



Advanced
Electronics
Laboratories

Device
Characterization,
Testing &
Evaluation
Facilities

Photovoltaic
Energy
Engineering
Laboratory

Device
Processing
&
Fabrication
Facilities

Electronic
Device
Design
Suite

Model
Simulation
Laboratory

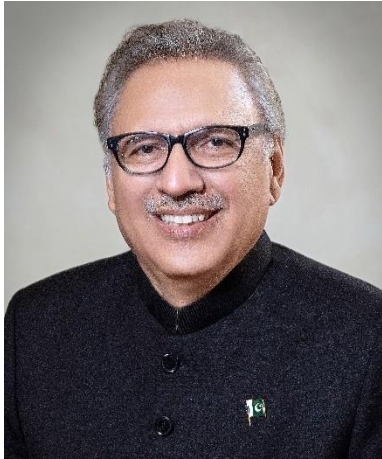


CENTRE FOR ADVANCED ELECTRONICS & PHOTOVOLTAIC ENGINEERING (CAEPE)

PROGRESS & PORTFOLIO REPORT (2018-2020)

INTERNATIONAL ISLAMIC UNIVERSITY ISLAMABAD





H.E. Dr. Arif Alvi
Chancellor, IIUI/ President of Pakistan



Prof. Dr. Suliman Abdullah Aba Al-Khail
Pro Chancellor, IIUI



Prof. Dr. Masoom Yasinzaï
Rector, IIUI



Prof. Dr. Ahmed Yousif Ahmed Al Draiwesh
President, IIUI



Prof. Dr. Ahmed Shuja Syed
Founding Executive Director (CAEPE)

CONTENTS

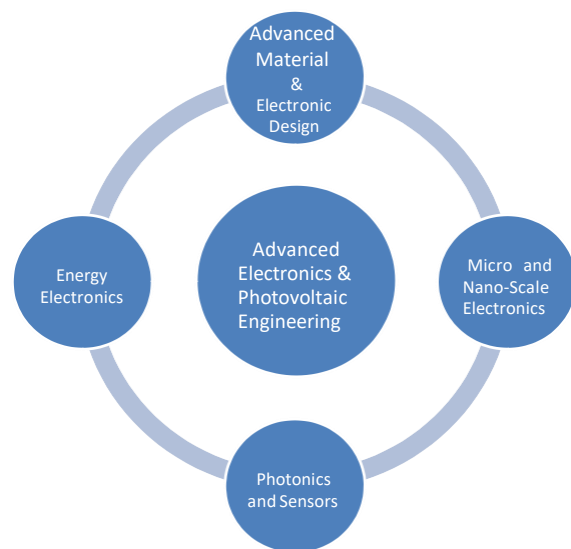
Page #	Chapter
Page 1	At a Glance
Page 3	Introduction & Background
Page 8	Facilities & Strengths
Page 27	Services, Teaching, Trainings & Dissemination



At A Glance

The Centre for Advanced Electronics & Photovoltaic Engineering (CAEPE) at International Islamic University, Islamabad is a university-wide Centre aimed to create knowledge and develop the cross-disciplinary market-driven research focused on the applications of Advanced Electronics & Photovoltaic Engineering via processes, components and systems. This research and development is important for the convergence of energy, photonic and nano-scale electronics avenues for economic growth in the country. The overall objective of the Centre is to establish a sustainable source of research training for developing qualified manpower with a focus on future requirements, and facility access services in these fields that are applied to the national needs.

- CAEPE is a university wide indigenous Centre and a user-access facility
- Number of Scientific Projects Utilizing the Facilities in the Centre ~ **300+**
- Enabling to target **4** Sustainable Development Goals (**SDGs**)
- Centre's Indigenous Research Problems are focused to create knowledge in **Micro- and Nano-scale** Engineering of Devices, Materials and Systems to enable solutions for Big Problems such as **Connectivity, Energy, Improving Quality of Life**



Means of Engagement

- **Knowledge**
- **Learning**
- **Demonstration**
- **Impact**
- **Collaboration**

4 QUALITY EDUCATION



7 AFFORDABLE AND CLEAN ENERGY



9 INDUSTRY, INNOVATION AND INFRASTRUCTURE



17 PARTNERSHIPS FOR THE GOALS



Research Strength

- Technology behind the Chip (Physical Layer Design)
- Semiconductor Fabrication
- Process Reliability
- Materials & Device Characterization
- Internet of Nano Things
- Power & Energy Electronics
- Photonics
- Novel Materials Devices, Circuits & Systems for Sensing, Detection, Communication & Computing

Impact Quantification

Impact Parameters	Quantum
Extent of Utility and Access	>300 scientific projects
Engagement of Returning Users	80%
Knowledge Creation & Dissemination in Process	>200 projects
Continual Skill Development	>2000 Runs
Responsiveness (Qualified Manpower Creation with Terminal Degrees in Dedicated Specialization; Collaborative Connections; Joint International Projects)	Manifold Increase on Yearly Basis

Sr. #	Content	No. of projects
1	Total number of the projects/users	300+
No. of student trained by the lab staff including BS Level Trainings on Design Suite		
2	Training Level - 1 (4 to 6 weeks)	130+
3	Training Level - 2 (Extensive Machine Training)	70+
4	No. of the department of Electrical Engineering (DEE), Faculty of Engineering & Technology (FET), students (MS/PhD) associated with the Centre (CAEPE)	60+
5	No. of Q.A Sessions on the machine	1000+
6	No. of International Training conducted of the lab staff	4
7	No. of National training conducted of the lab Staff	5

1- INTRODUCTION & BACKGROUND

- Introduction
- Structure, Prospects & Benefits
- National & International focus on the field of Advanced Electronics & PV Engineering

Introduction

The Centre for Advanced Electronics & Photovoltaic Engineering (CAEPE) at International Islamic University, Islamabad is a university-wide Centre aimed to create knowledge and develop the cross-disciplinary market-driven research focused on the applications of Advanced Electronics & Photovoltaic Engineering via processes, components and systems. This research and development is important for the convergence of energy, photonic and nano-scale electronics avenues for economic growth in the country. The overall objective of the Centre is to establish a sustainable source of research training for developing qualified manpower with a focus on future requirements, and facility access services in these fields that are applied to the national needs. The Centre is currently catering the needs of hundreds of local and national scientific users and projects and hosts an academic program in the specialization of Advanced Electronics under the umbrella of Faculty of Engineering & Technology. With variety of professionally licensed design tools, and a range of highly sophisticated process and characterization machines; the Centre is evolving as a hub of experimental research facilities in diverse areas of applied electronics, energy and photonics. The Centre is supported by various national and international grants awarded to its Principal Investigator & Founding Executive Director, Engr. Prof. Dr. Ahmed Shuja Syed, specifically from Islamic Development Bank (IDB), Kingdom of Saudi Arabia. With the keen interest and support of the honorable Rector and the worthy President of the university; the Government of Pakistan has also recently awarded a huge funding in tune of PKRs. Multi- hundred million for the capacity building of the Centre under the university's Mega PC-1. Islamic Development Bank, KSA has also desired to extend the benefits of the Centre to a larger community within the IDB member states.

Relevance & Background of the Centre

In the wake of the Pakistan's vision 2025; Govt. of Pakistan's Science, Technology & Innovation Strategy 2014-18 and Higher Education Commission's Target Areas for Technology Development 2016 as well as its Vision 2025; the fields of Advanced Electronics (Micro- and Nano-electronics Engineering, Optoelectronics, Energy Electronics etc.) and Energy (such as Photovoltaic Energy Engineering) had been identified as priority area for economic uplift and futuristic growth of the country. Thus, the Centre for Advanced Electronics duly approved in the 76th meeting of university's Board of Governors (May 2015) was re-named as Centre for Advanced Electronics & Photovoltaic Engineering (CAEPE) in the 80th meeting of the same esteemed board in February, 2017. The establishment of this university-wide Centre was notified in May, 2017 in the back drop of BOG's directives, two back to back international scientific grants awarded by the Islamic Development Bank (IDB) for the establishment of Advanced Electronics Laboratories (AEL) and Photovoltaic Energy Engineering Laboratory (PEEL), and support extended by the Govt. of Pakistan for the capacity building of the Centre in form of a generous share in Mega PC-1.



Inauguration of IsDB Funded Advanced Electronics Laboratories Project



Inauguration of Al- Farabi Research Complex

Structure, Prospects & Benefits

The Centre for Advanced Electronics & Photovoltaic Engineering (CAEPE) is a University-wide entity with the following objectives:

Mission

To conduct advanced electronics & photovoltaic engineering research that produces:

- New technologies
- Processes
- Systems that may provide new or significantly enhanced knowledge for direct benefit to economic opportunity in Pakistan.

Thus the Centre is aimed to create knowledge and develop the cross-disciplinary market-driven research focused on the applications of Advanced Electronics & Photovoltaic Engineering via materials, processes, components and systems for the convergence of energy, photonic and nano-scale electronics technology avenues or platforms.

Objectives

The overall objective of the Centre is to establish a sustainable source of research training for developing qualified manpower with a focus on future requirements, and facility access services in these field that are applied to the national needs.

