

# Innovative methods to promote optics at school level

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## 1. ABSTRACT

The conventional pedagogical techniques in Indian schools are predominantly limited to coursework and involve just necessary laboratory work. It lacks in inculcating the aptitude for practical applications relevant to the coursework amongst the students. This results in a major setback for the students as their mental approach remains constrained to books, where on the contrary, the future depends only on technologies and applications. Considering this, under Optics Outreach Education Program 2014, University of Delhi at Acharya Narendra Dev College SPIE Student Chapter conducted workshops in 22 schools of Delhi including various Government schools as well. The workshop zeroed into the concepts of optics and various innovative techniques developed by our Student chapter members to embark a new method of teaching.

**Keywords:** Optics Outreach, Wave Optics Kit, Interference, Diffraction, Wave Optics

## 2. INTRODUCTION

As a part of the curriculum of the higher secondary and senior secondary classes in India, students are taught the basics and details of optics including ray optics and wave optics. But the education is limited to theoretical knowledge and not extended using practical or hands-on experience. Lack of practical and hands-on experience restrict the mindset of students, and doesn't allow the inquisitive minds to explore optics to a greater extent. Under Optics Outreach Education Program 2014, University of Delhi at Acharya Narendra Dev College SPIE Student Chapter conducted workshop in 22 schools across Delhi and distributed a Wave Optics Kit conceived and designed by the Chapter to every school free of cost.

The kit allows the students to perform all sorts of experiments listed in their curriculum. These cost effective kits were conceived and designed by the Chapter students. The introduction of such a kit in the school laboratory not only allows the minds to explore the untaught parts of wave optics but also inculcate a sense of learning by self-experiment and an attitude of enquiry.

## 3. METHODOLOGY

We adopted hands on approach to make students understand the basics of ray and wave optics. We divided the students into two batches depending on their classes. The students from 9-10 were categorized as juniors and taught ray optics and the students of classes 11-12 were categorized as seniors and taught wave and fiber optics. The students were given hands-on knowledge about the apparatus and the procedure. The students were asked to perform the experiments with different width of single slits and observe the changes in patterns obtained. After the completion of the demonstration, the feedback regarding the demonstration were taken. The demonstration was conducted at a moderate pace taking into consideration the progress of every student of the class and their queries.

#### 4. WAVE OPTICS KIT FEATURES

The wave optics kits were distributed to all the schools. The contents of designed wave optics kit it as follows:

1. Grating mount with stand
2. LED Lamp with stand
3. Quarter Wave Plate with graduated mount and stand
4. Half Wave Plate with graduated mount and stand
5. Polarizer with graduated mount and stand
6. Analyzer with graduated mount and stand
7. Prism Table with stand
8. Diode Laser mount with stand
9. Prism
10. Hollow Prism
11. Single Slit
12. Double Slit
13. Diffraction Grating
14. Diode Laser with adaptor
15. Glass Slab
16. Multimeter
17. Acrylic Cube

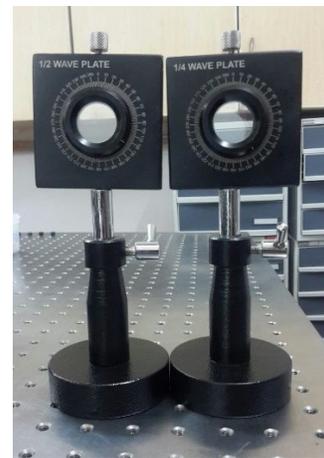
The contents of the kit are shown as below:



