LUMS | SBASSE

Create Your Own Future

Syed Babar Ali School of Science & Engineering (SBASSE)

Graduate Programmes

Welcome

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LUMS

The Lahore University of Management Sciences (LUMS) is ranked 111th in Asia and no. 1 in Pakistan by QS University Rankings Asia 2016. 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 science and engineering, humanities, social sciences, economics and law. The faculty at LUMS includes 199 PhDs from some of the world's finest institutions including Cambridge, Oxford, MIT, Berkeley, Georgia-Tech, Harvard and Stanford.

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Syed Babar Ali School of Science and Engineering (SBASSE)

SBASSE is a pioneering private research school in Pakistan, initiated in 2008, that imparts top quality education in 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 these six disciplines with several specialisations. 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 https://sbasse.lums.edu.pk

MS

Biology
Chemistry
Computer Science
Electrical Engineering
Mathematics
Physics

The MS Programme

The MS programmes at SBASSE are rigorous and designed to impart specialised professional and research oriented training to 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 standard duration for completing the MS degree is 2 years.

The School offers a 45% tuition fee waiver for all new MS students in the Basic Sciences as well as Mathematics. For returning students, a 50% tuition fee waiver is offered in both the Basic Sciences and Mathematics.

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, final thesis defense and publications in internationally indexed journals. Students have 4 years to complete the 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.

Department of Biology

The Department of Biology offers MS and PhD programmes with specialisations in Molecular Biology or Bioinformatics. The programme aims to produce knowledgeable and independent researchers who are well versed in recent advances and trends in molecular biology and bioinformatics, capable of identifying important unanswered questions, designing and carrying out experiments and understanding cells at a systems level. 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 the Biology graduate programme. In this context, graduate students in Biology are exposed to advanced courses in a wide range of research areas in Molecular and Cell Biology, Genetics and Epigenetics, Biochemistry and Structural Biology, Computational Biology and Bioinformatics 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 plants fight back diseases and develop resistance, how infectious pathogens evolve and how they become resistant, how viruses evolve, how drugs and immunoprophylatics are developed against viral infections and in complex diseases such as cancer. Mammalian, Drosophila, plants, 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 obtain insights into problems such as genomic evolution and cancer development. The department is equipped with state-of-the-art facilities and equipment that includes confocal microscope, fluorescence activated cell sorter (FACS), fast protein liquid chromatography (FPLC) apparatus, MiSeq Next Generation Sequencer, conventional and real time thermocyclers, ultrasonic bioruptor, gel documentation systems, high-speed centrifuges and tissue culture rooms as well as facilities for growing plants and flies. For high performance computing (HPC), the department has a dedicated HPC facility housed within the Bioinformatics research laboratory. The lab is equipped with both HPC nodes as well as general purpose graphical processing units (GPGPU) including NVIDIA's Grid K2 and Tesla K40C. Several in house software tools have also been made available online which leverage the lab's GPGPUs and HPCs.

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
Aziz Mithani	PhD, University of Oxford, UK
Safee Ullah Chaudhary	PhD, Korea Advanced Institute of Science and Technology (KAIST), South Korea
Syed Shahzad ul Hussan	PhD, University of Lubeck, Germany
Ahmed Jawaad Afzal	PhD, Southern Illinois University, USA
Muhammad Tariq	PhD, Friedrich Miescher Institute for Biomedical Research, Switzerland
Shaper Mirza	PhD, University of Alabama at Birmingham, USA
Syeda Kahkashan Hijazi	PhD, Boston University, USA

Research Programmes

Different research groups in Biology led by individual faculty members are as follows:

Biochemistry and Structural Biology

Dr. Syed Shahzad ul Hussan
Currently, Hussan lab focuses on the following areas: 1- Understanding the structural and conformational properties of antibody target sites on the envelope glycoproteins of hepatitis C virus (HCV) by using NMR techniques to obtain necessary information required for structure based vaccine design. 2- Discovery of new HCV neutralising antibodies from the sera of chronically infected patients by designing HCV antigenic probes and understanding the sub-molecular level mechanism of HCV neutralisation by these antibodies. 3- Identification, engineering and structural investigation of antiviral lectins, which inhibit viral entry to the target cells by recognising specific glycans present on the surface of the virus.

