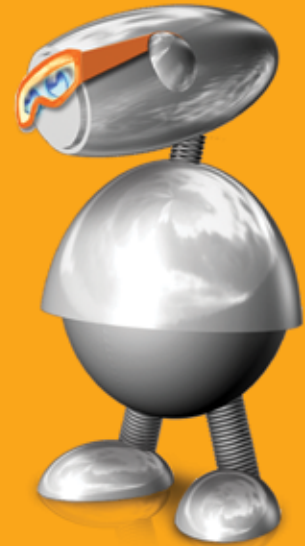


Fully Funded PhD



Programmes & Generous Financial Assistance in MS

SBASSE Graduate Programmes



70+ PhD
Faculty Members



Over 400 High Impact
Research Publications



30+ Research Groups



Over PKR 200 Million
Received for Research Projects



Syed Babar Ali
School of Science & Engineering

CONTENTS

- 03 / Syed Babar Ali
School of Science & Engineering
- 04 / Department of Biology
- 06 / Department of Chemistry
- 09 / Department of Computer Science
- 10 / Department of Electrical Engineering
- 13 / Department of Mathematics
- 15 / Department of Physics
- 18 / Admission Eligibility Guidelines



INTRODUCTION TO LUMS

The Lahore University of Management Sciences (LUMS), founded in 1985, has emerged as one of the top degree awarding institutions of South Asia, with a strong dedication towards the advancement of knowledge in a broad range of disciplines as its guiding vision. LUMS prides itself on its exceptional faculty and variety of subject offerings, including business management, sciences, engineering, humanities, social sciences, economic and law.

SYED BABAR ALI SCHOOL OF SCIENCE & ENGINEERING

Syed Babar Ali School of Science and Engineering (SBASSE) at Lums is the first private research school of science and engineering in Pakistan that imparts high quality education while housing rigorous research activities pertaining to the environment, governance and healthcare as well as to general technological and scientific advancement. SBASSE offers the following graduate programmes:

THE MS PROGRAMME

The MS Programmes at SBASSE have been designed to involve the necessary rigour to enhance the understanding of the subject material, providing opportunity for better employment, and opening doors to a teaching career or further graduate study. The MS programme consists of a total of 30 credit hours and is offered in two forms: MS-with-Thesis and MS-by-Coursework. Students opting for MS-with-Thesis must take 24 credit hours of coursework and complete a 6-credit-hour Master's thesis under the supervision of a faculty advisor. The MS-by-Coursework option requires students to take 30 credit hours of coursework entirely. For full-time students, the MS programme typically takes 1.5-2 years depending on whether the MS-with-Thesis or the MS-by-Coursework option is pursued.

THE PHD PROGRAMME

The PhD programme at SBASSE prepares students to think scientifically and conduct high quality research independently. Students in the PhD programme are expected to undertake original research work under the guidance of their thesis advisor. Extensive research work is what distinguishes the PhD degree from other academic degrees. Research carried out by PhD students is expected to be disseminated in peer reviewed international journals and conferences.

The PhD degree involves completion of 42 credit hours; 18 credit hours of coursework and 24 credit hours of thesis 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 and lastly the PhD Thesis Defense.

All admitted PhD students will be provided full tuition fee waiver and a monthly stipend to cover their living expenses. However, they will be required to contribute to the departmental teaching and research assignments in compensation.

MS

- Biology
- Chemistry
- Computer Science
- Electrical Engineering
- Mathematics
- Physics

PhD

- Biology
- Chemistry
- Computer Science
- Electrical Engineering
- Mathematics
- Physics

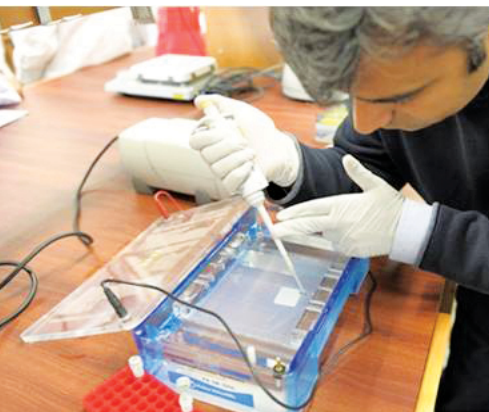
DEPARTMENT OF BIOLOGY

The Department of Biology offers MS and PhD Programmes in Molecular Biology and aspires to produce independent researchers who can take up challenges of the 21st century biology. The state-of-the-art research labs, experienced faculty and a world class collaborative environment at LUMS contribute to our competitive advantage. Students take advanced classes and conduct independent research in partial fulfillment for their PhD degree. All PhD students receive generous financial support in the form of a tuition waiver and monthly stipend.

RESEARCH OPPORTUNITIES

Research is an essential component of the graduate programme. Research projects in the department are addressing fundamental questions in biology like how complex organisms develop from a single cell and how cell fates are determined, how gene expression is regulated in extremophiles, how cell cycle is controlled in stem cells and how organisms evolve over thousands of years. Mammalian, *Drosophila*, plant and bacterial model systems are used to answer these questions through experimentation in the labs and through computational biological approaches *in silico*. Computational biologists are using mathematical and statistical tools to mine large sets of data and find solutions to complex biological questions as well as to model future drugs. Students will be able to choose from a wide range of research programmes in molecular and cell biology, genetics and epigenetics, biochemistry, biophysics, and structural and computational biology for their thesis research.

