

A training session report on
Material Characterization Techniques

Under STUTI program funded by DST



In association with
Indian Institute of Technology, Gandhinagar
(Project Management Unit)



Coordinated by

Prof. P.K. Bajpai

Department of Pure & Applied Physics,
Guru Ghasidas Vishwavidyalaya, Bilaspur
Chhattisgarh – 495009, India

1st to 7th November 2022

Acknowledgement

Firstly, Guru Ghasidas Vishwavidyalaya highly acknowledges the Department of Science and Technology (DST), Govt. of India for the STUTI program (Synergistic Training Program Utilizing the Scientific and Technological Infrastructure). We are also grateful to IIT Gandhinagar recognised as a Project Management Unit (PMU). The workshop was conducted on the instruments funded by DST-FIST Sanction No. SR/FST/CSI-264/2015 on the title '*Material Characterization Techniques*'. The workshop was coordinated by **Prof. P.K. Bajpai**. We enormously obliged to Honourable Vice-Chancellor **Prof. Alok Kumar Chakrawal** for the motivation and support during the 7-days workshop. We, vastly appreciate all the resource persons of GGV, Bilaspur for their enlightening lecture sessions and well-organized hand-on training sessions.

Also, we acknowledge all the supporting staff of the Guru Ghasidas Vishwavidyalaya office for their valuable contributions without which the training workshop could not have been possible.

Prof. P.K. Bajpai

Coordinator

Summary

The goal of this training session is to popularize material characterization Techniques among students, faculty, scientists and industry professionals through a week-long training workshop. The workshop was conducted at Guru Ghasidas Vishwavidyalaya (A Central University), Bilaspur, Chhattisgarh from 01st Nov to 7th Nov, 2022 and comprised of lectures and hands on training sessions. This initiative is funded by Department of Science & Technology under the program **STUTI** (*Synergistic Training Program Utilizing the Scientific and Technological Infrastructure*). Through this workshop the participants were introduced basic principles and various techniques of material characterization techniques i.e., X-ray diffraction, Photoluminescence, FT-IR, UV-Visible spectroscopy, Differential scanning calorimetry and basic of Computational physics including density functional theory. The focus of this workshop was to have “*a balance between theory and practical training on the equipment. Emphasis is on hands-on use of equipment for demonstration/characterization by each participant and analysis of participant’s samples*”.

Introduction

The Guru Ghasidas Vishwavidyalaya (A Central University), Bilaspur, Chhattisgarh commenced a week-long training session on the instruments supported by DST under FIST program on “*Material Characterization Techniques*” in its campus from 1st to 7th November, 2022. More than 30 faculty members, postdoctoral researchers, and doctoral students from all over India have participated in this training workshop (**Annex-1**). The event is funded by the Department of Science and Technology (DST), under STUTI program (Synergistic Training Program Utilizing the Scientific and Technological Infrastructure), in which IIT Gandhinagar is identified as a Project Management Unit (PMU). Detailed characterization of various samples and operation of instruments has demonstrated to create awareness among the participants (**Annex-2 & 3**). This report provides a quick overview of both the lecture and technical sessions.

- Lecture Session

Vice-Chancellor of Guru Ghasi Das Vishwavidyalaya, **Prof. Alok Kumar Chakrawal** gave a speech about the significance of such workshop from perspective of research and growth. He acknowledged and welcomed all the participants for their enthusiastic interest in research disciplines and recommended them to indulge in learning of various sophisticated instruments of the university. **Dr. Pradip das** (Department of Pure and applied physics, GGV, Bilaspur) delivered lecture on X-Ray Diffraction in Material Analysis explaining the fundamentals of X-ray. He also gave an overview on historical background of the X-ray Diffraction, X-Ray radiography and X-ray fluorescence spectrometry. **Prof. P. K. Bajpai** (Department of Pure and applied physics, GGV, Bilaspur) gave an expert talk on *Raman spectroscopy for beginners*. He also gave an overview on advantages and disadvantages of IR spectroscopy and Raman spectroscopy. **Dr. S. Banerjee** (Department of Chemistry, GGV, Bilaspur) gave a motivational lecture on microwave and green synthesis by encouraging student for green synthesis that will promote the reduction of harmful effects to earth. **Dr. Jai Singh** (Department of Pure and applied physics, GGV, Bilaspur), gave an expert talk on *UV-Vis Spectroscopy* and explained briefly the principle and importance of experimental aspects. He provided various illustrations on absorption, red, blue shift of light, bandgap determination etc, followed by a technical discussion

