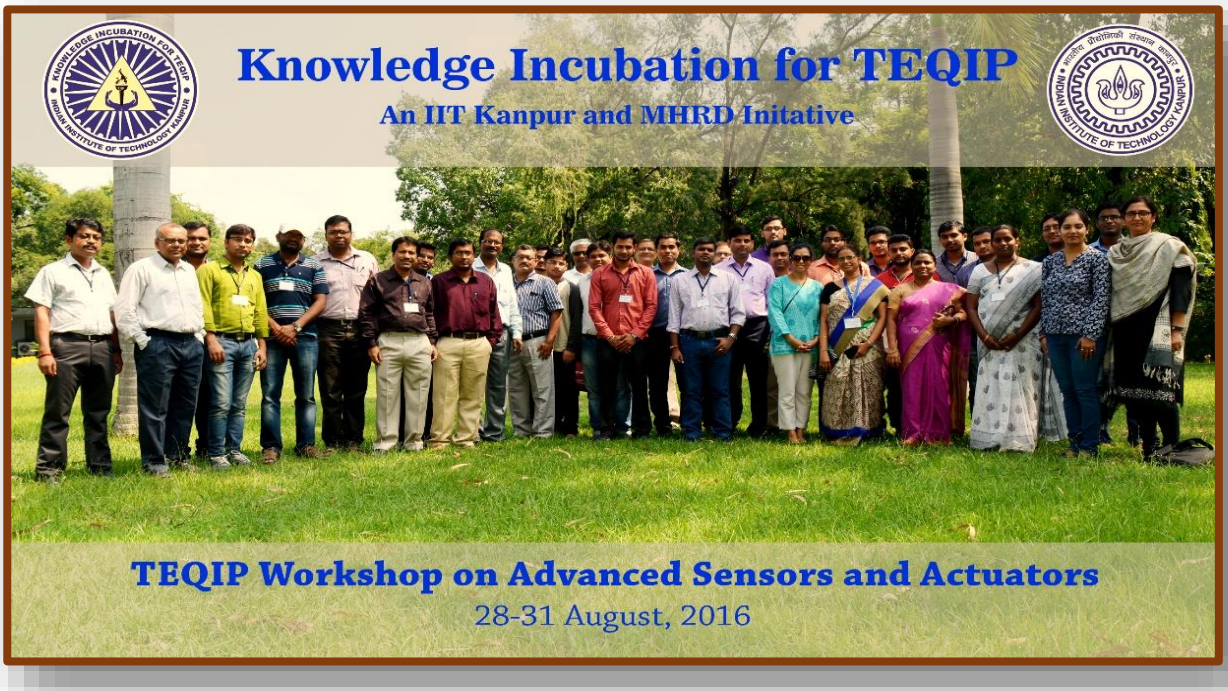
KNOWLEDGE INCUBATION FOR TEQIP, IIT KANPUR

TEQIP Workshop on Advanced Sensors and Actuators

August 28 - 31, 2016



Sensors and actuators are key components of any automation system. Almost each industry sector, such as: aeronautical, automobile, electronics, medical sciences, food sciences, transportation, and many other, will require (at some stage) the usage of sensors and actuators to automate, manage and/or regulate the process in hand. Automation certainly enhances the quality, quantity and throughput of the product and hence augments the nation's economic growth. To achieve the goal of 'Digital India' knowledge and use of sensors and actuators is crucial. Keeping this in mind KIT, IIT Kanpur in association with Centre for Mechatronics, IITK organized a 4 day workshop on "Advanced Sensors and Actuators" to make teachers/researchers aware of theoretical and practical aspects of sensors and actuators together with the associated technologies in practice. The workshop comprised of the essential theory with hands on experiments by the experts from academic institutions and industries. Eminent researchers in the areas of Aeronautical, Computer Science, Mechanical Engineering, Electrical and Electronics, Physics, and Medical Sciences, etc. from across the country delivered the lectures.

