UNIVERSITY OF NORTH BENGAL

B.Sc. Honours Part-II Examination, 2020

PHYSICS

PAPER-IV

Time Allotted: 2 Hours | Full Marks: 35

The figures in the margin indicate full marks.

Question No. 1 is compulsory and Group-A, Group-B and Group-C as per direction

1. (a) What do you mean by optical path and reduced path lengths? 1

   (b) Draw on OR and an AND gate using p-n junction diodes and explain their operation. $1\frac{1}{2}$

   (c) Show that the distance between two virtual sources in a Fresnel's bi-prism is given by $d = 2a(\pi - 1)\alpha$, where the symbols have their usual significance. $1\frac{1}{2}$

   (d) Why the centre of Newton's ring is dark? — Explain. 1

GROUP-A

(Geometrical Optics)

Answer any *one* of the following 10×1=10

2. (a) Prove that the axial magnification is proportional to square of the transverse magnification. 4

   (b) Show that when a thick lens is surrounded by a homogeneous medium, the nodal points coincide with the principal points. 4

   (c) How will you arrange two lenses for, 1+1

   (i) Dispersion without deviation?

   (ii) Deviation without dispersion?

3. (a) What is achromatism? Find the required condition of achromatism for two lenses separated by a distance. 1+2

   (b) Two convex lenses of focal lengths 10 cm and 20 cm are placed 5 cm apart in air. Find the cardinal points of the system. 2

   (c) Calculate the values of Cauchy's constants A and B for dispersion through crown glass. Given $\mu_C = 1.541$; $\lambda_C = 6563$ Å ; $\mu_F = 1.524$ and $\lambda_F = 4862$ Å. 2

(d) Give the merits and demerits of Ramsden's eyepiece, why is it called a positive eyepiece? 2+1

GROUP-B

(Physical Optics)

Answer any *one* of the following 10×1=10

4. (a) Apply Huygen's principle to deduce the laws of reflection of plane waves at plane surface. Hence on the basis of wave theory, explain the phenomena of total internal reflection. 5

   (b) When a film of transparent material of refractive index 1.2 is put behind on of the slits of a two-slit Young's experiment, the zeroth order fringe moves to the position previously occupied by the 4^{th} order bright fringe. Given that the wavelength λ of the light used 5000 Å. Find the thickness of the film. 3

   (c) To which class does the interference in Newton's rings and that in the bi-prism experiment belong? 1

   (d) What happens to the interference pattern if the entire apparatus used in Young's experiment is immersed in water? 1

5. (a) With a neat diagram, explain the formation of fringes by Lloyd's mirror and explain why the central fringes is dark. 4+1

   (b) Find an expression for fringe width in Young's double slit experiment. 2

   (c) The inclined faces of a bi-prism ($\mu = 1.5$) make angles of 1° with the base of a prism. A slit is 10 cm away from the bi-prism, and it is illuminated with a light source of $\lambda = 5900$ Å. Find out the fringe width observed at a distance of 1 m from the bi-prism. 2

   (d) What do you mean by anti-reflection coating? 1

6. (a) Discuss the phenomenon of Fraunhofer diffraction of a single slit and show that the intensities of successive maxima are nearly in the ratio 4+2

$$\frac{4}{9\pi^2} : \frac{4}{25\pi^2} : \frac{4}{49\pi^2} \ \ldots\ldots$$

   (b) Explain half-period zone in relation to a plane wave front. Show that it acts as a convergent lens having multiple foci. 4

7. (a) Find an expression for resolving power of grating. 4

   (b) A thin transparent plate of refractive index 1.5 is introduced in one arm of Michelson interferometer. It causes 12 fringe shift. Find the thickness of plate, taking $\lambda = 600$ nm. 2

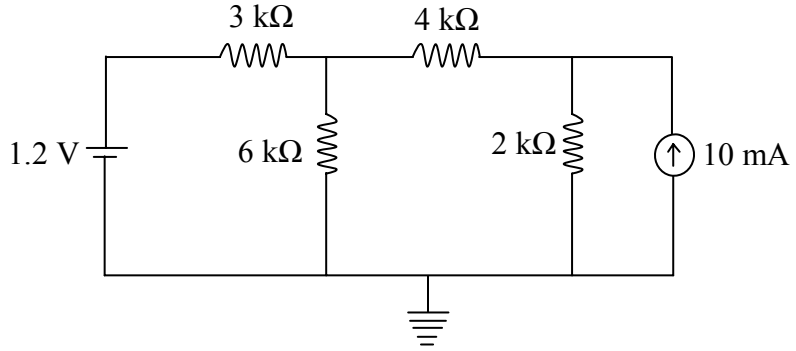
   (c) Discuss the differences between prism and grating spectrum. 2

   (d) Show that the interference patterns in reflected and transmitted lights in thin film are complementary to each-other. 2

GROUP-C
(Electronics-I)

Answer any *one* of the following 10×1=10

8. (a) State Thevenin's Theorem. Calculate the current through the 4 kΩ resistor of the given circuit. 3



(b) Explain the terms (i) barrier potential (ii) depletion region for a p-n junction. 2+3
Derive an expression for the barrier potential of an unbiased p-n junction in terms of the donor and acceptor concentrations.

(c) Explain with necessary circuit diagram, how a diode can be used as a clamper. 2

9. (a) The Boolean expression for two variables Y_1 and Y_2 in terms of inputs A, B and C are 2

$$Y_1 = (A+B)\cdot(B+C)\cdot(C+A)$$
$$Y_2 = AB + BC + CA$$

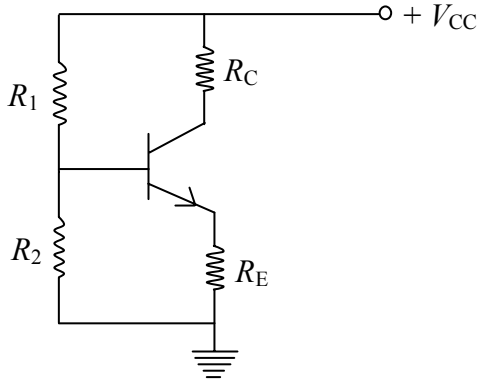
Find the relation between Y_1 and Y_2.

(b) Implement the logic circuit of the Boolean junction $Y = \overline{A\overline{B} + \overline{A}B}$ using NOR gates only. 2

(c) For the circuit shown in the figure below, given that 4

$$V_{CC} = 20\,\text{V},\ R_C = 5\,\text{k}\Omega,\ R_E = 1\,\text{k}\Omega,\ R_1 = 20\,\text{k}\Omega \text{ and } R_2 = 3\,\text{k}\Omega$$

The transistor parameters are $\beta = 100$, $V_{BE} = 0.7\,\text{V}$. Assume $I_{CO} << I_C$. Determine the Q-point.



(d) Use 2's complement method to perform the subtraction 48 – 24. 2

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