with participants. In another lecture, he gave an overview on *Imaging of Materials by SEM*, which added explanation on the basics of microscopy followed by Electron Microscopy especially SEM and TEM. **Prof. Charu Arora** (Department of Chemistry, GGV, Bilaspur) provided an interactive session on *Thermal Method of Analysis*. She also explained briefly about the working model of DTA, TGA and DSC along with the parameters that is used in experimental setup and their impact on the data end to end from the advantages to disadvantages. **Prof. G. K. Patra** (Department of Chemistry, GGV, Bilaspur) gave a lecture on *Cyclic Voltammetry- Basic Instrumentation and Analytical Application* which includes an overview on non- conventional energy and generation of hydrogen energy from the water. **Dr. Govardhan R. Turpu** (Department of Pure and applied physics, GGV, Bilaspur) gave a lecture on *FTIR: Theory, Instrumentation and Application*, which includes fundamentals of EMR and importance of Mid IR in organic chemistry. **Prof. M. N. Tripathi** (Department of Pure and Applied Physics, GGV, Bilaspur), gave a lecture on *Hartree-Fock & Density Functional Theory: Fundamentals and Applications*, which provided an overview to the participants on the aspects of fundamentals of computation as a tool in all branches of physics, such as, high energy physics, astronomy, cosmology, condensed matter physics, biophysics, material physics. **Dr. R. P. Patel** (Department of Pure and Applied Physics, GGV, Bilaspur) presented a lecture on *Photoluminescence Spectroscopy*. He illustrated distinction between spectroscopy and spectrum, as well as the differences between absorption and emission spectroscopy. **Dr. S. P. Patel** (Department of Pure and applied physics, GGV, Bilaspur), gave a lecture on *Characterization of material using ion beam*, which included principles of different accelerators used in ion beams.

- Technical Session

Day **One** hands-on session, started with a demonstration for the Rietveld refinement was given by the research scholar **Mr. Sanand Kumar Pradhan** student of **Dr. Pradip Das**. The refinement process including making DAT file, CIF file was well explained and usage of Origin Software for data smoothening was also discussed. This session included characterization and examination of in-house prepared samples. Day **two** session included, demonstration of Raman instrument by **Ms. Vidhi** and **Ms. Neha** (Department of Pure and applied physics, GGV, Bilaspur). In this session hands-on training was provide to all the participants on the operation of instrument and software of metal oxide sample. Day **three** session included, interaction by **R. K. Pandey** (Department of Pure and applied physics, GGV, Bilaspur) where he provided an overview and hands-on training on UV-Vis Spectroscopy setup with research scholar **Neha** and showed examples on *Application of UV-Vis is based on our intelligence*, which intrigued all the participants. **Dr. Sandhya Yadav** (Department of Pure and applied physics, GGV, Bilaspur), gave an overview as well as hands-on training on DSC-TGA setup. Day **four** lab session includes demonstration of *Cyclic Voltammetry* instrument and hands on training was given by **Dr. Uday Pratap Azad** (Department of Chemistry, GGV, Bilaspur) to all the participants. On the same day, **Dr. Bijnaneswar Mondal** (Department of Chemistry, GGV, Bilaspur), showed demonstration on *Fourier transform infrared* (FT-IR) instrument and hands on training to all the participants. He gave a detailed knowledge of instrument and software used in FTIR also including sampling. On the day **Five**, all the participants were taken to a short tour to *Ratanpur* and *Khuta ghat Dam* situated in Bilaspur. Further on the same day, a networksing dinner was organized by the program coordinator in presence of Vice-Chancellor **Prof. Alok Kumar Chakrawal** at international guest house, GGV, Bilaspur. Day **Six** includes a session on *DFT programming* system that was introduced by **Mr. P. Rambabu and Mr. Bareth** (Department of Pure and applied physics, GGV, Bilaspur). In this lab session DFT Codes such as full potential and Pseudo potential codes used in VASP Software were explained in detail with examples. On the same day, hands-on training in photoluminescence spectroscopy was shown by **Dr. Arti Shrivastava and Dr. A. K. Singh** (Department of Chemistry, GGV, Bilaspur).

