Office Bearers:

Dr. Ayan Banerjee  
Faculty Advisor

Subhrokoli Ghosh  
President

Debapriya Pal  
Secretary

Avijit Kundu  
Treasurer

Amar Deo Chandra  
Outreach Coordinator

Vinay Pareek  
Public Relations
Members’ List:

Currently the chapter has 20 registered members.

Unnati Ashar
Prithviraj Basak
Shubham Chandel
Amar Deo Chandra
Sayantan Das
Amlan Datta
Thomas Tushar Dutta
Subhrokoli Ghosh
Avijit Kundu
Rohan Maji
Niladri Modak
Debangana Mukhopadhyay
Debapriya Pal
Vinay Pareek
Sai Raman Patra
Sawon Pratiher
Sudipta Saha
Souvik Sil
Souvik Sil
Aman Sinha
Roshan Tiwari
Chapter Activities:

This year the chapter has organized events to promote various facets of optics among the students and also during the outreach activities.

Notably, the following activities were organized for that purpose:

1. **Introductory session for freshmen:**

   The session mainly focused on spreading information about SPIE, its benefits and how IISERK Chapter involved over the years. The goal was to bring in new students to participate in different chapter activities.

   **Event details:**
   **Date:** 29th August, 2018
   Chapter faculty advisor Prof. Ayan Banerjee gave a popular talk on Light in Everyday life including basic and industrial research opportunities with light and a brief exposure of optics based research labs at IISER Kolkata. Around 60 students participated in this event; all were provided refreshments. Glimps of the event is captured below.
2. SPIE IISERK Autumn 2018 Lecture Series:

Talk 1: Dr. Debangshu Chadhuri, Associate Professor, Department of Chemical Sciences  
Date: 14th March, 2018

Prof. Chaudhuri gave the first lecture of the series this year. The title of the talk was ‘Looking at Molecules one at a time’. He discussed an overview of molecular spectroscopy with time resolved analysis in pico and femto seconds time scale. Around 70 students participated in this event. Refreshments were provided to all.

Talk 2: Dr. Ayan Banerjee, Professor, Department of Physical Sciences  
Date: 17th October, 2018

Prof. Banerjee’s talk was based on ‘Optical Tweezers’ to celebrate the occasion of Nobel Prize in Physics 2018 by Arthur Ashkin for the optical tweezers and their application to biological systems. He gave a general overview about the working of Tweezers and various novel applications of this system. He also enlightened the audience about the advancement of optics and the market value of optics related field. Around 60 students attended this event and refreshments were provided.

Talk 3: Dr. Bidisha Sinha, Associate Professor, Department of Biological Sciences  
Date: 2nd November, 2018

Prof. Sinha gave an interesting talk on the topic, “Light matters in Biology”. She gave an overview of different basic microscopic techniques and their applications in biology to the undergraduates in a lucid manner during the talk. Around 70 students participated in this event. Refreshments were provided.
Talk 4: Prof. Bipul Pal, Professor Department of Physical Sciences  
Date: 6th November  
Prof. Pal provided insights on Light Matter Interaction in response to intense laser field in different materials during his talk titled ‘Self Action of Light’. He explained basic non-linear properties of light to the novices in lucid manner. Around 60 students took part in this event and refreshments were provided.

3. SPIE International Day of Light:

Our Chapter is of the proud recipients of 2018 IDL Micro Grant for SPIE to organize an outreach cum popular event during mid May to celebrate the UNESCO International Day of Light.

As a part of this, we have organized a one day Optics Festival for students (of nearby schools and colleges along with the research scholars of IISER Kolkata) among various other plans. We have invited reputed schools from Kalyani and nearby places and had around 150 school participants in the event on 29th May 2018.
The schedule of the event followed is given below:

9:30 AM: Reporting Time (Research Complex Auditorium, IISER Kolkata).
9:45 AM: Inauguration by the Prof. Sourav Pall, Honorable Director of IISER Kolkata.
10:00 AM: Popular Talk by Prof. Anantha Ramakrishnan, Indian Institute of Technology Kanpur. (Title: Infra Red Light and enhanced Imaging)
11:15 AM: Break (Refreshments was provided).
11:45 AM: Hands on Experimental Demonstration of various fun experiments based on light.
1:15 PM: Departure.