The department houses state-of-the-art labs and equipment like fluorescent microscopes, fluorescence activated cell sorters (FACS), Confocal microscope, real time PCR machines, ultrasonic bioruptor, high speed centrifuges and tissue culture facility. In addition, the department also boasts computer labs containing modern bio computing facilities.



THE FACULTY

The Department of Biology is led by the following faculty members who have acquired vast experience in their respective areas of research. Additional faculty members are being recruited to further strengthen and diversify our research programmes.

Ahmad Jawaad Afzal
PhD, Southern Illinois University
United States of America

Aziz Mithani
D.Phil. University of Oxford
United Kingdom

Safee Ullah Chaudhary
PhD, Korea Advanced Institute of Science
and Technology
South Korea

Muhammad Tariq
PhD, Friedrich Miescher Institute
Switzerland

Saima Anwar
PhD, University of the Punjab
Pakistan

Sohail A. Qureshi
PhD, University of Maine
United States of America

Syed Shahzad ul Hussan
PhD, University of Luebeck
Germany

Zakir Ullah
PhD, Michigan State University
United States of America



RESEARCH

Biology of Hepatitis-C virus; Gene Regulation in Extremophilic Archaea Dr. Sohail A. Qureshi

Hepatitis-C viral (HCV) infections reduce the quality of life for over 170 million people worldwide. Although HCV was discovered about 21 years ago, the available treatment options for infected individuals are limited. Despite much effort, development of vaccines and drugs against HCV has been hampered due to rapid evolution of the virus. Dr. Sohail Qureshi's group is interested in studying the basic biology of HCV and in particular to understand how HCV encoded proteins influence the transcriptome, proteome and epigenome of infected hepatocytes during different stages of infection. Additionally, they are working to identify conserved regions within the HCV genome that may serve as useful vaccine candidates.

Archaea represent a highly diverse class of prokaryotic microorganisms capable of withstanding harsh environmental conditions such as extremes of temperature, pH, salinity and pressure. Using *Sulfolobus* as a model organism, Dr. Sohail Qureshi's group is studying mechanisms through which heat-shock, DNA damage and oxidative stress are induced. The goal is to identify factors that sense such stresses and to understand how they interact with the various components of transcription machinery and influence expression of their respective target genes.

Cell Signaling, Cell Cycle Regulation and Stem Cell Differentiation Dr. Zakir Ullah

The research focus of the group led by Dr. Zakir Ullah is to understand the molecular circuits that regulate stem cell proliferation, differentiation and exit from the mitotic cell cycle leading to terminal cell differentiation. Differentiation of Trophectoderm Stem (TS) cells into Trophectoderm Giant (TG) cells is used as a model system. TS cells differentiate into cells of the placental lineage, including TG cells which are terminally differentiated polyploid cells involved in implantation of the embryos in the uterus during early stages of child development. Additional projects in the lab include production and differentiation of induced pluripotent stem cells and effect of viral infections on cell cycle regulation.

Epigenetics: Cell Fate Maintenance Dr. Muhammad Tariq

Cell memory is a process which ensures different cell types (blood, liver, neuron, kidney, heart etc) in our body remember their identity which was established early during development while we were just a clump of cells in our mother's womb. Epigenetics research lab at LUMS utilises fruit fly (*Drosophila melanogaster*) to understand role of Polycomb and Trithorax group proteins which are key players in the process of cell memory. Polycomb group proteins maintain genes in silent (inactive) state while Trithorax group proteins act as anti-silencers and thus contribute to maintenance of identity of different cell types throughout our life. Different research projects in the group aim to understand how cell fates are established and how PcG/TrxG functions can be modulated to switch one cell type to another.

Computational Systems Biology Dr. Aziz Mithani

The focus of Computational Systems Biology group is the development and application of computational and mathematical methods in the area of modern biology to understand how biological systems function and evolve over time. The group is using computational techniques to understand the genetics of bread wheat and the hybridisation events that have led the evolution of modern day bread wheat from different goat grasses and Eikorn (pasta wheat). This project is in collaboration with the Harberd Lab at the Department of Plant Sciences, University of Oxford and uses the latest genomic science including high-throughput sequencing and associated statistical analysis to determine the precise nature and extent of the genetic variation that has led to the modern day bread wheat.

Plant Molecular Biology Dr. Ahmad Jawaad Afzal

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 synergize to provide robust host defense that halts most infections. My current work focuses on understanding the role of the multifunctional protein RIN4, which regulates both branches of the plant immune system.