Day **seven** session held with a presentation by two participants namely **Vijay Prajapati** and **Sai Sikha Naidu** on *Nanotechnology* (CNT) and *Nitriding* respectively. Further, the function was

continued with a *Valedictory Function*, where all the participants were given a certificates by **Prof. Alok Kumar Chakrawal** (Honorable Vice chancellor, GGV) and program coordinator

- *Types of samples tested*

During the hand-on experiments of various instruments, more than 20 different samples were studied. On X-ray Diffractometer, several metal-based perovskites materials are examined. On Raman spectroscopy, many metal oxide samples were tested. For the Microwave instrument analysis, several organic samples were carried out using two different ionic liquid media. Later, for the measurement using UV-Vis Spectrophotometer, various organic fluorescent compounds were studied. Also, for DSC-TGA measurement, several hydrated metal complexes are investigated. Similarly, few cationic polymers were also used for “Cyclic Voltammetry” instrument. Likewise, some organic heterocyclic compounds were examined for FT-IR measurement. Furthermore, the hands-on training session of photoluminescence Spectrophotometer was carried out on various metal coordination complexes.

Outcomes of the Workshop

The workshop attracted 61% male and 39% female participants from 24 different institutes (**Figure 1**). About 31 participants were allowed for this training session. The goal of this training event was to bring together participant from many disciplines and raise awareness of the institute's advanced facilities. Throughout the session participants asked major questions regarding theoretical and practical aspects of X-ray Diffractometer, Raman spectroscopy, Microwave instrument analysis, UV-Vis Spectrophotometer, DSC-TGA measurement, FT-IR measurement. The expert gave suggestions for possible solutions and invited participants to future collaborations. Finally, the feedback (**Annex-4**) from the participant was considered in the valuation of the workshop. The major the majority of the participants were pleased with the training session and suggested that more workshops to be held in the future. Few participants suggested organizing such a workshop training session on more advanced characterization techniques.