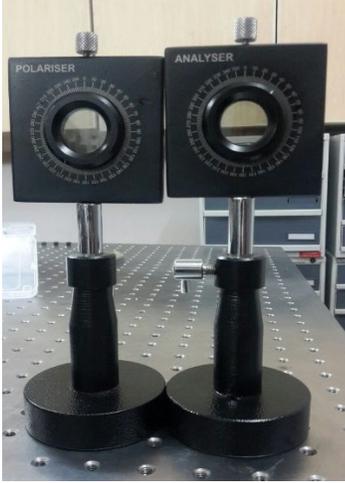
i) Grating Stand



ii) LED Lamp



iii) Quarter Wave Plate  
& Half Wave Plate



iv) Polarizer & Analyzer



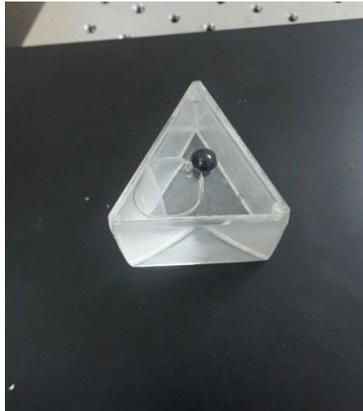
v) Prism Table



vi) Laser Stand



vii) Prism



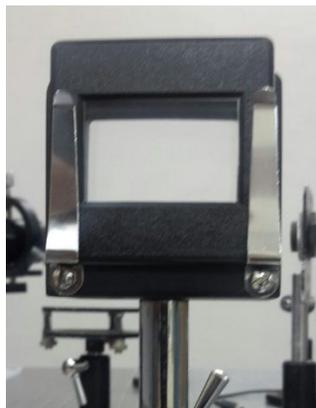
viii) Hollow Prism



ix) Single Slit



x) Double Slit



xi) Diffraction Grating



xii) Laser Diode & Adaptor



xiii) Glass Slab



xiv) Pocket Multimeter



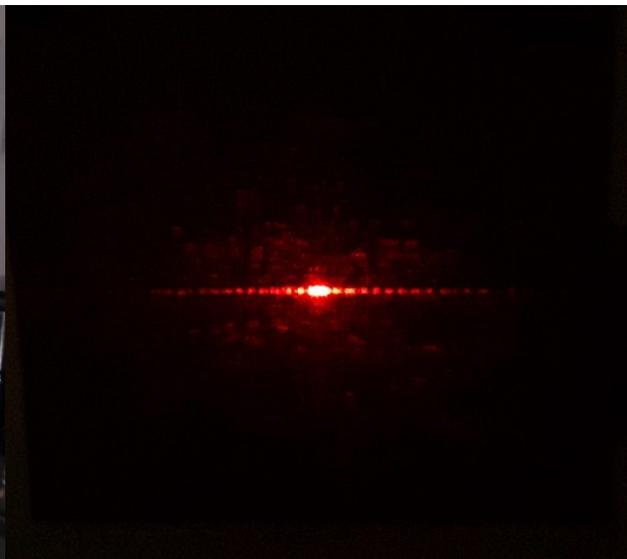
xv) Acrylic cube

The experiments that can be performed with the kit are as follows:

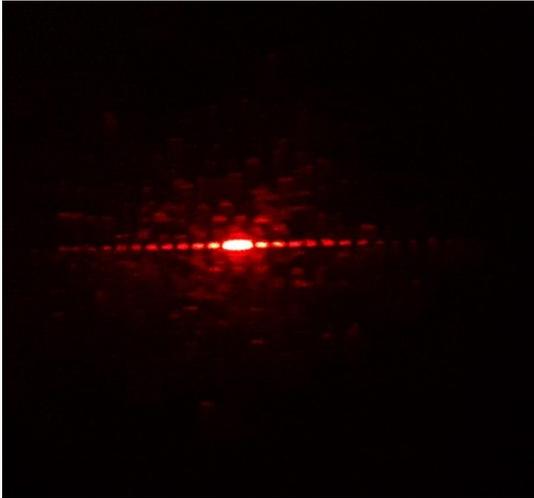
- 1) Study of polarization and Malus law.
- 2) Study of refraction of light with glass slab.(Snell's law)
- 3) Study and demonstration of diffraction of light.
- 4) Study of behavior of light through  $\frac{1}{2}$  and  $\frac{1}{4}$  wave plates.
- 5) Determination of lateral displacement of laser through glass slab.
- 6) Study of dispersion of light through glass prism and other liquid prisms.
- 7) Study of changes in lateral displacement of light upon passing through liquids of different medium.
- 8) Study of single slit and double slit diffraction of light and their variation with slit width.
- 9) Study of Brewster's Law.
- 10) Study of critical angle and total internal reflection.



Diffraction of laser through diffraction grating.



