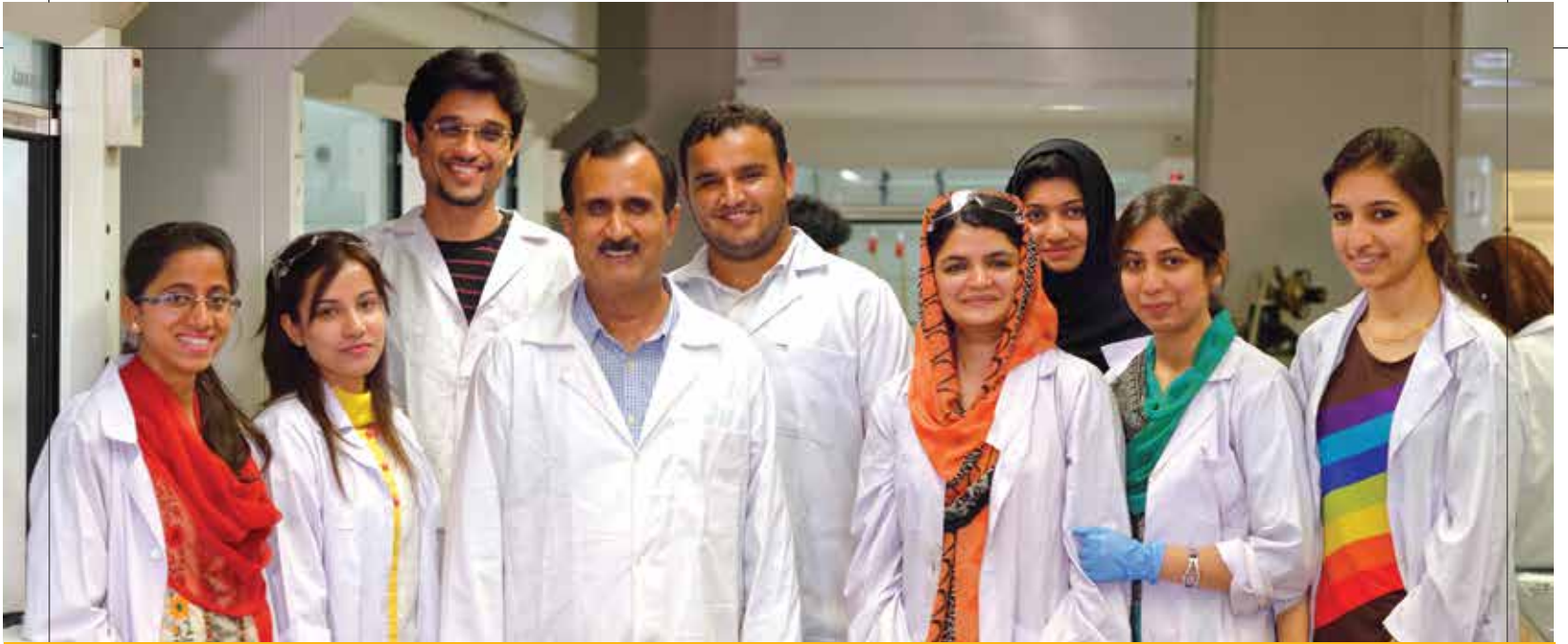# LUMS

SYED BABAR ALI SCHOOL OF SCIENCE & ENGINEERING
GRADUATE PROGRAMMES

Lahore University of Management Sciences

The Syed Babar Ali School of Science and Engineering (SBASSE) was established in 2008. It comprises of the departments of Biology, Chemistry, Computer Science, Electrical Engineering, Mathematics and Physics.

Contents

Introduction to LUMS

The Lahore University of Management Sciences (LUMS) is ranked amongst the top 170 universities in Asia by QS World University Rankings. It is one of the top degree awarding institutions in the region, with a strong aim to advance education in a broad range of disciplines including business management, selected areas of sciences and engineering, humanities, social sciences, economics and law. The faculty at LUMS includes 170 PhDs from some of the world's finest institutions including Cambridge, Oxford, MIT, UC-Berkeley, Georgia-Tech, Harvard and Stanford.
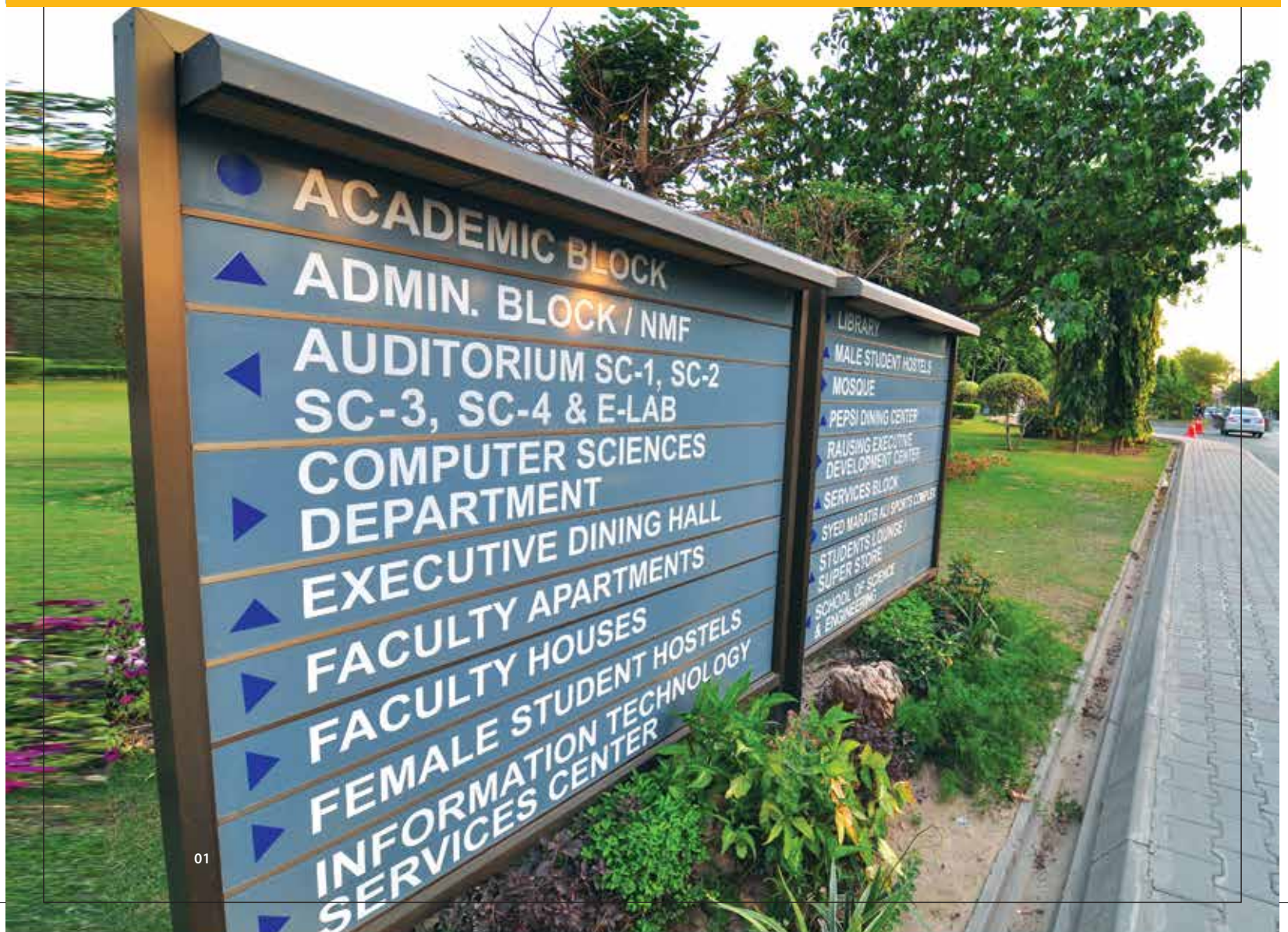
Syed Babar Ali School of Science and Engineering (SBASSE)

Initiated in 2008, SBASSE is the pioneering private research school in Pakistan that imparts top quality education in selected areas of science and engineering. It offers 4-year undergraduate programmes in Biology, Chemistry, Computer Science, Electrical Engineering, Mathematics and Physics that lead to a BS degree. SBASSE also offers MS and PhD programmes in all six disciplines. The School has an excellent infrastructure and state-of-the-art laboratories for conducting research that requires experimentation. Additional information about SBASSE, its academic programmes, research activities as well as its faculty are available at www.lums.edu.pk/sbasse.

MS

Biology

Chemistry

Computer Science

Electrical Engineering

Mathematics

Physics

The MS Programme

The MS programmes at SBASSE are rigorous and designed to challenge incoming students. To graduate, students must accumulate a total of 30 credit hours either entirely from coursework, or by collecting 24 credit hours from coursework and the rest from a thesis. Students should note that not all SBASSE departments offer the "MS-by-coursework" option. The typical duration for completing the MS programme is 2 years.

PhD

Biology

Chemistry

Computer Science

Electrical Engineering

Mathematics

Physics

The PhD Programme

The SBASSE PhD programme prepares students to think scientifically and conduct high quality research independently. Students entering the PhD programme must have an MS or MPhil degree. To graduate, students must earn a total of 42 credit hours from which 18 must be from coursework and 24 from research. Students are encouraged to tackle both coursework and research in parallel; success in both these components is a requirement for the award of the PhD degree. Major milestones that must be achieved for the successful completion of the PhD degree include clearing the GRE Subject Test with a score at the 60th percentile or above, comprehensive/qualifying examination, thesis proposal defense, thesis defense and a first-author publication in an indexed journal. Students have 4 years to complete all graduation requirements. All PhD students admitted to SBASSE are provided a full tuition fee waiver and a monthly stipend of PKR 40,000 to cover their living expenses. Continuation of financial support is dependent on satisfactory academic performance.

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Department of Biology

The Department of Biology offers MS and PhD programmes in Molecular Biology. The programme aims to produce knowledgeable and independent researchers who are well versed in recent literature and trends in molecular and cell biology, capable of identifying important unanswered questions, designing and carrying out experiments, and also analysing and interpreting experimental data. State-of-the-art research labs, experienced faculty along with a collaborative environment conducive to professional growth and development, contribute to the programme's competitive edge.

Research Opportunities

Research is an essential component of any graduate programme. In this context, graduate students of Biology are exposed to advanced courses in a wide range of research areas in Molecular and Cell Biology, Genetics and Epigenetics, Biochemistry and Biophysics, Structural and Computational Biology and subsequently select a research project that is to their liking. Current research projects address fundamental questions in biology including how complex organisms develop from a single cell and how cell fates are determined, how gene expression is regulated in extremophilic microbes, how plants fight disease and develop resistance, how viruses evolve, how drugs and immunoprophylatics are developed against viral infections and in complex diseases such as cancer. Mammalian, Drosophila, plant, bacterial and pseudo-viral systems are employed to answer some of these questions through experimentation and use of computational biological approaches in silico. The Department's computational biologists employ mathematical and statistical tools, and develop algorithms to mine large sets of data in order to understand how genomes evolve and how cancer progresses. Biology labs are equipped with equipment that include confocal microscope, fluorescence activated cell sorters (FACS), fast protein liquid chromatography (FPLC) apparatus, conventional and real-time thermocyclers, ultrasonic bioruptor, gel documentation system, electrophoresis equipment, temperature-controlled water-baths, shakers, and incubators, high-speed centrifuges, cell and tissue culture rooms as well as, a facility for growing plants.