Engineering and Structural Investigation of Anti-HIV Lectin; Studying the Bioactive Conformation of the V3-domain of HIV gp120 in Co-Receptor Bound State Dr. Syed Shahzad Ul Hussan

In recent years, several anti-HIV lectins have been discovered that inhibit viral entry to the host cell by specifically binding to the carbohydrate fragments on the HIV envelope (1). These lectins provide important leads for drug as well as antibody targets, but the goal of their use as therapeutics has not been met due to possible immune response of the host against these proteins. Therefore, designing a smaller protein that can inhibit HIV entry can be a better lead or potential therapeutic. Microvirin is one of the lectins that potentially inhibit HIV entry to the host cell. We have solved the structure of this lectin in complex with HIV envelope carbohydrate fragment (2). This lectin is 12 kDa in size and consists of two homologous domains. But contrary to all other known anti-HIV lectins, microvirin has only one carbohydrate-binding site located in one domain. I intend, Syed Shahzad ul Hussan, to engineer this protein to reduce its size to 6 kDa in a way that its anti-HIV activity is not negatively affected.

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 established itself in its unique ability to initiate and maintain internationally recognised research programmes in a variety of chemical disciplines for the last few years, especially nano-science and materials chemistry. The Department's faculty consists of an outstanding group of scientific leaders who are committed to pursuing and maintaining excellence in research. The faculty has already demonstrated this by publishing research articles in highly prestigious and high impact international journals, including Nature, Nature Materials, Advanced Materials, Angewandte Chemie Int. Ed., Journal of the American Chemical Society, Nano Letters, ACS Nano, Small, Chemistry of Materials, Chemical Communications, Langmuir and Nanoscale etc. It is an exciting opportunity for students to join and make the most of the fertile research environment. The department's mission is to produce outstanding graduates who can excel and become future leaders in academia and industry.



THE FACULTY

The Department of Chemistry at LUMS has experienced faculty members who are committed to excellence in teaching and developing world-class research programmes especially at the interface of other science and engineering disciplines.

Ahsan Ullah
PhD, Freie University Berlin
Germany

Basit Yameen (Adjunct)
PhD, Max Plank Institute for Polymer
Research
Germany

Falak Sher
PhD, University of Cambridge
United Kingdom

Ghayoor Abbas
PhD, Michigan State University
United States of America

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

Irshad Hussain
PhD, University of Liverpool
United Kingdom

Rahman S. Z. Saleem
PhD, Michigan State University
United States of America

RESEARCH

In addition to the traditional areas of chemical sciences, the Department of Chemistry is pursuing on many interdisciplinary research projects interfacing chemistry with various fields, including biology, medicine, physics, environmental and material sciences and engineering. The faculty is actively conducting research involving nanoscience and technology, macromolecular chemistry, green synthesis/catalysis, renewable energy technologies, healthcare, and environmental remediation.

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, and their applications in renewable energy technologies (solar/fuel cells and H₂ production), catalysis, drug/gene delivery, disease diagnostics, bacterial detection and environmental remediation etc.

Solid State Chemistry

Dr. Falak Sher

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.

Catalysis and Green Chemistry

Dr. Ghayoor Abbas

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, catalysis, and material science.

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, micro fluidics, 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.

Drug Discovery

Dr. Rahman Shah Zaib 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 and the dengue fever virus and in the 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.

Bio - organic Chemistry

Dr. Ahsanullah

This group focuses on the design and solid-phase synthesis of peptidomimetics especially heterocyclically modified peptides as potential enzyme inhibitors targeting HCV proteins. This area is extended to the synthesis of natural cyclopeptide-mimetics especially conformationally locked pseudo-cyclopeptides and development of peptide ligation reactions. The exploitation of multi-component reactions for small molecules of biological relevance is also being explored.



RESEARCH FACILITIES

The teaching and research labs at the Department of Chemistry are well equipped with experimental facilities and equipment including spectroscopic, structural and materials characterisation tools. These tools, include GC-MS, FT-IR spectrometer with diamond ATR attachment, FT-IR spectrometer for thin-films analysis, UV-Vis spectrophotometers, spin coater, differential scanning calorimeter (DSC), microwave synthesiser (CEM), refrigerated/non-refrigerated microcentrifuges, high-temperature furnaces, pellet press machine, high-temperature autoclave with steel/teflon reactor, impedance analyzer with climate chamber attachment, potentiostat with cyclic voltameter, water contact angle measuring equipment, magnetic susceptibility balance and goniometer etc. Scanning electron microscope (SEM), powder XRD, TGA-DTA, HPLC, spectro fluorometer with plate reader, Zetasizer Nano-ZS and UV-Vis-NIR spectrometer are in order and will be available very soon.

COLLABORATIONS

The faculty members at the Department of Chemistry have developed very effective and fruitful research collaborations with prominent national and international research groups in the US, UK, Germany, Switzerland, Turkey, China, and Saudi Arabia. Such collaboration keep the Department abreast of the latest developments and allow usage of advanced technology and equipments which are currently not available anywhere in Pakistan. These collaborations have been very useful and several joint research articles are being published in prestigious international journals.



THE DEPARTMENT OF COMPUTER SCIENCE

The Department of Computer Science was founded in 1994, as an undergraduate programme with just two faculty members. Today, the department has fifteen faculty members, with doctorates from some of the best universities in the world. The Department became part of SBASSE in 2008. Major research areas in the department, include Computer Architecture, Computer Vision, Data Mining, Multimedia Systems, Network and Wireless Communications, Software Engineering, and Theory of Computation.

Faculty members of the Department, together with their graduate students, continue to publish their research in the leading journals of the field and present papers in more than thirty top-tier conferences. Over the past three years, the Computer Science faculty has published over 115 research papers and sought PKR 120 million in research grants from national and international funding agencies.