TOPICS DISCUSSED

- Sensors technology in Healthcare
- Introduction to Sensors, Actuators and Applications
- Miniaturized Evanescent Mode Microwave / RF cavity resonators for Sensor Applications.
- Sensors and Actuators Interfacing with MATLAB, Lab VIEW, & Arduino (at Centre for Mechatronics)
- Smart Sensors and Actuators
- Smart IPMC
- Embedded System
- Sensors and Actuators in Manufacturing, CNC and CMM
- Manufacturing Science Lab visit
- Solar Systems
- Automobile Industry Sensors and Actuators
- Zinc Oxide nanostructures and its utility in sensing of gases
- Sensor Applications in Unmanned Aerial Systems
- Bio-MEMS Lab visit
- Solar Energy Research Enclave visit
- Demo on Sensors used in mini helicopter (at IITK airstrip)
- Acoustic Sensors and Actuators
- BOSCH Automotive Sensors
- Cameras for appearance and shape measurement

LIST OF SPEAKERS

- Dr. Anant Mehrotra, Assistant Professor, Department of Neurosurgery, Sanjay Gandhi Post Graduate Institute of Medical Sciences
- Dr. Arun Srivastava, Associate Professor,
  Department of Neurosurgery, Sanjay Gandhi Post Graduate Institute of Medical Sciences
- Dr Anita Murugkar, Associate Professor
  Dr. Babasaheb Ambedkar Marathwada University,

Aurangabad, MS

- Dr. R.K.Jain, Principal Scientist, SIR- CMERI, Durgapur, WB
- Mr. Kapil Dongre, Tata Motors
- Mr. Arvind, Assistant Manager, Bosch
- Dr. J. Ramkumar, Department of Mechanical Engineering
  IIT Kanpur
- Dr. Bishakh Bhattacharya, Department of Mechanical Engineering, IIT Kanpur
- Dr. Shantanu Bhattacharya, Department of Mechanical Engineering, IIT Kanpur
- Dr. Nachiketa Tiwari, Department of Mechanical Engineering,
  IIT Kanpur
- Dr. Ashish Dutta, Department of Mechanical Engineering
  IIT Kanpur
- Dr. Sandeep Shukla, Department of CSE, IIT Kanpur
- Dr. K S Venkatesh, Department of Electrical Engineering
  IIT Kanpur
- Dr. Parthasarathi Sensarma, Department of Electrical Engineering,
  IIT Kanpur
- Dr. Abhishek, Department of Aerospace Engineering
  IIT Kanpur

Workshop Organizers:

- **Dr. Ashish Dutta**
  Professor,
  Dept. of Mechanical Engineering, IIT Kanpur

- **Dr. Anjali Vishwas Kulkarni**
  Principal Research Engineer,
  Center for Mechatronics, IIT Kanpur

PARTICIPATING INSTITUTES

Institute	Number of Participants
IET, Lucknow	1
HBTI, Kanpur	1
KNIT Sultanpur	4
VNIT Nagpur	4
Dr. B A Technological University, Lonere	7
MMMUT Gorkhpur	3
AMU Aligrarh	3
NIT Jalandhar	1
National Institute of Technology, Tiruchirappalli	2
Jadavpur University, Kolkata	2
NIT Raipur	3
Government Engineering College, Ajmer	2
College of Engg. Kidandoor Kerala	1
RCC Institute Of Information Technology, Kolkata	3
IFTM Moradabad	1
SVNIT, Surat, Gujarat	1
G J University of Science and Technology, Hisar,	2
NIT Kurukshetra	1
Total	**42**

WORKSHOP SCHEDULE

August 28, 2016

Time	Event
8: 30 AM -9:00 AM	**Registrations**
9:00 AM – 10:00 AM	**Inauguration and Opening Lecture on Sensors technology in Healthcare** *Dr. Anant Mehrotra and Dr. Arun Srivastava*
10:00 AM – 10:30 AM	**Tea break**
10:30 AM – 11:50 AM	**Introduction to Sensors, Actuators and Applications** *Dr. A. Dutta*
11:50 AM – 12 noon	**Break**
12:00 PM – 1:20 PM	**Miniaturized Evanescent Mode Microwave / RF cavity resonators for Sensor Applications.** *Dr. Anita Murugkar*
1:20 PM – 3:00 PM	**Lunch Break**
3:00 PM – 4:00 PM	**Sensors and Actuators Interfacing with MATLAB, LabVIEW, & Arduino** *Dr. Anjali Kulkarni and Dr. A. Dutta* ***At Centre for Mechatronics***
4:00 PM – 4:15 PM	**Tea break**
4:15 PM – 5:30 PM	**Lab Session Continued**