A walk-in cold room is also available for protein purification and storage. In addition, the Department also has a computational biology laboratory that is fully equipped with computers and essential software that is required for simulating processes and solving various biological problems in silico.

Faculty

The Department of Biology is led by the following members of faculty who are accomplished and experienced in their respective areas of expertise. Additional faculty members are constantly sought to further strengthen and expand the Department's research programmes.

Amir Faisal PhD, Friedrich Miescher Institute for Biomedical Research, Switzerland	**Ahmed Jawaad Afzal** PhD, Southern Illinois University, USA
Aziz Mithani PhD, University of Oxford, UK	**Muhammad Tariq** PhD, Friedrich Miescher Institute for Biomedical Research, Switzerland
Sadia Hamera PhD, Chinese Academy of Sciences, China	**Saima Anwar** PhD, University of the Punjab, Pakistan
Safee Ullah Chaudhary PhD, Korean Advanced Institute of Science and Technology, South Korea	**Shaper Mirza** PhD, University of Alabama at Birmingham, USA
Syed Shahzad ul Hussan PhD, University of Lubeck, Germany	

Research Programmes

Research programmes led by the Biology faculty members are listed below.

Dr. Muhammad Tariq
Research Interest: Epigenetics
The epigenetics laboratory at SBASSE utilises the fruit fly (Drosophila melanogaster) as a model system to understand the role of Polycomb and Trithorax group proteins, which are known to play pivotal roles in maintenance of cell memory. Polycomb group proteins (PcG) maintain genes in a silent (inactive) state whereas Trithorax group proteins (TrxG) act as anti-silencers. The goals of the various ongoing projects are to understand at the molecular level how cell signalling is linked to maintenance of cell memory by PcG and TrxG, and how these factors may play a role in transgenerational inheritance of epigenetic states of gene expression.

Dr. Aziz Mithani
Research Interest: Computational Systems Biology
The focus of the Computational Systems Biology group is to develop and apply computational and mathematical methods to understand how biological systems function and evolve with time. Specifically, such approaches are being employed to decipher the genetics of bread wheat and understand the type and number of hybridization events through which modern day bread wheat has evolved from different goat grass and Eikorn (pasta wheat). This project is being carried out in collaboration with Harberd Laboratory at the Department of Plant Sciences, University of Oxford, and uses the latest technologies in genomic sciences including high-throughput sequencing and associated statistical analysis to determine the precise nature and extent of genetic variation that has led to the modern day bread wheat.

Dr. Saima Anwar
Research Interest: Cell Signalling and Epigenetics
Different cells in the body respond to a variety of intrinsic as well as extrinsic signals during normal development as well as pathological conditions by altering their gene expression profiles or patterns. The dual roles Polycomb Group of proteins (PcGs) play in maintaining cellular fate as well as its transition signifies the dynamic nature of cell memory. The laboratory aims to understand the role of PcGs in this process, and how PcGs and TrxGs mediated gene regulation is impacted by signalling cascades that are triggered by environmental factors including stress.

Dr. Safee Ullah Chaudhary
Research Interest: Biomedical Informatics
An integrative analysis of biological and clinical data can help researchers develop a deeper appreciation of the principles underpinning life. Towards this goal, the group constructs integrative models of complex pathologies, such as cancer, to as far as building decision support systems for conditions such as pregnancy. The current research focuses include multi-scale investigation of the human colon cancer, integrative modelling of cellular bioenergetics, development of a next-generation cancer modelling platform, top-down proteomics and remote e-health monitoring systems.

Dr. Syed Shahzad ul Hussan
Research Interest: Structural Biology Laboratory
Employing cell culture, biochemical methods, and nuclear magnetic resonance (NMR) based structural biology approaches, this group focuses on the following areas: 1. Probing structural and conformational properties of antibody target sites (epitopes) on envelope glycoproteins of hepatitis C virus (HCV). 2. Identification of new HCV neutralizing antibodies from sera of chronically infected patients. 3. Identification and engineering of HIV and HCV cellular entry inhibitor lectins and understanding their basis of blocking viral adhesion and entry by NMR spectroscopy.

Dr. Sadia Hamera
Research Interest: RNA Silencing and Host-pathogen Interactions
RNA silencing is a regulatory process that controls gene expression at transcription (TGS) and post-transcription (PTGS) levels. In TGS, RISC proteins AGO4/6 recruit siRNAs to maintain the epigenetic blueprints of repeat associated loci, transposons and silence exogenous nucleic acids through methylation. Plants take advantage of this silencing machinery for defense against pathogens. As an anti-host defense, pathogens in turn encode suppressor/effector proteins that block RNA silencing responses in hosts. The main focus of RNA silencing group is to decipher the roles of various components (and identify new ones if necessary) that are involved in plant innate immunity. Given that a large number of Pakistani crops are destroyed by pathogens, the major goal of this work is to improve the environmental fitness of economically important crops by enhancing their resistance against various pathogens.

Dr. Amir Faisal

Research Interest: Cancer Therapeutics

The promise of targeted or personalised treatments for cancer in a post-genomic era has been highlighted by the success of several drugs that target particular driving mutations in different types of cancer. The cancer therapeutics group at SBASSE is currently focused on the following: 1. Determining the mechanism of action of drugs that target proteins involved in cancer, including Aurora family of mitotic kinases. 2. Understanding the underlying mechanisms through which cells "learn" to become resistant to various drugs. 3. Identification of naturally occurring compounds for treating cancer (in collaboration with the Department of Chemistry). The group also aims to identify novel drug targets using synthetic lethal screens.

Department of Chemistry

The Department of Chemistry aspires to establish itself as an internationally recognised and globally competitive centre for graduate teaching and research. The Department has initiated and maintained internationally recognised research programmes in a wide variety of chemical disciplines for the last few years that include nanoscience and nanotechnology, materials chemistry, catalysis, drug discovery and medicinal chemistry. The faculty consists of an outstanding group of scientists who are committed to pursuing and maintaining excellence in research.

The graduate programme (MS and PhD) in Chemistry is an exciting opportunity for students to take advantage of the Department's conducive and thriving research environment to contribute effectively in the development of science. The Department's mission is to produce outstanding graduates who can excel and become future leaders in academia and industry.

Research Opportunities

The Department of Chemistry at LUMS is comprised of a diverse group of research-active faculty members. In addition to the traditional areas of chemical sciences, they work on interdisciplinary research projects interfacing chemistry with various fields, including Biology, Medicine, Physics, Environmental and Material Science and Engineering. The faculty research groups are actively working to develop world-class research programmes in Nanoscience and Nanotechnology, Macromolecular Chemistry, Green Synthesis/Catalysis, Renewable Energy Technologies, Drug Discovery, Medicinal Chemistry, Healthcare and Environmental Remediation.

Chemistry teaching and research labs are well equipped with the state-of-the-art experimental facilities and equipment. There is a good collection of supplies and equipment including spectroscopic, structural and materials characterization tools. These tools include field emission scanning electron microscope equipped with advanced detectors, EDS and e-beam lithography, NMR (23 MHz), GC-MS, TGA-DTA, DSC, LC-MS, HPLC, Vibrating Sample Magnetometer (VSM), XRD, Zetasizer Nano – ZSP, Multi-label Plate reader, FT-IR spectrometer with diamond ATR attachment, FT-IR spectrometer for thin films analysis, UV-Vis spectrophotometers, spin coaters, microwave synthesizer (CEM), refrigerated/non-refrigerated micro-centrifuges, high-temperature furnaces, photo-reactors, pellet press machine, high-temperature autoclave with steel/teflon reactor, impedance analyzer with climate chamber attachment, potentiostat with cyclic voltammeter, contact angle measuring equipment, magnetic susceptibility balance goniometer and more.

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The Chemistry faculty has developed very effective and fruitful research collaborations with prominent national and international research groups in USA, UK, Germany, Switzerland, Turkey, China and Saudi Arabia. These collaborations are very helpful in keeping the faculty abreast with the latest developments in the field and to use advanced technology platforms and high-tech equipment that are currently not available anywhere in Pakistan. So far, these collaborations have been very effective in getting highly competitive international research grants and in publishing high quality research articles in prestigious international journals.

Faculty

The Chemistry faculty is committed to achieving excellence in teaching and developing world-class research programmes especially at the interface of Chemistry and other science and engineering disciplines. Given below is the list of currently available faculty and their research areas:

Basit Yameen PhD, Max Planck Institute, Mainz, Germany	**Salman Noshear Arshad** PhD, University of Illinois at Urbana-Champaign, USA
Ghayoor Abbas PhD, Michigan State University, USA	**Falak Sher** PhD, University of Cambridge, UK
Irshad Hussain PhD, University of Liverpool, UK	**Habib-ur-Rehman** PhD, Leibniz Institute for New Materials, Germany
Muhammad Zaheer PhD, University of Bayreuth, Germany	**Muhammad Saeed** PhD, University of Tubingen, Germany
Rahman S. Z. Saleem PhD, Michigan State University, USA	

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Research Programmes

Research programmes led by the Chemistry faculty members are listed below.

Dr. Ghayoor Abbas
Research Interest: Catalysis and Green Chemistry
This group is interested in designing novel green synthetic methodologies for the functionalisation of aromatic hydrocarbons. The newly synthesised organic compounds will have applications in a wide range of areas including pharmaceutical chemistry, polymer chemistry, renewable energy and catalysis and material science.

Dr. Salman Noshear Arshad
Research Interest: Nano-Engineered Materials
This group focuses on the design and synthesis of novel hierarchical and multifunctional nanoscale materials with tunable microstructures and properties. The emphasis is on the low cost and scalable nanoscale materials and their nanocomposites for energy, environment and bio-related applications. Moreover, the group has research interests in in-situ electron microscopy for characterising the mechanical response of materials at nanoscale and how the interfaces can be engineered for maximum performance.

Dr. Irshad Hussain
Research Interest: Functional Nanomaterials
This group focuses on the synthesis of metal/metal oxide nanoparticles/nanoclusters with a fair control over their size, shape and surface chemistry, their use as building blocks to develop new nanostructured materials with controlled nanoscale features and unique properties. These nanomaterials are also being evaluated to explore their potential applications in renewable energy technologies (solar/fuel cells and H2 production), catalysis, drug/gene delivery, disease diagnostics, sensing, bacterial detection and environmental remediation.

Dr. Habib-ur-Rehman

Research Interest: Polymers and Nanocomposites

This group focuses on the synthesis of low loss optical materials that can be used in micro photolithography for a wide range of applications such as in backplanes, photonics, microfluidics, data communications and telecommunications. In addition, processes are being developed to produce high refractive index materials (hybrids and nanocomposites) and thin films of silica, polymers and metal oxides for applications in photonics and renewable energy technologies.

Dr. Muhammad Saeed

Research Interest: Synthetic Organic Chemistry and Chemical Biology

This group focuses on unravelling molecular mechanistic details of disease development by various endogenous and exogenous factors, and discovering disease specific and pharmaceutically exploitable new targets. Current research involves the investigation of the role of estrogen metabolism in development of breast and prostate cancers, and discovering/synthesizing new organic compounds for pharmaceutical intervention. Additionally, the group is involved in discovering new organic reactions and developing novel organometallic compounds in the pursuit of accomplishing total syntheses of biologically active aporphine alkaloids. To accomplish these scientific endeavours, the group exploits techniques of synthetic organic chemistry, chromatographic sciences and chemical biology.