RESEARCH

THEORY OF COMPUTATION

Theory of Computation is the formal study of power as well as the 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, randomised algorithms, data structures, complexity theory, computational biology, computational geometry, cryptography, computational learning theory, coding theory and several others.

NETWORKS AND 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 developing world. Areas of research, include network protocols and standards, performance evaluation, pervasive computing, multimedia communications, access control, data privacy and network security.

COMPUTER VISION

Computer Vision focuses on the theoretical aspect and the 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 practise without relying on real patients and innovative ways to map socio-economic parameters for Pakistan.

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 CS 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 datasets.

SOFTWARE ENGINEERING

Software Engineering is dedicated to the design and modification of software so that it efficiently carries out tasks designed by clients, in any sphere of public or private life. The focus of the research undertaken by the Software Engineering Lab at SBASSE is in the areas of E-government Architectures, Quality of Conceptual Models, Maintenance Metrics, Architecture recovery of Legacy Systems, Soft Computing and Autonomic Computing. Projects underway also include: Automated Failure Recovery in Distributed Systems, Architecture Recovery of Legacy Systems, Injecting Autonomic Behaviour in Legacy Systems, Measuring Quality in Self-Managed Systems, Spatial Complexity Metrics and e-Governance Architectures and Frameworks.

ARTIFICIAL INTELLIGENCE AND ROBOTICS

The Artificial Intelligence and Robotics research at LUMS are primarily focused on Applied Soft Computing, with CS Department 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.

THE FACULTY

Arif Zaman
PhD, Stanford University
United States of America

Mian Muhammad Awais
PhD, Imperial College London
United Kingdom

Shahab Munir Baqai
PhD, Purdue University

Asim Karim
PhD, Ohio State University
United States of America

Junaid H. Siddiqui
PhD, University of Texas
United States of America

Sohaib Ahmad Khan
PhD, University of Central Florida
United States of America

Basit Shafiq
PhD, Purdue University
United States of America

Murtaza Taj
PhD, Queen Mary, University of
London United Kingdom

Zartash Afzal Uzmi
PhD, Stanford University
United States of America

Muhammad Fareed Zaffar
PhD, Duke University
United States of America

Naveed Arshad
PhD, University of Colorado
United States of America

Ihsan Ayyub Qazi
PhD, University of Pittsburg
United States of America

Hamid Abdul Basit
PhD, National University of
Singapore

Shafay Shamail
PhD, University of Bath
United Kingdom

DEPARTMENT OF ELECTRICAL ENGINEERING

The Department of Electrical Engineering is the largest Department at SBASSE. Founded in 2008, the Department started off by offering a very rigorous and modernised undergraduate programme which is accredited by the Pakistan Engineering Council. Today, the department has about 400 undergraduate and graduate students and 18+ full-time PhD faculty members. The first batch of undergraduate students graduated in June 2012. The electrical engineering programmes give students both a strong foundation and specialisation in important contemporary areas of electrical engineering, including communication systems, computer networks, embedded systems, nano electronics, VLSI design signal processing, control systems, robotics, renewable energy systems and opto electronics. Students are also strongly encouraged to collaborate with other disciplines at SBASSE such as Physics, Biology, Computer Science, Mathematics and Chemistry.

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 subjects. Since the inception of the department, the faculty and their academic staff (most of whom are LUMS graduate students) have published 50+ 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. Faculty members have also visited and 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 organisation, including the Punjab Environmental Protection Agency (EPA), Punjab Irrigation Dept (PID), Cleaner Production Institute (CPI), World Wildlife Fund (WWF) and International Water Management Institute (IWMI).

THE FACULTY

Aamir Rashid
PhD, University of Toulouse
(INP - Toulouse)
France

Abubakr Muhammad
PhD, Georgia Institute of Technology
United States of America

Hassan Abbas Khan
PhD, University of Manchester
United Kingdom

Ijaz Haider Naqvi
PhD, IETR-INSA, Rennes
France

Jahangir Ikram
PhD University of Manchester
United Kingdom

Muhammad Adeel Pasha
PhD, University of Rennes-1
France

Momin Ayub Uppal
PhD Texas A&M University
United States of America

Nadeem Ahmed Khan
PhD Eindhoven University of
Technology
Netherlands

Nauman Ahmad Zaffar
MS, University of Pennsylvania
United States of America

Nauman Zaffar Butt
PhD, Purdue University
United States of America

Naveed Ul Hassan
PhD, Ecole Superieure d'Electricite
(Supelec), Gif-sur-Yvette
France

Shahid Masud
PhD, Queen's University, Belfast
United Kingdom

Shahrukh Ather
MS, Lahore University of Management
Sciences (LUMS)
Pakistan

Syed Azer Reza
PhD, University of Central Florida
United States of America

Tariq Mahmood Jadoon
PhD, University of Strathclyde
United Kingdom

Waqas Majeed
PhD, Georgia Institute of Technology
United States of America

Zartash Afzal Uzmi
PhD, Stanford University
United States of America

50 +

peer reviewed research
articles in highest ranked
international journals

RESEARCH

Advanced Communications Lab (AdComm)

Associated Faculty: Dr. Ijaz Haider Naqvi, Dr. Momin Uppal, Dr. Naveed Ul Hassan, Dr. Tariq Jadoon

URL: <http://adcom.lums.edu.pk/>

Research at the AdCom lab deals with many diverse aspects of modern-day telecommunication systems; main themes include modelling, design, simulation, implementation, and performance characterisations. Some of our recent research has focused on areas such as cross layer optimisation and networking problems in upcoming wireless systems (LTE/LTE-A), system-level aspects in wireless sensor networks, efficient coding strategies for cooperative communication, robust close-to-capacity designs for dirty-paper coding, and experimental implementation of relaying platforms and performance analysis of ultra wideband systems. The research conducted strives to develop algorithms and solutions that are useful as well as practical.