August 29, 2016

Time	Event
9:00 AM – 10:00 AM	**Smart Sensors and Actuators , SMA** *Dr. Bishakh Bhattacharya*
10:00 AM – 10:30 AM	**Tea break**
10:30 AM – 11:50 AM	**Smart IPMC** *Dr. R.K. Jain*
11:50 AM – 12 noon	**Break**
12:00 PM – 1:20 PM	**Embedded System** *Dr. Sandeep Shukla*
1:20 PM – 3:00 PM	**Lunch Break**
3:00 PM – 4:00 PM	**Sensors and Actuators in Manufacturing, CNC and CMM** *Dr. J. Ramkumar*
4:00 PM – 4:15 PM	**Tea break**
4:15 PM – 5:30 PM	**Lab visit to Manufacturing Science Lab**
8:00 PM	**Workshop Dinner at PBCEC lawn**

August 30, 2016

Time	Event
9:00 AM – 10:00 AM	**Solar Systems** *Dr. P. Sensarma*
10:00 AM – 10:30 AM	**Tea break**
10:30 AM – 11:50 AM	**Automobile Industry Sensors and Actuators** *Mr. Kapil Dongre*
11:50 AM – 12 noon	**Break**

12:00 PM – 1:20 PM	**Zinc Oxide nanostructures and its utility in sensing of gases** *Dr. Shantanu Bhattacharya*
1:20 PM – 3:00 PM	**Lunch Break**
3:00 PM – 4:00 PM	**Sensor Applications in Unmanned Aerial Systems** *Dr. Abhishek*
	Bio-MEMS Lab Visit *Dr. Shantanu Bhattacharya*
4:00 PM – 4:15 PM	**Tea break**
4:15 PM – 5:30 PM	**Lab visit to Bio-MEMS Lab continued** **Solar Energy Research Enclave visit**

August 31, 2016

Time	Event
9:00 AM – 10:00 AM	**Demo on Sensors used in mini helicopter at IIT Kanpur Airstrip** *Dr. Abhishek*
10:00 AM – 10:30 AM	**Tea break**
10:30 AM – 11:50 AM	**Acoustic Sensors and Actuators** *Dr. Nachiketa Tiwari*
11:50 AM – 12 noon	**Break**
12:00 PM – 1:20 PM	**BOSCH Automotive Sensors** *Mr. Arvind*
1:20 PM – 3:00 PM	**Lunch Break**
3:00 PM – 4:00 PM	**Cameras for appearance and shape measurement** *Dr. K. S. Venkatesh*
4:00 PM – 4:15 PM	**Tea break**
4:15 PM – 5:30 PM	**Valedictory Function**

SUMMARY of FACULTY FEEDBACK

Workshop

Questions	*Excellent*	*Good*	*Ordinary*
Clarity of communication about workshop	12	03	00
Organization of the sessions	14	01	00
Quality of lectures	10	05	00
Quality of posters	05	09	01
Effectiveness of discussions	02	02	01
Effectiveness of learning experience	05	10	00
	Appropriate	***Short***	***long***
Duration of workshop	14	01	00
	Definitely	***Maybe***	***No***
Would you like to have more such	15	00	00
Would you like e-lectures by experts on	13	00	00
Suggest specific topic that you would like additional expert lectures on	• Challenges in fabrication of advanced sensors • Sensors used in biomedical applications & their real time implementation • Embedded systems • Big data, object oriented systems, natural language processors. • Biomechanics vibration. • Arrange the lectures on networking CS/IT researches, could computing and new inventions in computer science, also on new researches in IT. • I am from CSE background. If you conduct an expert lecture on cloud computing it will be good for CSE member. • Lectures related to “robotic manipulation” like-serial parallel manipulation. • Sprig back analysis of work hardening material for non-linear • Lectures on robotic machining • Cloud chip computing, Natural language processing (NLP) • Related to computer science dept • Lectures that help for a computer engg. student on software • Big data, data mining with big data		

Additional Suggestions	• Increase the time duration of lab session for more practical knowledge. • Focus should be on research advancements in technology • The workshop is well arranged but on the first day of workshop provide some study material related to workshop topic • I think there will not be any extra thing needed. All the arrangement is excellent with time management • Expand the duration of workshop. • Practical lab must be improve • Workshop should conducted for computer science.