In the second part of the IDL activities, we have organized a educational trip for nearby locality school going children in collaboration with Ek Pehal (this is an IISER-K Student’s initiative to promote free education) to Science City for a day. Details of the events were submitted separately in due time. Here is some glimpse of the events.
4. PARADIGM- Cultivating Innovation:

This was a one day science exhibition-cum-demonstration organized during INQUIVESTA, science festival of IISER Kolkata. In the first edition of the event organized on 3rd March 2018, there were around 300 student visitors. Total 15 groups with 3-4 members each group showcased different science models which was judged by a 3 member panel. We have organized a hands on demonstration session on various domains of science. Especially, Dr. Supratim Banerjee performed nice experiments such as photo luminescence and colourful polymerization of polymers, which enthralled the students during the demonstration. Our SPIE members also showed some nice real time experiments to explain some basic phenomenons like angular momentum conservation and a popular talk on ‘Life Cycle of Stars’ was given by Amar Deo Chandra. Some glimpse of this grant event is following.
Science projects:

**Project 1:**

*Name:* Understanding the synchronization of identical dynamic systems: Huygens' clocks  
*Abstract:* The synchronization of two pendulum clocks hanging from a wall was first observed by Huygens during the XVII century. This type of synchronization is observed in other areas, and is fundamentally different from the problem of two clocks hanging from a moveable base. Here we study the motion of coupled pendulum and try to figure out the spring constant. The predicted value of spring constant is observed experimentally, validating the model. Coupled oscillators are an example of resonant energy exchange. Mathematical treatment of the coupled oscillator problem leads to a steady-state solution of motion, which is expressed by the superposition of the normal modes. Among the various coupled pendulum problems, a string-coupled pendulum oscillator made using a light string is one of the easiest to construct and analyse. In addition, when compared with other coupled oscillator problems, the string-coupled pendulum oscillator problem makes it easier to understand the physical meaning of the two normal mode frequencies and how these two normal mode solutions can be superposed to yield the desired steady-state solutions for a coupled oscillator.

![Image of pendulum experiment](image_url)

**Project 2:**

*Name:* A method to determine wavelength of an unknown laser source using a prism from the properties of dispersive medium.  
*Abstract:* Generally, in a dispersive medium, velocity of light (v) is a function of its wavelength (λ). Thus, refractive index (μ), which is the ratio of velocity of light in free space (c) to v, is also a function of λ. Now, μ can be represented as an infinite series of powers of λ, known as the Cauchy relation. Our proposed method uses a glass prism as a dispersive medium (assumed to be homogeneous and isotropic), whose μ we can determine for any given laser source from the deviation of light rays due to refraction. Once we know μ values for two different λ values, we use an approximated form of Cauchy relation to arrive at an expression for λ of some unknown laser source, easily determinable from its μ. In our project, using λ values of two different lasers, we calculate λ of a third laser and compare with its actual λ.

![Image of laser experiment](image_url)
Project 3:
Name: Verification of Damping of Oscillating Pendulum

Abstract: Our main motivation while planning this experiment was to implement what we have learned in the current course. We aimed to develop an experiment that helps us observe the effect of damping on an oscillating pendulum. We planned to build the apparatus from scratch using simple instruments and perform the experiment. The entire session was video-recorded: the video was fragmented into split second frames and all these images were processed through Physics trapper to obtain data that can be graphically represented. Situations to obtain all three cases of damping were created and recorded.
Project 4:

*Name:* Oscillations of a Coupled Pendulum in the Presence of Magnetic Fields

*Abstract:* We have studied magnetic effects in a coupled oscillation. In the first part we have tried to model this setup using some physical approximations, and then simulated it in python. In the second part the experiment is conducted and analysed in Tracker software. Finally, the results from both the parts are discussed.
**Project 5:**

