Roll No. .....

Question Booklet Number

O. M. R. Serial No.

M. Sc. (Fourth Semester)

(NEP) EXAMINATION, 2025-26

PHYSICS

(Physics of Liquid Crystals) (Elective)

Paper Code							
B	0	1	1	0	0	5	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. Liquid crystals widely used in drug delivery systems are :

(A) Lyotropic

(B) Thermotropic

(C) Both (A) and (B)

(D) None of the above

2. PDLC has application in :

(A) Tunable focus lens

(B) Laser beam steering

(C) Projection display

(D) Smart Windows

3. PDLC stands for :

(A) Polymer Dispersed Liquid Crystal

(B) Polymer Diffused Liquid Crystal

(C) Polymer Divided Liquid Crystal

(D) Polymer Doped Liquid Crystal

4. LC writing tablets consume power only during erasing and not during writing because :

(A) They operate in emissive mode

(B) The device stores charge like a capacitor

(C) The LC material has zero anisotropy

(D) The written state is optically stable due to bistability

5. The phase of liquid crystal in LC based writing pads is :

(A) Nematic

(B) Cholesteric

(C) Smectic

(D) None of the above

6. LC droplets used for detecting proteins or DNA rely on :

(A) Surface-induced configurational transition

(B) Increase in conductivity

(C) Change in viscosity

(D) Change in elastic constant

7. The presence of biomolecules at the LC-aqueous interface generally causes :

(A) Increase in positional order

(B) Transition from isotropic to crystalline phase

(C) Distortion of the director field

(D) Formation of disclination lines only

8. Liquid crystal phase commonly used in biological sensing applications ?

(A) Nematic

(B) Cholesteric

(C) Smectic

(D) Discotic

9. Liquid crystals are used in biosensing due to :

(A) Electrical conduction

(B) Interaction with surface molecules

(C) Fluorescence

(D) None of the above

10. A major advantage of liquid-crystal-based tunable photonic crystals is :

(A) Fast electro-optic response

(B) Low voltage operation

(C) Compact device

(D) All of the above

11. The central wavelength from a cholesteric liquid crystal is given by :

(A) $\lambda = n.P/2$

(B) $\lambda = n.P$

(C) $\lambda = 2n.P$

(D) $\lambda = 4n.P$

12. SLMs are widely used in :

(A) Optical data storage

(B) Holography and adaptive optics

(C) Nuclear reactors

(D) X-ray imaging

13. SLM modulates :

(A) Phase only

(B) Amplitude only

(C) Both (A) and (B)