Cell Signalling and Cancer Therapeutics

Dr. Amir Faisal
The Cancer Therapeutics group focuses on identifying and characterising novel synthetic and natural compounds with therapeutic potential for cancer. This involves assay-guided isolation and synthesis of compounds with anti-proliferative activities against cancer cell lines of different origins and identifying their mechanism of action. The group is also interested in understanding mechanisms of cancer drug resistance, evaluating drug combinations to overcome such resistance and identifying novel drug targets through hypothesis based screening.

Computational Genomics and Systems Biology

Dr. Aziz Mithani
The focus of the Computational Genomics and Systems Biology group is to develop and apply computational and mathematical methods in the area of modern biology to understand how biological systems function and evolve over time. Specifically, such approaches are being employed to decipher the genetics of bread wheat and understand the type and number of hybridisation events through which modern day bread wheat has evolved from different goat grass and Eikorn (pasta wheat). This project 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. The other project involves development of Rahnuma v2.0, a web-based tool to facilitate comparisons of metabolic networks between organisms and prediction of metabolic pathways between metabolites or groups of metabolites. Rahnuma v2.0 will provide an intuitive way to answer different biological questions focusing on differences between multiple organisms or evolution of different species by allowing pathway based metabolic network comparisons at organism as well as phylogenetic levels.

Epigenetics

Dr. Muhammad Tariq
The Epigenetics group is interested in understanding how cell fates are established and how they are maintained during development. In particular, Tariq lab works on Polycomb (PcG) and Trithorax group (TrxG) genes which are involved in maintaining epigenetic states of gene expression. Molecular and biochemical approaches are being used in Drosophila melanogaster (fruit fly) to address various questions linked to epigenetic cell memory at a systems level. Establishing molecular link between PcG/TrxG mediated epigenetic cell memory and cell signalling pathways is a major long term goal of Epigenetics group.

Molecular Epidemiology and Microbiology

Dr. Shaper Mirza
The laboratory is dedicated to understanding the association of diabetes with respiratory tract infections caused by Streptococcus pneumoniae, which is a cause of at least 40% of total pneumonia infections and invasive pneumococcal disease. The research programme is comprised of four major components which are i) Investigation of humoral immune response, which is critical for clearance of pneumococcal pneumonia. The group is investigating the antibody response and antibody and complement mediated opsonophagocytosis of S. pneumoniae, using neutrophils from healthy donors; ii) Using human macrophage cell line (THP-1) and neutrophil cells lines (HL-60), projects are underway to understand signal transduction pathway and signalling molecules involved in impairment of bactericidal activity of neutrophils and macrophages; iii) Measurement of B cell response to pneumococcal polysaccharide pre and post vaccination; iv) Resistance in S. pneumoniae to antibacterial agents is growing at an exponential rate. A significant proportion of pneumococcal isolates are penicillin resistant, which is the drug of choice for treating pneumonia and invasive disease. Studies in this area are focused on alternative approaches to treatment of drug resistant pneumococci. Peptides from antibacterial human protein, lactoferrin are being used to determine their antibacterial potential.

Plant Molecular Biology

Dr. Ahmed Jawaad Afzal
Afzal lab is laying emphasis on understanding the role of the multifunctional protein RIN4, which regulates both branches of the plant immune system. Plants employ multiple layers of immunity to guard against infection. The first layer responds to structures within conserved microbial molecules. The second layer responds to effector proteins, which are pathogen-encoded virulence factors. These two "branches" of the immune system synergise to provide robust host defense that halts most infections.

Systems Biology, Proteomics and Health Informatics

Dr. Safee Ullah Chaudhary
The Biomedical Informatics Research Laboratory (BIRL) at LUMS aims to develop next generation modelling and simulation software for applications in proteomics and Systems Biology. Currently, the lab is developing a next-generation multiscale cancer modelling and simulation pipeline for integrative investigations into tumorigenesis. The group is also developing a high performance top-down proteomics search engine for protein identification from high resolution mass spectrometry data. The lab is also involved in BIGDATA mining for mobile health applications and associated clinical informatics.