*Name:* Acoustics of Glass Harmonica

*Abstract:* How does the frequency vary with the water amount in a vibrating wineglass? The main focus was on how and why the frequency changes as it does. We recorded the frequencies for different heights and liquids. The frequency for each height interval was recorded three times, and an average was found. Measurement of frequency was done with the help of mobile phone using Phyphox App, and by using Excel, we found the mode of our data. Using A.P. French’s paper on wineglass acoustics, we were able to prove mathematically and through Origin how and why the frequency changes as it does.

**Project 6:**

*Name:* CD Spectrograph

*Abstract:* We used CD as the grating for constructing our home made spectrograph, we took the photos of spectrum of lights from different sources, we calibrated our spectrograph using lasers of three different colours – red (671nm), green(532nm) and blue(472nm) and calculated the wavelength of light from sodium vapour lamp.
Project 7:

**Name:** Studying the Electrical Analogues of Oscillator Systems

**Abstract:** The electrical analogues of some oscillator systems were studied and responses recorded, beginning with the Forced damped oscillator. Lissajous figures were applied to study the phase response of an RC circuit and a forced damped oscillator (LCR circuit). Then a study of an electrical analogue of a coupled oscillator system was performed.

Project 8:

**Name:** An Experimental Design to Measure Small wavelength Differences

**Abstract:** This project is an Experimental design through which the measurement of small wavelength differences between two similar wavelengths. We have done some modification. But, we faced a problem in performing the Experiment, because the lens which we used for converting the planar wave fronts into the spherical wave fronts is not clear that much, for counting the number of fringe shifted after the interference pattern coincidence. If we could get a much clear lens, we can get sharp interference pattern and the coincidence in the interference patterns.
Project 9:

Name: Visualising Vibrational nodes on plate using granules

Abstract: This project is an Experimental design through which the measurement of small wavelength differences between two similar wavelengths. We have done some modification. But, we faced a problem in performing the Experiment, because the lens which we used for converting the planar wave fronts into the spherical wave fronts is not clear that much, for counting the number of fringe shifted after the interference pattern coincidence. If we could get a much clear lens, we can get sharp interference pattern and the coincidence in the interference patterns.
**Project 10:**

**Name:** Measuring the diameter of hair and wire using laser diffraction

**Abstract:** Often it is necessary to determine the diameter of a fine wire, thin thread or other object that cannot be measured by conventional means. These items can be measured by using methods of diffraction and interference known as Young’s Double Slit Experiment. While Young’s experiment deals with the pattern of light impinging on two narrow slits separated by a small distance, the method can be applied to...
an object with a small diameter as well. Where the diameter is within an order of magnitude of the wavelength of laser light used.

**Project 11:**  
**Name:** Physical Representation of Waves produced by Different musical instrument  
**Abstract:** In that project our aim is to get a detailed knowledge of chladni figures, normal modes and standing waves etc. produced by musical instruments harmonics. Typically the surface of a plate, diaphragm or membrane is vibrated, and regions of maximum and minimum displacement are made visible in a thin coating of particles, paste or liquid. Different patterns emerge in the excitatory medium depending on the geometry of the plate and the driving frequency.

**Project 12:**  
**Name:** Double Pendulum  
**Abstract:** In our project we have taken an attempt to study the chaotic non-linear motion of a double pendulum and its trajectory.
Project 13:

Name: Kater's pendulum

Abstract: A Kater’s (reversible) pendulum is a special design of simple physical pendulum. By using a reversible pendulum, local gravitational acceleration $g$ may be determined from the period of oscillation of KATER’S pendulum without knowing the mass or the moment of inertia of pendulum. Reversible pendulum is a compound pendulum whose pivot point and centre of oscillation are interchangeable. That is, if a compound pendulum is suspended upside down with centre of oscillation as the new pivot it will have the same time period and old pivot point will be the new centre of oscillation.