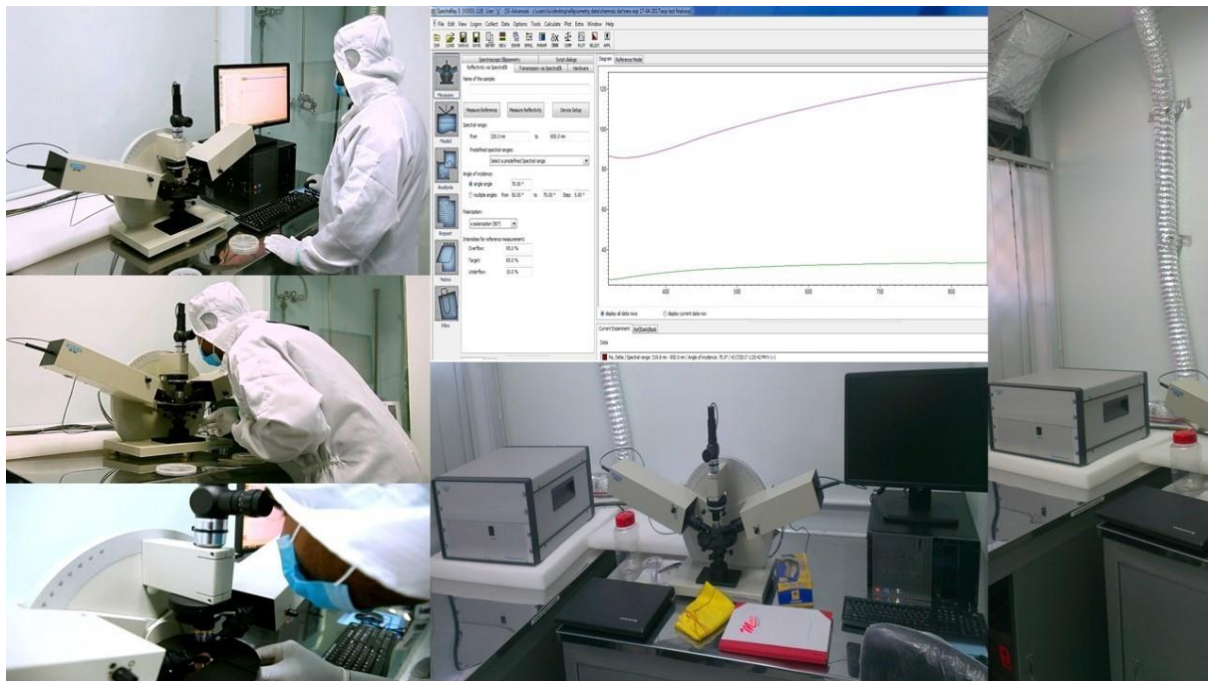


Glimpses: Staff Trainings in The Centre

National & International focus on the field of Advanced Electronics & PV Engineering

Advanced Electronics and Photovoltaic Engineering (Engineering of circuit, devices & system at nano scale for electronics, energy and photonics applications) are two of the most impactful R&D areas in the domain of Electrical Engineering with cross - disciplinary convergence.

TOP 10 Electrical Engineering Schools in the World are offering degrees in Electrical Engineering with Specialization and focus on Advanced Electronics and Photonics.



Activities at a Glance

National Connect

Advanced Electronics and Photovoltaic Engineering is one of the highlighted key priority area that is likely to drive the future of development and growth in Pakistan, one of the major technology and innovation support goals in Pakistan's Science, Technology & Innovation Strategy and among the significant fields for HEC's new R&D framework.

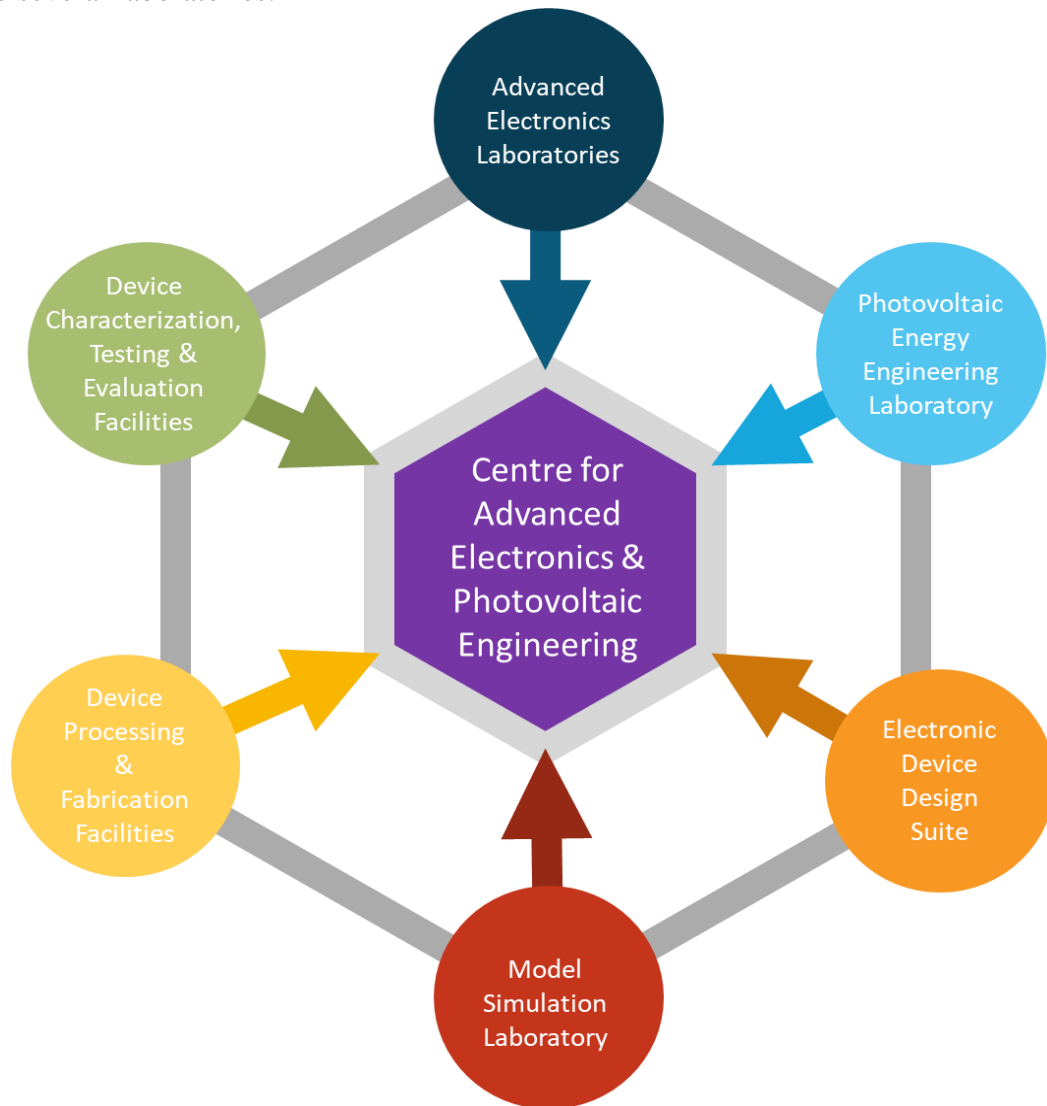


2- FACILITIES & STRENGTHS

- Facilities
- Electronic Device Design Suite
- IsDB- Funded Advanced Electronics Laboratories
- IsDB- Funded Photovoltaic Energy Engineering Laboratories
- Research Themes and Scientific Problems Addressed
(Inclusive of Accomplished Theses)
- Research Groups & Themes in the Wake of National Priorities
and Societal Relevance of Scientific Problems with
Accomplished Studies - (2018-2020)
- Grant Portfolio
- Team and Collaborations

Facilities

The Centre is equipped with highly sophisticated design and experimental facilities divided into several laboratories:



- ❖ Advanced Electronics Laboratories
- ❖ Photovoltaic Energy Engineering Laboratories
- ❖ Electronic Device Design Suite
- ❖ Model Simulation Laboratory
- ❖ Device Processing & Fabrication Facilities
- ❖ Device Characterization, Testing & Evaluation Facilities



Facilities in the Centre

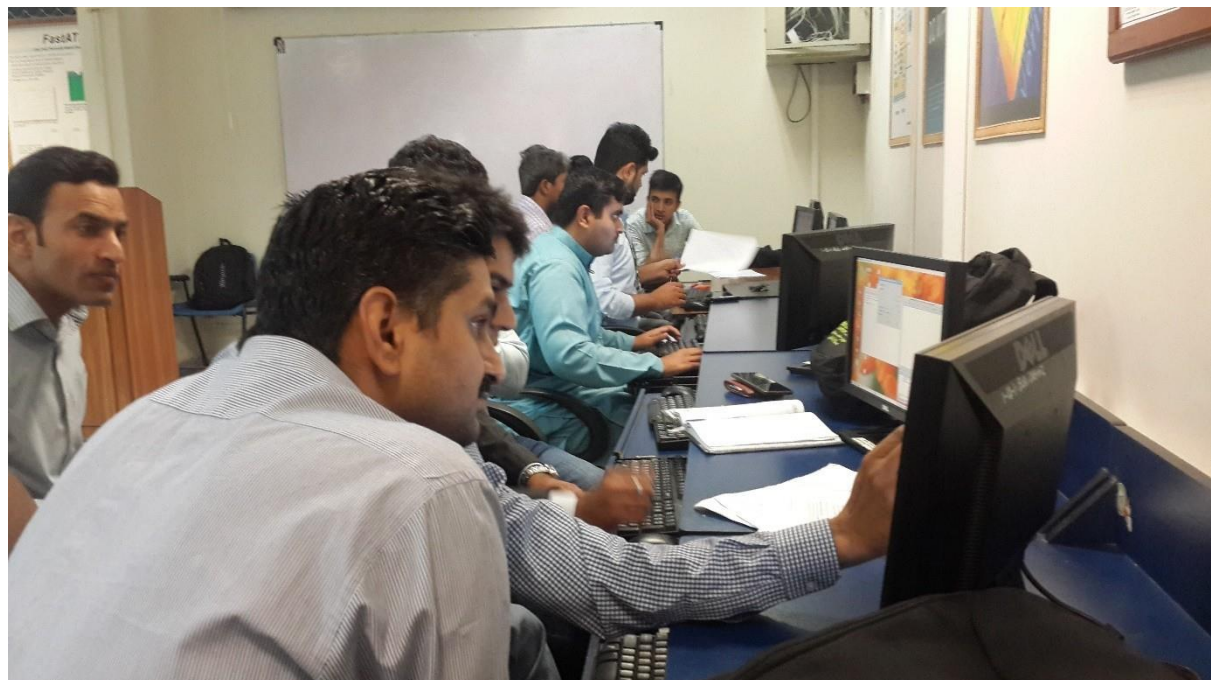
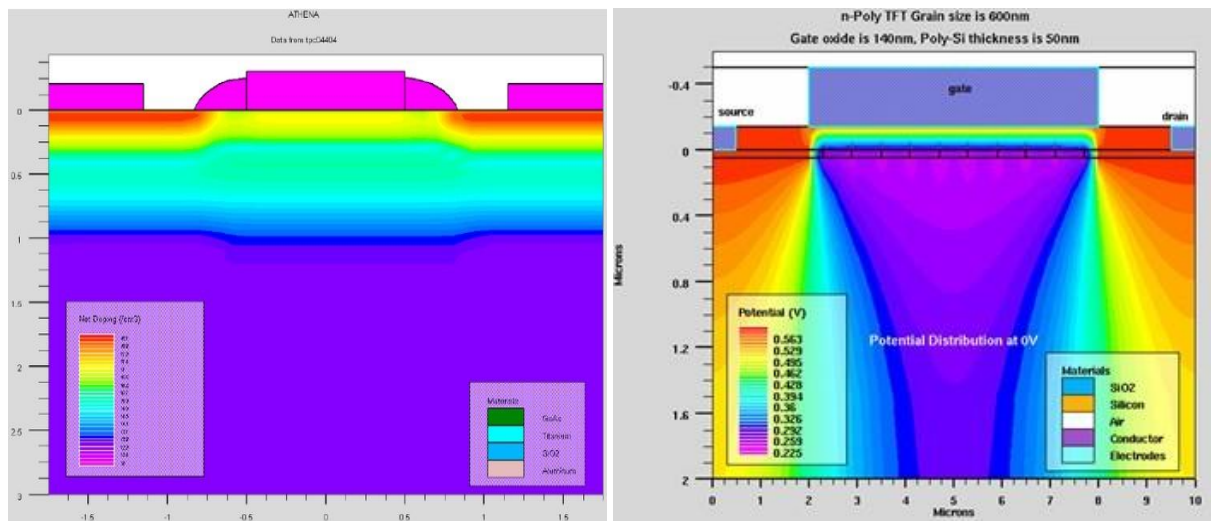
Electronic Device Design Suite