Cyber-Physical Networks and Systems Lab (CYPHYNETS)

Associated Faculty: Dr Abubakr Muhammad

URL: <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, infrastructure, environment and sustainable development in the context of Pakistan and the developing world. One of the main research thrusts is control, estimation and optimization of water resources in Pakistan. Systems theory techniques from the domain of cyber-physical systems are freely employed into design and operation of hydro-systems. The other major research thrust at CYPHYNETS is theoretical and experimental research in various areas of robotics.

CYPHYNETS 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 sustainable development. On the theory side, geometric algorithms and systems theory are applied to study fundamental problems in algorithmic robotics.

Devices, Optics and Electromagnetics Group

Associated Faculty: Dr. Syed Azer Reza, Dr. Aamir Rashid, Dr. Hassan Khan

Research is being conducted in the design of intelligent instrumentation using Opto-electronic sensors and devices. Spectral response modelling, characterization and analysis of III-V Phototransistors is being conducted for high speed Opto-electronic systems such as Photoreceivers. Other activities include Computational Electromagnetics in which simulation of MIMO and UWB antennas in complex operating environment is being explored through numerical models.

Electronics and Embedded Systems Group

Associated Faculty: Dr. Shahid Masud, Dr. Jahangir Ikram, Dr. M. Adeel Pasha, Shahrukh Athar

URL: <http://lums.edu.pk/sse/ee/cluster/electronics-and-embedded-systems>

The main focus of this research cluster is to explore customised hardware, software and codesign 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. In 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.

Energy and Power Systems Group

Associated Faculty: Nauman Ahmed Zaffar, Dr. Aamir Rashid, Dr. Hassan Khan, Dr. Khurram Khan Afridi

URL: <http://lums.edu.pk/sse/ee/cluster/energyandpower-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 for is also being conducted using various characterisation 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 renewable in smart grids along with the development of Smart Micro Grid infrastructure at LUMS.

Signal, Image and Video Processing Laboratory

Associated Faculty: Dr. Nadeem Khan, Dr. Waqas Majeed, Dr. Jahangir Ikram, Dr. Shahid Masud

URL: <http://lums.edu.pk/sse/mmrl/index.php>

LUMS conducts research in the area of Video Processing, Computer Vision and Signal Processing. Current area 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. Lab has housed several Senior and Master's Projects, Master's thesis and externally and internally funded research and development projects.

Networks and Communications Lab (NC Lab)

Associated Faculty: Dr Zartash Uzmi

URL: <http://suraj.lums.edu.pk/zartash/>

The Networks and Communications (NC) lab at the LUMS Syed Babar Ali School of Science Engineering conducts research in Networking Systems. Specific research areas include wireless networks, congestion control, network and systems security, data provenance and forensics, routing, energy-efficient networking, data centres, traffic engineering, network architecture, and distributed multimedia systems. The lab supports both experimental as well as theoretical research in these areas. The group has a strong track record of publishing research at leading International Conferences and Journals including ACM Sensys, IEEE INFOCOM, ACM CoNext, IEEE/ ACM Transactions on Networking, ACM SAC, ACM Grid, ACSAC, DCOSS, DRCN, Global Internet, ICC, and Globecom. 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 (San Jose), Marvell Semiconductor and Max Planck Institute for Software Systems.

DEPARTMENT OF MATHEMATICS

Mathematics is the rigorous study of structure, relationship, and pattern. As such, it is both the most fundamental of all the sciences and also the most applicable. The Department of Mathematics offers undergraduate and PhD degree programmes. The Faculty at the Department of Mathematics work 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 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, cancer kinetics, social choice theory, and statistics. Regular involvement with international conferences and publications keeps LUMS faculty abreast of global education trends. Moreover, eminent visiting scholars further diversify and enrich the learning experience at LUMS.

THE FACULTY

The faculty members hold PhDs from some of the world's finest institutions, such as Cambridge, Oxford and Pennsylvania among others.