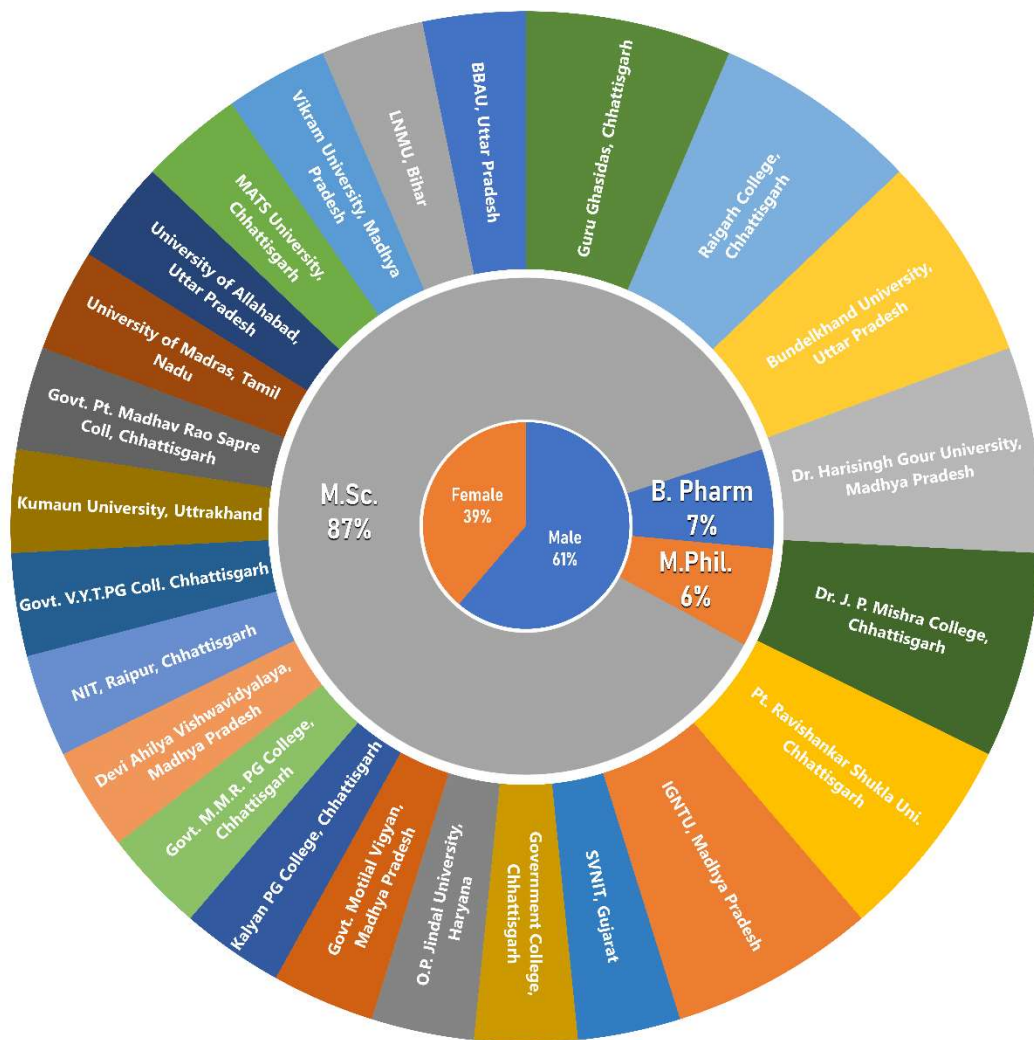


Figure 1. Participants registered workshop from different institutes.

Annexure 1: Brochure for the program

Chief Patron

 Prof. Alok Kumar Chakrawal
 Vice-Chancellor, GGV, Bilaspur

Patron

 Prof. Manish Shrivastava
 Registrar, GGV, Bilaspur

Coordinator

 Prof. P.K. Bajpai
 Dean, School of Physical Sciences

Speakers

- Prof. P.K. Bajpai, Professor, Department of Pure & Applied Physics, GGV, Bilaspur.
- Prof. G.K. Patra, Professor, Chemistry Department at GGV Bilaspur.
- Prof. H. S.Tewari, Professor, Department of Pure & Applied Physics, GGV, Bilaspur.
- Prof. M.N. Tripathi, Professor, Department of Pure & Applied Physics, GGV, Bilaspur.
- Dr. R. P. Patel, Associate Professor, Department of Pure & Applied Physics, GGV, Bilaspur.
- Dr. Jal Singh, Associate Professor, Department of Pure & Applied Physics, GGV, Bilaspur.
- Dr. R. K. Pandey, Assistant Professor, Department of Pure & Applied Physics, GGV, Bilaspur.
- Dr. M. P. Sharma, Assistant Professor, Department of Pure & Applied Physics, GGV, Bilaspur.
- Dr. G. R. Turpu, Assistant Professor, Department of Pure & Applied Physics, GGV, Bilaspur.
- Dr. Subhash Banerjee, Assistant Professor, Chemistry, GGV, Bilaspur.
- Dr. Pradip Das, Assistant Professor, Department of Pure & Applied Physics, GGV, Bilaspur.
- Dr. S. P. Patel, Assistant Professor, Department of Pure & Applied Physics, GGV, Bilaspur.
- Mr. P. Rambabu, Assistant Professor, Department of Pure & Applied Physics, GGV, Bilaspur.
- Dr. B. Mondal, Assistant Professor in Chemistry, GGV, Bilaspur.