This part of the Centre, inceptioned in year 2009, is focused to facilitate students and researchers to design and model VLSI/ULSI devices, circuits and systems. The “Design Suite” is equipped with state of the art, trade-off commercial design tools such as Silvaco TCAD, Cadence (Analog/Custom/digital IC design bundle), Soft MEMS (Mems Pro), Mentor Graphics HEP (IC Nanometer design; Design, Verification & Test; PCB Expedition; Embedded SW Development), IBM SRIM/TRIM and SUSPRE, COMSOL, SCAPS etc. The Design Suite is unique in a sense that it caters the concept of an ‘Electronic Design House’, where such facilities are available under one roof. Some of these tools are available in few universities in Pakistan here and there; but perhaps the concept of “one-window design suite” is pioneered in International Islamic University, Islamabad. The Design Suite is particularly focusing on the design applications related to micro and nano-scale physical processes, next generation devices, circuits and systems (including MEMS) from process to circuit to package level. This is a mega facility aimed to train our future electronic engineers for global electronic design industry as well as address research problems in line with International Technology Roadmap of Semiconductors (ITRS). The laboratory is established with the keen “Fab-less” approach.

The Electronic Device Design Suite provides research leadership in electronic design automation by making available leading-edge university research results and tools for the design and test of advanced electronic circuits and systems. Device Modeling and Simulation explores scaling and process development of advanced electronic and photonic devices. These tools cover device transport and performance as well as process modules. These predictive tools help to provide physical insights into new devices, new physical phenomena arising from nano-size geometry, new materials and interfaces.



Activities at a Glance



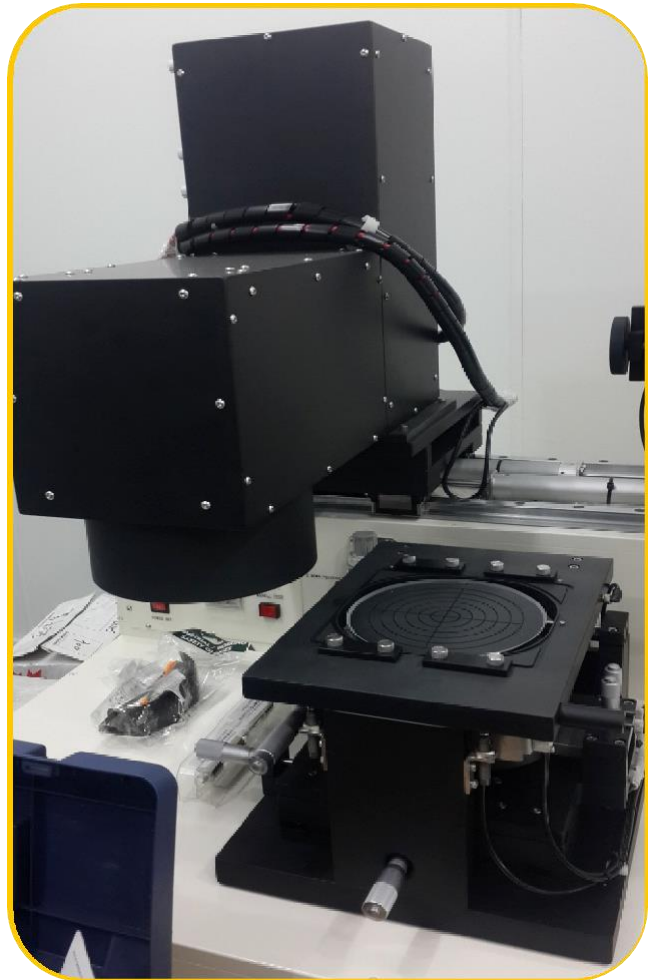
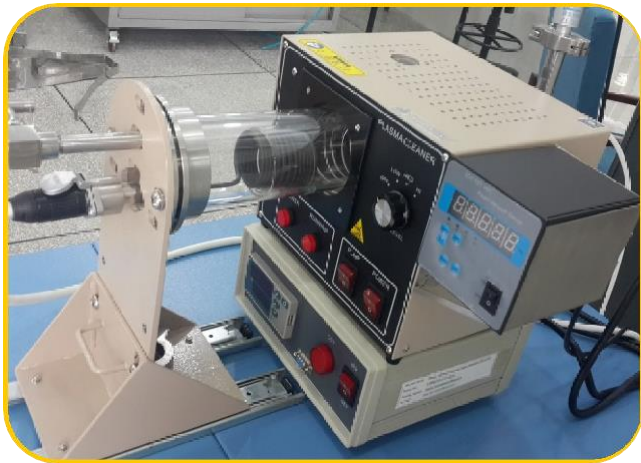
Device Design Suite

IsDB- Funded Advanced Electronics Laboratories

The primary objective of this crosscut facility is the development of metrology and characterization tools to support patterning, nano-engineered device processing and overall integrated circuit fabrication and packaging for variety of application areas.

The idea of this Suite is to apply interdisciplinary and bottom-up approaches that enable discovery of novel and radical alternatives to complex Fab-less electronic device design and processes. The specific focus is on nano-engineered devices with unique properties that enable continuation of functional scaling, where existing technology tapers off, and supports a research environment and portfolio that explores critical nanometer scale semiconductor manufacturing, facilitating a world-class student resource and measurable value through novel materials, devices and Fab-less manufacturing options. The labs are equipped with the following facilities:

- ❖ Multi-Head Probe Station
- ❖ Nano-Chip Reliability Grade Hall Effect System
- ❖ ASMEC- Electro-Physical Characterization System
- ❖ Metrology Grade Spectroscopic Ellipsometer
- ❖ Atomistic Layer Nanomaster Deposition System
- ❖ Optical Microscopy and Profilometry
- ❖ Rapid Thermal Processing (Annealing, Synthesis and RT-CVD System)
- ❖ Impedance Spectroscopy System
- ❖ MEMS Grade Spin Coating, Stirring and Baking
- ❖ Fume Hood/Wet Bench for Sample Preparation, Etching and Cleaning



IsDB Funded Advanced Electronics Labs

IsDB- Funded Photovoltaic Energy Engineering Laboratories

The Government of Pakistan has identified 7 critical elements of its mega-vision plan for the bright future of the country. People, Knowledge Economy and Energy are three important elements covering the scope of this project by aspiring human resource development, research focused to the national needs and energy technology at its heart.

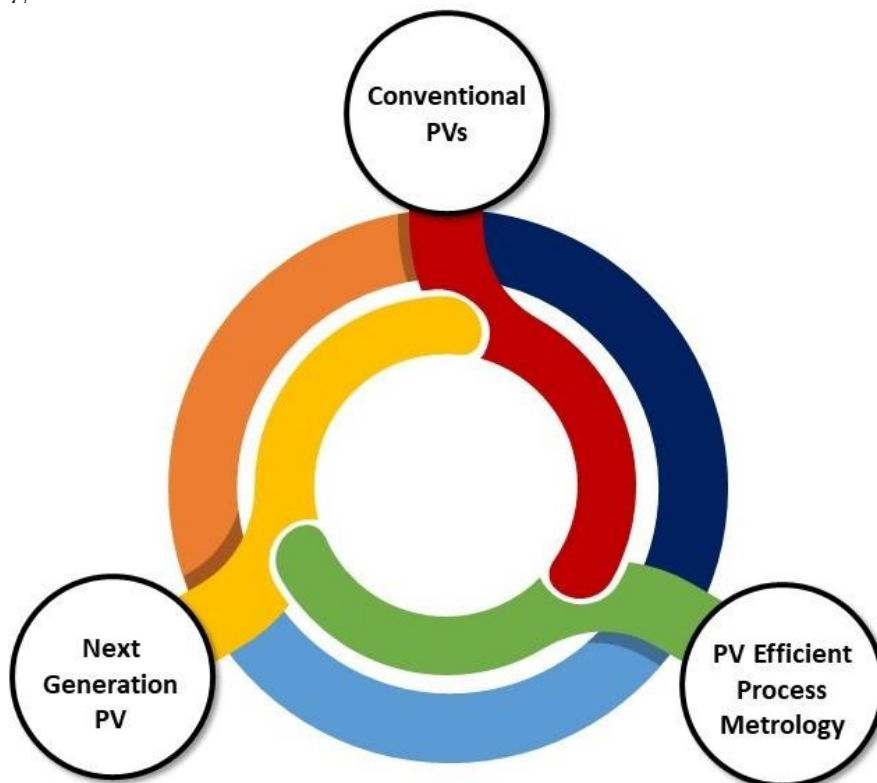
The project is focused to cater the needs for development of the skilled human resource in the broader area of energy research with a special emphasis on PV engineering. The development of this laboratory in International Islamic University, Islamabad is university's first formal initiative to conduct teaching and research and produce trained manpower in this much desired area. In nutshell; the PV Engineering lab's project is targeted to:

- Capacity building of education and research in the PV engineering/energy sector in the country
- Producing high quality S&T manpower in the key areas of science and engineering of Photovoltaic technology

The focus problem areas covered under the provision of this laboratory are as follows:

- PV phenomena in semiconductors
- Solar cell focused Multi-junctions, nano-heterostructures, thin-film electronics
- Metrology and Characterization of solar cells and photovoltaic processes for subsequent fabrication and utility

Based on the focus of the PV labs, the focused research activities are carried in the following three challenge areas:



