**Tutorial 2**

**Geometrical Optics:**

- Laws of reflection and refraction from Fermat's principle;
- Matrix method in paraxial optics-thin lens formula,
- nodal planes, system of two thin lenses,
- chromatic and spherical aberrations.

Q1:

Using matrix method, find out the equivalent focal length for a combination of two thin lenses of focal lengths $f_1$ and $f_2$ separated by a distance a. *10*

2015

Q2:

Obtain the system matrix for a thin lens placed in air and made of material of refractive index 1·5 having radius of curvature 50 cm each. Also find its focal length. 10

2017

Q3:

What do you mean by spherical aberration of a lens ? Show that if two plano-convex lenses are kept at a distance equal to the difference of their focal lengths, the spherical aberration would be minimum. *15*

2018

Q4:

What is axial chromatic aberration ?
A convex lens has a focal length of $15{\cdot}5 \times 10^{-2}$ m for red colour and $14{\cdot}45 \times 10^{-2}$ m for violet colour. If an object is kept at a distance of 40 cm from the lens, calculate the longitudinal chromatic aberration of the lens. *10*

2019

Q5:

Prove that when light goes from one point to another via a plane mirror, the path followed by light is the one for which the time of flight is the least. *20*

2019

Q6:

State and explain Fermat's principle of extremum path. Discuss the cases of rectilinear propagation of light and reversibility of light rays in context of Fermat's principle. Using Fermat's principle, deduce the thin lens formula. *15*

2020

Q7:

What is chromatic aberration ? Obtain the condition for achromatism using combination of two thin lenses placed in contact to each other. Can this system work as achromatic doublet if both are of same material ? Justify your answer. *15*

2021

Q8:

Obtain the system matrix for a thick lens and derive the thin lens formula. 20

2022

Q9:

Using Huygens' principle for a plane wave travelling from rarer medium 1 to a denser medium 2, show that

$$\frac{\sin i}{\sin r} = \frac{v_1}{v_2} = \frac{\mu_2}{\mu_1},$$

where i and r are the angles of incidence and refraction, respectively. $v_1$, $\mu_1$ and $v_2$, $\mu_2$ are the velocities and refractive indices in media 1 and 2, respectively. *10*

2023

Q10:

Obtain condition for achromatism of two thin lenses separated by a finite distance. If the dispersive powers of the materials of the two lenses are 0·020 and 0·028, their focal lengths are 10 cm and 5 cm, respectively. Calculate the separation between them in order to form achromatic combination. *15*

2023

Q11.

Write down the system matrix for a combination of two thin lenses in paraxial approximation. Hence obtain the focal length of the combination and the positions of unit planes. 10

2024

Q12.

Consider a thin lens combination of two convex lenses of focal lengths $f_1 = +10$ cm and $f_2 = +20$ cm, respectively, separated by 25 cm. Determine the focal length of the combination and the positions of unit planes. 10

2024

Q13.

Consider a thick lens of thickness t made of a material of relative refractive index n. Let $R_1$ and $R_2$ be the radii of curvature of its two surfaces. Obtain the system matrix of the lens. *15*

2025