Technical Committee

- Prof. P. Thakur, Professor- Chairman
- Dr. A.K. Singh, Associate Professor- Member
- Dr. Dinesh Uthra, Assistant Professor- Member
- Dr. Alka Singh, Assistant Professor- Member
- Dr. Shalini Tigga, Assistant Professor- Member
- Dr. Vijaya Kumar, Assistant Professor – Member
- Dr. Sandhya Yadav, Assistant Professor – Member
- Dr. Bivash Dolai, Assistant Professor – Member
- Dr. Faruk Abdullah, Assistant Professor -Member
- Dr. A. Bhattacharya, Assistant Professor – Member
- Mr. D.P. Sarwanah, Assistant Professor – Member
- Mr. Ravindra Kumar, Assistant Professor – Member

Registration & Contact Details
 Interested participants must register and only selected candidates would be invited for the workshop.

For selected candidates Registration fees, local travel, Boarding and lodging will be covered by GGV, Bilaspur.
 Interested participants should register using the following link: <https://forms.gle/cMAN7Ryd55zWLy1M7>

Registration Deadline: 20 October 2022

Shortlisted candidates will be intimated by email, latest by 22nd October 2022.

Eligibility criteria:

(a) Minimum qualification: Post Graduate (Science) or B.Tech. (Technology)
 (b) Professors/Scientists/Post-Doc Fellows/Ph.D. Fellows/ Industry persons who are actively involved in R&D
 (c) Not more than 2 participants from one institute

For more information:
 Coordinator: Prof. P.K. Bajpai
 Mail: bajpai.pk1@ggv.ac.in

Department of Science & Technology (DST) funded

Training workshop under STUTI (Synergistic Training Program Utilizing the Scientific and Technological Infrastructure)



7Days Workshop on Material Characterization Techniques
 1st November to 7th November 2022
 Department of Pure & Applied Physics, GGV, Bilaspur, Chhattisgarh

Acknowledgements



Contents of the workshop

Day 1 - Session I & II

- Inauguration and Welcome note
- Introduction of the Participants and the Host
- Basic introduction to XRD techniques
- Hands on: powder diffraction

Day 2 - Session I & II

- Photoluminescence spectroscopy
- Hands on: Photoluminescence spectra
- Lab visit

Day 3 - Session I & II

- UV-Visible spectroscopy
- Applications of UV – Visible Spectroscopy in Chemistry and Nano technology
- Hands On : UV – Visible spectroscopy

Day 4 - Session I & II

- Differential Scanning Calorimetry
- Hand on: FTIR
- Hands on: DSC

Day 5 - Session I & II

- Density functional theory: Basics and Calculations
- Hands on: Familiarization with server and software

Day 6 - Session I & II

- FTIR spectroscopy
- Hands on: FTIR

Day 7 - Session

- Interactive and Problem-solving session

Overview of STUTI and Objectives of Workshop

DST welcomes all the participants for the workshop on material characterization Techniques organised under STUTI. The STUTI program envisions hands-on-training and sensitization of the state-of-the-art equipment as well as towards sharing while ensuring transparent access to S&T facilities. Department of Science and Technology has identified IIT-Gandhinagar to function as a Project Management Unit (PMU) and as co-ordinator for this workshop.

This workshop is aimed to provide an insight into the basic principles and various techniques of material characterization techniques i.e., X-ray diffraction, Photoluminescence, FTIR, UV-Visible spectroscopy, Differential scanning calorimetry and basic of Computational physics including density functional theory. The participants will be introduced to the basic concepts of these techniques and insights into the analysis of the data, troubleshooting and the advanced modes of operation. The participants will be provided with hands on experience on the operation of the instrument and will have a chance to interact with subject experts and analyse their own samples (with prior approval).

Schedule

Day 1	Day 2	Day 3
08:30 Registration	09:00 Session I	09:00 Session I
09:00 Inaugural Session	11:00 Break	11:00 Tea Break
10:45 Tea Break	11:30 Expert Talk	11:30 Expert Talk
11:00 Session I	12:30 Lunch	12:30 Lunch
12:30 Lunch	14:00 Session II (Hands on)	14:00 Session IIA
14:00 Session II (Hands on)	15:30 Tea Break	15:30 Tea Break
15:30 Tea Break	16:00 Campus Visit	16:00 Session IIB
16:00 Campus Visit		17:00 Discuss