Teaching

Which subjects do you teach?	• Digital electronics, microprocessors, biomedical, biomedical instrumentation • Sensors & remote control • Analog electronics, digital electronics communications, measurements & instrumentation engg., microprocessors • Principles of compiler design • Design analysis & algorithm • Software architecture. • C programming, software testing lab • Fundamental programming languages • CP, DBMS • On software languages M.Tech 2nd year student	
What is average student to teacher ratio in your institute?	• 30:01 • 15:01 • 40:01	
Questions	***YES***	***NO***
Do you have additional support for teaching (tutors, graders, teaching Assistants, etc.)?	07	02
Do you give class projects for UG classes?	07	01

Do you give class projects for PG classes?	03	03
Do you have sufficient resources for laboratory courses?	08	01
	Sufficient	***Inadequate***
Is the library/journal/e-connection support adequate?	07	01

	Definitely	***May* be**	***No***
Would you like to have common (TEQIP) repository of course material?	09	00	00
Would you like to visit IITK to participate in and develop course	09	01	00
Would you like to participate in creation of the repository material (course	07	02	00

	e-courses	***Workshops***	***Content***	***none***
How can IITK effectively help you	08	09	02	00

How can TEQIP help improve your teaching?	• All of the workshops organized under TEQIP if the materials are available online and accessible by all. • By organizing more workshops & seminars on recent advances in technology & science. • By organizing and effectively importing workshops and knowledge there of obtained on recent advances in technology science. • By arranging such workshop and the faculty improvement program. • To organize the different types of workshops (computer networking) • By taking more workshop

Research

Questions	***Definitely***	***Maybe***	***No***
Would you like to visit an IIT for a visiting-faculty/ post-doctoral fellow, if offered (via TEQIP)?	15	00	00
Would you like to share/use research infra-structure at IITK, if made available?	13	02	00
Would you like to conduct collaborative research with IITK?	10	05	00
Would you like lectures by experts (Indian and international) on niche research	12	03	00
Do you want special-topic conferences?	13	02	00

How can TEQIP help improve your research?	• Procurement of instruments for research and development. Joint collaboration in common research interest can also beneficial. • May be a joint collaboration in common research interact and knowledge enhancing sessions. • We may benefit from joint collaborative efforts with IITK on research & knowledge exchanging. • By providing fund when needed for project • TEQIP provides the fund for improvement in laboratories and advance workshops which is under TEQIP • By providing the sponsorship for project and promote to do research in any field/area. • TEQIP provides us to interact with experts which help me a lot on my research • TEQIP provide to communicate with expert to help my research work • TEQIP provides us to interact with experts which help me a lot on my research • To organize real time operating topic workshops. • By making more workshop on domain of project. • Providing platform to work on research work, with expert guidance in area of data mining for big data

SUMMARY OF STUDENT FEEDBACK

Workshop

Questions	*Excellent*	*Good*	*Ordinary*
Clarity of communication about workshop	12	07	00
Organization of the sessions	10	09	00
Quality of lectures	09	10	00
Quality of posters	07	10	00
Effectiveness of discussions	07	02	00
Effectiveness of learning experience	10	09	00
	Appropriate	***Short***	***Long***
Duration of workshop	16	02	00
	Definitely	***Maybe***	***No***
Would you like to have more such sessions?	16	02	01
Would you like e-lectures by experts on special topics?	16	02	01
Suggest specific topic that you would like additional expert lectures on	• Sensor in space • Bio Sensors • Production line sensors • Sensors used in wireless networks • Biomedical and agriculture sensors & their uses. • Computing and programming platforms used in various domain of mechanical engg. • Vision sensors and challenges in it. • Industrial Automation. • Advanced statistical techniques & their applications. • Image processing & programming • Signal conditioning of sensors & actuators. • Industrial robot actuators and sensors • Mathematical explanation fiber optic sensors • Health care/ rehabilitation robotics/ challenges. • Assembly language programming for micro controllers especially for ARM • Biomedical and economics sensors		

Additional Suggestions	• Also show the students project so other college student will take knowledge. • Duration of lunch break can be reduced and an additional lecture can be conducted. • Add some lectures on imaging sensors and problems in imaging. • Lab can be arranged for the hands on training. • I would like to learn design of biomedical devices, implants etc. • More lab session on robotics. • More emphasis on mathematical treatment required. • Introduction of actuators and sensors i parallel type manipulator • On advanced robotics. • More lab sessions would be highly appreciable and useful for the participants • We need more lectures on microcontrollers. • More lab sessions as compared to lectures.

