Hanoi University of Science and Technology
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LAB REPORT

For Electrics and Thermodynamics

Experiment 5

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Experiment 5

INVESTIGATION OF TRANSMISSION OF ELECTROMAGNETIC WAVE (MICROWAVE)

I. Experiment Motivation

Evaluate both qualitative and quantitative results of transmitting and receiving microwave.

II. Experimental Results

1. Investigation of straight-line propagation of microwaves

Observation:

- When the receiver is align with the rail (the transmitter and receiver are facing each other), the volt-meter shows the maximum value. (1.95V)
- When the receiver move far from the rail (in a plane perpendicular to the rail), the value of volt-meter decreases.

Conclusion:

- Microwave propagates best in straight line.

2. Investigation of penetration of microwaves

Observation:

- Initial (with no absorption plate): 1.37 (V)
- Final (with absorption plate): 1.08 (V)
- When a dry absorption plate (electrical insulator) is put between transmitter and receiver, the volt-meter slightly decrease

Conclusion:

- Microwave can penetrate through the dry absorption plate.
- Not all of the microwave will penetrate through the dry absorption plate, a part of them will be absorbed by the absorption plate.

3. Investigation of screening and absorption of microwaves

Observation:

- Initial (with no reflection plate): 1.37 (V)
- Final (with reflection plate): 0.1 (V)
- When a reflection plate (conductor) is put between transmitter and receiver, the volt-meter shows a value that very small compared to the value when the absorb plate is absent. In this case, the voltage-meter shows a value approximate 0 (0.02).

Conclusion:

- Microwave is reflected mostly instead of passing through the reflection plate

4. Investigation of reflection of microwaves

Observation:

Angles of reflector (degree)	Angles of incidence (degree)	Max voltage (V)
30	34	2.02
40	43	2.04
50	50	2.06
60	62	2.02

- When the arrow is the bisector of 2 rails (the reflector angle is equal to the incidence angle), the voltage-meter shows maximum value.

Conclusion:

- Microwave reflects best when perpendicular bisector of the reflection plate is the bisector of an angle created by the transmitter and receiver.
- When the microwave reflects, the angle of incidence equals the angle of reflection.

5. Investigation of refraction of microwaves

Observation:

- When the angle between 2 rails is 30^o, the volt-meter shows the maximum value. V = 1.25 (V)
- After turning the receiver to different angle, the value of voltage-meter decreases.

Conclusion:

- Microwave refracts best with angle of 30^{o}.

6. Investigation of diffraction of microwaves

Result:

- Minimum value measured by voltage-meter: 0.01V
- When the single slit plane is put in the rail: V = 0.27V

Observation:

When the single slit plane is put in the rail, the value on the voltage-meter increases. When the plate is between the probe and the transmitter, the value on the voltage meter is approximately 0. When the probe is moved on the horizontal plane, the value slightly increases.

Conclusion:

Microwave has diffraction properties.

7. Investigation of interference of microwaves

Observation:

- When the probe is moved parallel to the plate, the value on the voltage meter is oscillating. Number of maxima = 3

Conclusion: Microwave has property of interference.

8. Investigation of polarization of microwaves

Observation:

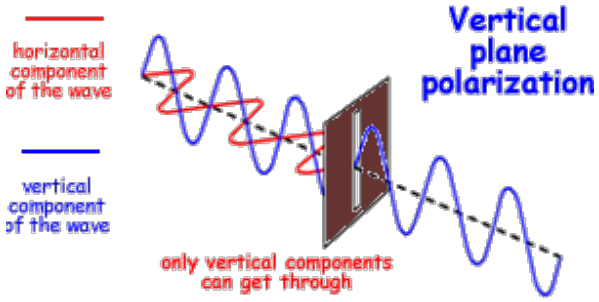
Signal through vertical polarization grating: 1.38V (V)

Signal through horizontal polarization grating: 0.01 (V)

Signal through 45^{o} inclined polarization grating: 0.78(V)

Conclusion:

- When we put a polarization grating between transmitter and receiver, the microwave (electromagnetic) will be polarized as shown in fig 1.



Because the vertical wave is electric wave, and the receiver's signal we receiver is Voltage. Therefore:

- With vertical polarization grating, only the vertical wave can go through. The receiver's signal is big.
- With horizontal polarization grating, only the horizontal wave can go through. The receiver's signal is very small (approximate to 0).
- With 45^o inclined polarization grating, a part of vertical wave and horizontal wave can go through. The receiver's signal is smaller than when we use vertical polarization grating and bigger than when we use horizontal polarization grating.

9. Determining wavelength of standing waves

f	x_1 (mm)	x_2 (mm)	$x = x_1 - x_2$
1	166	194	28
2	194	214	20
3	214	242	28

$$\bar{x} = \frac{1}{3}\sum_{i=1}^{3} x_i = 25.33(mm)$$

$$\Delta x = \sqrt{\frac{\sum_{i=1}^{3}(x_i - \bar{x})^2}{3}} = 3.77\ (mm)$$

$$\bar{\lambda} = 2\times \overline{x} = 2\times 25.33 = 50.66(\text{mm})$$

$$\Delta\lambda = \Delta x = 3.77\ (mm)$$

Hence

$$\lambda = \bar{\lambda} \pm \Delta\lambda = 50.66 \pm 3.77(mm)$$

Frequency of the microwave:

$$\overline{f} = \frac{c}{\bar{\lambda}} = \frac{3 \times 10^8}{39.34 \times 10^{-3}} = 5.92 \times 10^9(Hz)$$

$$\Delta f = \bar{f}\sqrt{\left(\frac{\Delta\lambda}{\bar{\lambda}}\right)^2 + \left(\frac{\Delta c}{c}\right)^2} = 0.44 \times 10^9\ (Hz)$$

$$f = \overline{f} \pm \Delta f = (5.92 \pm 0.44) \times 10^9(Hz)$$