Adnan Khan
PhD, Rensselaer Polytechnic Institute
United States of America

Arif Zaman
PhD, Stanford University
United States of America

Faqir Bhatti
PhD, University of London
United Kingdom

Imran Naeem
PhD, University of Witwatersrand
South Africa

Masood Shah
PhD, University of Aberdeen
United Kingdom
Mujahid Abbas
PhD, National College of Business
Administration and Economics
Pakistan

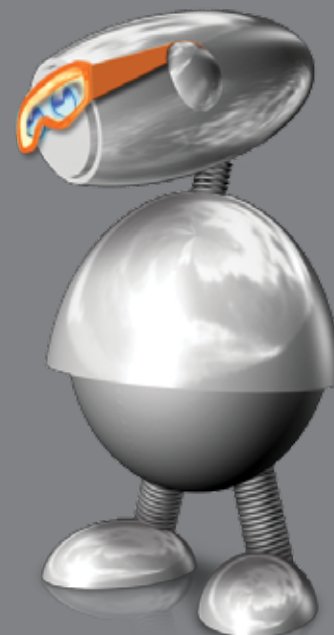
Sultan Sial
PhD, University of Western Ontario
Canada

Mudassar Imran
PhD, Arizona State University
United States of America

Muhammad Dur-e-Ahmad
PhD, Arizona State University
United States of America

Muhammad Imran Qureshi
PhD, University of Oxford
United Kingdom

Shaheen Nazir
PhD, GC University
Pakistan



RESEARCH CENTERS

Centre for Advanced Studies in Mathematics (CASM)

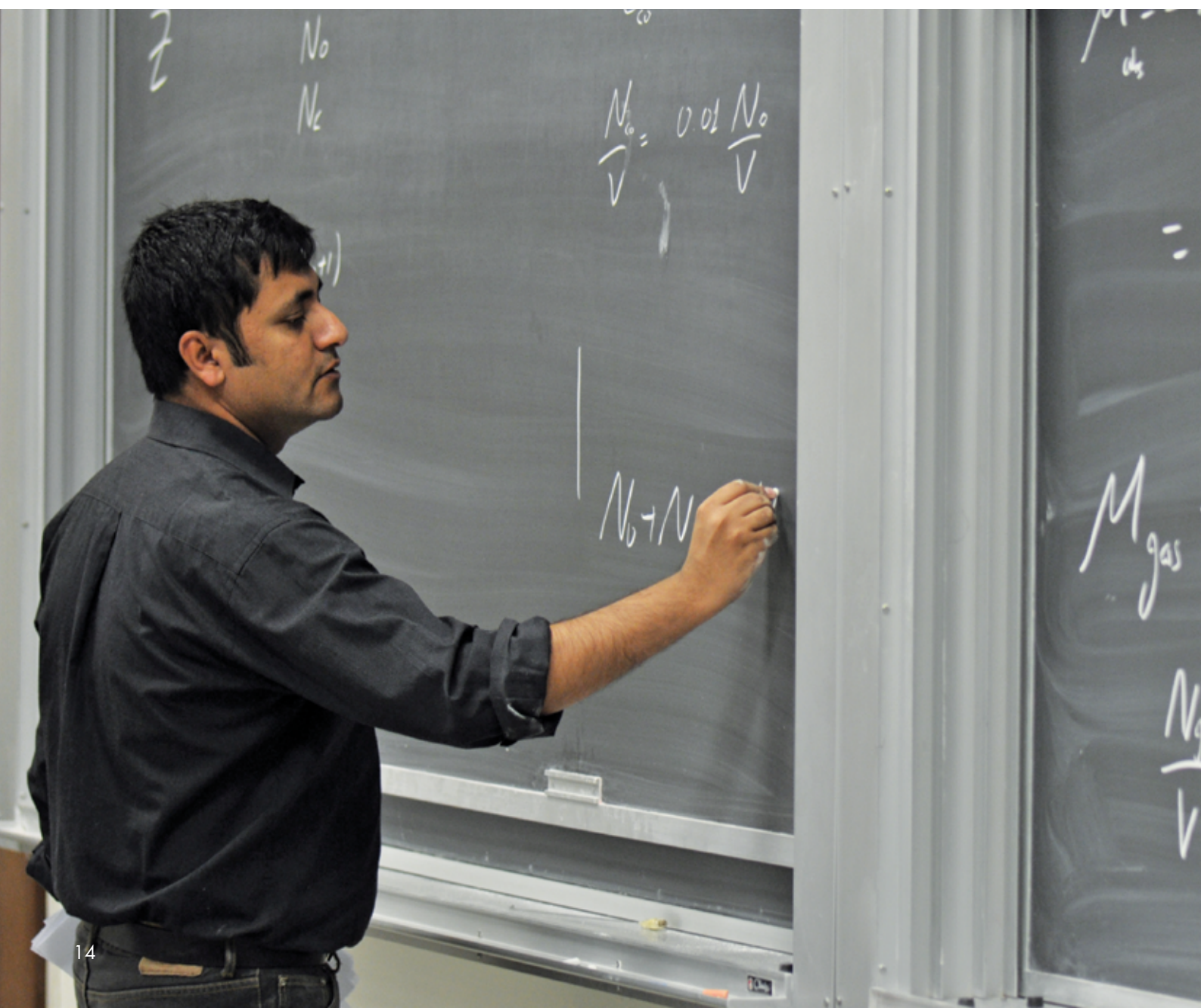
Director: Faqir Muhammad Bhatti

The Centre for Advanced Studies in Mathematics 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.

Currently areas of activity include Functional Analysis, Operator Theory, Mathematical Biology, Scientific Computation, Graph Theory, Enumerative Combinatorics, and Symmetries of Differential Equations. The Centre for Advanced Studies in Mathematics 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: engender and facilitate science and engineering research efforts; assist researchers with specialised computational needs; and provide research and development exposure to students.



