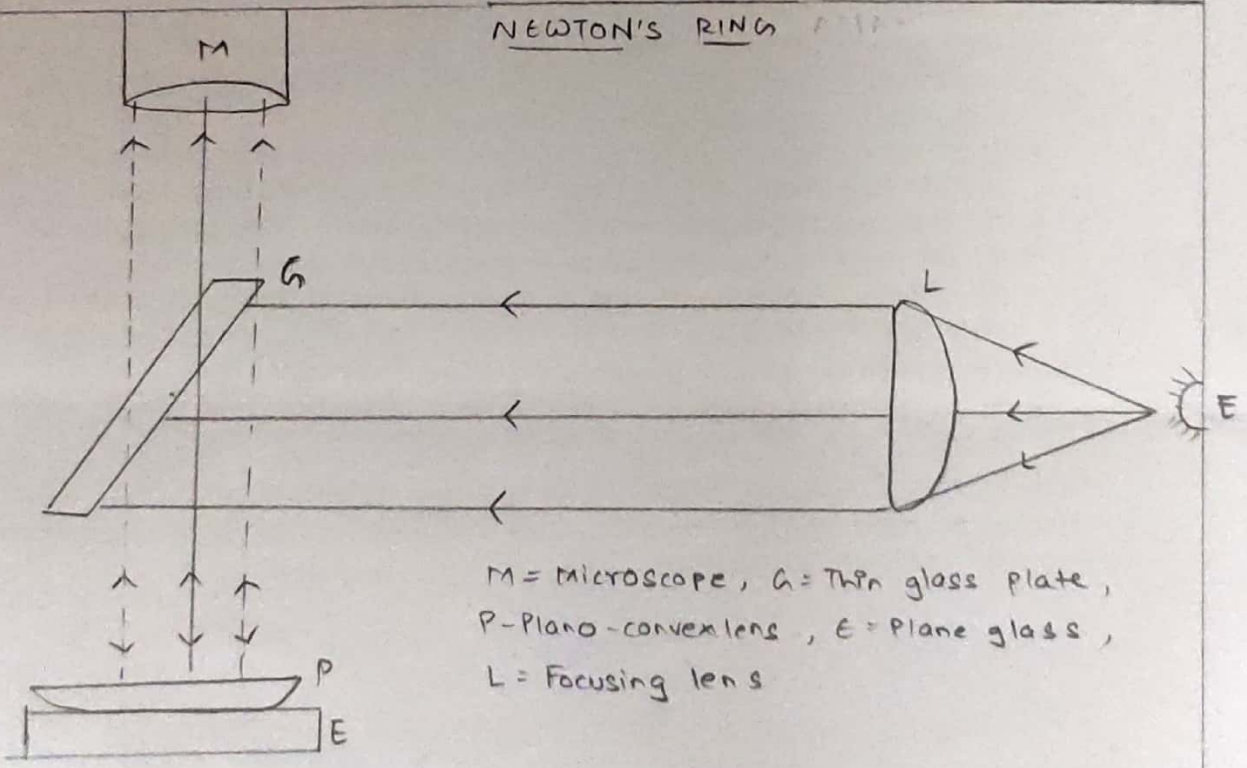
Experiment No.:- 05 **Date:-** 30/03/2021

(Module 4) **NEWTON'S RING**

FEC202.1: Understand principles of interference and diffraction in order to develop new instruments and improve existing optical instrumentation.

AIM: - To determine the radius of curvature of a Plano-convex lens by obtaining Newton's Ring pattern.

APPARATUS: - Travelling microscope, plane glass plate (or clean old photographic plate),Plano-convex lens of very large radius of curvature, condensing (focusing)lens of small focal length, sodium source(monochromatic source),magnifying lens, thin glass plate etc.