Facilities

- Class AAA Sun Simulator with complete diagnostics
- Plasma Enhanced Chemical Vapour Deposition System
- Magnetron Sputtering System
- Scanning Electron Microscopy
- Photoluminescence/Electroluminescence Spectroscopy System
- EUV Lithography



Facilities at PV Energy Engineering Labs

New Facilities added to the Centre

The Centre is constantly growing with its capabilities to target new research problems that may benefit the future generations. The new facilities added to the Centre in the last few months are:

- X-Ray Diffraction System
- Class 100 Clean Room
- Thickness Profilometry
- Atomic Force Microscope
- Electro spinning and Electrospraying System
- Femto-Pico Ampere Measurement System

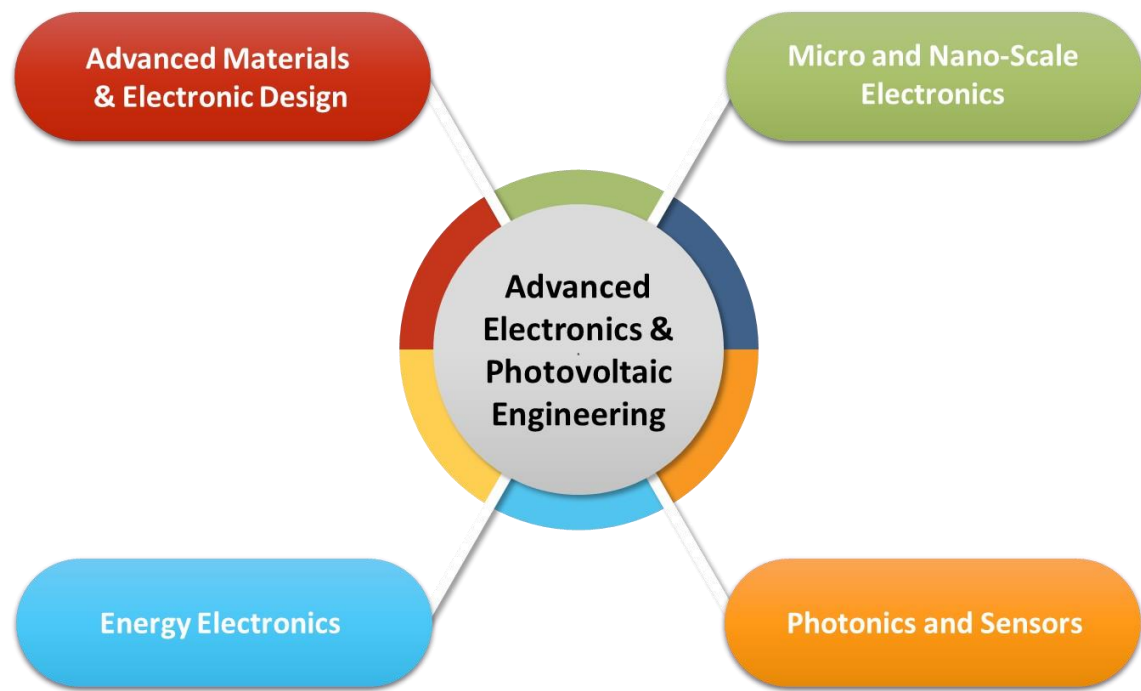
Apart from the above mentioned machines several new machines are also under procurement to strengthen the Centre capabilities further.

Future Plans

- Development of dedicated building/space for the Centre (PSDP's PC-1 Support).
- Development of additional experimental techniques with the help of PSDP's PC-1 allocation of capacity building of Centre facilities.
- Targeting the new funding windows.
- Development of new Research and training networks

Upcoming facilities in Year 2020-2021

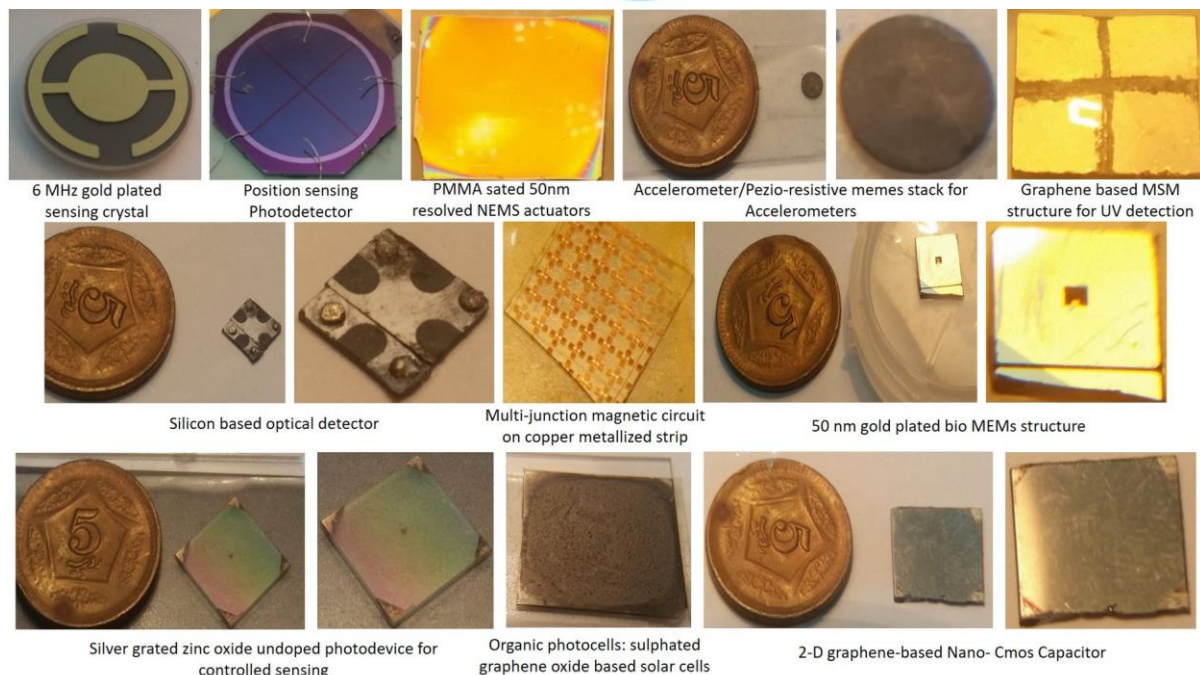
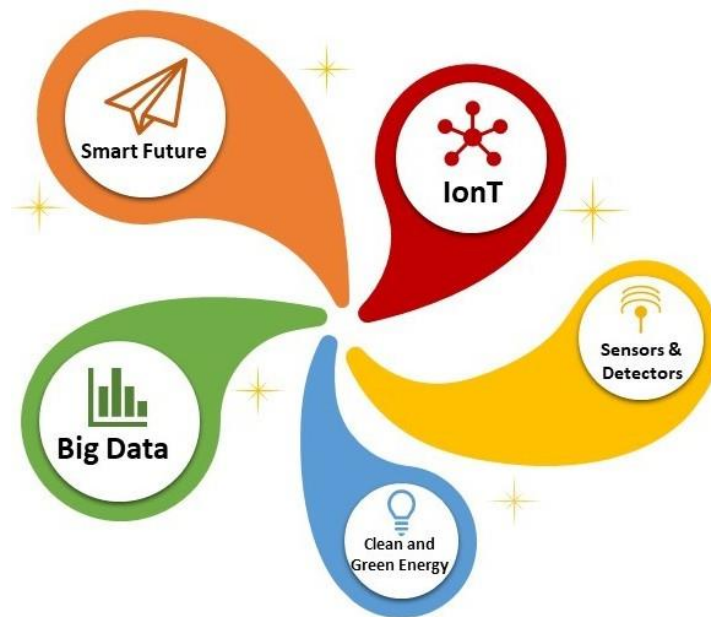
- Even bigger class 100 Clean-room
- CZ Crystal Grower System
- Dual Stainless Steel Glove Box with Gas Purification System
- 1200°C Quartz Tube Furnace with Glove Box Purification System
- Multi-function Film Coater with Turbo Pump: (Thermal Evaporating, Carbon Coating, Plasma Sputtering in one customized design)
- Broad Beam Metal Implanter
- Compact Precision Screen Printing Film Coater
- DC/RF Dual-Head High Vacuum Magnetron Plasma Sputtering Coater system
- 4" Mask Aligner
- Film/Coating Thickness Profilometer
- PECVD Split Tube Furnace
- Long Tape Casting Coater
- Precision Grinding / Polishing Machine
- Vibrating Sample Magnetometer



Glimpse of Facility Utilization

Research Themes and Scientific Problems Addressed (Inclusive of Accomplished Theses)

- Technology behind the Chip (Physical Layer Design)
- Semiconductor Fabrication
- Process Reliability
- Materials & Device Characterization
- Internet of Nano Things
- Power & Energy Electronics
- Photonics
- Novel Materials Devices, Circuits & Systems for Sensing, Detection, Communication & Computing



Prototypes & Fabrication of Devices in Various Research Projects

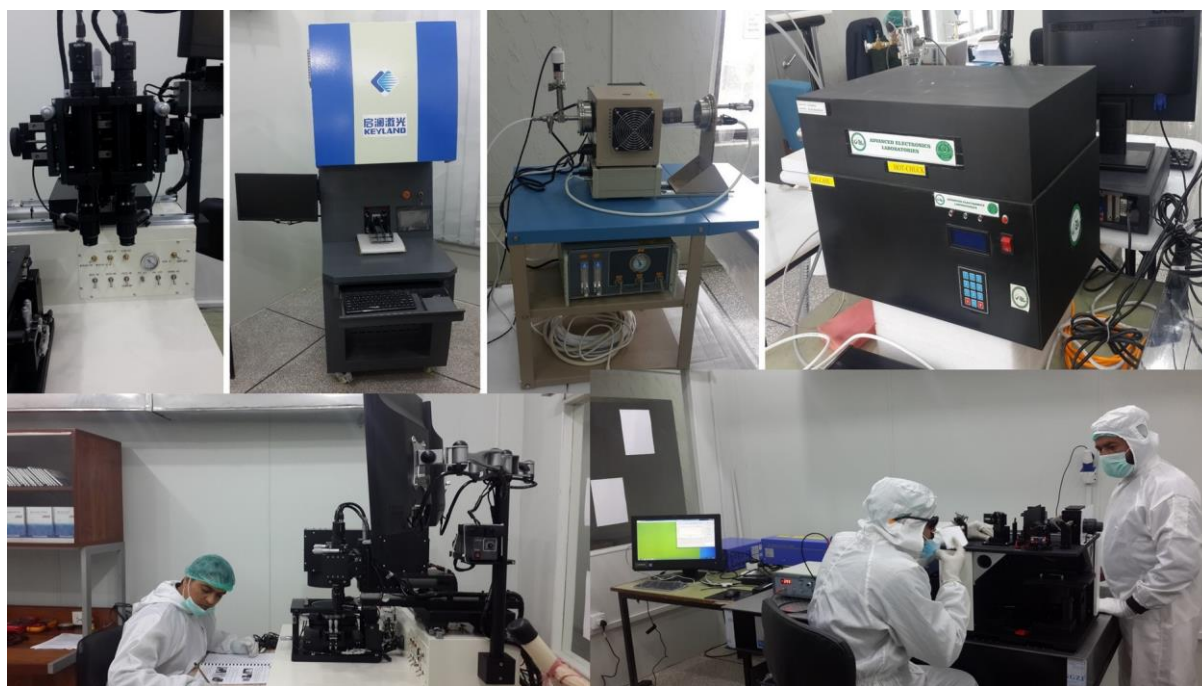
Research Groups & Themes in the Wake of National Priorities and Societal Relevance of Scientific Problems with Accomplished Studies - (2018 - 2020)