DEPARTMENT OF PHYSICS

The Department of Physics has an outstanding teaching and research environment. The research focuses on probing fundamental physical aspects of the universe and the underlying mathematical structures as well as novel applications in diverse areas, including nanoscience, optics and materials. An important character of the department is embodied in 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.

THE FACULTY

Muhammad Sabieh Anwar
D.Phil, Oxford University
United Kingdom

Ata-ul-Haq
PhD, University of Stuttgart
Germany

Fakhar-ul-Inam
PhD, University of Ohio
United States of America

Amer Iqbal
PhD, Massachusetts Institute of Technology
United States

Anzar Khaliq
PhD, University Pierre et Marie Curie
France

Babar Ahmad Qureshi
PhD, Syracuse University
United States of America

Mumtaz Ali Sheikh
PhD, University of Central Florida
United States of America

Imran Younus
PhD, Syracuse University
United States of America

COLLABORATIONS AND OUTREACH

There are active collaborations which our faculty and students enjoy with research groups and consortia throughout the world, especially through a Federation Agreement with the Abdus Salam International Centre for Theoretical Physics in Trieste (Italy). Here students are actively involved in summer research programmes both at LUMS and at other institutes in Pakistan and abroad, for example through Summer Exchange with CERN, and contribute to various outreach activities. The teaching laboratories have provided a model that has been successfully replicated at other Universities in Pakistan, all within the cost-conscious milieu of the developing world.

30+faculty
research papers
published in top physics
journals
since 2008

**Active
collaboration**
with the
Abdus Salam
international centre
for theoretical physics in Italy

RESEARCH FACILITIES

The Department of Physics houses well-equipped laboratories. The department's laboratories in solid state physics, optics and photonics, laser engineering, radiation physics, 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 workshop 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 or synthesised at high temperatures and their various dielectric, electronic, thermal, magnetic and optical characterisations can be performed with available equipment. Furthermore, high performance computing resources enable students to solve and visualise problems in research or perform complex mathematical first principle calculations.

RESEARCH

Spin and Photon Physics

Principal Investigator: 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.

Through innovative optical materials integrated with thermal control, the group is also involved in the development of economical solutions towards the polymerase chain reaction (PCR) technique for the rapid and reliable detection of genetic and infectious diseases. Furthermore, novel in-situ measurement and synthesis techniques are being demonstrated for thermoelectric oxides that are useful for renewable energy conversion and ultra-high capacitance materials.

On the fundamental side, Dr. Anwar's group is carrying out 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 doing "electronics free of charge"! In Dr. Anwar's group, there is a major emphasis on detecting and evaluating these spintronic effects using laser light. "X-rays for heritage" is another initiative being pursued whereby characteristic X-rays emitted from Moghul miniatures pigments, coinage and ancient manuscripts are quantified.

This project is poised to enlighten the Pakistani community with new perspectives on their own culture and history. All of these research directions lie at the interface of condensed matter systems, optical and spin physics.

Nano-Quantum Optics

Principal Investigator: Dr. Ata Ulhaq

Confined excitons in nanostructured solid-state materials are an interesting test-bed for a variety of quantum optical phenomena. They not only exhibit quantised character, much like natural atoms, but in addition also show deviations from isolated atom due to the solid-state nature of these structures. Dr. Ata's group is particularly interested in exploring the physics of one- and three-dimensionally confined exciton structures. The emphasis is not only to explore the dynamics of excitons inside these structures but also perform quantum optical experiments on the emitted light.

The aim to develop quantum light sources with high coherence and photon indistinguishability, a pre-requisite for the development of optics based quantum information schemes. The group focuses on using cavity quantum electrodynamic effects as well as coherent excitation and is also interested in probing different aspect of exciton-based quantum fluidics in two-dimensional quantum well structures. The work lies at the interface of nano physics, condensed matter physics, quantum and linear optics.

Computational Materials

Principal Investigator: Dr. Fakhar-ul-Inam

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, has 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.

String Theory

Principal Investigator: Dr. Amer Iqbal

Dr. Amer Iqbal's research interests are at the cutting edge frontiers of the small and large-scale structure of the universe we inhabit. One of the most profound theories for describing the fundamental make-up of the universe is string theory which posits that electrons and quarks are not point-like particles but strings vibrating in a higher-dimensional space time.

The theory has implications for a possible unification of Einstein's general relativity and quantum theory – a happy confluence between the macro and the microcosm. One aspect of Dr. Iqbal's work focuses on the interconnection and reconciliation between various string theories, their application to gauge theories and mathematical aspects of topological strings. It is well known that strings propagating on singular backgrounds give rise to gauge theories in a certain limit. A related question is the geometry of space time itself. Answers to these questions will help us in satiating some of the intrigue mankind has harboured from its very origins, about the world we live in!

Knots also interest Dr. Amer's group. Knots are classified by their deformation properties: two knots are distinct if they cannot be transformed into one another without breaking the lace. An active area of pursuit right at the interface of mathematically inspired physics is seeing how knots link up with topological strings.