(D) None of the above

14. Liquid crystal temperature sensors mainly work due to :

(A) Phase retardation

(B) Plane of polarization

(C) Selective reflection

(D) Selective transmittance

15. The liquid crystal used in 7-segment displays operates in :

(A) TN mode

(B) IPS mode

(C) VA mode

(D) ChLC Mode

16. In a 7-segment LCD, each segment is controlled by :

(A) Separate electrodes

(B) Single electrode

(C) Seven electrodes

(D) Crossed electrodes

17. A 7-segment LCD display is commonly used to display :

(A) Images

(B) Alphabets

(C) Numerical digits

(D) Colour patterns

18. A nematic liquid crystal switching is based on :

(A) Electrically controlled birefringence

(B) Electrically controlled luminescence

(C) Electrically controlled scattering

(D) Electrically controlled reflection

19. The contrast in an LCD mainly depends on :

(A) Molecule size of LC

(B) Polarizer and alignment quality

(C) Colour filter quality

(D) All of the above

20. The advantage of VA displays over other LCDs is :

(A) Low cost

(B) Wide viewing angle

(C) High Contrast

(D) Fast response

21. The advantage of IPS displays over other LCDs is :

(A) Low cost

(B) Wide viewing angle

(C) High Brightness

(D) Fast response

22. In normally white mode TN LCDs, the phase difference produced is :

(A) 0

(B) $\pi/4$

(C) $\pi/2$

(D) π

23. Polarizers in LCD are used for :

(A) Generation and filtering of polarized light

(B) Colour generation

(C) Modulation of polarized light

(D) All of the above

24. In TN LCD, the angle between the director on the two surfaces is :

(A) 0°

(B) 45°

(C) 60°

(D) 90°

25. Working principle of a twisted nematic (TN) LCD is based on :

(A) Scattering

(B) Rotation of polarized light

(C) Reflection

(D) Kerr Effect

26. Nematic order parameter S for perfectly aligned molecules is :

(A) 0

(B) 1/2

(C) -1/2

(D) 1

27. At the nematic-isotropic transition temperature, the birefringence becomes :

(A) Maximum

(B) Non zero Minimum

(C) Zero

(D) Infinite

28. The order parameter in nematic liquid crystals is defined as :

(A) $S = < \cos\theta >$

(B) $S = \frac{1}{2}\left(3 < \cos^2\theta > -1\right)$

(C) $S = < \sin^2\theta >$

(D) $S = < \tan\theta >$

29. The relation between birefringence and order parameter is :

(A) $\Delta n \propto 1/S$

(B) $\Delta n \propto S$

(C) $\Delta n \propto S^2$

(D) $\Delta n \propto \sqrt{S}$

30. If the thickness is doubled, the phase retardation becomes :

(A) Half

(B) Double

(C) Same

(D) Four times

31. The twist elastic constant K_{22} is measured using :

(A) Planar aligned Cell

(B) Vertical aligned Cell

(C) Twisted aligned cell

(D) All of the above

32. Elastic constants in liquid crystals are the order of :

(A) 10^{-6} N

(B) 10^{-8} N

(C) 10^{-10} N

(D) 10^{-12} N

33. Polarized light passing through vertical aligned LC cell faces a phase difference of :

(A) π

(B) $\pi/2$

(C) 0

(D) 2π

34. If the cell thickness is doubled, the relaxation time will :

(A) remain same

(B) double

(C) become half

(D) become four times

35. The relaxation time after removing the electric field depends on :

(A) Applied voltage

(B) Elastic constant and rotational viscosity

(C) Dielectric anisotropy only

(D) All of the above

36. The rise time of a nematic liquid crystal primarily depends on :

(A) Rotational viscosity and applied electric field only

(B) Elastic constant only

(C) Cell thickness only

(D) All of the above

37. Polarized light with polarization plane parallel to LC director passing through perfectly planar aligned LC cell faces a phase difference of :