Dr. Rahman S. Z. Saleem

Research Interest: Drug Discovery

This group focuses on the development of next generation drugs and molecules with potential biological applications. The group is especially interested in exploring the chemical space for cancer treatment, in the molecules that can modulate the activity of viruses of the Flaviviridae family, especially HCV and the dengue fever virus and in molecules that can help in the understanding of the mechanism of action of potential inhibitor. Currently, this group is working on the check-point kinase 2 inhibitors, p53 peptidomimetics (both of which are potentially useful targets for therapeutic intervention in cancer treatment) and anti-malarial drugs.

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Dr. Falak Sher
Research Interest: Solid State Chemistry

This group focuses on the synthesis of functional inorganic materials such as electronic and magnetic metal oxides by the conventional solid state and sol gel methods, their crystal structures analysis by the powder X-ray diffraction and investigation of other physical properties.

Dr. Basit Yameen
Research Interest: Soft Matter and Interfaces

This group focuses on the design and synthesis of functional bulk and surface tethered polymers, complex macromolecular architecture, stimuli responsive macro and nanoscale (smart) materials, surface functionalisation of nanoparticles, nanoporous materials, and nanocomposites for applications in alternative energy technologies (solar/fuel cells), addressing environmental challenges (remediation and sensing), and engineering materials for biomedical applications (nanomedicine).

Dr. Muhammad Zaheer
Research Interest: Nanocatalysis

This group focuses on the design of robust, active, selective and environmentally benign heterogeneous catalysts for the production of renewable energy, biofuels and biochemicals. Mono/bimetallic nanoparticles are dispersed over highly robust silicon carbide (SiC) and silicon carbonitride (SiCN) supports whose porosity is tuned by the self-assembly of diblock copolymers. The nanoporous catalysts are tested for their potential applications in CO2-neutral and reversible storage of hydrogen in renewable liquid organic compounds, for instance, glycerol and formic acid.

Department of Computer Science

The Department of Computer Science at LUMS boasts fourteen full-time faculty members, with doctorates from some of the best universities in the world. The major research areas in the Department include Computer Vision, Data Mining, Networks and Distributed Systems, Software Engineering, Theory of Computation, Artificial Intelligence and Robotics. Faculty members of the Department, together with their students, have published their research in renowned conferences and journals in the field. Over the past four years, the Computer Science faculty has published over 140 research papers and sought PKR 160 Million in research grants from national and international funding agencies. Computer Science graduates of LUMS are one of the most sought-after individuals in academia and industry, both locally and internationally. CS students have had direct placements at companies like Google, Microsoft and Facebook and have received admissions in leading universities of the world including MIT, Stanford, Harvard and UIUC.

Research Opportunities

As an integral element of a graduate education, Computer Science at SBASSE provides unmatched research possibilities, opportunities and resources. Graduate students are exposed to a wide array of research areas in Research Computer Vision, Data Mining Networks and Distributed Systems, Software Engineering, Algorithms and Theory of Computation, Artificial Intelligence and Robotics. The Department not only encourages students to get involved in rigorous research alongside coursework but also provides fully equipped clusters, groups and labs. The **Computer Vision Lab** was founded in 2003 as the first graduate research lab in the Department of Computer Science, LUMS, and the first computer vision lab in Pakistan. The **Robotics and Intelligent Computing (RICE) Lab** has developed two working robots indigenously, and plans to develop an automatic assembly line robotic system. The **Networks and Communications (NC) Lab** conducts research in Networking Systems. The lab supports both experimental as well as theoretical research in these areas. The lab has maintained collaborations with University of California (Davis), University of Pittsburgh, University of Illinois (Chicago), Swinburne University of Technology, Freiburg University, SRI International, Cisco Systems (San Jose), Marvell Semiconductor Corporation and Max Planck Institute for Software Systems. The **Knowledge and Data Engineering (KADE) Lab** has hardware and software resources for the development and evaluation of algorithms and computational models for analysis of large structured and semi-structured date-sets. KADE conducts research in Data Mining, Machine Learning and Intelligent Information Processing. **Software Engineering Research Lab (SERL)** is a group of dedicated individuals exploring new horizons in Software Engineering and its related areas. The focus of research undertaken by SERL members is in areas

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of software quality, self-managing software systems, e-government architectures, soft computing, code clone detection, software reuse, design patterns and refactoring, and autonomic computing. Another thrust of research in this lab is the research and programme analysis group at the Department of Computer Science. Research is focused on automated verification using programme analysis techniques to build reliable and secure programmes with an emphasis on parallel, distributed, and concurrent systems software.

Faculty

The Department of Computer Science has fourteen full-time PhD faculty members. All faculty members have several years of experience exhibited not only through their taught courses and curriculum but also through rigorous research work and publications in renowned journals and conferences. The Department is always looking forward to have new members to strengthen and expand their research programmes.

Arif Zaman PhD, Stanford University, USA	**Asim Salim ul Karim** PhD, Ohio University, USA
Basit Shafiq PhD, Purdue University, USA	**Hamid Abdul Basit** PhD, National University of Singapore, Singapore
Ihsan Ayub Qazi PhD, Pittsburgh University, USA	**Imdad Ullah Khan** PhD, Rutgers University, USA
Junaid Haroon Siddiqui PhD, UT Austin, USA	**Muhammad Fareed Zaffar** PhD, Duke University, USA
Mian Muhammad Awais PhD, Imperial College, UK	**Murtaza Taj** PhD, Queen Mary University of London, UK
Naveed Arshad PhD, University of Colorado, USA	**Shafay Shamail** PhD, Bath University, UK
Sohaib Ahmad Khan PhD, Central Florida University, USA	**Suleman Shahid** PhD, Tilburg University, Netherlands

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Research Programmes

Following is a list of faculty members and their core research areas:

Dr. Murtaza Taj & Dr. Sohaib Ahmad Khan
Research Interest: Research Computer Vision

Computer Vision focuses on the theoretical aspects as well as practical applications of machines that can 'see', that is, extract useful information from an image or video, to carry out certain functions or tasks. Current research in the Computer Vision Lab at SBASSE focuses on applications of this field for developing countries. In this context, recent projects include the development of a crawler for Google Earth that allows for segmentation of nucleated villages in satellite imagery, as well as the development of a low-cost ultrasound training simulator that will allow trainee doctors to practice without relying on real patients and innovative ways to map socio-economic parameters for Pakistan.

Dr. Asim Karim & Dr. Arif Zaman
Research Interest: Data Mining

Data Mining involves extracting informative patterns from large scale data-sets. The rapid growth in this field is fuelled by increasing demand for automated data analysis and the rise in computation power. The Computer Science Department at SBASSE is currently undertaking research in the realm of parallel algorithms for data mining, efficient message protocols and hardware/software performance benchmarking, machine learning and intelligent information processing. The Department has two fully equipped labs – Knowledge and Data Engineering Lab and High Performance Computing Lab with hardware and software resources for the development and evaluation of algorithms and computational models for analysis of large structured and semi-structured date-sets.

Dr. Muhammad Fareed Zaffar, Dr. Ihsan Ayyub Qazi, Dr. Basit Shafiq & Dr. Zartash Afzal Uzmi
Research Interest: Networks, Information Security, Privacy and Distributed Systems

This research area explores the manner in which computing devices interconnect and the design of innovative computer systems that such interconnection enables. The focus is on the fundamental theory of computer networks and innovative applications of systems especially in the context of the developing world. Areas of research include cloud computing and data centres, mobile and wireless networks, network security, pervasive computing, multimedia communications, access control, data privacy and smart grids. Faculty members working in this area have published their research in the most prestigious conferences and journals including ACM SIGCOMM, IEEE INFOCOM, ACM CoNEXT, ACM IMC, IEEE/ACM Transactions on Networking and ACSAC.

Dr. Hamid Abdul Basit, Dr. Naveed Arshad, Dr. Junaid Haroon Siddiqui, Dr. Shafay Shamail & Dr. Suleman Shahid

Research Interest: Software Engineering

Software Engineering is the study and application of engineering to the design, development, and maintenance of software. The focus of the research undertaken by the Software Engineering Lab is in the areas of Software Reengineering, Software Testing and Quality Assurance, Software Engineering for Smart Grids, Formal Verification and Validation, Software Architectures for e-Government initiatives, and Software Engineering for Healthcare Systems. The research output of the Software Engineering group has been disseminated at various top international conferences and journals like ICSE, ICSM, OOPSLA, TSE, TSG, SASO, and ASE, among others in recent years.

## Dr. Imdad Ullah Khan & Dr. Arif Zaman

**Research Interest: Algorithms and Theory of Computation**

Theory of Computation is the formal study of the power as well as limits of computing machines. This is accomplished by the design of efficient algorithms as well as proofs of intractability for various computational problems. Theoretical computer science includes sub-areas such as Graph Theory and Algorithms, Randomized Algorithms, Data Structures, Complexity Theory, Computational Biology, Computational Geometry, Cryptography, Computational Learning Theory and Coding Theory.