1. Graphene Electronics

- Hyper Sensitive Electrical Characterization of 2D Graphene Transistor Matrix
- SE Analysis of Novel Graphene Structures for Photonics
- Fabrication and characterization of Graphene Induced Metal Semiconductor Metal (MSM) Structure for Detection and Sensing Applications
- Implant-Engineering of 2D graphene MOS matrix
- Simulation, Synthesis and Electrical characterization of Graphene oxide
- Analysis and Characterization of multi-layer Graphene crystal for MOS transistors
- Post fabrication device reliability analysis of Graphene based MOS Capacitors
- Exploring the Avalanche behavior in Graphene-Based photodetectors

2. Silicon Photonics: Sensing & Detections

- Design and Characterization of Silicon Quadrant Detector for Robust Position Sensing
- Design Optimization and Post-fabrication analysis of silicon differential for photonic applications
- Modelling of carrier multiplication layer of hetero junction avalanche photodiode



Experimental Activities -I

3. ZnO: UV Detection

- ZnO Nano Wire Based Ultra Violet Detector
- Advanced Electrical & Optical characterization of ZnO matrix for sensing applications
- Effect of Ion Implantation on ZnO nano composites for photonic & detection applications
- Fabrication and evaluation of contact electronics for undoped ZnO template

4. Next-Generation Solar Cells

- Electrical and Optical Modelling of Bulk Heterojunction polymer solar cells
- Capacitance Voltage process metrology of engineered ZnTe/CdTe based Solar cells
- Reliability of Device growth techniques for the Process optimization of CdZnTe solar Cells.
- Defect mapping for efficient fabrication of CdTe based Solar Cell
- Device Simulations of Critical Parameters for the Thickness Optimization in Polymer- Fullerene based Organic Solar Cells
- Dye-Sensitized Solar Cells
- Design and Characterization of ZnCuSe structures for Next Generation Solar Cell Application
- Design and modelling of 3rd generation polymer based organic solar cells



Experimental Activities - II

5. Energy Efficient Nano electronics

- Next Generation Energy Efficient process protocols in Si-CMOS Electronics
- Design of Ultra-Thin Metal Layer for CoolMOS Electronics
- Energy Efficient Contact Electronics in GaN for Variable Application
- Analysis of High K dielectric for 14 nm technology node
- Simulation, Formation and Characterization of TiN Samples for CMOS Process and Applications

- Simulation and Characterization of Atomic layer deposited TiN for CMOS Processing and Applications
- Effect of annealing dynamics of the Ion-Engineered ZnTe/CdTe based Solar Cell
- Investigation of leakage parameters of HfSiO₄ based MOS Capacitors for CMOS Circuits
- Design of an energy efficient LDMOS with high breakdown voltage and low on resistance
- Comprehensive bias temperature instability (BTI) modal with incorporated voltage, Temperature, frequency and duty factor dependence for CMOS devices
- Failure mode analysis of process, Voltage and temperature variations on several Fin-FET based SRAM sense amplifier

6. Power Devices

- Design and Simulation of a HV SiC PIN Diode for high Power Application
- Evaluation in design variants in Insulated Gate Bipolar Transistors (IGBT) for High Power Applications
- Modeling and Simulation of Design Variants for the Development of Si-C Thyristors



Activities at a Glance

7. III-V Device Engineering

- Fabrication and characterization of Ion-Engineering III-V Matrix for photonic Integrated Circuits
- Electrical Isolation of GaN devices for application in photonic integrated circuits
- Effect of annealing dynamics on Ion engineered GaN devices for photonics applications
- Investigation of metal contacts engineering of InGaAsP for optoelectronics devices
- Shelf life of GaN based High Electron Mobility Transistors (HEMT) for high frequency Application

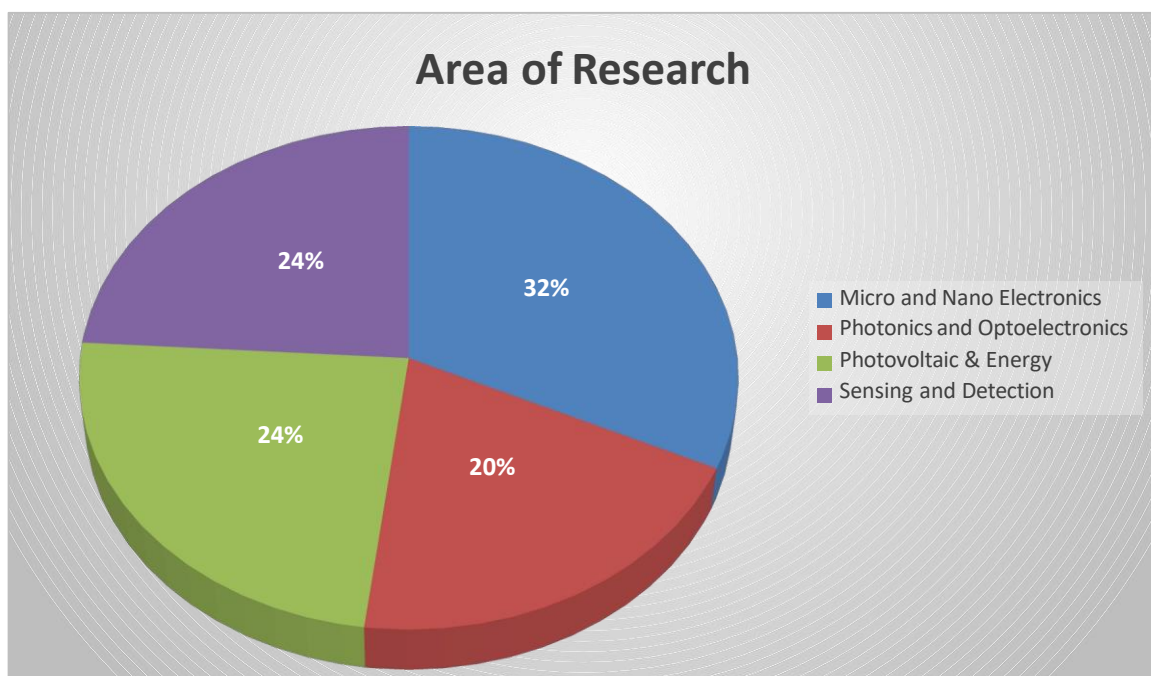
- Optimization of AlGaIn based HEMT in TCAD for high frequency applications
- High performance low noise amplifier design for wireless communication using GaN HEMT
- Electrical Isolation of III-V matrix for Photonic Devices

8. Supercapacitors & Nano Harvesters Future Devices, Circuit & Systems

- Fabrication and characterization of Stretchable Super capacitors for Energy Systems Applications
- Super Capacitor Properties of Transistor Metal Oxide - Conducting Polymer- Graphene Ternary Nano Composites
- Flag type nanogenerator for harvesting wind energy

9. Future Devices, Circuits & Systems: NANO/CNTs, MEMS, Neuromorphic Circuits, Nano sensors, RF Filters

- Characterization and Investigation of Functionalized MWCNTs based Polymer Nanocomposites
- Design and analysis of chemical sensors for chemical warfare agents in MEMS design
- Simulation and Characterization of defects of Au/To/SiO₂/Si based devices for MEMS and Chemical sensing applications
- Self-Healing strain Sensors
- Design of Microstrip based RF switchable filter for S-band radar application



Spread of Research Activities: Theme Proportion

Grant Portfolio

The Centre is inherited with several local and international grants and user access portfolio acquired such as:

- IIU Research Fund for the Development of Device Design Lab
- IDB, KSA Technical Assistance Grant Program- Establishment of Advanced Electronics Laboratories
- IDB, KSA Technical Assistance Grant Program- Establishment of Photovoltaic Energy Engineering Laboratory
- USA's Department of Energy's Lawrence Berkeley Lab's User's Facility Access Program
- HEC's Grant for the Development of Model Simulation Suite
- Govt. of Pakistan's PSDP/Mega PC-1 Award Allocation for the capacity building of the Centre- Civil Works for the dedicated space development (~ 20,000 Sqft) & Central Laboratories Facility Development
- Pakistan Science Foundation – National Science Foundation, China, Joint Research Project

The Centre has been most active entity in the university by targeting the national and international funding calls including Asia Connect, Pakistan Science Foundation Consortium Projects, UNESCO – IUPAC, EPSRC – GCRF, British Counsel's ICRG, HEC's NRPU and HEC's GCF etc.



Experimental Activities - III

Team and Collaborations

- Prof. Dr. Ahmed Shuja Syed
Founding Executive Director CAEPE /Advisor to the Rector & President (Engineering Programs), IIUI
- Dr. Gul Hassan
Assistant Professor/ Cleanroom Manager, CAEPE
- Dr. Erum Jamil
Assistant Professor/Incharge Department of Electrical Engineering
(Focal point: Female students/Users, training & Workshop)
- Engr. Shoaib Alam
Research Associate/Laboratories Manager, CAEPE
- Engr. Muhammad Ali
Research Associate/Research Liaison Manager, CAEPE
- Engr. Faraz Qayyum
Lab Engineer/I.T & Networking Manager, CAEPE
(Focal Point: Device Design Suite)
- Mr. Shah Fahad
Research Associate, CAEPE
- Engr. Khalid Usman
Lab Engineer, CAEPE
- Mr. Shoaib Waqas
Lab Assistant, CAEPE
- Engr. Majid Khattak
Lab Technician
- Engr. Hammad Shakeel
Lab Technician

Lawrence Berkeley National Laboratory (LBNL), USA has been a major collaborator to support the specific research and technical usage of the facility duly incorporated as facility usage agreement. The Centre is also collaborating with many national and international organizations, research groups, R&D synergy forums, and electronics manufacturing companies.