FORMULA:-

$$R = \frac{D_{n2}^2 - D_{n1}^2}{4(n_2 - n_1)\lambda}$$

Where, D_{n2} = diameter of n_2^{th} dark ring,

D_{n1} = Diameter of n_1^{th} dark ring,

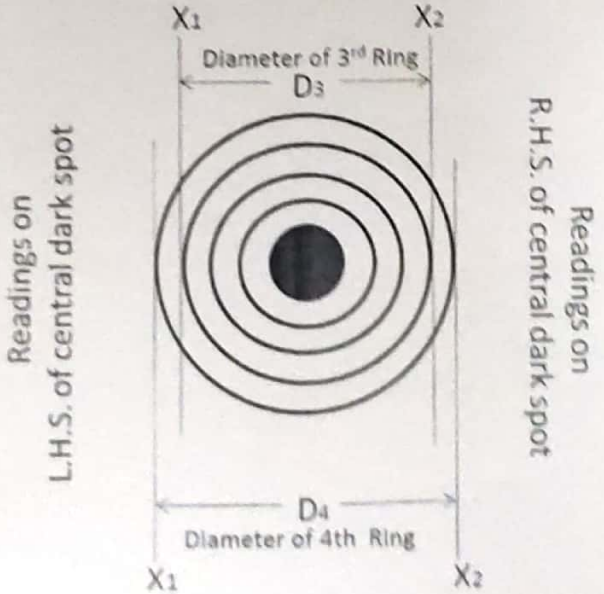
λ = Wavelength of light used,

R = radius of curvature of Plano convex lens.

PROCEDURE:-

1. Arrange the apparatus as shown in diagram. Take care that parallel light rays from source are incident on thin glass plate making angle of 45°.Collect the rays getting reflected from air film (between Plano-convex & thick glass plate) in microscope. These rays interfere with each other to produce interference pattern in form of concentric rings.
2. Adjust the microscope vertically to focus interference rings. (In case some difficulty is experienced, the microscope may first focus upon the upper surface of thick plate and the lens is placed over it. Then move the travelling microscope above till the rings is seen clearly)
3. In the view move to left side of central dark spot. Count the rings being crossed by vertical cross wire & go **beyond 15th dark ring.** Set horizontal motion of microscope on slow motion screw.
4. Move microscope slowly & coincide the **vertical cross wire** tangentially on the 15th ring (dark ring) and note down reading on **horizontal scale.**
5. Move microscope slowly towards central dark spot to take readings for 12th, 9th, 6th and 3rd dark ring on left side of central dark spot.
6. Then further move the microscope gradually so that in view vertical cross wire crosses the central dark spot & then tangentially coincides with 3rd ring's edge on right side of central dark spot. Take the reading.
7. Move microscope slowly further to right of central dark spot to take readings up to 15th dark ring in the same fashion.

CAUTION: - Within set of readings if any ring is missed out while moving the microscope, NEVER go back with SLOW MOTION SCREW OF MICROSCOPE. Skip that reading & consider next ring.



Newton's Rings in microscope view

OBSERVATIONS:-

1. Total number of divisions on the horizontal Vernier scale of travelling microscope,

N = 50

2. Value of smallest division on the horizontal main scale of travelling microscope,

M=0.05 cm

3. Least count of travelling microscope, L.C.=m/N=0.001 cm

Microscope reading =M.S.R. + (C.D. × L.C.)
Where, M.S.R. =main scale reading C.D. =coinciding division number

4. Wavelength of light from sodium source = λ= 5893 A°

OBSERVATION TABLE:-

Reading on horizontal scale of traveling microscope

Obs. No.	Ring No. 'n'	Microscope reading with vertical crosswire coinciding with n^{th} dark ring edge on---- Left side of central spot 'X_1' cm	Right side of central spot 'X_2' cm	Diameter of n^{th} ring $Dn=\|X_2-X_1\|$	D_n^2 $(cm)^2$
1.	15	2.6+4(0.001)=2.614	2.04+9(0.001) =2.049	0.565	0.320
2.	12	2.6+5(0.001)=2.605	2.05+49(0.001) = 2.199	0.506	0.256
3.	09	2.55+12(0.001)=2.562	2.1+24(0.001)= 2.124	0.438	0.192
4.	06	2.5+14(0.001)= 2.514	2.15+5(0.001) = 2.155	0.359	0.128
5.	03	2.45+11(0.001)=2.461	2.22+9(0.001) = 2.209	0.252	0.063

GRAPH:-

Plot the graph of D_n^2 (on Y axis) against 'n' serial no. of ring (on X axis)

CALCUATIONS:-

From Graph, Slope = 0·0273 cm^2

$R = \frac{slope}{4\lambda}$ = 94·6 cm

RESULT: - Radius of curvature of Plano-convex lens, R = 946 cm

COMMENTS:-

1. Why do we get circular fringes in Newton's ring set up?

The path difference b/w the reflected ray and incident ray depends upon the thickness of air gap b/w lens and glass, since the air film thickness is constant in circular shape.

2. Why the central spot appears dark in Newton's rings?

The air film thickness formed at centre between the glass plate and lens is zero. Hence geometric path difference is zero.

3. What changes will you observe in the Newton's ring fringe pattern if monochromatic light is replaced by polychromatic light (sunlight)?

If polychromatic light is used in place of monochromatic light, the coloured fringes will be obtained with alternate different coloured lights and dark concentric rings.