Translational Bioinformatics

Dr. Syeda Kahkashan Hijazi
The focus of the Translational Bioinformatics group broadly rests on developing and utilising computational and statistical techniques for the analysis and visualisation of transcriptomic data generated by high-throughput genomic technologies. This is an emerging area advancing in the facilitation of better understanding of traditional molecular biology and cutting edge clinical applications. Currently, these approaches are being applied in the identification of gene-expression signature in cytological normal buccal, nasal and bronchial epithelium that can distinguish smokers with squamous cell carcinoma of the head and neck (HNSCC) from matched smokers without HNSCC. Similar approaches are being used to understand other inflammatory and neoplastic airway diseases. The projects are being carried out in collaboration with Boston University Medical Center, Boston University, USA.

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 other science and engineering disciplines. 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 state-of-the-art experimental facilities and equipment. There is a fine collection of supplies and equipment including spectroscopic, structural and materials characterisation 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.

The Chemistry faculty has developed very effective and fruitful research collaborations with prominent national and international research groups in the USA, UK, Germany, Switzerland, Turkey, China and Saudi Arabia. These collaborations are instrumental 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 national and 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.

Basit Yameen — PhD, Max Plank Institute for Polymer Research, Mainz, Germany

Ghayoor Abbas — PhD, Michigan State University, USA

Irshad Hussain — PhD, University of Liverpool, UK

Muhammad Zaheer — PhD, University of Bayreuth, Germany

Salman Noshear Arshad — PhD, University of Illinois at Urbana-Champaign, USA

Falak Sher — PhD, University of Cambridge, UK

Habib-ur-Rehman — PhD, Institute for New Materials, Germany

Muhammad Saeed — PhD, University of Tubingen, Germany

Rahman S. Z. Saleem — PhD, Michigan State University, USA

Research Programmes

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

Catalysis and Green Chemistry

Dr. Ghayoor Abbas

This group is interested in the development of novel green synthetic methodologies, utilising transition metal catalysis, for the functionalisation of aromatic hydrocarbons. Our newly developed catalytic reactions provide rapid access to previously inaccessible materials which can have potential applications in a wide range of areas including medicinal chemistry, agrochemicals, organic electronic materials, and photoredox catalysis.

Multifunctional Nano-Composites

Dr. Salman Noshear Arshad

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 material solutions for energy and environment. Moreover, the group has research interests in on site electron microscopy for characterising the mechanical response of materials at nanoscale and how the interfaces can be tailored for maximum performance.

Functional Nanomaterials

Dr. Irshad Hussain

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.

Polymers and Nanocomposites

Dr. Habib-ur-Rehman

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.

Synthetic, Organic and Bioorganic Chemistry and Chemical Biology

Dr. Muhammad Saeed

Understanding the mechanism of disease development and designing strategies for intervention of these processes by natural and synthetic organic compounds are the main interests of this research group. Current area of research involves the dissection of the *de novo* biosynthesis of thymidine base (T), and mutagenesis by specific oxidative metabolites of endogenous and exogenous chemicals. Additionally, the group is interested in targeting viral proteases (HCV, dengue, Zika, HIV etc.) for the development of Direct-Acting Antiviral (DAA) drugs. To accomplish these endeavours, the group exploits techniques of synthetic organic chemistry, chromatographic sciences, computational modelling, cell cultures, and molecular biology.

Drug Discovery

Dr. Rahman S. Z. Saleem

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, 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.