Some of the Team Members at CAEPE

3- SERVICES, TEACHING, TRAININGS & DISSEMINATION

- Usage and Trainings
- Access
- Programs & Projects
- Data Statistics
- List of Focal Users from Faculty in the University
- Events
- Dissemination
- Visits

Usage and Trainings

The facility is an open access to IIU students and faculty as well as other universities and scientific organizations on a University's BOG approved Service Cost Model.

Entry into the Centre's facilities requires Safety Training through the Master Users. One should follow the General as well as Specialized Training Requirements to utilize the services. Other specific Health and Safety training may be required depending upon the machine to be used. Your technical contact will provide additional information as needed.

Individual equipment training is required and can be scheduled by contacting the appropriate technical or administrative staff for each facility.

Viable Experience; International & National Relevance

- About 14 Years of Device Design Experience on International Industrial Simulators/ Modeling Tools
- Connected to World-wide FABs
- About 8 years of rigorous Quality Assurance of Centre Process Characterization Tools
- Indigenous Machine Engineering
- Over 300 Nation-wide returning users on variety of projects since the formal inauguration of the facility
- Continuing ties with the strategic organization
- National and International Funded projects on the forefront of Advanced Electronics and Photovoltaic engineering, as part of Centre's portfolio

Access

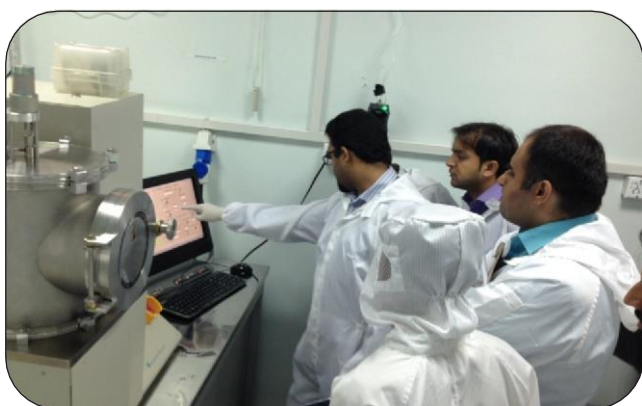
Access Support

CAEPE, being a leading user facility, has also access to the Epitaxial Growers, Ion Implantation Services, Fabs for Standard CMOS development, III-V Devices, MEMS/ Microsystems applications; with experience in taping out the chips and discrete devices.

CAEPE is also in collaboration with some of world's top of the line research groups and experimental facilities.

Access to the Centre Facilities

The Centre provides an open access to its facilities for all the users who wish to use its capabilities for their respective research. All the facilities are charged through the **CAEPE Service Cost Model**



Teaching and Training at the Centre

Programs & Projects

User's Spread within the Scientific disciplines

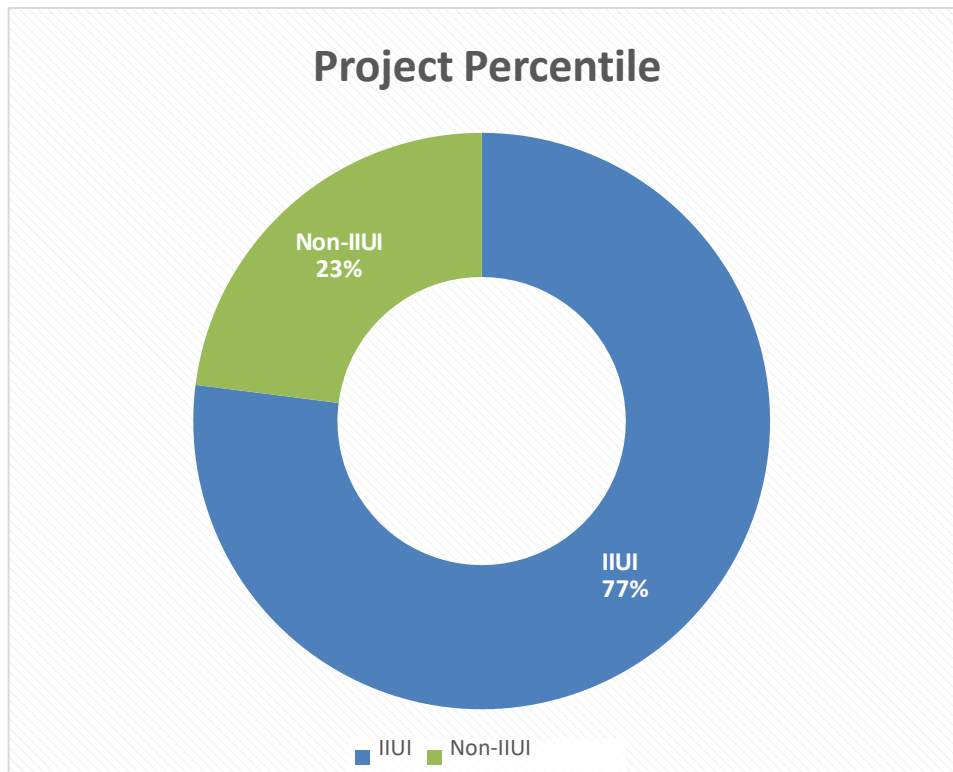
- Electrical and Electronic Engineering
- Physics/Nanotechnology
- Mechanical Engineering/Engineering Science/Materials Engineering
- Chemical & Process Engineering/Environmental Processes/ Civil Engineering
- Biomedical Engineering/ Bio Physics & Technology

Some of the frequent users of the Centre's facilities having **multiple and diverse** scientific projects are listed below:

	SOME OF THE FREQUENT USERS
▪	Department of Electrical Engineering (International Islamic University, Islamabad)
▪	Department of Mechanical Engineering (International Islamic University, Islamabad)
▪	Department of Civil Engineering (International Islamic University, Islamabad)
▪	Department of Physics (International Islamic University, Islamabad)
▪	Department of Environment Sciences (International Islamic University, Islamabad)
▪	Department of Bio-Technology (International Islamic University, Islamabad)
▪	Sulaiman Bin Abdullah Aba Al-Khail – Centre for Interdisciplinary Research in Basic Science (SA-CIRBS) (International Islamic University, Islamabad)
▪	Bahria University, Islamabad
▪	School of Chemical & Material Engineering (NUST)
▪	College of Electrical and Mechanical Engineering (NUST)
▪	U.S Pakistan Center for Advanced Studies in Energy (NUST)
▪	COMSATS Institute of Information Technology, Islamabad
▪	COMSATS Institute of Information Technology, Abbottabad
▪	Gomal University, D.I Khan
▪	National Institute Of Lasers & Optronics (NILOP)
▪	The National Engineering and Scientific Commission (NESCOM)
▪	Riphah University, Islamabad
▪	The Islamia University of Bahawalpur
▪	Ummal - Qura university Makkah, KSA
▪	Federal Urdu University of Arts, Science & Technology, Karachi
▪	Mirpur University of Science and Technology
▪	University of Kotli, AJK
▪	Abdul Wali Khan University, Mardan
▪	Ghulam Ishaq Khan Institute (GIKI, Topi)
▪	National University of Computer and Emerging Sciences (FAST)
▪	Quaid-i-Azam University
▪	Sardar Bahadur Khan Womens University



User Access & Support of Facilities in the Centre



Share of Service Projects in the Reporting Period

Current Academic Program

Centre is the custodian of Department of Electrical Engineering's MS/PhD program with strength in Advanced Electronics stream.

Facility Usage in Regular Teaching Hours

Under graduate courses

- Microelectronics technology
- VLSI technology
- Optoelectronics
- Selected FYPs

Almost 150 undergraduate students, both from male and female sections of BS Electrical Engineering Program are being taught in the Centre for hand-on sessions in multiple courses.

Graduate (MS/PHD) Courses offered in the Centre

- Microelectronic Devices
- Microsystems Technology
- Optoelectronic Devices
- Microwave and Millimeter-wave Devices
- Advanced Computer Architecture
- Advanced VLSI Design
- Photonic Devices & Circuits

- MEMS and Micromachining
- Advanced Microelectronic Technology
- Advanced Semiconductor Devices
- Modeling and Simulation of Semiconductor Devices
- Photovoltaic Electronics
- Power Semiconductor Devices
- Photovoltaic Material system
- Analytical Methods in Nano-scale Electronics
- Micro fluidics and Lab-on-a-chip Systems
- Advanced Multiprocessor Systems
- VLSI Test Principle and Challenges
- Integrated Circuits (IC) Packaging
- Integrated Chip (IC) Manufacturing Technology
- Semiconductor Device Reliability
- Organic Electronics
- Smart Sensors Technology
- Infrared Detectors & Systems
- Energy Materials Design
- Advanced Thermoelectric Technology
- Special Topics in Nanoelectronics
- Advanced Nano-scale Photovoltaics
- Compound Semiconductor Device Processing
- Quantum Information Process Devices
- Computational Nano electronics
- Special Topics in Electronic Design Technology
- Special Topics in Micro and Nanosystem
- Special Topics in Optoelectronics and Photonics

Data Statistics

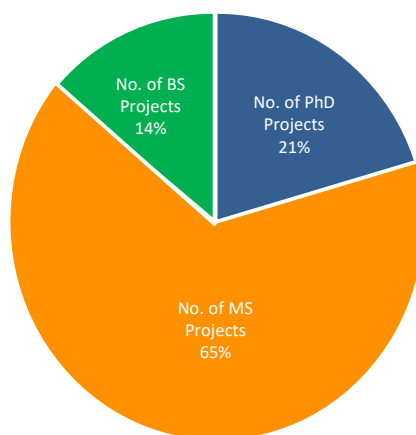
- A large number of students are getting trained, guided and supervised in the Centre since the very inception of the laboratories.
- Each project has an average tenure of almost 1 year and 2-3 years for MS and PhD research students, respectively, for experimental training and facility usage.
- Currently over 60 students from graduate program alone from the Department of Electrical Engineering, are engaged with the Centre for taught courses and research access and supervision. Students and faculty members from other departments in the university and other organization are separately recorded with unique project's identification numbers.