Day 4	Day 5	Day 6	Day 7
09:00 Session I	09:00 Session I	09:00 Session I	09:00 Interactive session
11:00 Tea Break	11:00 Tea Break	11:00 Tea Break	11:15 Tea Break
11:30 Expert Talk	11:30 Expert Talk	11:30 Expert Talk	11:30 Closing remarks
12:30 Lunch	12:30 Lunch	12:30 Lunch	
14:00 Session IIA	14:00 Session IIA	14:00 Session IIA	
15:30 Tea Break	15:30 Tea Break	15:30 Tea Break	
16:00 Session IIB	16:00 Session IIB	16:00 Session IIB	
17:00 Discussion	17:00 Discussion	17:00 Discussion	

Networking Dinner on Day 6

Sessions IIA & IIB will be Hands on training

Annexure 2: List of registered participants for the workshop

Sr. No.	Candidate Name	Gender	Educational Qualification	Email address	University/Institute
1	Chandrakant	Male	M.Sc. (Physics)	cksharma4050@gmail.com	Babasaheb Bhimrao Ambedkar University, Uttar Pradesh
2	Priya Barik	Female	M.Sc. (Physics)	priyab298@gmail.com	Indira Gandhi National Tribal University Amarkantak, Madhya Pradesh
3	Khrsheed Ahmed	Male	M.Sc. (Physics)	khursheedkohli@gmail.com	
4	Rohit Kumar	Male	M.Sc. (Physics)	rkroy190@gmail.com	Lalit Narayan Mithila University, Bihar
5	Anita Verma	Female	M.Sc. (Physics)	anitaverma999@gmail.com	Pt. Ravishankar Shukla University Raipur, Chhattisgarh
6	Suleman	Male	M.Sc. (Physics)	slmnkjr7771@gmail.com	
7	Sai Shikha Naidu	Male	M.Sc. (Physics)	saishikhanaidu@gmail.com	Vikram University, Madhya Pradesh
8	Jyotsana Mishra	Female	M.Phil (Biotechnology)	jjyotsna07mishra@gmail.com	MATS University Raipur, Chhattisgarh
9	Vijay Prajapati	Male	M.Sc. (Physics)	vijayprajapati.phd2021@allduniv.ac.in	University of Allahabad, Uttar Pradesh
10	Ajith Kumar	Male	M.Sc. (Physics)	ajith6986@gmail.com	University of Madras, Tamil Nadu
11	Sangeeta Kanwar	Female	M.Sc. (Physics)	sangeetakanwar26@gmail.com	Government Pt. Madhav Rao Sapre College, Chhattisgarh
12	Rakesh Chandra Joshi	Male	M.Sc. (Physics)	rakeshjoshi941151@gmail.com	Kumaun University, Nainital, Uttrakhand
13	Ratnakar Upadhyay	Male	M.Sc. (Botany)	thegreatratnakar72493@gmail.com	Government V.Y.T. PG Autonomous College, Chhattisgarh
14	Munita Rajpoot	Female	M.Sc. (Physics)	munitarajput62434@gmail.com	Dr. J. P. Mishra Govt. Science College Mungeli, Chhattisgarh
15	Narottam Kumar Purlay	Male	M.Phil (Physics)	nkpurlay13@gmail.com	
16	Priya Chandra	Female	M.Sc. (Physics)	chandrapriya31051998@gmail.com	National Institute of Technology (NIT) Raipur, Chhattisgarh
17	Rahul Tiwari	Male	M.Sc. (Physics)	rahultiwaringbu@gmail.com	Devi Ahilya Vishwavidyalaya, Indore, Madhya Pradesh
18	Anjali Mehto	Female	M.Sc. (Physics)	anjalimehto12@gmail.com	Dr. Harisingh Gour University Sagar, Madhya Pradesh
19	Monika	Female	M.Sc. (Physics)	monikapoddar906@gmail.com	
20	Kamta Prasad	Male	M.Sc. (Physics)	Kamtakushwaha1999@gmail.com	Bundelkhand University, Jhansi, Uttar Pradesh
21	Yogendra Rajpoot	Male	M.Sc. (Physics)	yogendrarajpoot1355619@gmail.com	
22	Gourango Mukharjee	Male	B. Pharm	gmukharjee9007@gmail.com	Raigarh College of Pharmacy, Chhattisgarh
23	Rudra Pratap Singh	Male	B.Pharm	rudra.211099@gmail.com	
24	Janardan Pratap Singh Rathore	Male	M.Sc. (Physics)	janardanrathore301@gmail.com	Government M.M.R. PG College Champa, Chhattisgarh
25	Bharti	Female	M.Sc. (Physics)	bhartichandrakar97@gmail.com	Kalyan Post Graduate College Bhilai, Chhattisgarh
26	Kuldeep Lodhi	Male	M.Sc.(Chemistry)	lodhikuldeep84@gmail.com	Government Motilal Vigyan Mahavidyalaya, Bhopal, Madhya Pradesh
27	Kiran Thakur	Male	M.Sc. (Physics)	iiamkiransingh@gmail.com	O.P. Jindal Global University, Haryana
28	Ajita Rajkumari Tigga	Female	M.Sc.(Chemistry)	ajitatigga11@gmail.com	Government College Sakri Bilaspur, Chhattisgarh
29	Bhagyesh Parmar	Male	M.Sc.(Chemistry)	bhagyeshparmar1234@gmail.com	Sardar Vallabhbhai National Institute of Technology, Surat, Gujarat
30	Neha	Female	M.Sc. (Physics)	neha87538@gmail.com	Guru Ghasidas Vishwavidyalaya, Bilaspur, Chhattisgarh
31	Pragati Sahu	Female	M.Sc. (Physics)	sonampg22396@gmail.com	