Dr. Mian Muhammad Awais & Dr. Asim Karim

Research Interest: Artificial Intelligence and Robotics

Artificial Intelligence and Robotics research at LUMS is primarily focused on Applied Soft Computing, with contributions to the fields of Intelligent Speech and Natural Language Processing, Intelligent System Modelling, Simulation and Controls, Data Mining and Self Rule Generation, Artificial Intelligence, Databases and Aspect Oriented Programming, Neural Networks and Fuzzy Systems, and Robot Design, Planning, and Learning. The Robotics and Intelligent Computing (RICE) lab at SBASSE has also developed two working robots indigenously and plans to develop an automatic assembly line robotic system.
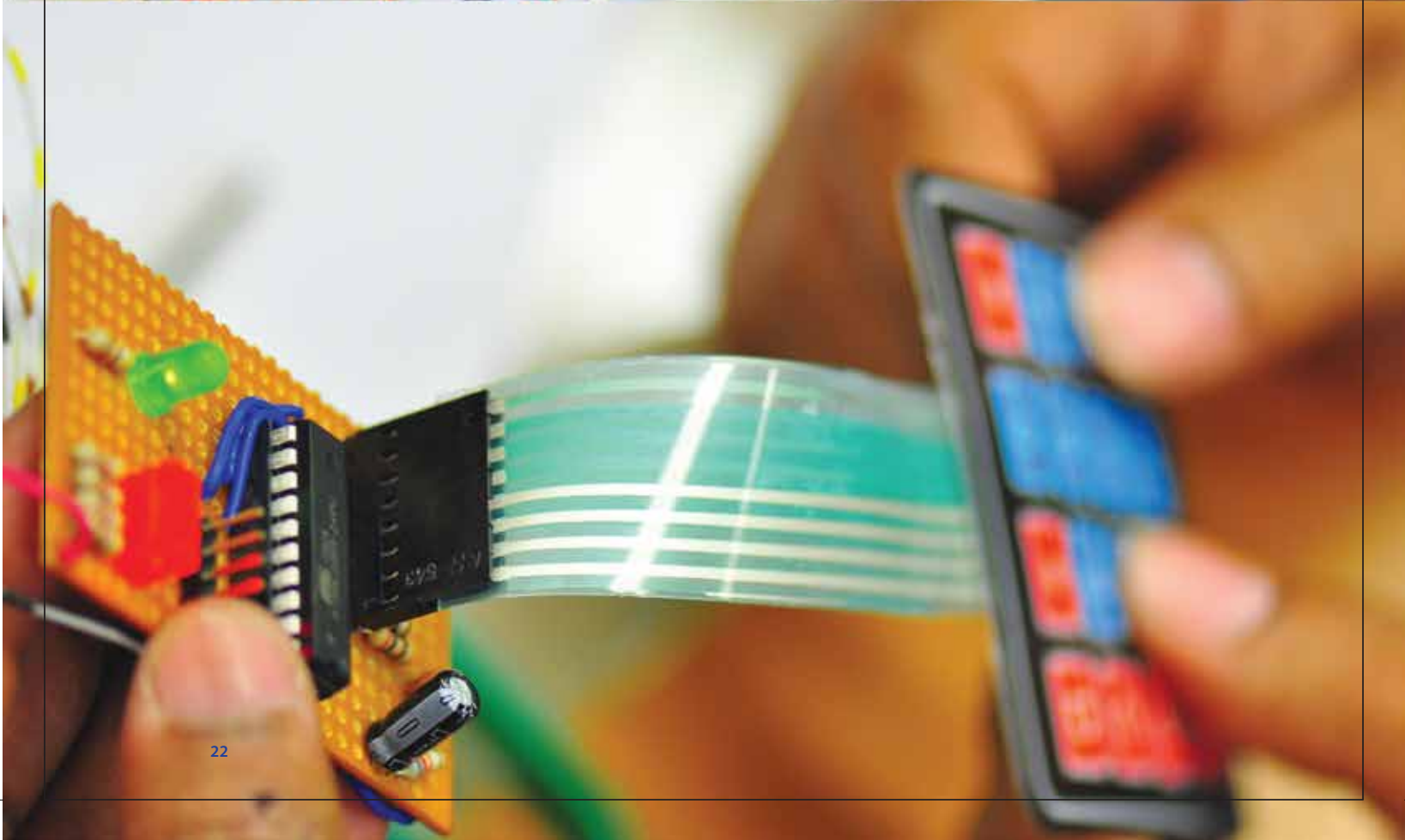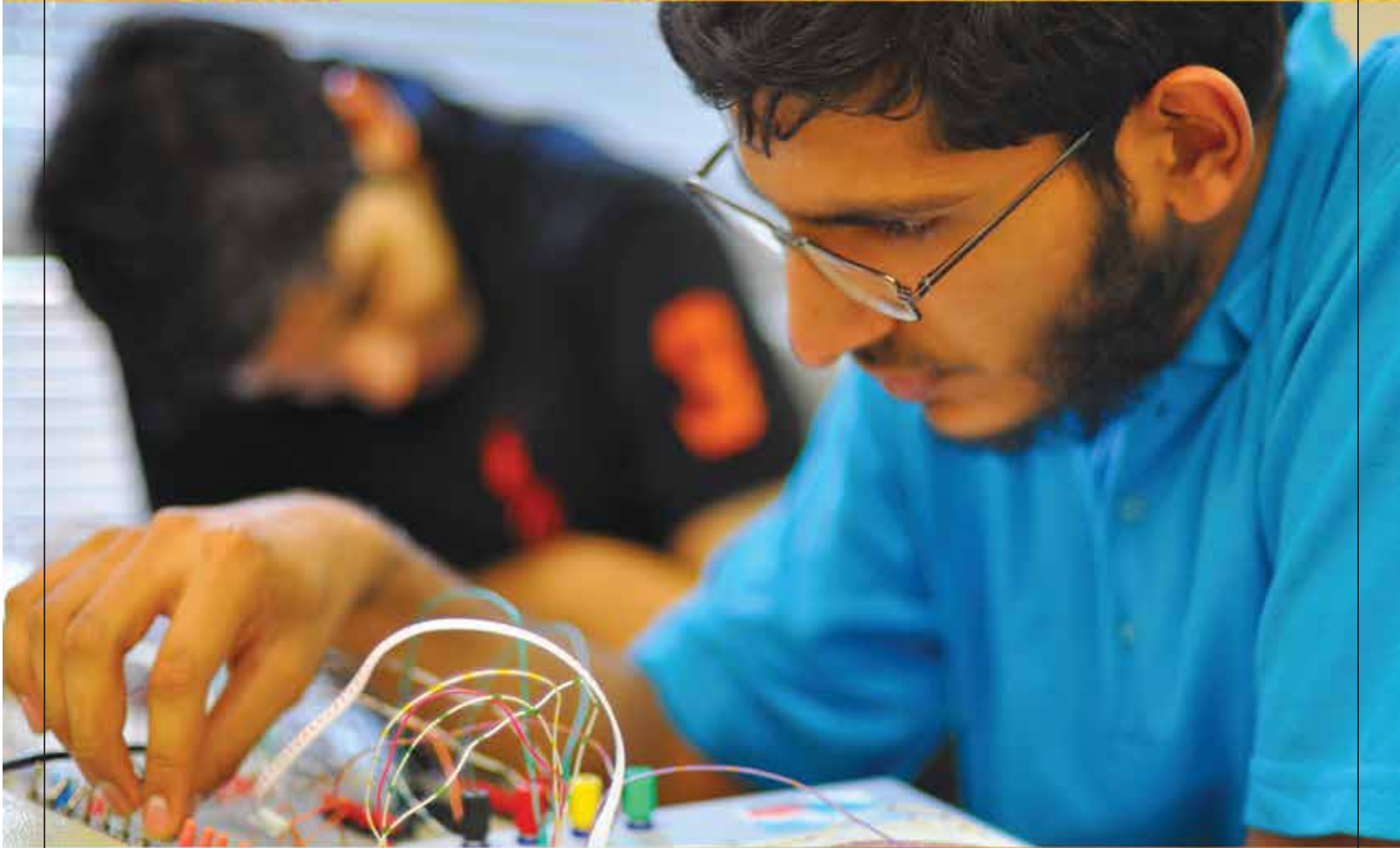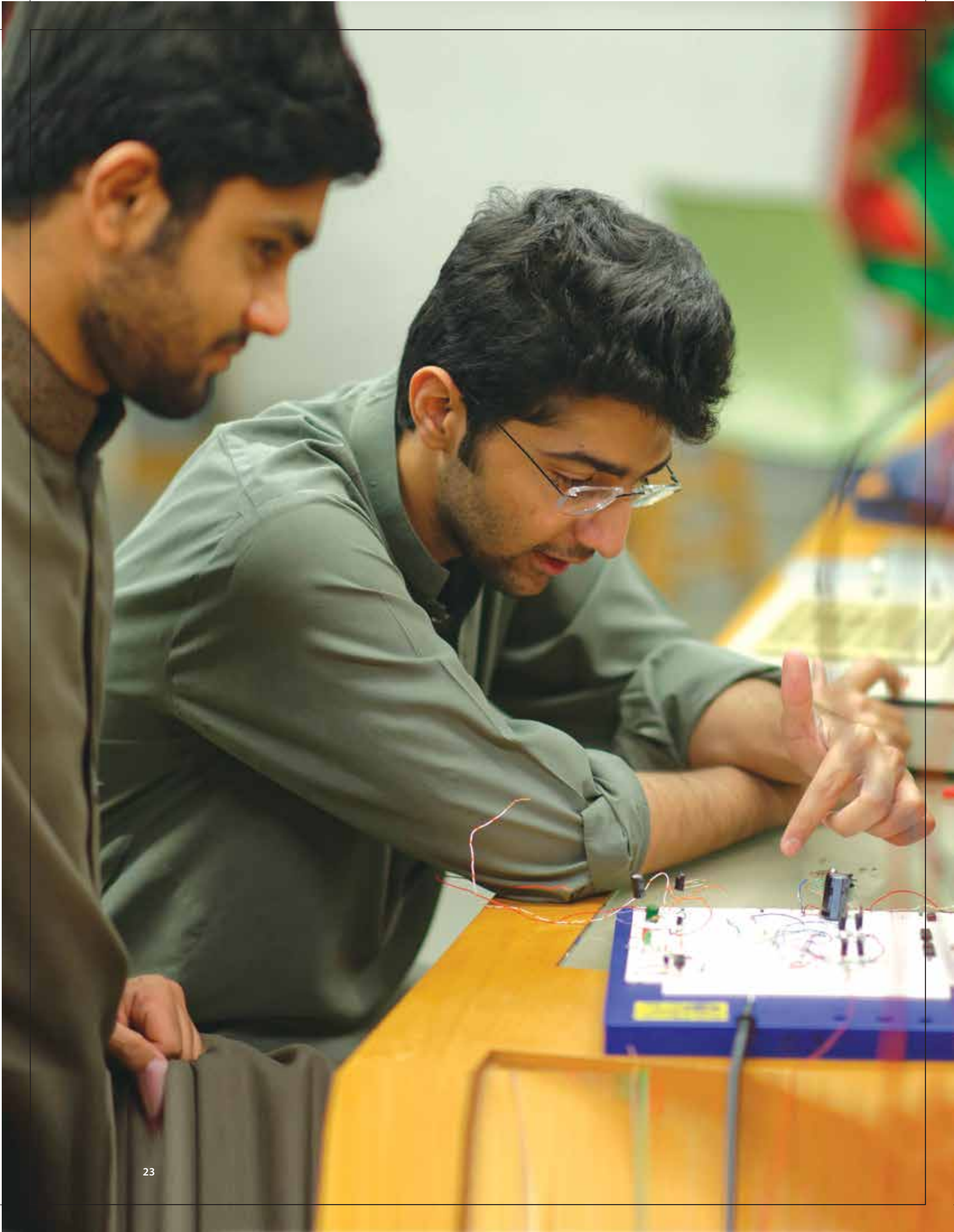
Department of Electrical Engineering

The Largest department at LUMS, the Department of Electrical Engineering (EE) was established in 2008. It offers a very rigorous and modernised graduate programme. Today, the Department has approximately 50 graduate students and 20 full-time PhD faculty members. The alumni of EE Department have been placed in top tier universities around the globe including MIT, UT Austin, Cambridge, EPFL Switzerland, Upenn, TUM Munich, Carnegie Mellon University, RICE University, UIC Chicago, Rutgers, Georgia Tech, USC, NTU Singapore, UCSD and Michigan State University.

Research Opportunities

The Department hosts a growing research active full-time faculty with PhDs from the world's top institutes. The EE faculty is committed to solving important issues pertaining to a wide range of areas. Since its inception, the faculty and their academic staff (most of whom are LUMS graduate students) have published 100+ peer reviewed research articles in the highest ranked international journals published by IEEE, ACM, IET, IEE and IOP and presented their research findings at dozens of top tier conferences in their respective fields. Several of these publications are a direct outcome of MS and PhD thesis work carried out in the Department. Faculty members regularly visit and have maintained research collaborations with several top academic institutes of the world; hosted professors and students from institutes within Pakistan and abroad; organised workshops, conferences and seminars both locally and at the international level.

Structured into various research clusters and labs, the Department has collaborated and obtained funding from local and international industry including the likes of National Instruments, Mentor Graphics and Mitsubishi. It has also secured competitive grants from agencies including Higher Education Commission (HEC), National ICT R&D Fund and German Academic Exchange (DAAD). Some faculty members have served as consultants and collaborators for several government agencies and non-government research organisations including the Punjab Environmental Protection Agency (EPA), Punjab Irrigation Department (PID), Cleaner Production Institute (CPI), World Wildlife Fund (WWF) and International Water Management Institute (IWMI).

