



Indian Association for the Cultivation of Science
(Deemed to be University under the *de novo* category)

Integrated Bachelor's - Master's Program

End Semester (Sem-II) Examination - Spring 2021

Subject: Electricity, Magnetism and Optics

Full marks: 50

Subject Code(s): PHS 1201

Time allotted: 3 hr

Attempt any *ten* questions

1. Three charges are situated at the corners of a square of side a . How much work is needed to bring in another charge $+q$, from far away and place it in the fourth corner. Also find out the work done to assemble the whole configuration of four charges. **(5 marks)**
2. Write down the expression for magnetic vector potential \vec{A} in terms of the volume current density \vec{J} . Hence demonstrate that this expression is consistent with the Biot-Savart's law. **(5 marks)**
3. Derive the lens equation for a thin lens using the Fermat's principle. **(5 marks)**
4. Two lenses having focal lengths $f_1 = +9.0$ cm and $f_2 = -18.0$ cm are placed 3.0 cm apart. If an object with height 2.50 cm is located 20.0 cm in front of the first lens, calculate (a) the position and (b) the size of the final image. **(5 marks)**
5. Determine the locus of points, having constant path difference from the slits, in the Young's double slit experiment. Hence or, otherwise, find out the fringe width of the resulting interference pattern. **(5 marks)**
6. A film of oil (refractive index=1.7) is formed between a plane glass plate and an equi-convex lens (refractive index of both may be taken to be 1.5). The focal length of the lens is 1m. Find out the radius of the 10th dark ring, when light of wavelength 600 nm falls normally on the combination. **(5 marks)**
7. Find out the intensity due to Fraunhofer diffraction from a double slit. Hence determine the maxima, minima and missing orders associated with the pattern on the screen. **(5 marks)**

8. A double slit diffraction pattern is observed in the focal plane of a lens of focal length 0.5 m. The wavelength of incident light is 500 nm. The distance between two maxima adjacent to the maximum of zero order is 5 mm, while the fourth order maximum is missing. Find the width of each slit and distance between their centers. **(5 marks)**
9. Consider a grating of width 5 cm with slits of width $a = 0.001$ mm separated by a distance of 0.002 mm. How many orders will be visible at $\lambda = 550$ nm? Calculate the width of principal maxima. Will there be any missing orders? **(5 marks)**
10. Derive the resolving power of a grating and show that a grating with high dispersive power does not necessarily have a higher resolving power. **(5 marks)**
11. A right circularly polarized beam of light ($\lambda = 525$ nm) is incident normally on a doubly refracting crystal with optic axis parallel to the surface. The thickness of the crystal is 0.003 mm. It is also given that, $n_o - n_e = 0.175$. Find the state of polarization of the emergent light beam. **(5 marks)**
12. In a He-Ne laser, transition from 3S to 2P level gives a laser emission of wavelength 632.8 nm. If the 2P level has energy equal to 15.2×10^{-19} J, calculate the pumping energy required. Assume no loss. **(5 marks)**