Quadrant II – Transcript and Related Materials

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Unit - 2: Interference.

Module Name: Interference by division of wavefront.

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Notes

INTERFERENCE:

The phenomenon of redistribution of light energy due to the superposition of light waves from two to more coherent sources is known as interference.

Interference produced at any region is of two types destructive and constructive interference. It is called as destructive interference when the dark band is produced at a point and constructive interference when the bight band is produced at a point.

When two or more coherent waves of light are superposed, the resultant effect is brightness in certain regions and darkness at the other regions. The regions of brightness and darkness alternate and may take the form of straight band, or circular rings. The alternate bright and dark bands are called interference fringes.

The interference can be produced by two methods:

1. Interference by division of wavefront
2. Interference by division of amplitude.

Interference by division of wavefront:

In this method, the coherent sources are obtained by dividing the wavefront, originating from a common source, by employing mirrors, biprisms or lenses. Here we require a point source or a narrow-slit source to obtain the division of wavefront.

Michelson's Interferometer:

In the previous example, we looked at how the wavefront gets divided. Now let us look at how to divide a wave by partial reflection, the two resulting wavefronts maintaining the original width but having reduced amplitudes. The Michelson interferometer is an important example of this.

Here the two beams obtained by division of amplitude are sent in different directions against plane mirrors, hence they are brought together again to form interference fringes.

The arrangement is shown schematically in the figure given below.

The main optical parts consist of two highly polished plane mirrors M1 and M2 and two plane-parallel plates of glass G1 and G2. Sometimes the rear side of the plate G1 is lightly silvered (as shown by the heavy line in the figure) so that the light coming from the source S is divided into 1. A reflected and 2. A transmitted beam of equal intensity. The light reflected normally from the mirror M1 passes through G1 a third time and reaches the eye as shown. The light reflected from the mirror M2 passes back through G2 for the second time, is reflected from the surface of G1 and into the eye. The purpose of the plate G2, called the compensating plate, is to render the path in a glass of the two rays equal. This is not essential for producing fringes in monochromatic light, but it is indispensable when white light is used. The mirror M1 is mounted on a carriage C and can be moved along the well-machined ways or tracks T. This slow and accurately controlled motion is accomplished by means of the screw V, which is calibrated to show the exact distance the mirror has been moved. To obtain fringes, the mirror M1 and M2 are made exactly perpendicular to each other by means of screws shown on mirror M2.

Even with the above adjustments, fringes will not be seen unless the following requirements are fulfilled.

The light must originate from an extended source. (In previous case point source or slits were used)

The light must in general be monochromatic.

An extended source suitable for use with a Michelson interferometer may be obtained in any one of several ways. A sodium flame or a mercury arc, if large enough may be used without the screen L. If the source is small a ground-glass screen or a lens at L will extend the field of view. Looking at the mirror M1 through the plate G1, one then sees the whole mirror filled with light. In order to obtain fringes, the next step is to measure the distance of M1 and M2 to the back surface of G1 roughly with a millimeter-scale and to move M1 until they are the same to within a few millimeters. The mirror M2 is now adjusted to be perpendicular to M1 by observing the image of a common pin, or any sharp point, placed between the source and G1. Two pairs of images will be seen, one coming from reflection at the front surface of G1 and the other from reflection at its back surface. When the tilting screws on M2 are turned until one pair of images falls exactly on the other, the interference fringes should appear. When they first appear, the fringes will not be clear unless the eye is focused on or near the black mirror M1, so the observer should look constantly at this mirror while searching for the fringes. When they have been found, the adjusting screws should be turned in such a way as to continually increase the width of the fringes, and finally, a set of concentric circular fringes will be obtained. M2 is then exactly perpendicular to M1 if the latter is at an angle of 45° with G1.