**Experiment 6**

# Michelson Interferometer

**Aim:**

**(A):** Interference Fringes Observation

**(B):** Calculate the refractive index of glass using Michelson Interferometer.

**Apparatus Required:**

Use the system with its accessories as shown in Figure (1) below

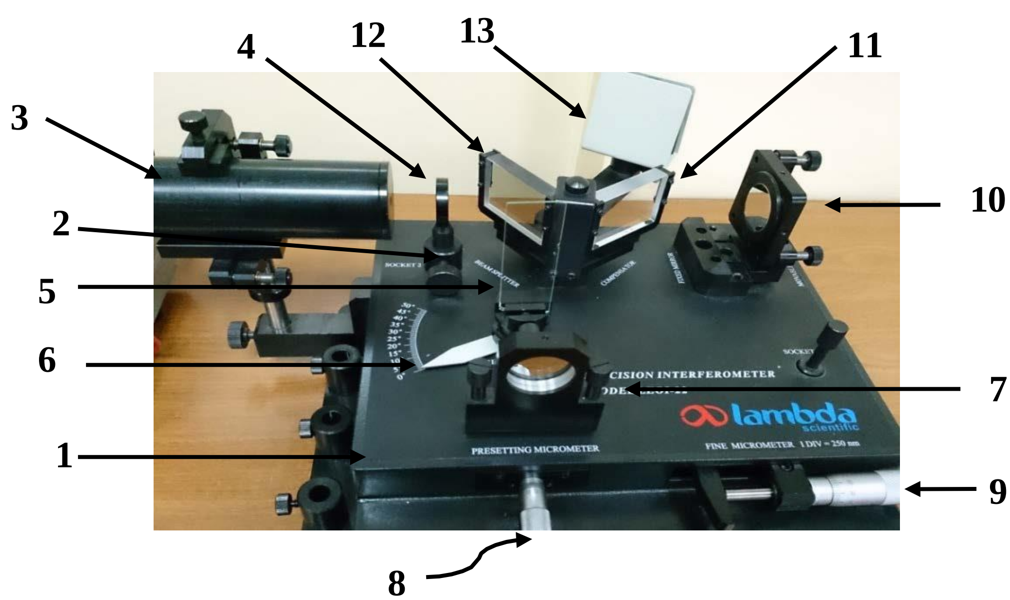


Figure (1)

1. Main Stage
2. Socket 2 for beam expander
3. He-Ne Laser
4. Beam Expander
5. Transparency Slice
6. Rotation Pointer and Socket 3
7. Fixed Mirror
8. Presetting Micrometer
9. Fine Micrometer
10. Movable Mirror
11. Compensator
12. Beam Splitter
13. Two in one screen

**Theory:**

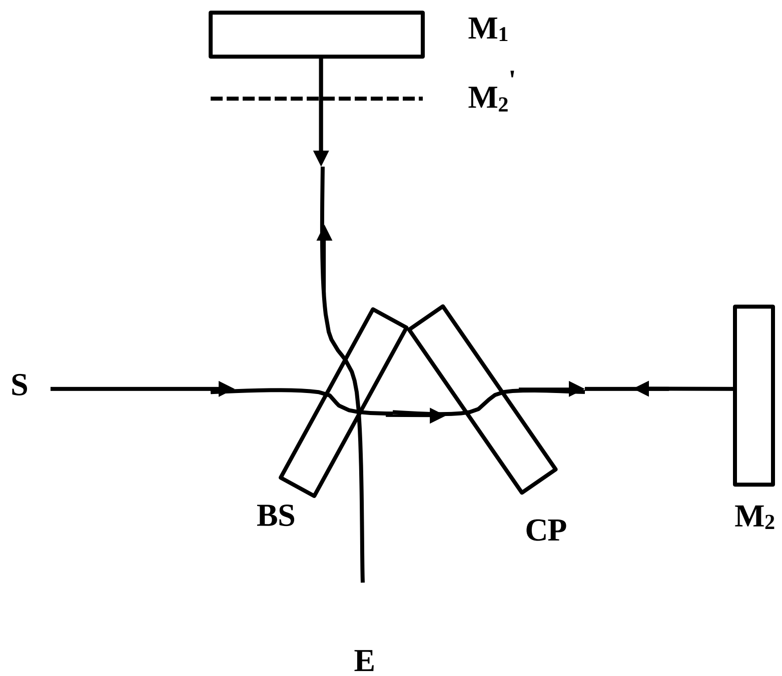


**Figure (2): Michelson interferometer**

The above figure shows a schematic diagram of Michelson interferometer. The beam of light from the light source (S) strikes the beam-splitter (BS), which reflects 50% of the incident light and transmits the other50%. The incident beam is therefore split into two beams; one beam is reflected toward the fixed mirror (MR1R), the other is transmitted toward the movable mirror (MR2R).