Project 14:

Name: Study of diffraction pattern in mechanically chopped L.A.S.E.R.

Abstract: Diffraction pattern from a grating or slit can be used to calculate the spacing or wavelength of the light source. It's normally done by displacing the photo detector but here we showed a way of keeping it stationary and finding it in time domain. We used a laser and kept an optical chopper between it and the photo detector to produce pulses. The pulses produced should show smooth rise and fall of intensity but instead they show an undulatory pattern (like damping). This is due to the diffraction at the edges of the chopper. This project studies that in detail.
**Project 15:**
**Name:** Computational Analysis of different S.H.M.

**Abstract:** We wanted to visualize the various equations we have seen throughout our course. To plot those differential equations of 2nd order we have to take help of numerical analysis. So, we have learnt how to compute integrals through numerical analysis and how to solve differential equations. We have learnt Euler and Range Kutta 4 Methods (better) to solve differential equations. ii) Our 2nd part of the project is to predict the damping factor from a given plot of damped system. iii) We have also considered 2-D oscillations & tried to plot the various lissajous figure in RK 4 method and matplotlib.

**Project 16:**
**Name:** Study of Damped oscillations

**Abstract:** First of all, our aim was to study the damping in a body oscillated by rubber bands on an air track apparatus. We created an analogy to mass spring assembly and calculated the damping coefficients of air for different masses and different air drags. We also calculated the spring analogue stiffness of the rubber bands. Secondly, we calculated the change in damping coefficient by replacing the body with a magnet of almost the same shape, size and mass. We studied the damping due to eddy currents induced by the oscillating magnetic field, thereby verifying the Lenz’s law.

**Project 17:**
**Name:** Wave velocity on a stretched string

**Abstract:** To study the wave velocity (phase velocity) by employing the concept of harmonics, normal mode and wave equation.

**Project 18:**
**Name:** Measuring the diameter of hair using laser diffraction

**Abstract:** Often it is necessary to determine the diameter of a fine wire, thin thread or other object that cannot be measure by convectional means. These items can be measured by using methods of diffraction and interference known as Young’s Double Slit Experiment. While Young’s experiment deal with the pattern of light impinging on two narrows slits separated by a small distance, the method can be applied to an object with a small diameter as well. Where the diameter is within an order of magnitude of the wavelength of laser light used.

**Project 19:**
**Name:** Determination of wavelength of various light sources using a CD Spectrometer

**Abstract:** The aim of the project is to find the slit spacing on a CD, which behaves like a diffraction grating and utilize this property to construct a CD spectrometer to measure the operational wavelength range of various lasers. The internal structure of a CD generates this unique property which is analogous to
a diffraction grating. This enables us to use it to construct an inexpensive spectrometer to characterise different lasers.

**Project 20:**

**Name:** Electrical Coupled Oscillator

**Abstract:** In our project we use an electrical system to study normal modes of coupled oscillators by varying the experimental initial conditions and computer simulations.
Project 21:

Name:  Studying lissajous figures using dry sand

Abstract: We studied various patterns of lissajous figures by varying the angular frequencies and relative phase between two directional motions. We also studied the variance of time period with the direction of motion.

Project 22:

Name:  Computer Simulation of Lissajous figures

Abstract: We constructed a Blackburn pendulum, which traced lissajous curves. The control parameter was the effective length of the pendulum, along one plane of oscillation, which effectively controlled the frequency ratio. We ran numerical simulations side-by-side to make qualitative comparisons to the obtained trajectories.
**Project 23:**

*Name:* Time evolution of three spring three mass system

*Abstract:* The project revolves around the study of the individual motions of three masses attached by three springs (two of which have the same spring constant and the third has a different one) when one of them is disturbed from rest. By capturing the movements in a video and detailed analysis of the situation through the Physlets Tracker software we were able to come to a quantitative description of the situation and determine the damping factor. Additionally we do a theoretical analysis of the situation in damped case and find the normal modes of oscillation for damped case.