Double Slit Diffraction Pattern



Single Slit Diffraction Pattern



Malus law demonstration at Lowest Intensity



Malus law demonstration at Highest Intensity



Total Internal Reflection of laser light in water

## 5. RESULTS & DISCUSSION

The workshop started with an informal discussion on physics and optics followed by a question session on optics. Many questions were raised by the student during the interaction. Some of them have been listed as under:

1. Is Huygens's principle valid for longitudinal waves?
2. Why is diffraction of sound more evident than that of light?
3. How are stationary waves formed?
4. How does a wave carry energy?
5. What are coherent sources?
6. Does energy conservation hold in Interference?
7. How does light propagate in vacuum?
8. Why light is a wave?
9. Difference between ray optics and wave optics?

The sessions were highly interactive where students came out with their queries and enjoyed the hands-on sessions. The workshop was praised by the students and the teachers for the ease in setup and understanding through the wave optics kit. The hands-on involvement was highly appraised by the students.

Some of the images showing Chapter members interacting with school students during the workshop:



a) Hands-on session in progress.



b) Wave Optics Kit demonstration and theory.

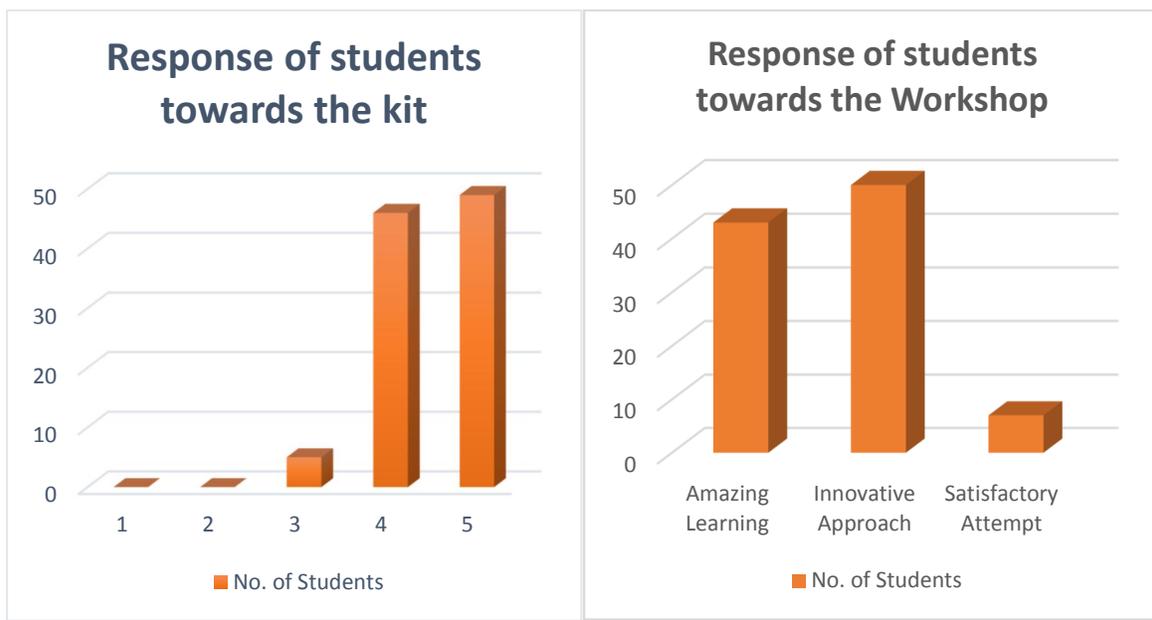


c) Optics theory and question session.



d) Ray optics demonstration to students.

The response of the students towards the kit and the workshop has also been analyzed. The data is based on 100 random feedback forms.



Graph 1. Rating of the kit on a 5 point scale (Scale 5 Highest).

Graph 2. Response of students towards the workshop

## 6. CONCLUSION

The developed kit provides the students with a hands-on experience to wave optics and the knowhow of the experiment. It not only allows the student to learn by themselves but also explore various aspects of wave optics that may not be practically demonstrated in the classroom. The grasp of theoretical concept is backed by the practical exposure provided by the kit. The demonstrations sparked the young minds to explore the area of optics and its wave nature to a greater extent. The kit shall be an asset to the schools for teaching wave optics for the new batches to come.

## 7. ACKNOWLEDGEMENT

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## 8. REFERENCES

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