RAJARATA UNIVERSITY OF SRI LANKA
FACULTY OF APPLIED SCIENCES

B.Sc. (General) Degree Examination
Second Year – Semester II Examination – March / April 2014

PHY 2204 - PHYSICAL OPTICS

Answer **FOUR** questions only. Time allowed: 2 Hours

1.

a. Derive equation, $n_2\frac{1}{V}-n_1\frac{1}{U}=(n_2-n_1)\frac{1}{R}$ for the refraction at a spherical surface. All the symbols have their usual meanings.

b. Show that the first and the second focal lengths of the spherical surface are given by,

$f_1=-\frac{Rn_1}{(n_2-n_1)}$ and $f_2=\frac{Rn_2}{(n_2-n_1)}$ respectivly.

c. The incident face of a glass block is bounded by a concave surface of radius 3 cm. A thin object of 2 cm height is situated in air and on the axis 10 cm from the curved face. If the refractive index of glass is 1.5, find,

i. the first and second focal lengths.

ii. the image distance.

iii. the lateral magnification and

iv. image height.

2.

a. Two thin lenses of focal lengths f_1 and f_2 are separated in air by a distance d. Prove that the equivalent focal length F of the two lens system is given by $F = \dfrac{f_1 f_2}{f_1 + f_2 - d}$.

b. Derive Newton's relationship for the two lens combination.

c. Two thin convex lenses of focal lengths 15.0 cm and 20.0 cm are placed coaxially 10.0 cm apart.

   i. Find the equivalent focal length of the system.

   ii. Locate the principal points and focal points of the system.

   iii. Locate the image of an object placed 60 cm away from the first lens.

3.

a. Derive equations for the distance to bright and dark fringes from central fringe of a double slit interference experiment.

b. In Young's double-slit experiment, an electron beam is used. What will happen to the interference pattern, if the velocity of the electrons is increased?

c. In another double-slit experiment sources with slit separation 0.2 mm is located 1.5 m from a screen. The distance between successive bright fringes on the screen is measured to be 3.30 mm. What is the wavelength of the light?

d. What is the color of the light?

4. A beam of, initially unpolarized, light is incident normally on a piece of polarizing sheet (polaroid) A, the transmitted light then falling on a second similar sheet B. A and B are set with their axes at right angles. A third polarizing sheet C is placed between the first two with its axis at an angle ϕ to that of sheet A.

   a. If the amplitude of incident light is E, what are the amplitudes of transmitted light before and after insertion of polarizer C?

   b. What are the intensities of transmitted light before and after insertion of polarizer C?

5.

a. How do you employ Newtons rings phenomonon for measuring the wavelength of light? Give neccesary theory.

b. Light of 589 nm is used to produce Newton rings using a plano-convex lens and a flat glass side. The radius of curvature of the lens is 1 m. A liquid is inserted between lens and the glass. Find the refractive index of the liquid if the diameter of the 10^{th} dark ring is 4.0 mm.

c. Are light waves longitudinal waves or transverse waves? How do you prove this?

d. What are the major differences between *Fresnel* and *Fraunhofer* diffraction?

6.

a. Derive the conditions for dark and bright regions in single slit *Fraunhofer* diffraction pattern.

b. Monochromatic blue light has been used to obtain the diffraction pattern of a narrow slit on a screen. Keeping the experimental set up unchanged if blue light is replaced by red monochromatic light, what will happen to the diffraction pattern?

c. Two coherent monochromatic light beams of intensities I and $4I$ are superimposed. Calculate the maximum and minimum possible intensities of the resulting beam.

d. Obtain an equation for the resolving power of an optical instrument having a slit width a.

e. Light of wavelength 550 nm is used to observe an object under a microscope. If the aperture of the objective lens has a diameter of 0.8 cm, what is the limiting angle of resolution?