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Faculty

Given below is the list of current members of EE faculty:

Abubakr Muhammad PhD, Georgia Institute of Technology, USA	**Farasat Munir** PhD, Georgia Institute of Technology,USA
Hassan Abbas Khan PhD, University of Manchester, UK	**Ijaz Haider Naqvi** PhD, IETR-INSA, Rennes, France
Jahangir Ikram PhD, University of Manchester, UK	**Muhammad Adeel Pasha** PhD, University of Rennes-1, France
Muhammad Tahir PhD, Politecnico di Torino, Italy	**Momin Ayub Uppal** PhD, Texas A&M University, USA
Nauman Ahmad Zaffar MS, University of Pennsylvania, USA	**Naveed Ul Hassan** PhD, SUPELEC, Gif-sur-Yvette, France
Nauman Zafar Butt PhD, Purdue University, USA	**Shahid Masud** PhD, Queen's University, Belfast, UK
Syed Azer Reza PhD, University of Central Florida, USA	**Tariq Mahmood Jadoon** PhD, University of Strathclyde, UK
Wasif Tanveer Khan PhD, Georgia Institute of Technology, USA	**Waqas Majeed** PhD, Georgia Institute of Technology, USA
Nadeem Ahmed Khan PhD, Eindhoven University of Technology, Netherlands	**Zartash Afzal Uzmi** PhD, Stanford University, USA

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Research Clusters

Dr. Momin Uppal, Dr. Ijaz Haider Naqvi & Dr. Naveed Ul Hassan
Advanced Communications Laboratory (AdCom)

http://adcom.lums.edu.pk/

The AdCom lab carries out research in many diverse aspects of modern-day telecommunication systems; its main themes include Modelling, Design, Simulation, Implementation and Performance Characterisations. The lab's research spans many diverse aspects of modern-day telecommunication systems such as cross layer optimisation and networking problems in wireless systems (LTE/LTE-A), event detection and identification in wireless sensor networks, efficient strategies for cognitive cooperative communication, experimental implementation of relaying platforms, performance analysis of ultra wideband systems, applied signal processing, as well as scheduling algorithms, demand response management, demand shaping and integration of renewable energy sources in smart grids. During the last three years the lab has been accorded international recognition through the acceptance of 44 research publications at prestigious peer-reviewed journals and conferences. Additionally, two patents were granted and two were submitted; one of those patent applications also got published recently.

Dr. Abubakr Muhammad
Laboratory for Cyber Physical Networks & Systems (CYPHYNETS)

http://cyphynets.lums.edu.pk/

Research conducted at CYPHYNETS pertains to Systems Engineering, Applied Mathematics and Robotics. The overall aim is the development of Cyber-Physical Systems (CPS) for welfare, environment and sustainable development. One of the main research thrusts is control, estimation and optimisation of water resources in Pakistan. The other major research thrust is theoretical and experimental research in various areas of robotics. The lab is self-sufficient to develop its own robot platforms including mechanical design, mechatronics, control, perception, software and algorithms. The focus is on developing unmanned ground vehicles for humanitarian applications such as landmine clearance and agriculture, in line with the lab's goal of developing cyber-physical systems for development.

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Dr. Nadeem Khan, Dr. Waqas Majeed, Dr. Muhammad Tahir & Dr. Zubair Khalid

Signal, Image and Video Processing Lab

http://lums.edu.pk/cluster/signal-image-and-video-processing-lab

The Signal, Image and Video Processing lab conducts research in the area of Video Processing, Computer Vision and Signal Processing. Current areas of interest include Activity Analysis and Recognition, Multi-view video (occlusion detection, view synthesis), Distributed Video Coding, scalable and multiple descriptive approaches for heterogeneous terminals and networks, Wavelet and DCT transform based compression techniques, Biomedical Signal/Image Processing and Classification. The past and ongoing project activities also include work on complexity scalable and power-aware video codecs, fast but high performance motion estimation techniques, Proprietary DCT and Wavelet based real-time video codecs for videoconferencing applications and Proprietary real-time audio HVXC codecs. The Lab has housed several senior and Master's projects, Master's thesis and externally and internally funded research and development projects.

Mr. Nauman Ahmad Zaffar & Dr. Hassan Abbas Khan

Energy and Power Systems Cluster

http://lums.edu.pk/SBASSE/ee/cluster/energy-and-power-systems

Research is being conducted on developing models for smart grids and their use in designing smart power distribution infrastructure for developing countries. Work in progress includes generation through renewable energy sources, integration with grid, power flow control, smart homes and smart metering infrastructure development. Detailed analysis on the performance of various kinds of bulk and thin film-based solar panels is also being conducted using various methods. Modelling and characterisation of high efficiency tandem solar cells using TCAD tool is also being investigated. The group has strong linkages with local and regional industry partners for electrical energy conservation, optimisation and integration of renewables in smart grids along with the development of Smart Micro Grid infrastructure at LUMS.

Dr. M. Adeel Pasha, Dr. Shahid Masud & Dr. Jahangir Ikram

Electronics and Embedded Systems Cluster

The main focus of this research cluster is to explore customised hardware, software and co-design solutions for embedded systems. The development of high speed programmable DSP chips as well as re-configurable and programmable hardware has made it possible that many operations of conventional high performance and low power applications can be implemented in the form of re-usable Silicon IP-cores and associated software code. This not only reduces design time and cost by orders of magnitude but enables manufacturers to maintain a balanced inventory. Important contemporary applications in which these modern system design techniques are being investigated include software defined radios (SDR) and wireless sensor networks (WSN). Other research activity includes hardware based algorithm acceleration in compute intensive systems such as multimedia (image/video) applications. This approach, instead of running the application tasks on a programmable processor, an application specific micro-architecture tailored to the application at hand is generated either by manually written or automatically generated Hardware Description Language (HDL) codes. This approach results in achieving ultra-low-power designs for complex system-on-chip applications.

## Dr. Syed Azer Reza, Dr. Wasif Tanveer & Dr. Farasat Munir

Devices, Optics and Electromagnetics Cluster

Research is being conducted on the design of intelligent instrumentation using Opto-electronic sensors and devices. Spectral response modelling, characterisation and analysis of III-V Phototransistors is being conducted for high speed Opto-electronic systems such as Photo receivers. Other activities include RF Integrated Circuits and Designing of MIMO and UWB antennas in complex operating environment.

Dr. Nauman Zafar Butt

**Semiconductor and Nanoelectronic Devices (SND) Lab**

Research at the SND lab focuses on the device design, physics based modelling and characterisation in a broad range of semiconductor and nanoelectronic technologies including MOSFETs, on-chip memory cells, solar cells, biological sensors, and, micro-electromechanical systems (MEMS). Computational/theoretical research is based on physics based numerical simulations and analytical modelling with a focus on discovering innovative solutions for emerging technologies. Experimental research focuses on device performance and reliability analysis using nanofabrication and electrical/optical device characterisation. Due to its multidisciplinary nature, SND lab closely collaborates across various departments within SBASSE as well as outside LUMS with other national and international universities. Some of the on-going projects include carbon nanotube based solar cells, III-V phototransistor modelling/characterisation, and biological sensors for Lab-on-a-Chip applications.

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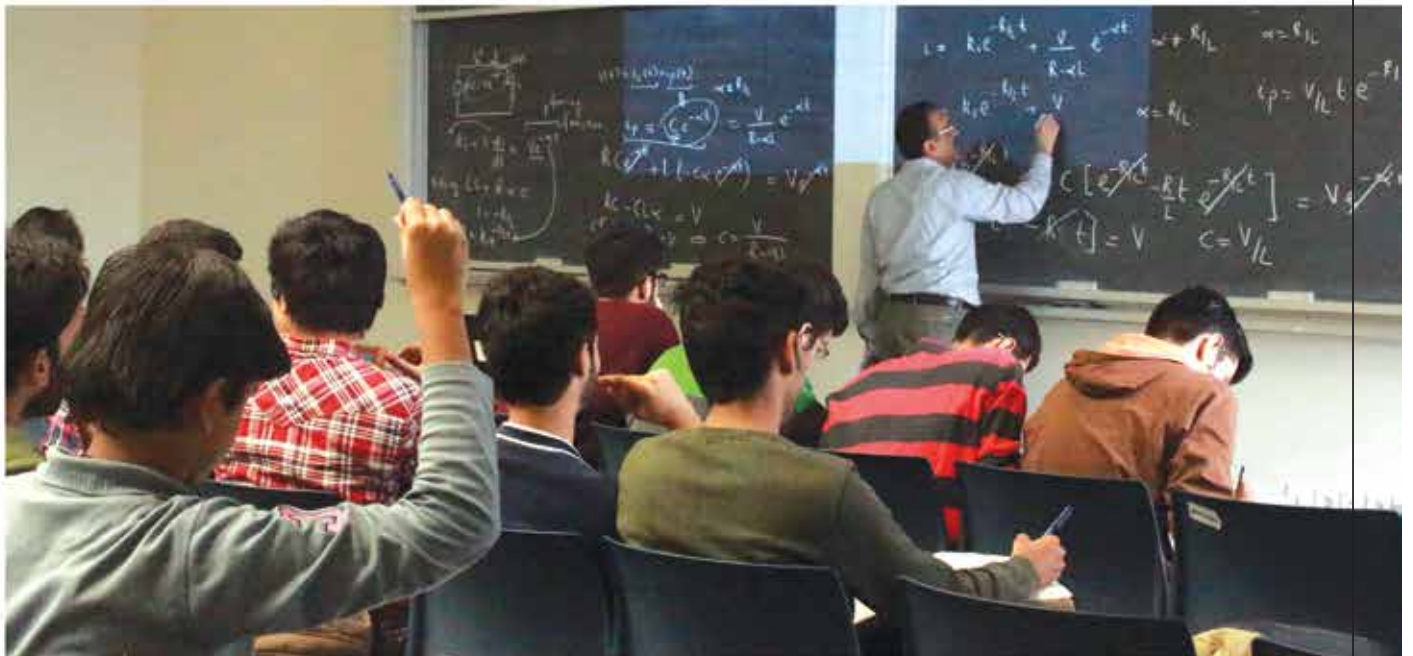
Department of Mathematics

Mathematics is both the most fundamental of all the sciences and also the most applicable as it involves a rigorous study of structure, relationship and pattern. The Department of Mathematics offers undergraduate, MS and PhD degree programmes. The faculty at the Department of Mathematics works across a wide spectrum of mathematical fields. The Department is dedicated to conducting research work in pure as well as applied mathematics. Some examples of interests within pure mathematics include Functional Analysis, Topology, Fixed Point Theory, Operator Theory, Graph Theory, Combinatorics, and Symmetries of Differential Equations. Areas in applied mathematics include Computational Statistical Mechanics, Numerical Methods, Mathematical and Computational Biology, Stochastic Processes, Epidemiology and Cancer Kinetics.

