Q1. (a) Determine a unit vector perpendicular to plane containing vectors \( A = i-j-3k \) and \( B = 4i+j-k \).

(b) Prove that \( (AXB).(CXD) = (A.C)(B.C) - (B.C)(A.D) \).

(c) Show that the gradient of a scalar function is irrotational.

\[
\begin{pmatrix}
2 \frac{1}{2} \\
1.3.2
\end{pmatrix}
\]

Q2. (a) Show that a particle moving under a central force, the angular momentum of the particle is always conserved.

(b) Obtain an expression for acceleration when a solid cylinder rolls down an inclined plane without slipping.

\[
\begin{pmatrix}
3 \frac{1}{2} \\
4
\end{pmatrix}
\]

Q3. (a) What is a damped harmonic oscillator? Solve its differential equation for the 'under damped oscillations.'

(b) What is the shape of Lissajous figures formed by superposition of two perpendicular Simple Harmonic Oscillations, when frequency of one is twice of other.

(i) Equal to other

(ii) Twice the other

\[
\begin{pmatrix}
7.3 \\
5, 2k
\end{pmatrix}
\]
Q4. What are elastic collisions? Two bodies of masses 'm' and 'M' are initially moving on straight line with velocities \( u_1 \) and \( u_2 \) in same direction \( (u_1 > u_2) \). After head-on elastic collision in one dimension they acquire velocities \( v_1 \) and \( v_2 \). Obtain expressions for final velocities \( v_1 \) and \( v_2 \).

Q5. (a) What is “Zone Plates” and how they are formed?
   (b) Explain how a zone plate acts like a convergent lens having multiple foci. Derive an expression for its focal length.

Q6. A) What is Diffraction? How is it different from Interference.
   b) Discuss analytically the intensity pattern for principal maxima of diffraction pattern due to a plane transmission grating.

Q7. Write short note on any two of the following
1. Zone plate
2. Fresnel's Bi-prism
3. Circularly polarized light
4. Resolving power of a microscope and a telescope
5. Interference due to wedge shaped film.