Annexure 3: Schedule date and activities during the workshop

	Day 1		Day 2
1st November 2022	08:30 Registration 09:00 Inaugural Session 10:45 Tea Break 11:00 Session I 12:30 Lunch 14:00 Session II (Hands on) 15:30 Tea Break 16:00 Campus Visit	2nd November 2022	09:00 Session I 11:00 Break 11:30 Expert Talk 12:30 Lunch 14:00 Session II (Hands on) 15:30 Tea Break 16:00 Lab visit
	Day 3		Day 4
3rd November 2022	09:00 Session I 11:00 Tea Break 11:30 Expert Talk 12:30 Lunch 14:00 Session IIA 15:30 Tea Break 16:00 Session IIB 17:00 Discussion	4th November 2022	09:00 Session I 11:00 Tea Break 11:30 Expert Talk 12:30 Lunch 14:00 Session IIA 15:30 Tea Break 16:00 Session IIB 17:00 Discussion
	Day 5		Day 6
5th November 2022	09:00 Session I 11:00 Tea Break 11:30 Expert Talk 12:30 Lunch 14:00 Session IIA 15:30 Tea Break 16:00 Session IIB 17:00 Discussion	6th November 2022	09:00 Session I 11:00 Tea Break 11:30 Expert Talk 12:30 Lunch 14:00 Session IIA 15:30 Tea Break 16:00 Session IIB 17:00 Discussion
	Day 7		
7th November 2022	9:00 Interactive session 11:15 Tea Break 11.30 Closing remarks		

Sessions IIA & IIB will be Hands on training

Annexure 4: Feedback summary

Sr. No	Content	% Rating
1	Overall grading of the program with reference to relevance of course, module/ content etc.	76% Rated on or above 8 points
2	Overall grading of the facilities provided by the institute, i.e., Hostel, Mess, Classrooms, Transport/infrastructure etc.	64% Rated on or above 8 points
3	Overall grading of the faculty members conducting the training	84% Rated on or above 8 points
4	How do you rate the overall training methodology	76% Rated on or above 8 points
5	How far the field visit is relevant and related to your research study	68% Rated on or above 8 points
6	Usefulness of this training in your current role	80% Rated on or above 8 points
7	Usefulness of this training in future work/job you may handle	84% Rated on or above 8 points
8	How far have you benefitted from interaction with the fellow participants of the training	68% Rated on or above 8 points
9	How far the course material supplied relevant and related to the training curriculum	72% Rated on or above 8 points
10	Overall grading of the process of training	80% Rated on or above 8 points
11	Your recommendation to your peers/ colleagues for the training Program	92% Rated on or above 8 points