaking symmetry

(D) None of the above

100. Characters are constant on :

(A) Subgroups

(B) Cosets

(C) Conjugacy classes

(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 प्रथमतः 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।