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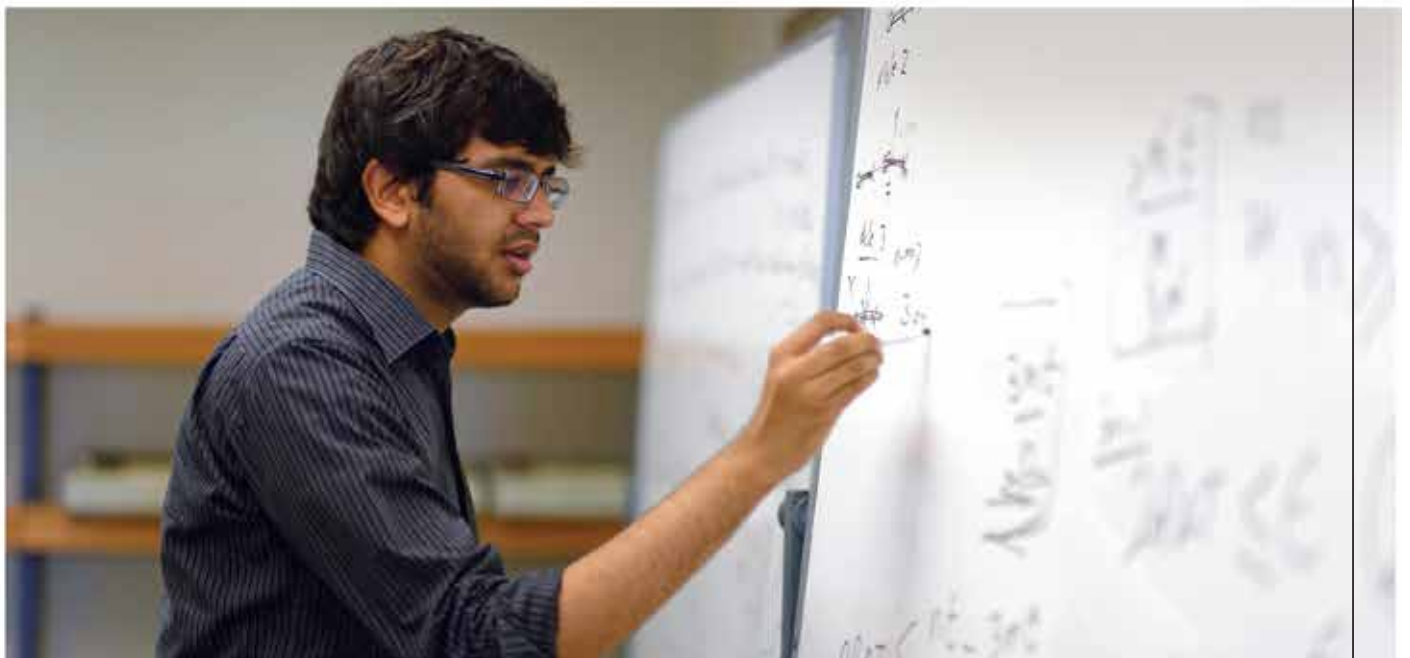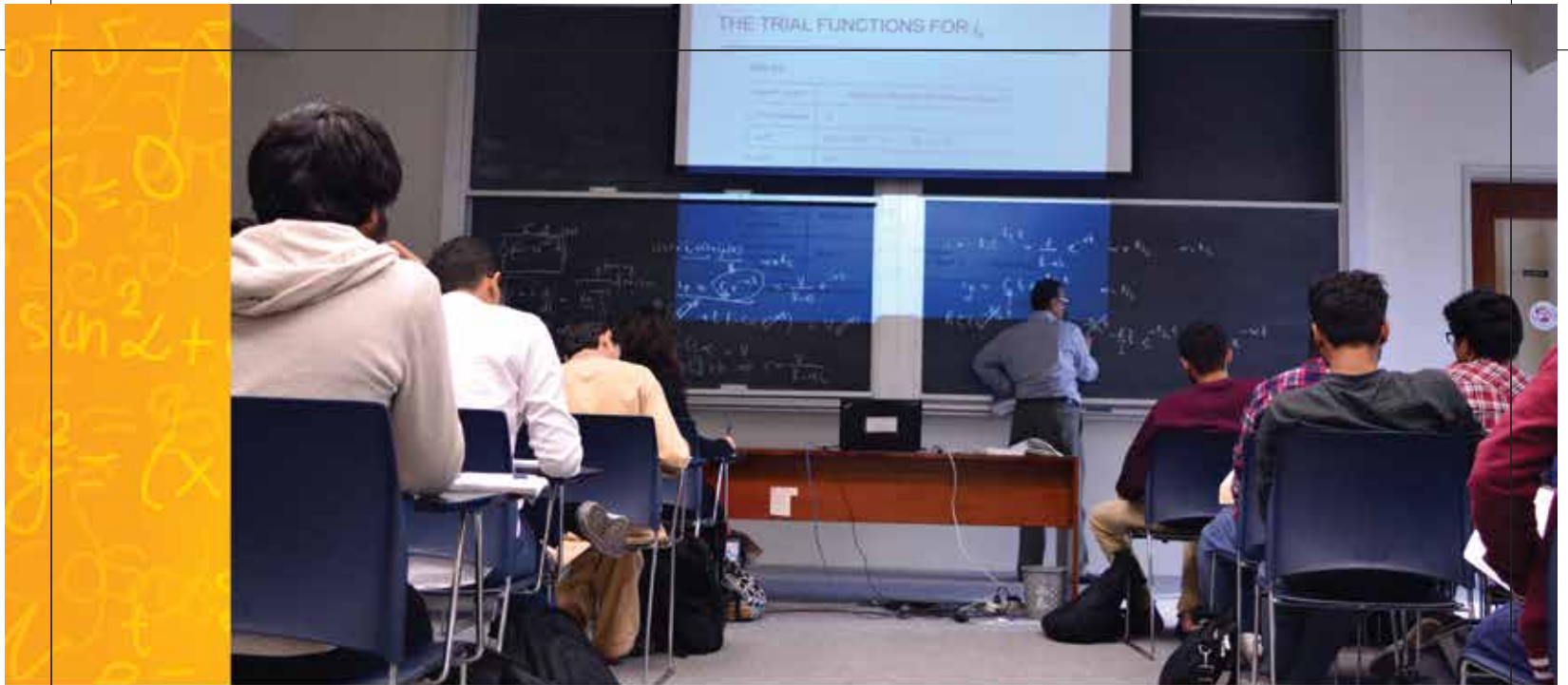
Faculty

The Mathematics faculty is comprised of individuals who have obtained their PhDs from well-established institutions. Moreover, eminent visiting scholars further diversify and enrich the learning experience.

Adnan Khan PhD, Rensselaer Polytechnic Institute, USA	**Amer Rasheed** PhD, European University of Brittany, France
Faqir Bhatti PhD, University of London, UK	**Hanif Mian** PhD, University of the Punjab, Pakistan
Haniya Azam PhD, GC University, Pakistan	**Hira Nadeem** MSc, Florida Atlantic University, USA
Imran Naeem PhD, University of Witwatersrand, SA	**Kamran Rashid** MS, University of Wisconsin-Madison, USA
Masood Hussain Shah PhD, University of Aberdeen, UK	**Mujahid Abbas** PhD, NCBA & E, Pakistan
Muhammad Imran Qureshi PhD, University of Oxford, UK	**Muhammad Ahsan** PhD, Central European University, Hungary
Shamim Arif PhD, University of Manchester, UK	**Shaheen Nazir** PhD, GC University, Pakistan
Sultan Sial PhD, University of Western Ontario, Canada	

Research Programmes

Faculty in the Department of Mathematics is involved in research across a broad spectrum. Following is a list of members of the Mathematics faculty, their research areas and interests.

Dr. Haniya Azam
Research Interest: Algebraic Topolgy

Using ideas from algebra, how can one classify topological spaces? This is the fundamental question which investigators in Algebraic Topology aim to address. Dr. Azam is interested in the cohomology of n-pointed configuration spaces of complex projective varieties and rational models for the cohomology of such spaces. There is a natural action of the symmetric group on these spaces as well as an induced action on the model which she studies to facilitate computations for cohomology. In particular, her interest is in the cohomology groups of configurations of Rieman surfaces with fewer points and the algebraic structure for the cohomology of unordered configuration spaces.

Dr. Masood Hussain Shah
Research Interest: Operator Theory

C* Algebras were first studied in connection with modelling observables in quantum mechanics. They have subsequently generated a lot of interest as an area of research. Fixed point theory is the investigation of existence, uniqueness and approximation of fixed points of mappings. From economics (Nash's theorem) to physics (phase transitions) there is a wide variety of applications of this exciting area of research. Dr. Shah's research focuses on these two areas.

Dr. Mujahid Abbas
Research Interest: Fixed Point Theory

Dr. Mujahid Abbas has been working on the Fixed Point Theory with its applications, Topological Vector Spaces, Nonlinear Operators, Best Approximations, Fuzzy Logics and Convex Optimisation theory. His main field of work has been in Fixed Point theory and its applications. This area of research is a very active field of mathematics with applications in other sciences such as differential and integral equations, engineering, approximation theory, control theory, game theory, optimisation and economics.

Dr. Imran Naeem & Dr. Muhammad Ahsan

Research Interest: Evolution Equations

Evolution Equations can be interpreted as differential laws describing the development of a system. Beginning with the study of differential equations, investigators now look at these in a more abstract setting. Dr. Naeem and Dr. Ahsan work in this exciting field in their own capacities.

Dr. Sultan Sial & Dr. Amer Rasheed

Research Interest: Scientific Computation

Real world problems can be formulated in mathematical terms (modelling), however as the models have grown increasingly more complex, a great deal of computing power is required to study them. Scientific computation involves investigation of robust and efficient methods for studying problems that require heavy computations.

Dr. Adnan Khan

Research Interest: Mathematical Biology

Modelling of complex biological phenomena has become fashionable over the past two decades, since the computing power required to analyse such models has become available. Dr. Adnan Khan has been working in this area, from modelling dynamics of proteins to the mathematical study of epidemics. Being the basic building blocks of life, it is important to understand how proteins move; this is a computationally intensive task using brute force techniques. Dr. Khan is interested in developing models which are simpler (easier to compute), yet capture all the essential dynamics. Another area of his research has been the modelling of epidemics, and using control theory to suggest measures for their management.

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Department of Physics

Research in the Department of Physics focuses on probing fundamental physical aspects of the universe and the underlying mathematical, as well as novel applications in diverse areas including nanoscience, optics, nanophotonics, quantum dynamics and magnetic materials. An important function of the Department is encouraging students to get involved in research questions and exploratory experiments outside the formal classroom or laboratory coursework. Regular seminars and colloquia are led by the faculty, students and distinguished speakers from outside LUMS and provide a chance to keep abreast of cutting-edge and high impact research.