Solid State Chemistry

Dr. Falak Sher

This group focuses on synthesis and characterisation of functional transition metal oxides with interesting properties and applications. Typically, the group investigates perovskite oxides (ABO3) for their potential applications in spintronics, thermoelectric devices, solid oxide fuel cells (SOFC) and photocatalysis for environmental remediation. Samples are synthesised by the conventional solid state chemistry and other soft chemistry methods, and characterised by the powder X-ray diffraction (XRD), scanning electron microscopy (SEM), thermogravimetric analysis (TGA) etc. Physical properties such as magnetic, electronic transport, thermal transport etc. are measured by the available facilities at SBASSE and through collaborations with various national and international research groups. Properties of these materials are correlated with their chemical nature and crystal structures, and various strategies are devised to fine tune and optimise their properties.

Soft Matter and Interfaces

Dr. Basit Yameen

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).

Catalyst Design

Dr. Muhammad Zaheer

This group focuses on the design of robust, active, selective and environmentally benign homogenous, heterogeneous and electro-catalysts for the derivation of renewable energy and chemicals from biomass (agricultural byproducts). Various catalyst supports prepared and utilised include mesoporous silica, metal organic frameworks (MOFs), silicon carbide (SiC) and N-doped SiC and carbon materials.

Department of Computer Science

The Department of Computer Science at LUMS boasts sixteen 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 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. The 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 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 sixteen full-time, PhD faculty members at the department have 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 seeking to induct new members to strengthen and expand their research programmes.

Faculty	Qualification
Arif Zaman	PhD, Stanford University, USA
Asim Salimul Karim	PhD, Ohio State University, USA
Basit Shafiq	PhD, Purdue University, USA
Hamid Abdul Basit	PhD, National University of Singapore, Singapore
Ihsan Ayub Qazi	PhD, University of Pittsburgh, USA
Imdad Ullah Khan	PhD, Rutgers University, USA
Junaid Haroon Siddique	PhD, University of Texas at Austin, USA
Mian Muhammad Awais	PhD, Imperial College London, UK
Muhammad Fareed Zaffar	PhD, Duke University, USA
Muhammad Hamad Alizai	PhD, RWTH Aachen University, Germany
Murtaza Taj	Queen Mary University, UK
Naveed Arshad	PhD, University of Colorado, USA
Shafay Shamail	PhD, University of Bath, UK
Sohaib Ahmad Khan	PhD, University of Central Florida, USA
Suleman Shahid	PhD, Tilburg University, The Netherlands
Zartash Afzal Uzmi	PhD, Stanford University, USA
Yasir Mehmood	PhD, Yahoo Labs and Pompeu Fabra University Barcelona, Spain

Research Programmes

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

Computer Vision

Dr. Murtaza Taj and Dr. Sohaib Ahmad Khan

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.

Data Mining

Dr. Asim Karim, Dr. Arif Zaman and Dr. Yasir Mehmood

Data Mining involves extracting informative patterns from large scale data-sets. The rapid growth in this field is fuelled by the increasing demand for automated data analysis and the rise in computation power. The Computer Science Department 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.

Polymers and Nanocomposites

Dr. Habib-ur-Rehman

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.

Networks, Information Security, Privacy and Distributed Systems

Dr. Muhammad Fareed Zaffar, Dr. Ihsan Ayyub Qazi, Dr. Basit Shafiq and Dr. Zartash Afzal Uzmi

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.

Software Engineering

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

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.

Algorithms and Theory of Computation

Dr. Imdad Ullah Khan and Dr. Arif Zaman

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.

Artificial Intelligence and Robotics

Dr. Mian Muhammad Awais and Dr. Asim Salimul Karim

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 Department of Electrical Engineering (EE) at SBASSE was established in 2008. It offers a very rigorous and modernised graduate programme. Today, the Department has over 150 graduate students and 23 full-time PhD faculty members. The first batch of EE MS students graduated in 2014 and found tremendous success in terms of job and graduate school placements. The EE programme gives students both a strong foundation and specialisation in important contemporary areas of electrical engineering including Communication Systems, Computer Networks, Embedded Systems, Nanoelectronics, VLSI Design Signal Processing, Control Systems, Robotics, Renewable Energy Systems and Optoelectronics. Students are also strongly encouraged to collaborate with other disciplines at SBASSE.

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 research 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 maintain research collaborations with several top academic institutes of the world; host professors and students from institutes within Pakistan and abroad; organise 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).