Both mirrors reflect the light directly back toward the beam-splitter (BS). The light from (MR1R) is transmitted through the beam-splitter (BS) to the observer's eye (E), and the other light from (MR2R) is transmitted through the compensator plate (CP) and reflected from the beam-splitter (BS) to the observer's eye (E).

Since the beams are from the same light source, their phases are highly correlated. When a beam expander is placed between the light source and the beam-splitter, the light rays spread out, and an interference pattern of dark and bright rings, or fringes, can be seen by the observer.

In above figure, ($M_2'$) is the virtual image of ($M_2$), and the light path of the Michelson interferometer can be seen as the light path of the air plate between ($MR1R$) and ($M_2'$).

The compensator plate (CP) parallel to the beam -splitter (BS) has the same thickness and refractive index with the (BS). Because the light paths of the two beams are equal, and different light waves have the same retardation, and it is easy for observing the white-light interference.
When place a transparency slice in one optical arm of the Michelson interferometer, light path of this arm will change as the transparency slice is rotating. The difference of the light path can be determined by counting the number of the fringes disappeared or appeared. And the light path has a relation to the rotating angle (θ), the thickness (d) and the refractive index (n) of the slice. If the entrance light is perpendicular to the transparency slice at first, and after rotating an angle (θ), the change of the number of fringes is (N). The refractive index (n) is given by:

$$n = \frac{n_0^2\, d \sin^2\theta}{2n_0\, d(1-\cos\theta) - N\lambda}$$

Where:

λ : is the wavelength of the He-Ne Laser(632.8 nm).

$n_0$ : is the refractive index of air.

N=number of fringes

d=………………..

θ=…………………

**Procedure:**

1. Place He-Ne laser and fixit with mount with a He-Ne Laser in the mounting hole on the side stage and turn on.
2. Place beam expander in (socket 2).Adjust the height of the laser tube to let the beam hit the center of the beam expander. Remove the beam expander.
3. View the beam spot on the beam splitter; it should be approximately in the middle of the beam splitter, and view also on the movable mirror. Adjust the laser tube until the beam spots on both the beam splitter and movable mirror are at the same height.
4. Place the two in one screen in the extension in (socket 1) and face the white screen towards the beam splitter. A beam spot will be seen on the screen which comes from the fixed mirror. There are also other spots on the screen with less brightness due to multiple reflections. Align the center of the white screen with the brightest beam spot.
5. Adjust the movable mirror until the two bright spots coincide with each other at the center of the white screen.
6. Position the beam expander into (socket 2) with the lens lock facing the beam splitter. If the expanded beam spot is not immediately incident on the movable mirror, then adjust the laser tube. The fringe pattern can be observed on the white screen.
7. Place the transparency slice clip in the mounting hole in (socket3). Mount the transparency slice on the clip. Adjust the clip and the rotational pointer and make sure that the slice is approximately perpendicular to the optical. path. If you not achieve fringes on the screen adjust the movable mirror to get a set of clear fringes on the white screen.
8. Slowly rotate the rotation stage. Count the number of fringe translations that occur as you rotate the table to an angle θ (at least 10 degree).
9. Calculate the refractive index of glass by using the equ.1.
10. Calculate percentage error of (n). p.e= $((n_{th}-n_{exp})/n_{th}) \times 100\%$
11. nth=1.5 of transparency slice

**Question:**

1. Discuss the source of error in your experiment.

2. Explain the working principles work of Michelson interferometer.

3.Define the refractive index.

4. By Michelson interferometer we can determine (a. Wave length of sodium D-Lines b. Refractive index of air) (True or False)