Sr. #	Content	No. of projects
1	Total number of the projects	300+
2	IIU share of the projects	231
3	Non-IIU share of the projects	69
4	No. of MS Projects	195
5	No. of PHD Projects	63
6	No. of BS Projects	42
7	No. of the departmental students (MS/PhD) associated with the Centre	60 +
8	No. of Q.A & Trainings conducted	1000 +
9	No. of International Training conducted for the Centre staff	4
10	No. of National Training conducted for the Centre staff	5



Research Students Using the Centre's Facilities

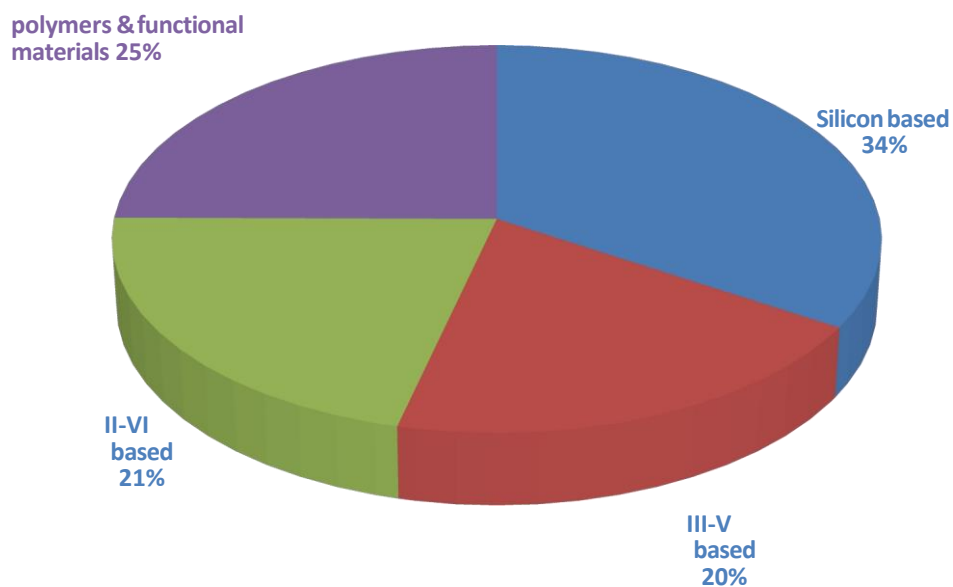
Spread of Projects



■ No. of PhD project ■ No. of MS project
■ No. of BS projects

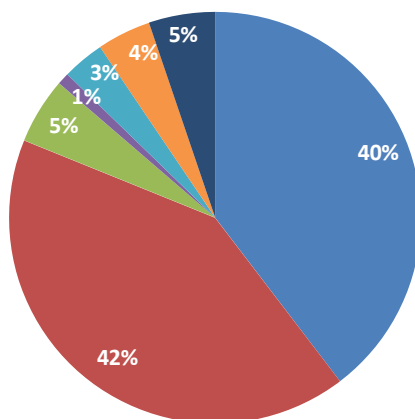
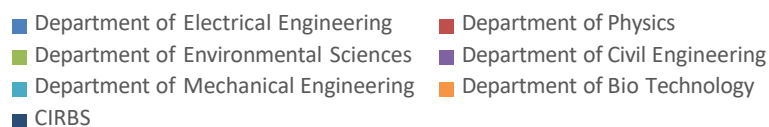
Proportion of Student - wise Usage of Facilities

Project Streams



Electrical & Optical Material – Wise Usage of Centre's Facilities

IIU's Department Wise Usage of Centre 's Facilities



List of Frequent/Primary Users* from Faculty Members in the University

Dr. Naeem Ahmad	Dr. Rafiullah Khan
Dr. Shaista Shehzada	Dr. Islamud Din
Dr. Javed Iqbal	Dr. Rehana Mustafa
Dr. Waqar Adil	Dr. Ghulam Mustafa
Dr. Nyla Jabeen	Engr. Waqas Haroon
Dr. Masoom Yasinzai	Dr. Mehwish Taneez
Dr. Ahmed Shuja Syed	Engr. Mamoon Riaz
Dr. Syed Salman Hussain	Dr. Sobia Tabassum
Dr. Seyab Khan	Dr. Syed Ali Imran
Dr. Afzal Hussain	Dr. M. Mumtaz
Dr. M. Mumtaz	Dr. Bushra Hazeef Kiyani
Dr. Laraib Ahmed Khan	Dr. M. Rahim
Dr. Bashir Ahmad	Dr. Inayat Ali Khan
Dr. Ahsan Ullah Kashif	Dr. Abdul Hameed
Dr. Erum Jamil	Dr. Aqsa Arshad
Dr. Kashif Nadeem	Dr. Gul Hassan
Dr. Wiqar Hussain Shah	Dr. Kiran Abdullah
Dr. Bushra Bari	Dr. Rakshanda Aziz
Dr. Shumaila Sajjad	Dr. Maliha Asma
Dr. Imran Murtaza	Dr. Athar Masood
Dr. Bushra Uzair	Dr. Saba Ashraf
Dr. Zulfiqar Ali	

* Secondary Users Not Counted

Events

The Centre hosts a week-long workshop for the faculty and the students of the Faculty of Engineering & Technology, every year; this activity is usually connected with Pakistan Engineering Council CPD program. The workshop is aimed to introduce the new technologies present in the Centre (CAEPE) to the students and the teachers, and train them on some of the cutting-edge research tools.



**Workshop & Interactive Session on
“Design optimization of solar cell
in Solar Cell Capacitance
Software”**

Centre for Advanced Electronics & Photovoltaic Engineering offers a 1-day workshop on **Design optimization of solar cell in Solar Cell Capacitance Software** for all of its graduate students who are entering into research phase from FALL 2019. Numerical modeling or analysis is a computer simulation program which uses the mathematical model for the implementation of a physical system. It is an essential tool for better understanding of the working parameters of any device. Numerical analysis can play a significant role in the manufacturing and fabrication of efficiently working semiconductors based photovoltaic devices. For design engineers and researchers, the highest priority job of numerical modeling techniques implementation is the integration of real-life problem with virtual machine environment because of finding the optimum and efficient ways for solving a complex problem. The precious time is saved due to performing the real design problem in computer-based tests environments without physical or practical implementation, so research institutions and universities emphasize computer-based learning techniques. For the numerical modeling of solar cells, physical parameters of material are taken as input for the simulation software. To translate the practical or real device $J - V$ characteristics and functional parameters such as power conversion efficiency, fill factor, open circuit voltage and short circuit current in device modeling, it is mandatory to take experimental data. Numerical simulation provides a better and easier way to understand the device behavior.

2nd December 2019

Timing:
11:00 am – 4:00 pm

Venue:
Centre for Advanced Electronics & Photovoltaic Engineering (CAEPE),
International Islamic University,
H-10, Islamabad

Themes

- Introduction to SCAPS
- Implementation of simple solar cell structure in SCAPS
- Numerical modeling for the efficiency enhancement of thin film solar cell in SCAPS
- Design optimization of solar cell structure in SCAPS
- Validation of experimental solar cell results in SCAPS

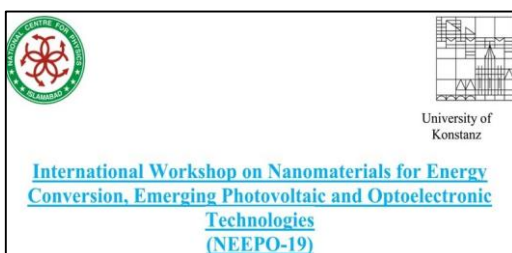
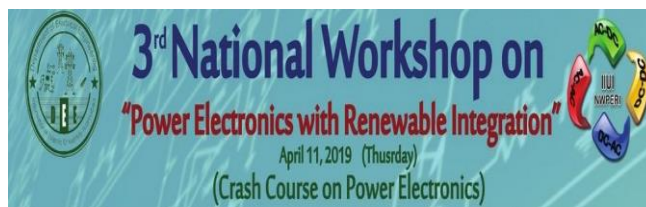
Who Should Attend?

Faculty members and research students of MS/PhD from IIUI who are entering into research phase from FALL 2019.

CAEPE in its present form and previously as IDB-funded laboratories project had taken several initiatives to conduct seminars, training weeks, national level workshops to introduce the frontiers of Advanced Electronics and PV Engineering to a larger audience. Similarly; we have been part of several international conferences in capacity of conference directors/advisors, co-organizers & focal point of tutorial sessions, international and technical committees, and keynote/plenary speaker. A list of few such events in the reporting period is as follows:

Sr. No.	Event	Venue	Dates
1.	3 rd International Conference on “Computing, Mathematics and Engineering Technologies iCoMET”	Sukkur, Pakistan	29 - 30 January, 2020
2.	Workshop & Interactive Session on “Design optimization of solar cell in Solar Cell Capacitance Software	CAEPE, IIUI	2 December, 2019
3.	International Conference on “Latest trends in Electrical Engineering &	Karachi, Pakistan	13 - 14 November, 2019

	Computing Technologies”		
4.	International Workshop on “Nanomaterials for Energy Conversion, Emerging Photovoltaic and Optoelectronic Technologies (NEEPO-19)”	Islamabad, Pakistan	7 – 9 October, 2019
5.	3rd National Workshop On “Power Electronics with Renewable Integration”	IIUI, Pakistan	11 April, 2019
6.	Emerging Trends and Applications of Optics, Photonics and Lasers (ExTRA – OPAL)	Islamabad, Pakistan	11 – 12 March, 2019
7.	Workshop & Interactive Session On “Energy Storage System: Science, Technology & Innovation”	IIUI, Pakistan	6 December, 2018
8.	Workshop, Panel Discussion & Interactive Session On “Innovation and Technology Development in Electronics and Energy Research”	IIUI, Pakistan	26 April, 2018
9.	2nd International Conference on “Intelligent Systems Engineering (ICISE)”	IIU Malaysia	20 – 21 March, 2018
10.	5th International Conference on Electrical Engineering (ICEE)	UET, Lahore Pakistan	15 – 16 February, 2018



Dissemination

The Centre is focused to create knowledge in the form of original work. With a keen and rigorous approach to publish in quality journals having meaningful impact across the wider scientific community, the students are encouraged to learn the experimental techniques, data analytics, theoretical framework building on the experimental observation and subsequent reporting in form of papers. The Executive director (CAEPE), faculty and the Centre's core students are demonstrating the original work in form of research papers, reports, lectures, thesis and pump – priming projects for grant applications.

