PHY F214 PHYSICS LAB-5 REPORT SEM-1 2017-2018

EXP No. = 7 EXP NAME=MICHELSON INTERFEROMETER

NAME-UTKARSH SINGH

ID No. -2016B5A30750G

DATE OF PERFORMING – 7.09.2017

AIM- 1. To calculate the wavelength of the laser using Michelson interferometer.

2.To calculate the refractive index of glass using Michelson Interferometer.

APPARATUS USED:

Breadboard,diode laser,laser mount,beamsplitter mount ,mirror mount (2 numbers),Screen and Rotation stage with glass mounted.

PRINCIPLE USED :

Mainly the principle that light behaves like a wave and can show the phenomenon of interference is used.

For task 1 that is to calculate the wavelength of laser we basically count the number of fringes that pass as we move the movable mirror m1 and then as the mirror is moved by a distance $\lambda/2$ the fringe pattern repeats itself so if n fringes repeat the distance moved should be $n\lambda/2=D$ so $\lambda=2D/n$. D is the optical path difference between the two interfering lights which is changed here by moving the mirror m1 to change the optical path length of one mirror or one of the interfering lights.

For task 2 that is to calculate the refractive index of glass plate we again use the same concept as above that as we move a distance of $\lambda/2$ from a particular position the fringe pattern repeats itself so here the optical path length is not changed by moving the mirror but by changing the angle at which the glass plate is kept in front of the movable mirror as we make it more inclined to the mirror m1 the more is the optical path length that the ray travels that is if the ray travels a distance d inside the glass the optical path length difference between the two interfering lights is μd. Now we

calculate that if we move the glass by an angle ϕ then what will be the distance travelled by the light in the glass through geometry then if n number of fringes repeat as the glass plate is moved by an angle ϕ then again $\lambda=2D/n$ now we know λ from task 1 and we know n.We calculate the optical distance travelled D by using angle ϕ and thickness of the glass plate we get $\mu=((2t-n\lambda)(1-\cos\phi))/(2t(1-\cos\phi)-n\lambda)$.

PROCEDURE AND OBSERVATION :

FOR TASK 1:

First we set up the experiment by keeping a beamsplitter in front of the laser mount at an angle of 45 to the direction of incident light next we put two mirrors mounted on two translation stages placed at the sides of the optical platform at right angles to each other. Both mirrors m1 and m2 can be tilted while only m1 can move horizontally by a micrometer attached to it.

When the laser falls on the beamsplitter it reflects and transmits 50 % of light through it .One portion beam A is transmitted through BS to m2 and the othr beam B is reflected by BS to m1 .Beam a ,returning from m2 is reflected at the back of BS to reach the screen placed at E and beam B, after reflecting from m1 passes thrugh BS to reach the screen.

1. **We attach the laser and align it so that the beam is parallel to the base and to strike the center of the moveable mirror and should be reflected back directly into the laser.**
2. **We position the beam splitter so that the beam is reflected at the fixed mirror and strikes at the center of the fixed mirror m2.**
3. **Two sets of bright dots appear on the screen one from each mirror interfering.Now bring the two set of dots as close as possible by adjusting the beam splitter and the mirrors.**
4. **Expand the laser beam by using the collimating lens in front of the screen.**
5. **We align again to obtain circular fringes and make a mark on the screen and start moving m1 using the micrometer. We note down the initial reading of the micrometer and then the final reading after n fringes repeat themselves.**

6. **We compute the distance moved by using the initial and final reading of the micrometer. The distance 10 micron on the thimble corresponds to 0.35 microns on the translation stage .**
7. **Repeat the process for three different n and use the formula λ=2D/n and take the average of all the wavelengths.**

Number of divisions moved in micrometer	Distance d in microns	Wavelength (nm)
22	7.7	770
23	8.05	805
22	7.7	770

For 20 fringes. $\lambda=2D/20$

Calculating the average of the wavelengths obtained

$\lambda=(\lambda_1+\lambda_2+\lambda_3)/3$ = 781.7 nm.

FOR TASK 2:

First we set up the experiment by keeping a beamsplitter in front of the laser mount at an angle of 45 to the direction of incident light next we put two mirrors mounted on two translation stages placed at the sides of the optical platform at right angles to each other. Both mirrors m1 and m2 can be tilted while only m1 can move horizontally by a micrometer attached to it. We also keep a glass plate in front of the moveable mirror m1 initially keeping it at 0 degree with respect to the mirror m1.

When the laser falls on the beamsplitter it reflects and transmits 50 % of light through it .One portion beam A is transmitted through BS to m2 and the other beam B is reflected by BS to m1 where it passes through glass plate twice one when it goes and one while returning . Beam a ,returning from m2 is reflected at the back of BS to reach the screen placed at E and beam B, after reflecting from m1 passes thrugh BS to reach the screen.

1. After mounting the glass plate on the rotation stage in front of the mirror m1 and adjusting the positions of the mirrors and BS to obtain a circular fringe. When the glass plate is introduced the fringe will be shifted and become blur.Move th mirror to and fro to make them clearer.
2. We mark a point on the fringe and slowly change thee angle of the glass plate with respect to the mirror m1 starting from 0 for three different angles. We count the number of times the fringe repeats as we rotate the glass plate.
3. We need to rotate by atleast 10 degrees and not more than 30 degrees as then the fringe pattern might get lost.

Degrees of rotation	Number of fringes repeated	μ(Refractive index of glass)
10	39	4.22
14	55	4.10
16	70	3.86

$\mu=((2t-n\lambda)(1-\cos\phi))/(2t(1-\cos\phi)-n\lambda)$

$t=0.131$ cm$=1.31*10^{-3}$ m

$\lambda=781.7*10^{-9}$ m

so the average refractive index of glass is

$\mu=4.06$

INFERENCE :

The change in the path length by a factor of λ/2 causes the fringe pattern to return and that light shows wave nature as like a wave it also interferes interference is a phenomenon in which two waves superpose to form a resultant wave of greater ,lower or same amplitude and produce bright and dark spots when the path difference between two light rays from the same source have a path difference of nλ/2 then the rays interfere constructively and produce a bright spot while if the path difference is (2n+1)λ/2 where n=1,2,3,...Then the light rays interfere destructively and produce a dark spot as they have a phase difference of pi.

When the phase difference between two interfering waves is an even multiple of pi then it is called constructive interference and when it is an odd multiple of pi then they interfere destructively.

POSSIBLE ERRORS:

1.There could be a backlash error in the micrometer and by manual error we could have moved the nob in opposite direction a little while trying to move it uniformly.

2. manual error in counting the number of fringes can occur as the fringes pass very quickly sometimes .

3. We should generally try to move the nob of the micrometer uniformly but generally that is not possible perfectly.

4. there may be a few systematic errors such as imperfect shape of glass and beamsplitter.