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B. Sc. (Hons) Semester III Open Book Examination 2 0 2 1 – 2 2

PHYSICS

Paper No. BPT-301 : Optics

Time : 4 hours 30 minutes *Full Marks* : 70

Instructions :

(i) The Question Paper contains 08 questions out of which you are required to answer any 04 questions. The question paper is of 70 Marks with each question carrying 17·5 Marks.

प्रश्नपत्र में 8 प्रश्न पूँछे गये हैं जिनमें से 4 प्रश्नों का उत्तर देना है। प्रश्नपत्र 70 अंकों का है, जिसमें प्रत्येक प्रश्न 17·5 अंक का है।

(ii) The total duration of the examination will be 4·30 Hours (Four Hours and Thirty Minutes), which includes the time for downloading the question paper from the portal, writing the answers by hand and uploading the hand-written answer sheets on the portal.

परीक्षा का कुल समय 4·30 घंटे का है जिसमें प्रश्नपत्र को पोर्टल से डाउनलोड करके पुनः प्रश्नों का हस्तलिखित उत्तर पोर्टल पर अपलोड करना है।

(iii) For the students with benchmark disability as per Persons with Disability Act, the total duration of examination shall be 6 Hours (Six Hours) to complete the examination process, which includes the time for downloading the question paper from the portal, writing the answers by hand and uploading the hand-written answer sheets on the portal.

दिब्यांग छात्रों के लिये परीक्षा का समय 6 घंटे निर्धारित है जिसमें प्रश्नपत्र को पोर्टल से डाउनलोड करना एवं हस्तलिखित उत्तर को पोर्टल पर अपलोड करना है।

(iv) Answers should be hand-written on plain white A4 size paper using black or blue pen. Each question can be answered in up to 350 words on 3 (Three) plain A4 size paper (only one side to be used).

प्रश्नों का हस्तलिखित उत्तर सादे सफेद A4 साइज के पन्ने पर काले अथवा नीले कलम से लिखा होना चाहिये। प्रत्येक प्रश्न का उत्तर 350 शब्दों तक तीन सादे पृष्ठ A4 साइज में होना चाहिये। प्रश्नों के उत्तर के लिए केवल एक तरफ के पृष्ठ का ही उपयोग किया जाना चाहिये।

(v) Answers to each question should start from a fresh page. All pages are required to be numbered. You should write your Course Name, Semester, Examination Roll Number, Paper Code, Paper Title, Date and Time of Examination on the first sheet used for answers.

प्रत्येक प्रश्न का उत्तर नये पृष्ठ से शुरू करना है। सभी पृष्ठों को पृष्ठांकित करना है। छात्र को प्रथम पृष्ठ पर प्रश्नपत्र का विषय, सेमेस्टर, परीक्षा अनुक्रमांक, प्रश्नपत्र कोड, प्रश्नपत्र का शीर्षक, दिनांक एवं समय लिखना है।

Q.1. *(a)* What do you understand by interference of light by division of wave front and division of amplitude? What are the fundamental conditions for production of interference fringes? 6

(b) What are achromatic fringes and how are they produced in laboratory? Explain with a suitable optical ray diagram. 7½

(c) In Lloyd's single mirror interference experiment, the slit source is at a distance of 2 mm from the plane of the mirror. The screen is kept at a distance of 1·5 m from the source. Calculate the fringe width for λ = 5890 Å 4

Q.2. *(a)* Describe the construction and working of Fabry-Pérot interferometer. How is it used to determine wavelength of light? How is it superior to Michelson's interferometer? 10

(b) Why is it necessary to use a telescope to observe fringe pattern in a Michelson interferometer but a microscope is needed to observe the Newton's rings? 3½

(c) In a Newton's ring experiment the diameter of the 15th ring was found to be 0·59 cm and that of 5th ring was 0·336 cm. If the radius of the plano-convex lens is 100 cm, calculate the wavelength of light used. 4

Q.3. *(a)* Explain the construction of Fresnel's half period zones. Show that *(i)* area of each half period zones are equal, *(ii)* radius is square root of natural numbers and *(iii)* intensity at a point is equal to one-fourth of the first-half period zone alone. 7½

(b) What do you understand by +ve and –ve zone plate? Prove that zone plate has multiple foci. What is the difference between zone plate and convex lens? 6½

(c) In a straight edge diffraction experiment, the separation between the slit and the edge is 6 metre and distance between the edge and eye piece is 4 metre. Calculate the position of first three maxima and their separation. 3½

Q.4. *(a)* Discuss the intensity distribution of Fraunhofer diffraction by drawing diffraction pattern due to single slit. Find out the position and intensity of central maxima, secondary maxima and secondary minima. 7

(b) Write the expression of intensity distribution for N slit diffraction and represent graphically each term. Show that there are $N-1$ minima and $N-2$ secondary maxima between two adjacent principal maxima. Explain the reason for higher orders having less intensity. Further, calculate the width of principal maxima and show that principal maximum is Sharper for larger N. 7

(c) What do you understand by missing order and where do they appear? Explain graphically by plotting intensity curve for single and double slit [if slit width is a and slits separation is $3a$]. 3½

Q.5. *(a)* Explain the Rayleigh criteria of resolution. Define resolving power and dispersive power of a plane transmission grating and obtain expression for the same. 6½

(b) What do you understand by the magnifying power and resolving power of telescope? 6½

(c) Calculate the resolving power of Fabry-Pérot interferometer, when reflectivity of reflecting surface is 0·9 and separated by 1 cm at 5000 Å. 4½

Q.6. *(a)* Describe the production of plain polarised light by Brewster's law and its applications in helium neon LASER and material science. Prove that when light incident on a transparent material at Brewster angle, the reflected and refracted rays are at right angle. 6½

(b) What do you understand by *(i)* dichroism, *(ii)* double refraction, *(iii)* optic axis and *(iv)* +ve and –ve crystals? Explain with suitable examples. 5

(c) On the basis of Huygens wave theory, explain the propagation of ordinary and extraordinary wave fronts in a calcite crystal *(i)* optic axis inclined to the refracting edge, *(ii)* optic axis is the plane of incidence and parallel to the reflecting edge and *(iii)* optic axis perpendicular to the reflecting edge and lying in the plain of incidence. 6

Q.7. *(a)* What are retardation plates? Describe construction and working of quarter-wave and half-wave plates. Explain their uses in the study of different types of polarizations. 7

(b) Show that plain polarised and circularly polarised lights are the special case of elliptically polarised light. 4½

(c) What do you understand by optical active materials? Define specific rotation and describe the construction and working of a bi-quartz polarimeter. 6

Q.8. *(a)* What do you understand by coherence? Explain in brief coherence length, coherence time, spatial coherence and temporal coherence. Obtain an expression for relation between *(i)* coherence length and bandwidth and *(ii)* coherence length and coherence time. 6

(b) What are the differences between spontaneous and stimulated emission? Derive the relation between Einstein coefficients and state its importance. 7½

(c) A sodium atom radiates 5893 Å wavelength for about 4×10^{-12} sec. What are the coherence length and bandwidth of light emitted by sodium lamp? 4

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