**Project 24:**

*Name:* Experimental observation of damping factor of water and determination of unknown mass

*Abstract:* Analysis of the amplitude of oscillation of mass spring system in air and water using video analysis software (Physics tracker) and thereby compare them with experimental result has been done. Using these results we tried to estimate damping factor of water using mass spring system along with this we tried to determine an unknown mass from vertical oscillation of mass-spring system.
Project 25:
*Name:* Generating lissajous figures using lasers

*Abstract:* This project is aimed at studying Lissajous-like figures by using lasers incident on a rotating mirror. A sample code was written to compare the observed figures with what is expected and predict the possible value of ratio of frequencies.

Project 26:
*Name:* Diffraction of helical structures.

*Abstract:* In this project our main aim was to determine the parameters of helical structures. We had two sample mounts, one which was a small spring of size of the orders which would behave as a single helix of a few centimetres and the 2nd one was a double helical patch inscribed on a glass plate that resembled a double helix. We used red laser of wavelength 635 nm to study the diffraction phenomena of the two samples. The theory associated is that of double and n slit diffraction patterns and babinet's principle.

Project 27:
*Name:* Damping factor (air VS water)

*Abstract:* We have calculated the damping constant of air and water separately and taking their ratio we comparing it with the theoretical value which was found in literature.
PS: We even have compiled a code to generate normal modes of n-coupled oscillators and tried to plot them (anyways this is off the record).

Project 28:
*Name:* Fourier analysis and its applications
Abstract: The project explores the implementation of Fourier transform and inverse Fourier transform as a mathematical tool for analysis of signals, following an inquiry into the physical nature of its working. Apply Fourier transform two in real life scenarios: a) Decompose an audio signal into its component frequencies, delete any of the undesirable frequencies and then reconstruct back a new audio signal in which the undesirable frequencies are absent. b) Analyse the frequencies of vibrations of a washing machine (with changing mass) using Fourier analysis.

Project 29: Transmission of sound through Light

Abstract: Our objective was to design a simple communication system that uses light to transmit signals. Our transmitter end was equipped with a music source and a transducer that converts sound signals to a time varying voltage signal and thereby to light signals. The light signals were received in the receiver section through a photodiode. The received signal was then amplified and was realised as sound output in our loudspeaker, connected to the receiver circuit.
Financial Statement:

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<th>Fund:</th>
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<td>1. Opening balance:</td>
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<td>2. Bank interest:</td>
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<td>3. Activity grant:</td>
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<td><strong>Total:</strong></td>
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<table>
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<th>Expenditure:</th>
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<td>1. Introductory session refreshments:</td>
<td>2,500.00</td>
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<td>2. SPIE lecture series refreshments: (4x2500)</td>
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<td>3. PARADIGM - Cultivating Innovation:</td>
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<td>4. Science projects:</td>
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<tr>
<td><strong>Total:</strong></td>
<td><strong>52,500.00</strong></td>
</tr>
</tbody>
</table>

**Balance amount:** 1,18,536.78

Planned activities:

1. Visit to VECC or BITM, Kolkata for SPIE IISERK student members
2. Workshop on basics of photography in association with PIXEL, Photography club of IISERK
3. SPIE lecture series (throughout the year)
4. CoOpt-2019 (to be held in May 2019)
5. Paradigm 2019 (to be held in March 2019)
6. Sky gazing session for IISER students and nearby school students.

Acknowledgement:

The chapter is thankful to all its members for working whole heartedly and actively participating in its activities. We express our sincere gratitude to Meg All and Arleen Johansson for their undying support, whenever needed. We are also thankful to our faculty advisor Prof. Ayan Banerjee for his continuous support and the previous office bearers for their cooperation whenever needed. Last but not the least the chapter is thankful to its current office bearers who made all this possible.

Election:

The chapter had election for the next set of office bearers and the result is out. New office bearers are taking in-charge from January 2019. We, the outgoing office bearers wish them all the best.