Faculty

The current list of EE faculty members include:

Abubakr Muhammad (on Sabbatical) PhD, Georgia Institute of Technology, USA

Farasat Munir PhD, Georgia Institute of Technology, USA

Ijaz Haider Naqvi PhD, IETR-INSA, Rennes, France

Momin Ayub Uppal PhD, Texas A&M University, USA

Muhammad Awais Bin Altaf PhD, Masdar Inst. of Science & Tech, UAE

Muhammad Tahir PhD, Politecnico di Torino, Italy

Nadeem Ahmed Khan PhD, Eindhoven University of Technology, Netherlands

Nauman Zafar Butt PhD, Purdue University, USA

Shahid Masud PhD, Queen's University, Belfast, UK

Tariq Mahmood Jadoon PhD, University of Strathclyde, UK

Waqas Majeed (on leave) PhD, Georgia Institute of Technology, USA

Zartash Afzal Uzmi PhD, Stanford University, USA

Ahmad Kamal Nasir PhD, University of Siegen, Germany

Hassan Abbas Khan PhD, University of Manchester, UK

Imran Cheema PhD, McGill University, Canada

Muhammad Adeel Pasha PhD, University of Rennes-1, France

Muhammad Jahangir Ikram PhD, University of Manchester, UK

Muhammad Zubair PhD, Australian National University, Australia

Nauman Ahmad Zaffar MS, University of Pennsylvania, USA

Naveed Ul Hassan PhD, University of Paris 11, France

Syed Azer Reza PhD, University of Central Florida, USA

Wala Saadeh PhD, Masdar Inst. of Science & Tech, UAE

Wasif Tanveer Khan PhD, Georgia Institute of Technology, USA

Research Clusters

Advanced Communications Laboratory (AdCom)

Dr. Momin Uppal, Dr. Ijaz Haider Naqvi and Dr. Naveed Ul Hassan

AdCom lab carries out research in modern-day telecommunication and smart grid systems; its main themes include Modelling, Design, Simulation, Implementation and Performance Characterisations. The lab's research spans many diverse aspects of telecommunication systems, such as Massive MIMO, cross layer design in wireless systems (5G, 4G), event detection and event identification in wireless sensor networks, efficient strategies for cognitive cooperative communication, experimental implementation of relaying platforms, performance analysis of ultra wideband systems, and applied signal processing. Research in Smart Power Grids domain includes, demand side management, consumer behaviour studies and integration of distributed renewable energy sources. During the last five years, the lab has been accorded international recognition through the publication of more than 50 research papers at various prestigious peer-reviewed journals and conferences and several million in research funding. Additionally, three patents were also granted during these years.

Laboratory for Cyber Physical Networks & Systems (CYPHYNETS)

Dr. Abubakr Muhammad

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.

Signal, Image and Video Processing Lab

Dr. Nadeem Khan, Dr. Muhammad Tahir, Dr. Muhammad Zubair and Dr. Waqas Majeed

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.

Energy and Power Systems Cluster

Mr. Nauman Ahmad Zaffar and Dr. Hassan Abbas Khan

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. 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.

Electronics and Embedded Systems Cluster

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

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 including 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. In this approach, instead of running the application tasks on a programmable processor, uses an application specific micro-architecture tailored to the application at hand which 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.

Devices, Optics and Electromagnetics Cluster

Dr. Hassan Abbas Khan, Dr. Syed Azer Reza, Dr. Imran Cheema, Dr. Sabieh Anwar (Phy), Dr. Muhammad Faryad (Phy), Dr. Mumtaz Sheikh (Phy), Dr. Farasat Munir and Dr. Wasif Tanveer

Research is being conducted in diverse areas of photonics and electromagnetics. Some of the areas include generation and detection of orbital angular momentum, microscopy, tunable optical delay line, biophotonics, agriphotonics, magneto optics, quantum optics, plasmonics, nanophotonics, and optical sensing. Research is also being conducted in 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. Research is also carried out in areas of RF sensing, RF circuits, antennas, and packaging.