Fundamental Theory

Principal Investigator: Dr. Babar Ahmed Qureshi

The main area of interest is how quantum mechanics changes our ideas about space-time. There is a top down and a bottom up approach to this problem. 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. Babar Ahmed Qureshi explores these phenomena by studying field theories on these structures. In the bottom up approach, 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. 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

Principal Investigator: Dr. Mumtaz Ali Sheikh

The use of optics in everyday life is ubiquitous. For example, we use internet all the time without realising that ultimately these are light pulses that carry the information across the world on a fibre optic network. The foundations for newer and newer television display technologies like LCDs, LEDs and three-dimensional TVs were laid by optical physicists. Digital SLR cameras are more expensive than ordinary cameras because they use more complicated optics. Now, there is a push towards development of optical computers as well.

Dr. Mumtaz Ali Sheikh focuses on using light for a large variety of similar applications. For example, 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. Projects he is currently working on include the development of a super-resolution confocal microscope using disordered media. He also has research interests in the areas of optical communication, singular optics and 3D laser ranging.

Experimental Particle Physics

Principal Investigator: Dr. Imran Younus

Dr. Imran Younus's group focuses on understanding the spin structure of the proton. Since the realisation that the proton is a composite particle, much work has gone into understanding its structure and how the quarks and gluons that make up this structure lead to the proton's basic properties, such as charge, momentum, spin and magnetic moment. While much has been learned about some of these properties from several decades of experimental studies, knowledge of the spin structure has lagged behind due to the subtleties involved in spin dependent measurements.

The first results from polarised deep inelastic scattering experiments in the late 1980s and early 1990s revealed that contrary to the prevailing wisdom, quarks did not carry a significant fraction of the proton's spin. However, those experiments, which effectively probed the quark spins through electromagnetic interaction, could not probe the charge-neutral gluons, and hence could only weakly constrain the gluon's contribution to the proton's spin. Polarised proton-proton collisions at high centre of mass energy employing the Relativistic Heavy Ion Collider at Brookhaven National Laboratory (USA) provide a unique and direct way to access the gluon spin through measurements of the double helicity asymmetry.

Dr. Younus is analysing the experimental data from PHENIX detector which is one of the two large particle detectors at the Relativistic Heavy Ion Collider. Recent measurement of double longitudinal spin asymmetry in neutral pion production by Dr. Younus and his collaborators have shown that the gluons inside the proton don't make up the missing spin of the proton, and "proton spin puzzle" remains unresolved!

PKR 120 MILLION in research grants from
NATIONAL AND INTERNATIONAL FUNDING AGENCIES



ADMISSION ELIGIBILITY GUIDELINES

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

- Academic Record
- Performance in Admission Tests
- Interview
- Completed application form along with all supporting documents

ACADEMIC RECORD

For MS:

- A minimum of 16 years of education is required for applying to the MS Programme
- Applicants must have maintained CGPA of at least 2.4 (on a scale of 4) or at least 60% marks in Intermediate/A-level examinations and all university-level or professional degrees.

For PhD:

- A minimum of 18 years of education is required for applying to the PhD Programme
- 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 Intermediate/A-level examination and Bachelor's degree.

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 applying to the MS Programme may also have degrees in MBBS, BDS or Pharm-D.

CHEMISTRY

- Chemistry
- Biochemistry
- Materials Science or Engineering
- Chemical Engineering
- Or closely related disciplines

COMPUTER SCIENCE

- Computer Science
- Software Engineering
- Information Technology
- 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
- Telecomm Engineering
- Other engineering disciplines peripherally related to electronics or electrical engineering

MATHEMATICS

- Mathematics
- Statistics
- Physics

- Other closely related disciplines

PHYSICS

- Physics
- Mathematics
- Computer Science
- Materials Science
- Optics
- Engineering
- Other closely related 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 (through the Educational Testing Service, ETS USA (www.ets.org)) and obtained marks at the 60th percentile or above in each of the Test sections (Verbal Reasoning, Quantitative Reasoning and Analytical Writing) are not required 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 & Physics.
- Applicants are exempted from SBASSE Subject Test if they have taken GRE Subject Test (through ETS USA) during the last two years and obtained a score at the 60th percentile 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
 - Computer Science: GRE General Test Score
 - Electrical Engineering: GRE General Test Score
 - Mathematics: GRE Subject Test in Mathematics
 - Physics: GRE Subject Test in Physics

Note: This is the minimum criteria applicants need to fulfill in order to be eligible to apply. Meeting the criteria does not guarantee admission into LUMS.



Applicants residing outside Pakistan are required to take the GRE General Test as well as the GRE Subject Test in the disciplines mentioned before.

- LGAT and SBASSE Subject Tests will be scheduled at the same time in Lahore, Islamabad and Karachi on April 13, 2014.
- GRE scores must be reported to LUMS officially from the testing agency by April 13, 2014 at the latest. The college code for reporting GRE scores to LUMS is 0679.

INTERVIEW

- Some shortlisted applicants may be requested to appear for an interview.



PUBLISHED BY

Office of Marketing, Fundraising & Alumni
Lahore University of Management Sciences
Telephone: +92-42-111-11-LUMS (5867) (Ext.2177)
Fax: +92-42-35896559
Email: admissions@lums.edu.pk
www.lums.edu.pk