(A) π

(B) $\frac{\pi}{2}$

(C) 0

(D) 2π

38. The splay Freedericksz transition in a planar cell is governed by which elastic constant ?

(A) K_{11}

(B) K_{22}

(C) K_{33}

(D) K_{23}

39. Strong surface anchoring leads to :

(A) Immediate switching at zero field

(B) No Freedericksz transition

(C) Lower threshold voltage

(D) Higher threshold voltage

40. Homeotropic alignment is obtained when director is :

(A) Parallel to the substrate

(B) Perpendicular to the substrate

(C) Tilted at a small angle

(D) Helically twisted

41. The backflow effect in nematic liquid crystals refers to :

(A) Flow caused by temperature gradient

(B) Director rotation inducing fluid flow

(C) Electric field induced turbulence

(D) Density wave propagation

42. The magnitude of elastic constants has the following order :

(A) $K_{11} > K_{22} > K_{33}$

(B) $K_{33} > K_{22} > K_{11}$

(C) $K_{33} > K_{11} > K_{22}$

(D) $K_{22} > K_{11} > K_{33}$

43. The threshold voltage will increase if :

(A) Cell thickness increases

(B) Dielectric anisotropy increases

(C) Permittivity increases

(D) Elastic constant increases

44. If the dielectric anisotropy increases, the threshold voltage will :

(A) Increase

(B) Decrease

(C) Remain same

(D) Be zero

45. Which of the following shows liquid crystallinity ?

(A) Polyimides

(B) Surfactants with aliphatic tail

(C) Surfactants with aromatic tail

(D) None of the above

46. Vertical alignment of liquid crystals in a cell can be obtained by :

(A) Polyimides

(B) Surfactants with aliphatic tail

(C) Surfactants with aromatic tail

(D) None of the above

47. Liquid crystal can be aligned in planar configuration in a cell by :

(A) Polyimides

(B) Lecithin

(C) Acetone

(D) Ethanol

48. Which theory describes the hydrodynamics of nematic liquid crystals ?

(A) Navier-Stokes theory

(B) Leslie-Ericksen theory

(C) Debye theory

(D) Landau theory

49. The threshold voltage for Freedericksz transition depends on :

(A) Elastic constant and dielectric anisotropy

(B) Density only

(C) Viscosity only

(D) Order parameter only

50. Optical birefringence in nematic liquid crystals is :

(A) $n_o - n_e$

(B) $n_o + n_e$

(C) n_o / n_e

(D) $n_o^2 - n_e^2$

51. For a nematic with positive dielectric anisotropy, the director tends to align :

(A) Parallel to electric field

(B) Perpendicular to electric field

(C) At 45° to electric field

(D) At -45° to electric field

52. The twist deformation term in Frank free energy is proportional to :

(A) $\left(\nabla . \vec{n}\right)^2$

(B) $\left(\vec{n} \times \nabla \times \vec{n}\right)^2$

(C) $\left(\vec{n} . \nabla \times \vec{n}\right)^2$

(D) None of the above

53. Which deformation is represented by $\nabla . n$?

(A) Twist

(B) Bend

(C) Splay

(D) None of the above

54. The heat capacity near the second-order transition in Landau theory shows :

(A) Divergence

(B) Finite discontinuity

(C) Zero value

(D) Exponential increase

55. Presence of the cubic term in I-N transition makes the transition :

(A) Second order

(B) Weakly first order

(C) Continuous

(D) Glassy

56. In nematic liquid crystals, the order parameter used in Landau-de Gennes theory is :

(A) Scalar density

(B) Vector polarization

(C) Second-rank traceless tensor

(D) Magnetization

57. In Landau theory, the condition for the first order transition is :

(A) $b > 0, c > 0$

(B) $b < 0, c > 0$

(C) $b = 0$

(D) $a > 0$

58. β for the order parameter in Landau mean-field theory is :

(A) 1/6

(B) 1/4

(C) 1/3

(D) ½

59. If $a = a_0(T - T_c)$, the equilibrium order parameter for $T < T_c$ is :

(A) $\psi = 0$

(B) $\psi = -\frac{a}{b}$

(C) $\psi = \frac{a}{b}$

(D) $\psi = \sqrt{\frac{-a}{2b}}$

60. For stability, which condition must be satisfied for the Landau free energy expansion for a second-order transition given by $F = F_0 + a\psi^2 + b\psi^4$:

(A) $a > 0, b < 0$

(B) $a < 0, b < 0$

(C) $b > 0$

(D) $a > 0$ only

61. The basic assumption of Landau theory the free energy near the phase transition can be written a :

(A) Fourier series of temperature

(B) Exponential function of entropy

(C) Logarithmic function of volume

(D) Power series in order parameter

62. In Landau theory for N-SmA transition, tricritical behaviour occurs when :

(A) Fourth-order coefficient becomes zero

(B) Second-order coefficient becomes zero

(C) Sixth-order term vanishes

(D) Order parameter becomes unity

63. The primary order parameter for the nematic-smectic A transition is :

(A) Density

(B) Magnetization

(C) One-dimensional translational order

(D) Polarization

64. According to van der Waals-type treatment of liquid crystals, orientational order arises due to :

(A) Only Repulsive interaction

(B) Only dipolar interaction

(C) Hydrogen bonding

(D) Balance between attractive and repulsive forces

65. The Maier-Saupe theory predicts the I-N transition to be :

(A) Second order

(B) Third order

(C) First Order

(D) Continuous without entropy change

66. In Maier-Saupe theory, if the mean-field interaction parameter increases, the clearing temperature :

(A) Decreases

(B) Increases

(C) Remains unchanged

(D) Increases and then decreases

67. In Maier Saupe theory, the order parameter at nematic –isotropic transition is :

(A) S = 0.21

(B) S = 0.33

(C) S = 0.54

(D) S = 0.43

68. In Maier-Saupe theory, the interaction potential depends on :

(A) $\cos \theta$

(B) $\cos^2 \theta$

(C) $\sin \theta$

(D) $\tan \theta$

69. According to Onsager theory, the critical parameter for I-N transition is :

(A) Temperature

(B) Volume fraction

(C) Pressure only

(D) Molecular polarity

70. In Onsager's hard-rod model, the isotropic-nematic transition is driven by :

(A) Attractive interaction

(B) Steric repulsion and excluded volume

(C) Dipole-dipole interaction

(D) Hydrogen bonding

71. deGennes generalized the Landau theory to explain :

(A) First order liquid crystal transition

(B) Second order liquid crystal transition

(C) Both (A) and (B)

(D) None of the above

72. The SmA to nematic phase transition is typically :

(A) Strongly first order

(B) Weakly first order or second order

(C) Always second order

(D) Glass transition

73. Which theory successfully explains the weakly first-order nature of the N-I transition ?

(A) Einstein theory

(B) Landau-de Gennes theory

(C) Debye-Hückel theory

(D) Curie-Weiss law

74. At the clearing temperature, the orientational order parameter is :

(A) 1

(B) 0.5

(C) 0

(D) 0.1

75. The nematic-isotropic (N-I) phase transition is generally :

(A) First order
(B) Second order
(C) Third order
(D) Glass transition

76. Liquid crystal polymer have :

(A) High mechanical strength
(B) Low melt viscosity
(C) Excellent thermal stability
(D) All of the above