Some of the **prominent** papers published in very important and **high impact factor** international journals, with in the reporting period are listed below:

- Highly sensitive wide range linear integrated temperature compensated humidity sensors fabricated using Electrohydrodynamic printing and electrospray deposition. Sensors and Actuators B Chemical, vol. 308, 128680, 2020.
- Effect of Fluoro-Substituted Acceptor-Based Ancillary Ligands on the Photocurrent and Photovoltage in Dye-Sensitized Solar Cells. Solar Energy, In Press, 2020.
- Interfacial Modification for Heightening the Interaction between PEDOT and Substrate towards Enhanced Flexible Supercapacitor Performance. Chemical Engineering Journal, vol. 379, 122326, 2020.
- Electrical, charge transients and photo response study of as-deposited and phosphorus implanted Cd_{1-x}Zn_xTe devices for PV applications. Radiation Physics and Chemistry, vol. 166, 108498, 2020.
- Highly bendable asymmetric resistive switching memory based on zinc oxide and magnetic iron oxide heterojunction. Journal of Materials Science: Materials in Electronics, vol. 31, 1105, 2020.
- Evaluation of defects and current kinetics for aging analysis of PEDOT: PSS based supercapacitors. Journal of Energy Storage, vol. 28, 101243, 2020.
- Ion-Induced Electrical Isolation in GaN-Based Platform for Applications in Integrated Photonics. IEEE Access, vol. 7, 184303, 2019.
- Investigation of Transport mechanism in graphene-induced Metal-Oxide-Semiconductor Capacitors (MOSCAP). Chinese Journal of Physics, vol. 61, 351, 2019.
- Investigations into Structure-Property Relationships of Ruthenium (II) Dyes with N,N'-diethyl group in Ancillary Ligand for Dye-Sensitized Solar Cells. Dyes and Pigments, vol. 171, 107754, 2019.
- The electrical behavior of functionalized multiwall carbon nanotubes decorated with polymer nanocomposites. Physica B: Condensed Matter, vol. 556, 17, 2019.
- Multi-colour electrochromic materials based on polyaromatic esters with low driving voltage. Journal of Materials Chemistry C, vol. 7, 9467, 2019.
- Effect of light and heavy ion irradiation on graphene device matrix: Optical and Transport Characteristics. Radiation Physics and Chemistry, vol. 156, 67, 2019.
- Bandgap engineering in TiO₂-Ge nanocomposite thin films. Arabian Journal of Science & Engineering, vol. 44, 603, 2019.

- Optimizing reaction kinetics of sequential deposition technique for ambient air and solution processed hybrid perovskite thin films. Journal of Materials Science: Materials in Electronics, vol. 30, 4250, 2019.
- Charge transient behavior and spectroscopic ellipsometry characteristics of TiN/HfSiO₂ MOS capacitors. The European Physical Journal Applied Physics, vol. 83, 10101, 2019.
- Defects anomaly in cobalt-doped ZnO nanostructures using optical and charge transient analysis. Chinese Journal of Physics, vol. 58, 159, 2019.
- Analytical Formulas for Mean Gain and Excess Noise Factor in InAs Avalanche Photodiodes. IEEE Transactions on Electron Devices, vol. 65, 610, 2018.
- Recombination strategy for processable ambipolar electroactive polymers in pseudo capacitors. Macromolecules, vol. 51, 5258, 2018.
- Structural, optical and annealing studies of nitrogen implanted GaAs. Physica B: Condensed Matter, vol. 544, 47, 2018.
- Investigation of the sensing mechanism in cobalt doped ZnO matrix based on structural, morphology, optical and electrical studies. Journal of Optoelectronics and Advanced Materials, vol. 20, 180, 2018.
- Mobility and perpendicular magnetic anisotropy in electrodeposited Co₃₂Fe₆₇B₁ thin films using boric acid as boron source. Journal of Magnetism and Magnetic Materials, vol. 458, 156, 2018.
- Simultaneous reduction and sulfonation of graphene oxide for efficient hole selectivity in polymer solar cells. Current Applied Physics, vol. 18, 599, 2018.
- Electrical and photo-stimulated characteristics of all-implanted CMOS compatible planar Si photodiode. Optik - International Journal for Light and Electron Optics, vol. 155, 297, 2018.
- Design, Electrical, and Optical Modelling of Bulk Heterojunction Polymer Solar Cell. International Journal of Photoenergy, vol. 2018, Article ID 9465262, 2018.



Visits

Some Important visits to the Centre are:

- The President Islamic Development Bank, KSA, His Excellency Dr. Bandar M. H. Hajjar visited Pakistan to discuss bilateral issues with the Prime Minister of Pakistan and other senior officials. During this visit,

Islamic Development Bank
Banque Islamique de Développement
President's Office - Bureau Du Président

البنك الإسلامي للتنمية
مكتب الرئيس

Date: 04/05/2019 التاريخ: 04/05/1440هـ
Corres: 04/07/4400
No: P-16905 الرقم: 04/07/4400
Encl: المرفقات:

Prof. Dr. Masoom Yasinzaï
Rector
International Islamic University
ISLAMABAD, Pakistan

Assalamu Alaikum Warahmatullahi Wabarakatuh

Excellency,

Please allow me to express my sincere gratitude for the warm welcome and hospitality graciously extended by the management of the International Islamic University Islamabad to the high-level delegation of the Islamic Development Bank (ISDB) Group during its recent visit to your prestigious institution on 3 May 2019.

The ISDB delegation was impressed by the achievements of IIUI and its impactful programs in all educational disciplines, particularly in science, innovation and technology. I was also pleased to see firsthand the implementation progress of the two scientific laboratories funded by the Bank.

I avail myself of this opportunity to assure Your Excellency of ISDB's willingness to continue strengthening its cooperation with your esteemed institution.

Please accept the assurances of my highest consideration.

Yours sincerely,
Dr. Bandar M.H. Hajjar
President,
Islamic Development Bank

8111 King Khalid St.
Al-Nadiah Al-Yamania Dist. Unit No. 1,
Jeddah 22332-2444,
Kingdom of Saudi Arabia
Tel: +966 12 6360400
Fax: +966 12 6366871
Pres@isdb.org
www.isdb.org

أ.هـ. شارع الملك خالد
حي النزهة اليمانية وحدة رقم 1،
جدة 22332-2444
مملكة العربية السعودية
هاتف: +٩٦٦١٢٦٣٦٠٤٠٠
فاكس: +٩٦٦١٢٦٣٦٦٨٧١
Pres@isdb.org
www.isdb.org



the delegation of Islamic Development Bank headed by its President graciously visited the Centre for Advanced Electronics & Photovoltaic

Engineering (CAEPE), at International Islamic University Islamabad.

- Islamabad. Dr. Hayat Sindi, the world-renowned scientist, entrepreneur and innovation expert was also part of the high-profile delegation.
- President, Shenzhen University (SZU), China, Prof. Li Qingquan along with his team of Professor(s) / Chinese delegation visited the Centre CAEPE
- Minister for Federal Education and



Professional Training Shafqat Mahmood inaugurated the Al-Farabi Research Complex at new campus of the International Islamic

University, Islamabad (IIUI) and visited the Centre

- The lead team headed by Dr. Ahsan Kibria, Operations Team Leader (Education), Islamic Development Bank, KSA visited the Centre for Advanced Electronics & Photovoltaic Engineering (CAEPE)
- Minhaj Khokhar, Former Advisor to PM Malaysia Mohatir Muhammad (on Technology), CEO and Venture Capitalist visited the Centre CAEPE from Silicon Valley, USA to discuss technology development and joint projects in Solar Cell/PV manufacturing in Pakistan



➤ Prof. Dr. Tahir Khan Dean of Engineering from University of Bradford visited CAEPE

➤ The lead team of Directorate of Science and Technology (DOST), KPK Peshawar visited the Centre CAEPE

➤ IsDB Education Supervision Mission comprised of Mr. Jawara Gaye, Global Lead Education Specialist and

Mr. Inamullah Khan, Field Representative, IsDB Pakistan visited Centre For Advanced Electronics & Photovoltaic Engineering (CAEPE) at IIUI. The Mission visited the Centre facilities and Met the Rector and the President of the University

- Pakistan Science Foundation (PSF) Team lead by Dr. Mirza Habib Ali, Director Research visited the Centre and interacted with the team therein visited the Centre For Advanced Electronics & Photovoltaic Engineering (CAEPE)
- Prof. Bernabé Marí Soucase from Technical University of Valencia, Spain and Dr. Alessandro Zanarini from



University of Bologna, Italy visited the Centre

- Dr. M. Mazhar Saeed, Director General, Planning & Development Division of Higher Education Commission visited the Centre
- Planning Commission Pakistan and HEC Joint Team visited the Centre
- Vice Rector Cumhuriyet University, Turkey, Dr. Unal Kilic visited the Centre

- Dr. Muhammad Ali Muhammad, Director Research NUST visited the Centre
- Delegate from Directorate General Audit Works (Federal) visited the Centre
- A high-profile diligation from KSA visited the Centre
- Visitors from NCP, GIK, Riphah at CAEPE
- High End dignitaries from National Centre For Physics visited the Centre CAEPE



- Emeritus Professor M. H. Rashid from Florida Polytechnic University, USA visited the Centre



Glimpse from some of the Visits to the Centre

- Vice Chancellors, heads of Scientific Organizations, review panels and evaluation experts from HEC and PEC, Deans and Chairs of various engineering and sciences program from universities all across Pakistan continued visiting the Centre and got abreast with our facilities, services and collaborative research models, throughout the reporting period.





A PARADIGM SHIFT IN ELECTRONICS AND ENERGY RESEARCH

ADDRESS

CENTRE FOR ADVANCED
ELECTRONICS &
PHOTOVOLTAIC ENGINEERING
(CAEPE)
FIRST FLOOR,
AL-FARABI RESEARCH
COMPLEX
INTERNATIONAL ISLAMIC
UNIVERSITY, SECTOR H-10
ISLAMABAD, PAKISTAN
PHONE #: 0092-51-9019927
0092-51-9019779
FAX #: 0092-51-9258019

CONTACT



[http:// www.iiu.edu.pk/caepe](http://www.iiu.edu.pk/caepe)



aelp@iiu.edu.pk



facebook.com/caepeiiui

Talk:

- Prof. Dr. Ahmed Shuja Syed
(Executive Director)
- Dr. Gul Hassan
(Cleanroom Manager)
- Engr. Shoaib Alam
(Laboratories Manager)