Research Facilities

The Department of Physics houses well-equipped laboratories for conducting experimental research. The Department's laboratories in Solid State Physics, Nanoscience, Optics and Photonics, Radiation Physics and Measurement and Instrumentation house mostly home-grown facilities in diverse areas of physics. All of this research activity is supported by active mechanical and electronic workshops with trained manpower, and is funded through institutional as well as extramural funding. Cryogenic electronic and thermal transport measurements are possible down to 5 K, thin films and bulk samples can be sputtered (using magnetron techniques) or synthesised at high temperatures and their various dielectric, electronic, thermal, magnetic and optical characterisations can be performed with available equipment such as atomic force microscopy, ellipsometry, surface polarimetry, vibrating sample magnetometry, and magneto-optical Kerr Imaging. A modern scanning electron microscope with a resolution down to a nanometer is also available not only for imaging but also for lithography. Furthermore, high performance computing resources enable students to solve and visualise problems in research or perform complex mathematical first principle calculations. There are also active collaborations, which the faculty and students participate in, with research groups and consortia worldwide.
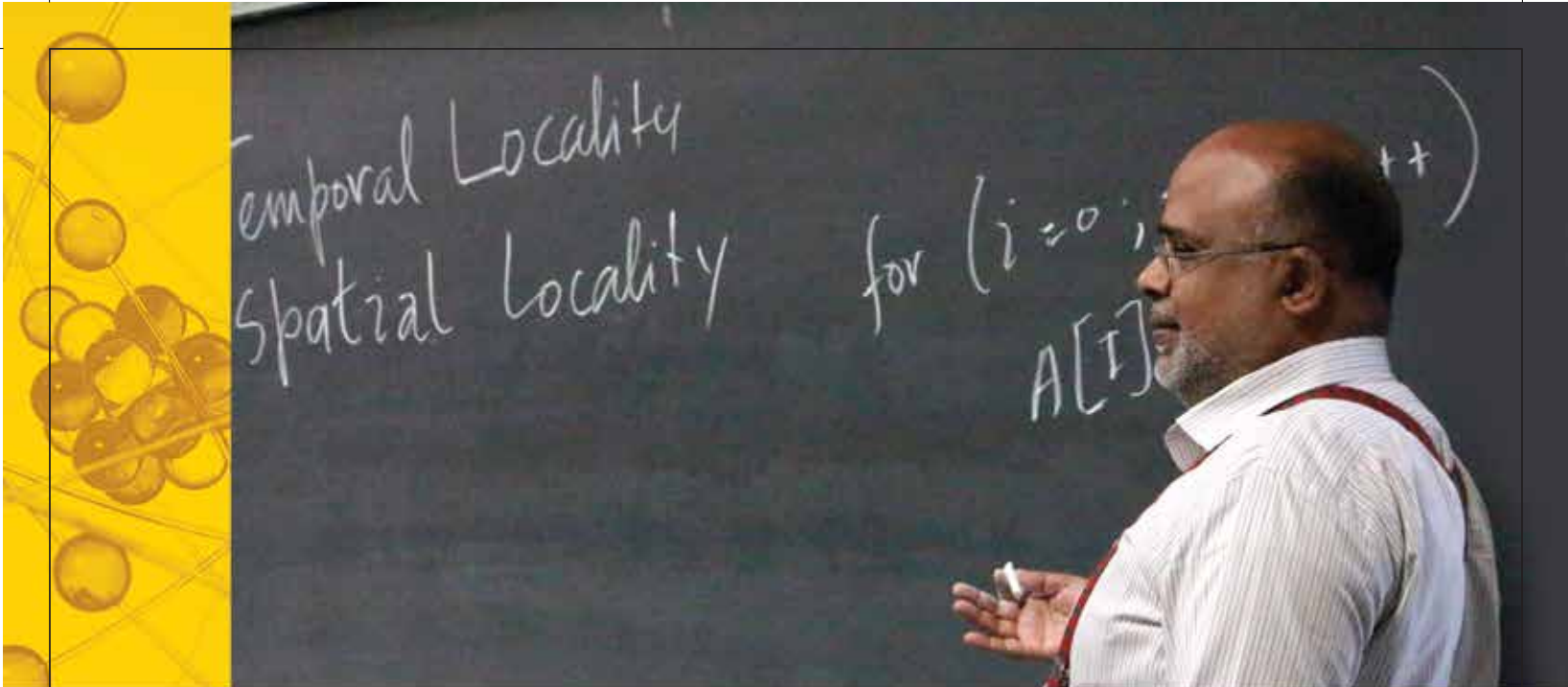
Faculty

Adam Zaman Chaudhry PhD, National University of Singapore, Singapore	**Fakhar-ul-Inam** PhD, Ohio University, USA
Babar Ahmed Qureshi PhD, Syracuse University, USA	**Muhammad Faryad** PhD, Penn State University, USA
Muhammad Sabieh Anwar D Phil, University of Oxford, UK	**Nigum Arshed** PhD, Quaid-e-Azam University, Pakistan
Mumtaz Ali Sheikh PhD, University of Central Florida, USA	

Research Groups

Following is a list of faculty members and their core research areas.

Dr. Sabieh Anwar
Research Interest: Spin and Photon Physics

In Dr. Sabieh Anwar's multi-disciplinary research group, the aim is to explore the fundamental properties of materials, especially at the nanoscale, and their interaction with external radiation such as light or electromagnetic radiation. Some aspects of this research also bear societal implications. For example, the group is developing polarised, miniaturised and mobilised magnetic resonance systems that can revolutionise the outreach of MRI, extending it to on-field inspections and testing, ambulatory medical care in disaster-struck areas, as well as routine analysis in the chemistry lab fume hood.

Dr. Anwar's group also conducts research on the burgeoning field of spin caloritronics. Temperature gradients can not only generate electrical voltages but also spin voltages which can become the source of energy for future spintronic devices – a whole new paradigm of using "electronics free of charge!" The group's major emphasis is on detecting and evaluating these spintronic effects using polarised light in the UV-visible range. This work naturally involves an in-depth investigation of magneto-optic effects in condensed matter systems.

Dr. Nigum Arshed
Research Interest: Quantum Information Theory
Quantum information theory deals with the storage, transmission and processing of information using quantum-mechanical systems. It is an exciting research field which studies how these tasks can be accomplished using distinct features of the underlying mathematical framework provided by quantum mechanics. These features can be used to improve the existing information-theoretic protocols, accomplish tasks and realise goals deemed impossible in the classical realm. Dr. Arshed's research is focused on modelling quantum channels in spin-boson and cavity QED systems, classical and quantum capacities of quantum channels and quantum memory channels. She is also working on using entanglement, a purely quantum mechanical resource, for efficient and reliable communication of information.

Dr. Adam Zaman Chaudhry
Research Interest: Quantum Dynamics
The theory of Quantum Mechanics has led to major technological developments in the science industry, and may yet lead to many more novel advancements in the field as well. However, before doing so, it is essential to understand the dynamics of realistic open quantum systems, i.e. systems that interact uncontrollably with the surrounding environment, thereby losing their fragile quantum abilities. Dr. Chaudhry's research tries to answer three big questions.1. How can the dynamics of open quantum systems be studied? 2. What can be done in order to control the dynamics, once the dynamics have been understood? 3. How can realistic open quantum systems be used in technology? Resolving these problems will directly impact many different subjects such as quantum optics, control theory, condensed matter, quantum information and chemical physics, leading to many possible applications including, but not limited to, extremely accurate measuring instruments, highly efficient artificial light harvesting systems, and perhaps even quantum computers.

Dr. Fakhar-ul-Inam
Research Interest: Computational Materials

The disordered phases of materials have long been a challenging field of research in materials science. The research in this area deals with a wide range of issues, from structure determination and electronic signatures to response under external perturbations and beyond. In the last two decades, the advancement in the first principle treatment of interatomic interactions, such as the Density Functional Theory (DFT), and its merging to the classical Molecular Dynamic (MD) simulation techniques, have allowed researchers to explore the structural and electronic properties of materials at the atomic scale. Dr. Inam's group's primary interest has been to explore the fundamental properties of materials using first principles molecular dynamics simulations and other theoretical techniques.

Dr. Muhammad Faryad
Research Interest: Plasmonics and Nanoengineered Materials

Surface plasmon-polariton (SPP) waves are guided by an interface of a metal and a dielectric material. Due to the localisation of SPP waves to the interface, they are important in solar cells, chemical sensors and plasmonic communication. Dr. Faryad has extensive experience in the study of SPP waves that are guided by interfaces of metal and nanoengineered dielectric materials such as sculptured thin films. Besides surface waves, the sculptured thin films find applications in optical filtering and polarised light sources. Thin-film solar cells have a nano-scale morphology that is nanoengineered to maximise the absorption of light and maximise the collection of light-generated carriers. These solar cells offer an alternative and inexpensive route to "thick" solar cells, e.g. crystalline silicon and GaAs, by relaxing the constraints on the material properties and reducing the volume of material significantly. Dr. Faryad's group is working on the techniques to increase the light absorption in thin film solar cells, such as amorphous silicon, using nanostructured back reflectors.

Dr. Babar Ahmed Qureshi

Research Interest: Fundamental Theory

The main area of interest is how quantum mechanics changes ideas about space-time. The fundamental uncertainties inherent in quantum mechanics cause severe deformation of space-time structure at very small scales, breaking down the smooth manifold structure of general relativity into something called quantum foam. Dr. Qureshi explores these phenomena by studying field theories on these structures. He is interested in studying how space-time itself, along with quantum fields, emerges from more fundamental objects such as matrices, as hinted by M-theory. At the same time he is also curious about the cosmological implications of these ideas. Other focus areas include many mathematical aspects of physics including quantum groups and their use in describing Quantum Hall States, which may be of particular use in devising a practical quantum computer. He is also working on some aspects of the now famous duality between gravitational and gauge theories.

Dr. Mumtaz Ali Sheikh

Research Interest: Photonics

The use of optics in everyday life is ubiquitous. For example, internet is used all the time without realising that ultimately these are light pulses that carry the information across the world on a fibre optic network. Even the foundations for contemporary television display technologies like LCDs, LEDs and three-dimensional TVs were laid by optical physicists. Dr. Sheikh focuses on using light for a large variety of similar applications. He has been involved in the development of extreme temperature optical sensors for use in gas turbines at temperatures where ordinary industrial thermocouples break down very quickly. His current projects include the development of a super-resolution confocal microscope using disordered media. He is also interested in the areas of optical communication, singular optics and 3D laser ranging.

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Research Centres

Centre for Advanced Studies in Mathematics (CASM)
Director: Dr. Faqir Bhatti
The Centre for Advanced Studies in Mathematics (CASM) is one of the leading centres for research in mathematics in Pakistan. In the 21st century, the role of mathematics in formulating and solving a variety of interdisciplinary problems has been well recognised. The continuing development of the mathematical and computational sciences is fundamental to the scientific progress of Pakistan. The basic activities of CASM are to promote mathematics amongst students and develop human resources in this field. The Centre's current areas of activity include Functional Analysis, Operator Theory, Mathematical Biology, Scientific Computation, Graph Theory, Enumerative Combinatorics, and Symmetries of Differential Equations. CASM aspires to promote interaction between mathematicians and experts of other disciplines, such as electrical and computer engineering, economics and social sciences. The Centre is actively engaged in conducting research, organising workshops and conferences, arranging short courses and exploring linkages with other disciplines, among other activities.

Centre for High Performance Computing
The Centre for High Performance Computing provides scientific computing facilities for the LUMS research community. The goals of the centre are to engender and facilitate science and engineering research efforts; assist researchers with specialised computational needs and provide research and development exposure to students. The computing facility comprises of an HPC cluster and multiple high end symmetric multiprocessing servers. Currently the centre is catering to the research and course needs across LUMS in the Departments of Electrical Engineering, Computer Science, Mathematics, Biology, Physics, Economics and the Suleman Dawood School of Business (SDSB).

Center for Water Informatics & Technology (WIT)
Director: Dr. Abubakr Muhammad
WIT is a recent initiative at LUMS combining hydro-informatics, water-smart agriculture, water quality innovations, economic analysis and public policy studies for sustainable water management. WIT also aims to facilitate the understanding of water's nexuses with food, agriculture, climate change, environment and sustainability. Via its focus on fundamental scientific research in water science and engineering, as well as applied translational research to convert scientific results into sound policy, it aims to uplift local institutions for water governance and to forge global and regional cooperation in water. Based at the SBASSE, while drawing expertise from all four schools at LUMS, WIT will both complement and complete the national scene in water research by integrated systems approaches to complex water related issues.

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Admission Criteria for MS & PhD Programmes

Note: These are the minimum criteria that applicants need to fulfill in order to be eligible to apply. Fulfillment of these criteria does not however guarantee admission into LUMS.

Admission is purely merit-based and rests solely on the following criteria:

- Academic record
- Performance in admission tests
- Interview performance (if applicable)
- Completed application form along with all supporting documents

Academic Record

For MS Programmes:

- A minimum of 16 years of education is required for applying to the MS Programme. Applicants are expected to have obtained their Bachelor's (or Master's) degree from national or foreign institutions that are accredited or recognised by the Higher Education Commission (HEC) of Pakistan.