Learning

Questions	***Yes***	***No***
Do you get enough class projects?	13	04
Is the learning adequate?	17	00
Do you have sufficient resources for laboratory	13	04
What is your area of specialization	• Machine Design • Wireless sensor networks. • Mech. Engg. Design • Signal Processing • Control Systems • Biomechanics, Biodesign • Industrial Automation • Machine learning. • Software engineering • Signal processing- digital and analog. • Robotics • Optical sensors • Robotics rehabilitation • Nano-technology • fluman response of vibration.	
	Sufficient	***inadequate***
Is the library/journal support/e-connection	14	03

	Definitely	***Maybe***	***No***
Would you like to have common (TEQIP) repository of course	15	00	02

Would you like to visit IITK to attend specialized courses?	19	00	00
Would you like MOOCS/e-resources based courses?	14	03	01
How can TEQIP help improve your learning?	• It was motivating • By having courses in other institutes especially to the UG students so that they can be motivated. • By providing opportunity to visit advanced centres like IITK and to explore the research advancements of the field. • Organizing some internship programme in image restoration by various techniques/ algorithms. • TEQIP may conduct series of workshops for different level. • By arranging small project based training courses in a particular specialized field. • Because of lectures & lab visits. • By conduct workshops. • Providing pool of e-lectures video clips images as open source • Knowledge of current research work in IIT and institute. • By doing more workshops • Help in learning cutting edge and recent advancement in sensors technology. • There can be more lectures by the industry people. • This was my first visit and it is quite good. These workshops are very affective.		

Research

Questions	*Definitely*	*Maybe*	*No*
Would you like to visit an IIT for a short visit /internship/post- doctoral stint if offered (via TEQIP)?	18	01	00
Would you like to share/use research infra-structure at IITK, if made available?	18	01	00
Would you like to conduct collaborative research with IITK faculty?	18	01	00
Would you like lectures by experts (Indian and international) on niche research areas/topics?	19	00	00
Do you want special-topic conferences?	18	00	00
How can TEQIP help improve your research?	• If workshops of these kind may be given on my area of research it would be of more help • By extending the facilities for the faculty by providing a long term training programme on projects specifically. • Such workshops organized by TEQIP provide opportunity to interact with the field experts as well as with the fellow researchers. This interaction is the most important way of improving the research work. • I am working on image restoration using some optimization techniques. So, I want research guidance and facilities to improve my knowledge and work at IIT Kanpur. • By allowing researcher to use research labs, equipments etc. • By allowing collaborative research with IITK PhD. Students, faculties etc. • By providing equipment and show facilities at better equipped institutions like IITs. • By conduct workshops and conduct special topic lectures by experts. • Discussion part, idea of new approaches is very helpful in research. • Visiting labs. Collaborative research, interaction with industry • If TEQIP can provide me a job, it'll be very wonderful for me. • Just a little help related to the fund as I do not have fund to do my PhD.		

OUTCOME

- After attending the workshop participants had better idea of theoretical and practical aspects of sensors and actuators together with the associated technologies in practice.
- Motivated research students to take up challenges related to application of sensors and actuators in several field.
- Emphasis was laid on giving participants suggestions on how to teach topics related to sensors and actuators more efficiently.
- Highlighting the use of sensors and actuators in several field, this workshop encouraged participants to propose courses on sensors and actuators at their parent institutes.
- Extensive laboratory experiments including various kinds of advanced sensors and actuators were covered motivating participants to build their own automated, experimental setups for research, thesis, projects etc.
- Talks delivered by speakers from various backgrounds made participants aware that sensors and actuators are integral part of technological advancement in any field.
- Participants were introduced to the techniques, applicability and new evolvements in this field.
- After the workshop participants had a better knowledge of how development of sensors and actuators took place over the decades and future possibilities in this field.

Organizer's Report

TEQIP workshop on 'Advanced Sensors and Actuators' was held during 28-31 August, 2016 at IIT Kanpur. The idea of this workshop was to make participants aware of the theoretical and practical aspects of sensors and actuators together with the associated technologies in practice, which has been achieved through the lectures of eminent researchers in the areas of Aeronautical, Computer Science, Mechanical Engineering, Electrical and Electronics, Physics, and Medical Sciences. Two lectures were dedicated on the applications of a variety of sensors and actuators in automotive industry. The lectures covered the essential theory with hands on experiments through daily lab session.

The workshop was successful as it fulfilled the objective of making the participants aware of the state-of-the–art research in the field of advanced sensors and actuators. This was possible through the numerous lectures based on the theme of the day and supporting lab sessions pertaining to the theory covered on that day.

The various topics covered are: Introduction to sensors and actuators; physics, modeling and fabrication of rf sensors, smart sensors and actuators (SMA's), smart ionic polymer-metal composite (IPMC) sensors with their applications in robotics; embedded systems, sensors in manufacturing CNC and CMM; Solar systems; sensors and actuators in automotive industry, sensors applications in unmanned aerial systems; Bio-MEMS sensors; acoustics sensors and vision systems.