Semiconductor and Nanoelectronic Devices (SND) Lab

Dr. Nauman Zafar Butt

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.

AI & Robotics in Precision Agriculture and Forestry

Dr. Ahmad Kamal Nasir and Dr. Mian Muhammad Awais (CS)

This research cluster is doing international and national projects in the field of precision agriculture and forestry. The aim is to develop indigenous ground and aerial mobile robotics solution for the agriculture sector of Pakistan from a purely technological perspective. Other aims of the research cluster are to conduct research on localisation, navigation and cooperative SLAM methods for heterogeneous multi-robot system from both applied and theoretical perspective.

RAMCASP Research lab

Dr. Wasif Tanveer

The objective and mission of the RF and Microelectronics Antennas, Sensors and Packaging (RAMCASP) Research lab is to achieve technology excellence in Pakistan by performing cutting-edge research and development in RF/Microwave domain to develop products in the area of information, communication and sensing, 5G technology, RF and mm-wave antennas and packaging, Internet of things, Wearable Wireless Health Care Devices, smart agriculture, printed electronics, smart and intelligent textile and packaging etc. The lab is equipped with state-of-the-art Microwave Measurement equipment and PCB rapid prototyping facilities and is actively engaged in collaborative projects with some multi-national and national organisations.

Department of Mathematics

Mathematics is the most fundamental of all the sciences and also the most applicable as it is the rigorous study of structure, relationship and pattern. 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 are Algebraic Geometry, Algebraic Topology, Combinatorial Commutative Algebra, Functional Analysis, Fixed Point Theory, Operator Theory 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.

Faculty

The Mathematics faculty includes PhDs hailing from some of the world's finest institutions such as Stanford, Western Ontario, Oxford, Imperial College London, NCSU, and Aberdeen. Regular involvement with international conferences and publications keeps the faculty abreast of global education trends. Moreover, eminent visiting scholars further diversify and enrich the learning experience.

Adnan Khan	PhD, Rensselaer Polytechnic Institute, USA
Ali Ashher Zaidi	PhD, Massey University, New Zealand
Amer Rasheed	PhD, Centre de Mathématiques Appliquées, INSA de Rennes, European University of Bretagne Rennes, France
Arif Zaman	PhD, Stanford University, USA [joint with Computer Science]
Haniya Azam	PhD, GC University, Pakistan
Imran Naeem	PhD, University of Witwatersrand, SA
Masood Hussain Shah	PhD, University of Aberdeen, UK
Muhammad Ahsan	PhD, Central European University, Hungary
Muhammad Usman	PhD, Imperial College London, UK
Muhammad Imran Qureshi	PhD, University of Oxford, UK
Shaheen Nazir	PhD, GC University, Pakistan
Sultan Sial	PhD, University of Western Ontario, Canada
Azmat Hussain	PhD, North Carolina State University, USA
Shamim Arif	PhD, University of Manchester, UK
Hanif Mian	PhD, University of the Punjab, Pakistan
Hira Nadeem	MSc, Florida Atlantic University, USA
Kamran Rashid	MS, University of Wisconsin-Madison, USA

Research Programmes

Faculty at the Department of Mathematics is involved in research across a broad spectrum, from Analysis and Algebra to High Performance Computation and Mathematical Biology. Brief descriptions of the faculty's research areas are given here.

Algebraic Topolgy

Dr. Haniya Azam
Using ideas from algebra, how can one classify topological spaces? This is the fundamental question which investigators in Algebraic Topology

try 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 algebra structure for the cohomology of the unordered configuration spaces. She is also interested in the area of Categorification, which lies at the cross roads of algebra, geometry, toplogy and representation theory. She uses the Lagrangian Floer theory to describe the Fukaya category of a Riemann surface of higher genus, the aim being to categorify the action of the mapping class group in this category.

Operator Theory

Dr. Masood Hussain Shah
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. The 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: the area of C-algebras and Operator Theory. He has also published in the area of fixed point theory.

