# UG (CBCS) Even Semester Examination, May 2025

## EDUCATION
## (B.Sc. B.Ed.)

2nd Semester

**Course No. : BSPH - 202**

( Mathematical Physics, Geometrical Optics, Waves & Oscillations )

Full Marks : 50

Pass Marks : 20

Time : 2 hours

*The figures in the margin indicate full marks for the questions*

(*Answer any five*)

1. (a) Evaluate $\vec{\nabla}\varphi$ at (1, -2, -1) if

   (i) $\varphi = 3x^2y - y^3z^2$ and (ii) $\varphi = \dfrac{1}{r}$

   where $r = (x^2 + y^2 + z^2)^{1/2}$ 6

   (b) The temperature of the points in space is given by $T(x, y, z) = x^2 + y^2 - z$. A mosquito located at (1, 1, 2) desires to fly in such a direction that it will get warm as soon as possible. In what direction should it move? 4

Or

2. (a) Show that the area bounded by a simple closed curve is 4

$$A = \frac{1}{2}\oint_c (xdy - ydx)$$

(b) Derive the expressions for the unit vectors $\hat{r}, \hat{\theta}$ and $\hat{\varphi}$ in terms of $\hat{\imath}, \hat{\jmath}$ and $\hat{k}$ 6

3. (a) Define Fourier series of a periodic function. 2

(b) Find the Fourier series representing $f(x)=x$, $0<x<2\pi$ and sketch its graph from $x = -4\pi$ to $x=4\pi$ 8

Or

4. (a) Show that 2+2+1=5

(i) $\Gamma(n+1) = n\Gamma(n)$ (ii) $\Gamma(1/2) = \sqrt{\pi}$

(iii) $\Gamma(7/2) = \frac{15}{8}\sqrt{\pi}$

(b) Find the eigen values of the matrix 5

$$\begin{pmatrix} 6 & -2 & 2 \\ -2 & 3 & -1 \\ 2 & -1 & 3 \end{pmatrix}$$

5. (a) Derive the Snell's law of refraction using Fermat's principle of light. 5

(b) Consider a set of rays, parallel to the axis, incident on a paraboloidal reflector. Show, by using Fermat's principle, that all the rays will pass through the focus of the paraboloid. 5

Or

6. (a) Show that the power of a combination of two lenses separated by a distance d is $P= P_1+P_2- d(P_1P_2)$ 5

(b) What is achromatism? Find the condition for achromatism of two lenses in contact. 5

7. (a) Explain briefly the spherical aberration? 2

(b) Show that the spherical aberration of a combination of two thin lenses is minimum when their separation is equal to the difference in their focal lengths. 6



(c) Find the equivalent focal length of Huygen's eye-piece? 2

Or

8. (a) Show that the spherical and chromatic aberrations of a system of two lenses separated by a distance $d$ is simultaneously minimum if the focal length of field lens ( $f_2$) is equal to the three times the focal length of eye-lens ( $f_1$) and separation of two lenses is equal to the two times the focal length of the eye-lens. 6

(b) Derive Newton's lens equation $x_1x_2 = f_1f_2$ 4

9. (a) Show that the rate of decrease of the total energy of a damped harmonic oscillator is proportional to the square of velocity if the damping force is proportional to the velocity. 4

(b) Find the amplitude and displacement of an oscillator driven by an external force $F(t) = F_0 \sin\omega t$. 6

Or

10. (a) A plane progressive wave is given by $y=10\sin \pi(0.01x - 2.00t)$ where $y$ and $x$ ae expressed in cm. Find (i) amplitude and (ii) frequency of the wave and (iii) phase difference at an instant between two points 40 cm apart. 3

(b) Derive the relation between the group velocity and phase velocity. Show that they are equal for a non-dispersive medium. 4

(c) Find the group velocity in a conducting medium and show that it is the case of anomalous dispersion. 4

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