On the first day, soon after the inauguration of the workshop by Dr. Bhaskar Dasgupta, the head centre for Mechatronics, Dr. Anant Mehrotra and Dr. Arun Shrivastav of SGPGI Lucknow delivered the opening lecture on the vital subject of 'Sensors technology in healthcare' elaborating on the range of sensors used in neuro diagnostics and surgery. Dr. Arun Srivastav has pointed out the importance of collaborative research and fabrication of indigenous sensors. Prof. A. Dutta gave a crisp introduction of the classification, principle of working, selection based on the application in hand and other important issues of the sensors and actuators. Third lecture was delivered by Dr. Anita G. Murugkar of Dr. Babasaheb Ambedkar

Marathwada Univ. of Aurangabad on the RF MEMS sensors, their physics, modeling and fabrication techniques. Post lunch, all the participants gathered in the Centre for Mechatronics to have first laboratory session. This lab session included hands-on experiments. The experiments covered were the demo and learning of PUMA robot with VAL language programming, stepper motor control with and without Arduino, stepper motor interface using advanced motion control card with LabVIEW platform, motion parameter settings using measurement and automation utility (MAX) of LabVIEW and motion programming, interfacing of Force-sensing resistor (FSR) using data acquisition card (DAQ) and its programming, study of quadrature encoder and DC servo motor control using Adruino interrupts, RC servo position control of serial arm, and ultrasonic and IR sensor & PWM control.

Second day session began with the expert lecture of Dr. B. Bhattacharya on shape memory alloys, their working principle, applications, fabrication techniques and ingenuity of using these kind of smart sensors. Dr. R. K. Jain of CMERI Durgapur introduced the participants with a different class of sensors such as IPMC, used specially in humanoid robots for use as muscles, limbs, etc. Dr. Sandeep Shukla presented the overall structure of the embedded systems, their hardware and software components, various design issues and regarding the current research trends and future directions. Post lunch session was dedicated to an introductory lecture on the various kinds of sensors and actuators used in manufacturing systems in CNN and CMM machines such as Strain gages, Force sensors, dynamometers, accelerometers, etc. followed by live demonstration and working of these kinds of sensors at Manufacturing Science laboratory.

Third day session started with the introduction and functioning of solar systems, their characteristics, applications, and grid configuration by Dr. P. Sensarama. The second lecture was delivered by Mr. Kapil Dongre of Tata Motors, Pune. He interactively introduced the participants various sensors and actuators used in Tata motors w.r.t. the automobile part, its functioning and the use of particular sensor in that part. He also gave the inspiring message of need of establishing of start-ups in these sectors. Dr Shantanu Bhattacharya delivered the lecture on Zinc oxide nanostructures, and their utility in sensing of gases. The forth lecture of the day covered the topic of role of onboard high technology sensors and actuators in unmanned aerial vehicles by Dr. Abhishek. He also talked about the use of ground based sensors for accurate tracking and ultra wideband radios for localization of these vehicles. Post lunch, participants visited ‘BioMEMS and Microfluidics’ laboratory where various micro fabrication and characterization facilities were demonstrated. From here, the participants were taken to visit the ‘Solar Energy Research Enclave’ to have the glimpses of Solar PV systems, various

technologies of PV panels, their tracking, Converters for Grid Connection and Organic Solar Cells.

On the fourth day, participants visited the Flight laboratory situated at the airstrip. With a brief presentation on the structural design and development of a mini helicopter, its test bed for performance measurements and control, demonstration of the flying autonomous quadrotor was given, which was fully enjoyed by all the participants. After returning from the airstrip field visit, Dr. Nachiketa Tiwari delivered the introductory lecture on the acoustic sensors and actuators, their working principle and other related research issues, followed by another industry lecture. Mr. Arvind of BOSCH India delivered the lecture on the various types of sensors and actuators used in BOSCH vehicles. The last lecture of the workshop was delivered by Dr. Venkatesh and his students followed by hands-on imaging programming using MATLAB. During this session, with introduction to vision and imaging advanced research topics in imaging were discussed such as silhouette based image reconstruction, gesture control and artificial intelligence.

The workshop was concluded with a valedictory function conducted by Dr. A. Dutta, where participants were requested to share their experience about the workshop and presented the certificates.

The feedback of the participants is encouraging and motivating, suggestive to have more such kinds of workshops in the future.

Thanks are due to the TEQIP, IIT Kanpur cell and the team. With their active support, the workshop turned out to be a successful academic event and useful for all the participants.