4. How can bright spot be obtained at the centre in reflected pattern?

Bright spot can be obtained by changing lens, medium and glass plate in such a way that total phase difference becomes zero instead of $\frac{\lambda}{2}$.

D.J.S.C.E. (Physics)		
Journal		
Knowledge	3	
Documentation	3	
Punctuality	3	
Virtual Lab (Performance & Documentation)	6	
Total	15	

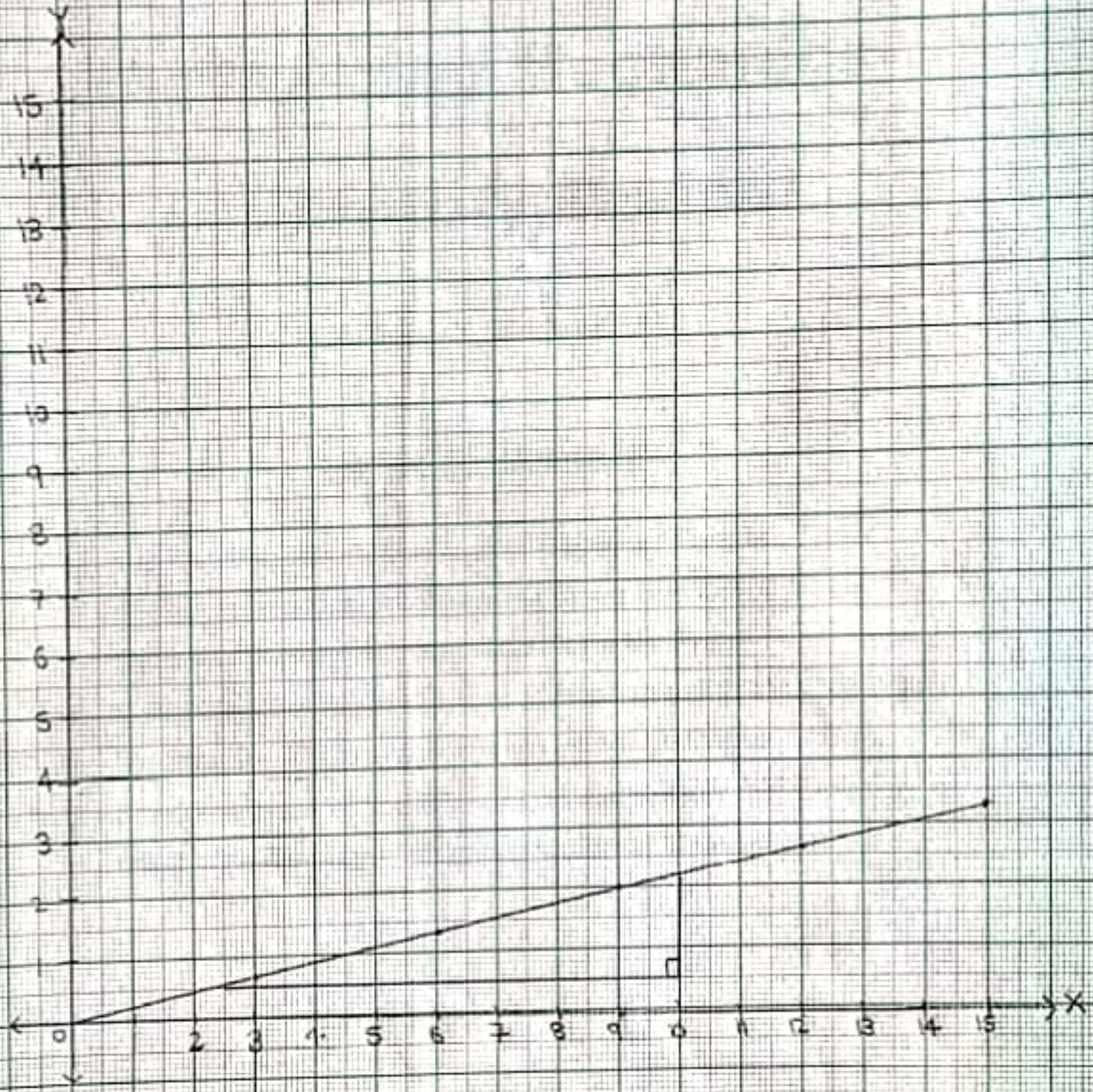
Date	Signature of the faculty

Scale

on both axes

1cm = 1 unit

D_n^2 vs Ring no 'n'



Ring No 'n'

$$\text{Slope} = \frac{1.7 \times 10^{-1}}{7.6} = 0.0228 \left[\frac{Y}{X}\right]$$