77. Which of the below system is not an example of lyotropic liquid crystal ?

(A) Soap and water
(B) Salts of fatty acid
(C) Suspensions of rod-like viruses
(D) Sugar and water

78. The thread-like texture observed in polymeric nematics is called :

(A) Marble texture
(B) Schlieren texture
(C) Threaded texture
(D) Mosaic texture

79. Polarized light passing through liquid crystal shows change in polarization state due to :

(A) Refractive index
(B) Polarization
(C) Optical Anisotropy
(D) Viscosity

80. Main-chain polymer liquid crystals have mesogens :

(A) Attached as side groups
(B) In the polymer backbone
(C) Dispersed in solvent
(D) In cross-linked network only

81. Bent-core liquid crystals has :

(A) Only nematic phase
(B) Ferroelectric switching without chirality
(C) Discotic column formation
(D) Lyotropic behaviour

82. Bent-core liquid crystals are also called :

(A) Calamitic LCs
(B) Discotic LCs
(C) Banana-shaped LCs
(D) Lyotropic LCs

83. Charge transport in discotic liquid crystals mainly occurs along :

(A) Radial direction of disc
(B) Between alkyl chains
(C) Column axis
(D) Layer normal

84. Columnar mesophase is a characteristic feature of :

(A) Calamatic LCs

(B) Discotic LCs

(C) Bent-core LCs

(D) Polymeric LCs

85. Grandjean texture is associated with :

(A) SmA phase

(B) Nematic phase

(C) SmC* phase

(D) ChLC Phase

86. Focal conic fan texture is characteristic of :

(A) Smectic phase

(B) Nematic phase

(C) Cholesteric phase

(D) Columnar phase

87. Schlieren texture is characteristic of :

(A) Smectic phase

(B) Nematic phase

(C) Cholesteric phase

(D) Columnar phase

88. Monotropic liquid crystals :

(A) Exist only in lyotropic form

(B) Appear only during cooling

(C) Appear only during heating

(D) Exist at all temperatures

89. In Enantiotropic liquid crystalline :

(A) Mesophase appears only on cooling

(B) Mesophase appears only on heating

(C) Mesophase exists in both heating and cooling cycles

(D) No isotropic phase exists

90. Polymorphism in liquid crystals means

(A) Existence of both solid and liquid phases

(B) Existence of multiple mesophases in the same compound

(C) Optical anisotropy

(D) Molecular chirality

91. The Nobel Prize (1991) related to liquid crystals was awarded to :

(A) Chandrasekhar

(B) Pierre-Gilles de Gennes

(C) Helfrich

(D) Prost

92. Which liquid crystal phase exhibits both orientational order and two-dimensional positional order ?

(A) Nematic phase

(B) Smectic Phase

(C) Both (A) and (B)

(D) Isotropic

93. Thermotropic liquid crystals depend primarily on :

(A) Pressure

(B) Concentration

(C) Temperature

(D) Magnetic field

94. Which type of liquid crystal is formed by dissolving amphiphilic molecules in a solvent ?

(A) Lyotropic

(B) Polytropic

(C) Thermotropic

(D) Metallotropic

95. Cholesteric liquid crystals are also known as :

(A) Discotic nematics

(B) Lyotropic crystals

(C) Chiral nematics

(D) Thermotropic smectics

96. In which phase molecules are arrange in layers ?

(A) Nematic

(B) Smectic

(C) Cholesteric

(D) Blue phase

97. Which phase of liquid crystal shows only orientational order ?

(A) Smectic

(B) Nematic

(C) Cholesteric

(D) Columnar

98. Who classified liquid crystals into nematic, smectic, and cholesteric phases ?

(A) Reinitzer

(B) Lehmann

(C) Friedel

(D) Pierre-Gilles de Gennes

99. The term *'liquid crystal'* was coined by :

(A) Otto Lehmann

(B) Georges Friedel

(C) Daniel Vorländer

(D) Pierre-Gilles de Gennes

100. Liquid crystals were first discovered by :

(A) Michael Faraday

(B) Friedrich Reinitzer

(C) Otto Lehmann

(D) Georges Friedel

(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।