Evolution Equations

Dr. Imran Naeem and Dr. Muhammad Ahsan
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. Imran Naeem studies exact solutions of evolution equations using Lie Symmetry methods. Dr. Muhammad Ahsan also works in this exciting area from another perspective. His research has been related to a Cauchy problem in a real Hilbert space (Semilinear Evolution equations involving maximal monotone linear operators, and nonlinear Lipschitz monotone operators), and some related perturbed problems.

Scientific Computation

Dr. Sultan Sial and Dr. Amer Rasheed
Real world problems can be formulated in mathematical terms (modelling), as the models have grown complex, a great deal of computing power is required to study these models. Scientific computation involves investigation of robust and efficient methods for studying problems that require heavy computations. Dr. Sial has been working on using finite element methods, on problems from material science, while Dr. Rasheed's research interest focuses on investigating crystal growth in metals using finite element methods.

Algebraic Geometry

Dr. Muhammad Imran Qureshi
Algebraic Geometry is the study of solutions of multivariate polynomial equations. The solutions of these polynomial equations which are the geometric objects of study in Algebraic Geometry are called Algebraic Varieties. Dr. Qureshi is interested in classification of families of algebraic varieties. In particular he is interested the classification of Fano varieties and Calabi-Yau varieties.

Mathematical Biology, Mathematical Analysis

Dr. Adnan Khan and Dr. Ali Ashher Zaidi
Modelling of complex biological phenomena has become fashionable over the past two decades, as the computing power required to analyse such models has become available. On the other side, non-local calculus has gained significance owing to its applications in various biological and physical phenomena. The theory of non-local calculus has to be developed in order to better analyse and understand these physical and biological phenomena. Dr. Adnan Khan has been working in this area, from modelling dynamics of proteins to the mathematical study of epidemics. He 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. Dr. Ali Ashher Zaidi has been working on developing techniques for solving non-local (functional) ordinary and partial differential equations, which arise in size structured cell growth models.

Spectral Theory

Dr. Muhammad Usman
Spectral theory can be seen as a generalisation of the ideas and concepts of eigenvalues and eigenvectors of a square matrix to a broader class of operators acting in different spaces. Dr. Usman's research interest lies in the spectral theory of quantum graphs. A quantum graph is a metric graph with one-dimensional Schrödinger operators acting on the edges and equipped with some appropriate boundary conditions at vertices. The main focus is on quantities related to the discrete spectrum of these operators.

Financial Mathematics, Stochastic Portfolio

Dr. Azmat Hussain
The Stochastic Portfolio Theory is a branch of Mathematical Finance. Robert Merton studied the portfolio allocation problem as a Stochastic Control Problem. In his model, an investor allocates his/her wealth between a risky asset and a riskless asset, then chooses the consumption rate to maximize the total expected utility. Dr. Hussain is interested in studying portfolio allocation models, on finite and infinite time horizons, that incorporate the past (recent/complete) performance of the portfolio. He is also interested in the financial risk management side of finance in addition to several other areas directly or indirectly related to Operations Research and Optimisation with applications in finance, healthcare and energy.

Department of Physics

Research at the Department of Physics focuses on probing fundamental physical aspects of the universe and the underlying mathematics, 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 Opportunities

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 external 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
Babar Ahmed Qureshi	PhD, Syracuse University, USA
Muhammad Sabieh Anwar	DPhil, Oxford University, UK
Mumtaz Ali Sheikh	PhD, University of Central Florida, USA
Maqbool Ahmed	PhD, Syracuse University, USA
Shaheen Irfan	PhD (in progress), University of the Punjab, Pakistan
Muhammad Faryad	PhD, Penn State University, USA

Research Groups

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

Spin and Photon Physics

Dr. Sabieh Anwar
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.

Quantum Dynamics

Dr. Adam Zaman Chaudhry

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.

Plasmonics and Nanoengineered Materials

Dr. Muhammad Faryad

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.

Fundamental Theory

Dr. Babar Ahmed Qureshi

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.

Photonics

Dr. Mumtaz Ali Sheikh

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. Mumtaz Ali 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.