- Applicants must have maintained a CGPA of at least 2.4 (on a scale of 4) or at least 60% marks in all university-level degrees (i.e. 4 years Bachelor's degree or 2 years BSc degree and 2 years MSc degree).
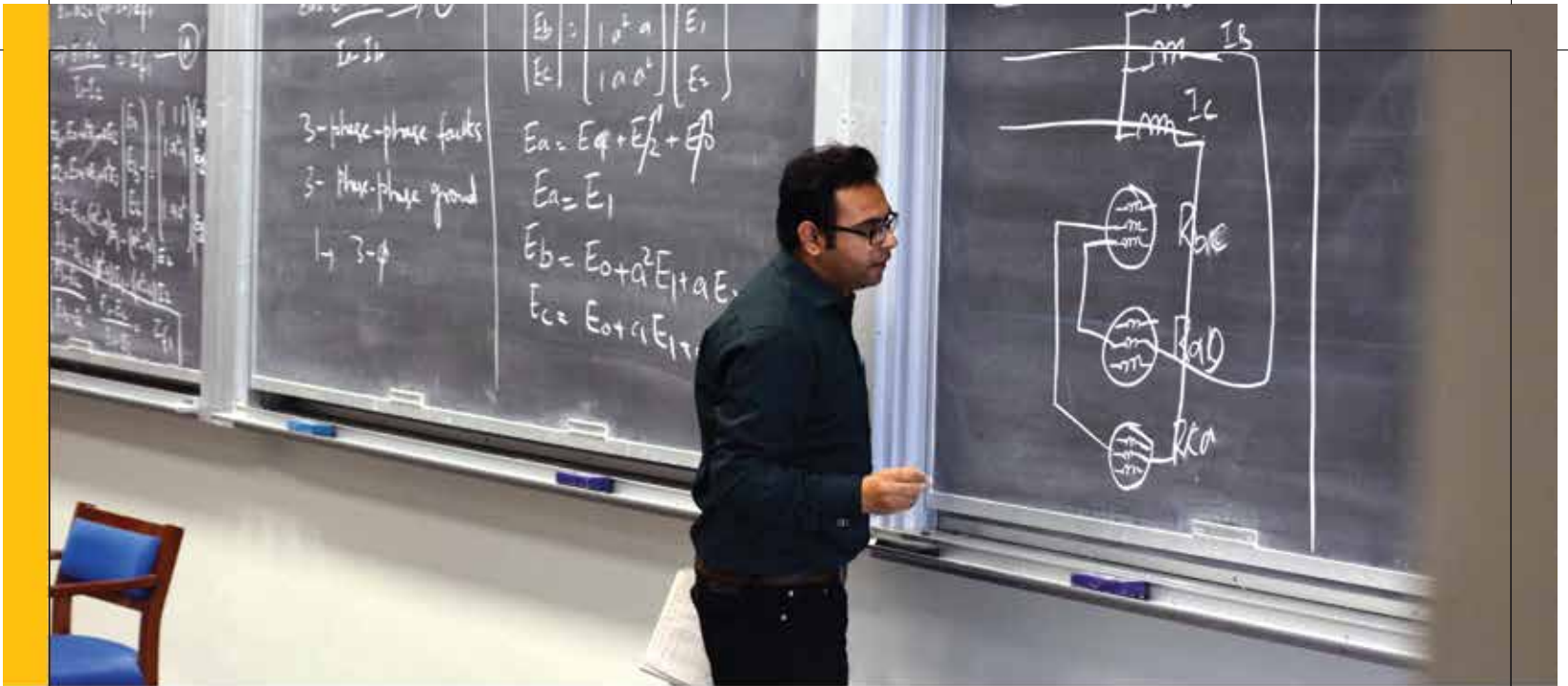
For PhD Programmes:

- A minimum of 18 years of education is required for applying to the PhD Programme. Applicants are expected to have obtained their Master's degree (MS or MPhil) from national or foreign institutions that are accredited or recognised by the Higher Education Commission (HEC) of Pakistan.

- Applicants must have obtained a CGPA of at least 3.0 (on a scale of 4) or First Division (in the annual system) in their Master's degree and at least a CGPA of 2.4 (on a scale of 4) or 60% marks in Bachelor's degree. Applicants obtaining 2 years BSc degree and 2 years MSc degree must have secured at least 60% marks in both degrees.

  Note: An applicant obtaining a Master's degree with CGPA computed over any scale other than 4.0 will be required to submit a letter/revised transcript from the respective university stating his/her CGPA on the scale of 4.0 OR submit a letter from HEC stating that the applicant meets the CGPA requirement for PhD admission.

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Applicants applying to the MS Programme must have their Bachelor's (or Master's) degree and applicants applying to the PhD Programme must have their Master's degree in any one of the following areas:

BIOLOGY
- Biology
- Biochemistry
- Bioinformatics
- Molecular Biology
- Microbiology
- Genetics
- Other closely related discipline

Applicants may also have the following degrees:
- MBBS
- BDS
- Pharm D

Applicants with professional degrees (including, MBBS, BDS, Pharm B) must have Second Division or above in their professional degrees in order to be considered eligible for MS/PhD

CHEMISTRY
- Chemistry
- Biochemistry
- Materials Science or Engineering
- Chemical Engineering
- Other closely related discipline

COMPUTER SCIENCE
- Computer Science
- Software Engineering
- Information Technology

For PhD: Other closely related disciplines

For MS: Other closely related disciplines that are synergistically aligned with computing (e.g. Mathematics, Statistics, Accounting, Economics or Management Sciences) and involve rigorous coursework in Mathematics and strong programming background

ELECTRICAL ENGINEERING
- Electrical Engineering
- Electronics
- Computer Science
- Engineering/Applied Physics
- Mechatronics Engineering
- Computer Engineering
- Telecom Engineering
- Other engineering disciplines peripherally related to electronics or electrical engineering

MATHEMATICS
- Mathematics
- Statistics
- Physics
- Any other closely related disciplines determined by Mathematics Graduate Committee

PHYSICS
- Physics
- Mathematics
- Computer Science
- Materials Science
- Optics
- Engineering
- Other closely related disciplines or allied Engineering disciplines

PERFORMANCE IN ADMISSION TESTS for MS/PhD:

• Applicants to the MS/PhD programme are required to take the LUMS Graduate Admission Test (LGAT), which is comprised of quantitative, verbal and analytical sections.
• Applicants who have taken the Graduate Record Examination (GRE) General Test during the last two years and obtained an aggregate score of 300 in the Quantitative and Verbal sections, may choose not to take the LGAT.
• In addition, applicants must also take the SBASSE Subject Test in their respective discipline i.e. Biology, Chemistry, Computer Science, Electrical Engineering, Mathematics and Physics.
• Applicants are exempted from SBASSE Subject Test if they have taken GRE Subject Test during the last two years and obtained a score at the 60th percentile or above in the discipline they are applying to:

• **Biology:** GRE Subject Test in Biology, or Biochemistry, Cell and Molecular Biology
• **Chemistry:** GRE Subject Test in Chemistry
• **Mathematics:** GRE Subject Test in Mathematics
• **Physics:** GRE Subject Test in Physics

• Applicants residing outside Pakistan are required to take the GRE General Test as well as the GRE Subject Test (through the Educational Testing Service, ETS USA (www.ets.org)) in the disciplines mentioned above. Due to the unavailability of a GRE Subject Test in Computer Science & Electrical Engineering, these applicants will be assessed based on their GRE General Test score only.
• LGAT and SBASSE Subject Tests will be scheduled at the same time in Lahore, Islamabad and Karachi on **April 10, 2016**.
• The deadline to take GRE/GRE Subject Test (if applicable) is **March 15, 2016** at the latest. The college code for reporting GRE scores to LUMS is 0679.

INTERVIEW
• All PhD applicants are required to go through an interview that includes delivery of a seminar on their MS research work
• MS applicants may also be requested to appear for an interview
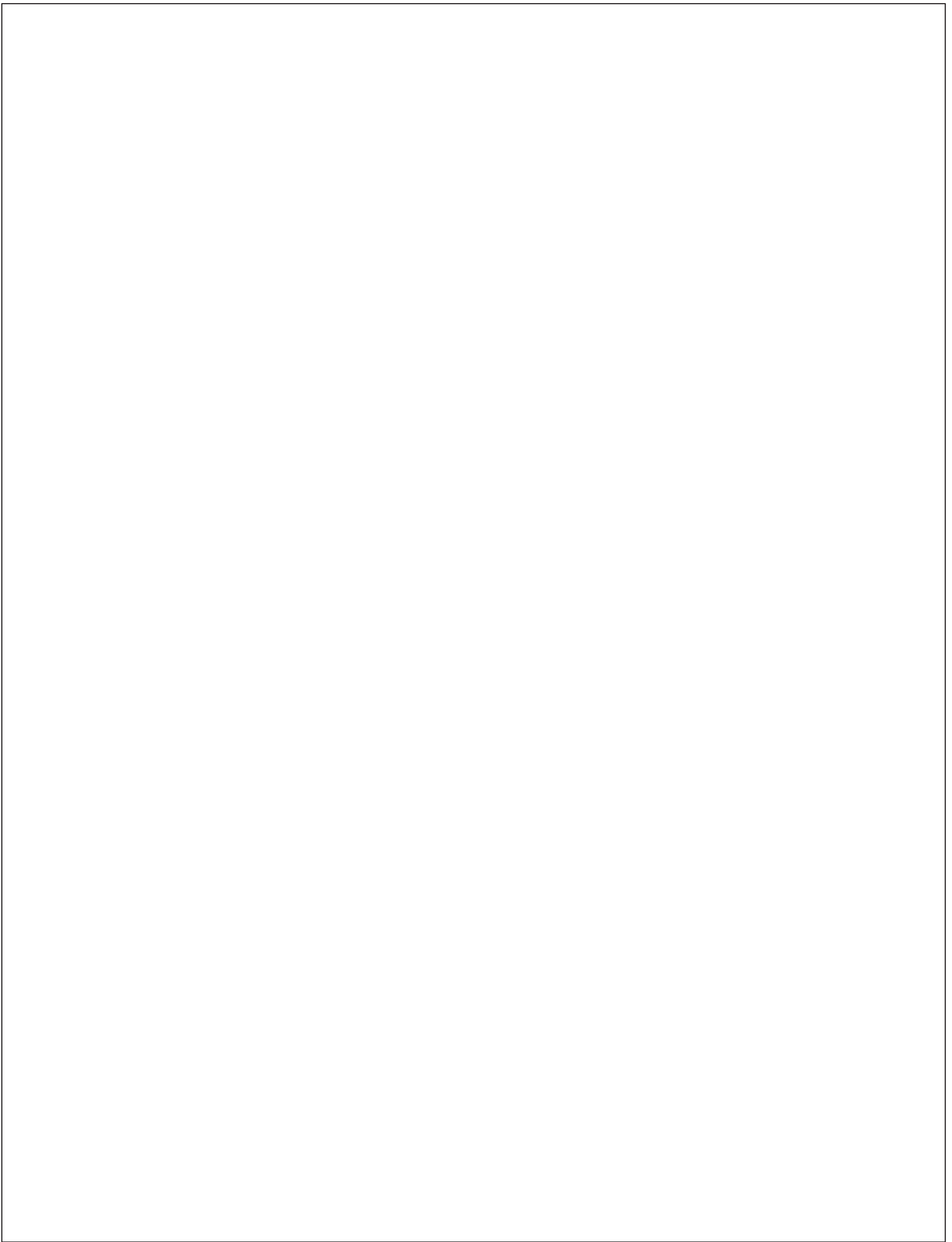
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