Cosmology

Dr. Maqbool Ahmed

The causal set theory is an attempt to reconcile general relativity with quantum theory, which is called the theory of quantum gravity. It assumes that the fundamental reality is not a smooth manifold but is rather a discrete structure called a causal set. Although a complete quantum version of the causal set idea is still lacking, researchers have been able to point out some important implications of the fundamental discreteness assumed in the causal set theory about various puzzles in physics. Dr. Maqbool Ahmed concentrates on the cosmological implications of the causal set idea and, in collaboration with others, has proposed a verifiable model of dark energy, arguably the most imporant problem in all of cosmology. He has also proposed a model of the early universe that derives life from the fundamental discreteness and sheds light on many of the problems of the early universe as seen from the causal set point of view. He is interested in exploring the implications of these models further and is working to see how well they match with observational data.

Research Centres at SBASSE

Centre for Advanced Studies in Mathematics (CASM)

Dr. Amer Rashid

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.

Centre for High Performance Computing

Nauman Zubair

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 of the Departments of Electrical Engineering, Computer Science, Mathematics, Biology, Physics, Economics and the LUMS Suleman Dawood School of Business (SDSB).

Centre for Water Informatics & Technology (WIT)

Dr. Abubakr Muhammad

WIT was established at LUMS in 2016. Housed at the Syed Babar Ali School of Science and Engineering (SBASSE), WIT aims to serve as a platform with a disciplinary focus on hydro-informatics and systems analysis, touching multidisciplinary research themes in water by engaging faculty and students from all departments of SBASSE; and by forging collaborations among the different schools within LUMS to provide the much needed, interdisciplinary perspective to water issues, under the guidance of a world-class advisory group.

WIT research and training programmes will work to cross the boundaries of traditional scientific disciplines to foster interdisciplinary understanding of water. Additionally, WIT will help to bridge the gap between academia and practice, and establish a fruitful co-operation between the academic community and industry, development agencies, NGOs, public administration, local communities, and other relevant institutions for building capacity in innovation and technology for water management. WIT will also promote a new mindset that redirects researchers' focus away from overly theoretical concepts towards new and innovative research solutions.

Admission Criteria and Deadlines

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

- Academic record
- GRE or LUMS Graduate Admission Test Performance*
- Interview performance (if and where applicable)
- Completed online application form along with all supporting documents

* For admission test details, visit: https://admission.lums.edu.pk/graduate-programmes

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), 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 HEC, 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.

Important Information

An applicant obtaining 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.

Applicants applying to the MS/PhD Computer Science must have secured at least 60% marks in their FSc exam. A'Levels students must have at least 65% marks on IBCC equivalence scale with at most 1 D grade.

Applicants who have obtained their degrees from institutions that are not listed with the HEC, Pakistan will be required to obtain an equivalence certificate from HEC.

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	CHEMISTRY
Biology	Chemistry
Biochemistry	Biochemistry
Bioinformatics	Materials Science or Engineering
Molecular Biology	Chemical Engineering
Microbiology	Other closely related discipline
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.

COMPUTER SCIENCE	ELECTRICAL ENGINEERING
Computer Science	Electrical Engineering
Software Engineering	Electronics
Information Technology	Computer Science
For PhD: Other closely related disciplines	Engineering/Applied Physics
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.	Mechatronics Engineering
	Computer Engineering
	Telecom Engineering
	Other Engineering disciplines peripherally related to Electronics or Electrical Engineering

MATHEMATICS	PHYSICS
Mathematics	Physics
Statistics	Mathematics
Physics	Computer Science
Any other closely related disciplines determined by Mathematics Graduate Committee	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, 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 16, 2017.

- The deadline to take GRE/GRE Subject Test (if applicable) is April 16, 2017 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

Financial Support

- External Scholarships (if available)
- Teaching Assistantships
- 45% Tuition Fee waiver for all new MS students (Basic Sciences and Mathematics)
- 50% Tuition Fee waiver for returning students (Basic Sciences and Mathematics)
- 100% Scholarship for PhD students

  For details, visit: https://financial-aid.lums.edu.pk

LUMS

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