

Ph.D. Prospectus
Faculty of Computer Science
Institute of Business Administration
Karachi

May, 2014

Table of Contents

- I. Introduction
- II. Admission Requirements
 - 1. Eligibility
 - 2. Test / Interview
 - 3. Fee and Financial Aid
- III. Doctoral Requirements
 - 1. Credit and Residency Requirements
 - 2. GRE (International) Subject Test
 - 3. PhD Comprehensive Exam
 - 4. Research Papers
 - 5. Dissertation Defense
 - 6. Summary
- IV. PhD Program Committees and Doctoral Faculty
 - 1. Supervision of PhD work
 - 2. Full-time PhD Faculty at the IBA FCS
 - 3. Other IBA Faculty
- V. PhD Course Description
- VI. Research Lab
- VII. Research Facilities for PhD Scholars
 - 1. IT Infrastructure
 - 2. IBA Intranet
 - 3. IBA Research Portal (IRP)
 - 4. New Library website and Virtual Library
 - 5. ICICT Conference
- VIII. Contact Us

Disclaimer: IBA reserves the right to revise the contents of this prospectus without prior notice. You are advised to refer to the FCS program office for the latest information.

I. Introduction

The IBA Faculty of Computer Science (FCS) of the Institute of Business Administration is offering graduate studies leading to PhD degree in Computer Science with a variety of specializations including Artificial Intelligence (AI), Human Computer Interaction (HCI), Information and Communication Technology (ICT), Management Information Systems (MIS), Numerical Analysis and Numerical Computing among others.

The FCS PhD program aims at encouraging those graduate scholars who can make a significant contribution to their field through original research. The various stages in the program are meant to ensure a thorough knowledge of their broader discipline. Quantitative and qualitative research capabilities are encouraged and interdisciplinary research along with interaction with the local industry is considered very positively.

The FCS PhD program motivates independence and originality of thought in the research process. The PhD program at IBA expects that not only will graduates display excellence in their field of research but that the discipline, research and professional competences they develop from their program will be very highly regarded by national and international employers. To achieve this, scholars are expected to immerse themselves in research in order to develop a strong and vibrant research culture at the institute.

The FCS PhD program structure and procedures may be changed from time to time by the IBA Board of Advanced Studies and Research (BASR).

II. Admission Requirements

1. Eligibility

Applications for admissions to PhD program shall be evaluated on an individual basis by the *Departmental Research Committee* of the Computer Science department (*DRC-CS*) using the following criteria:

Academic Record:

- M.Phil/MS/Equivalent in relevant subject from HEC recognized local/foreign university, with minimum 3.0 out of 4.0 GPA.

Additional Requirements:

- Submission of GAT Subject scores
- Brief proposal indicating research interests

All equivalence claims shall only be accepted after approval by the Higher Education Commission.

2. Test / Interview

All candidates will have to pass the IBA entrance test. The entrance test will comprise of a general graduate admission test which will test the applicant's abilities in Mathematics, English and Computing. The above tests will consists of multiple choice questions only.

3. Fee and Financial Aid

PhD scholars are entitled to full waiver of tuition fee for the entire program. A monthly stipend may also be given to the PhD scholars during the course work and residency period. PhD candidates shall be required either to act as a Research Associate to a Professor or to be Teaching Assistants and teach up to two undergraduate courses at the discretion of the Chairman of the department.

III. Doctoral Requirements

For completion of the PhD degree all candidates must satisfy the requirement given below, within a minimum of 3 years and a maximum of 6 years. An extension shall be required from the *Departmental Research Committee (DRC-CS)* in case a candidate exceeds the 6 year limit.

1. Credit and Residency Requirements

A total of 36 credits must be earned comprising of the following:

Course work credits	24
Dissertation credits	12
Total Credits	36

It is recommended that the course work credits should be completed during the first 4 semesters after admission to the program.

Course work credits must be earned from courses offered by the IBA FCS. The scholars can take a maximum of 9 credits hours during each semester. The courses selected by the candidates for PhD course work should be taken according to the following course level distribution:

500 Level courses
maximum credits
6

600 Level (or higher) Courses
minimum credits
18

A PhD scholar must register for a minimum of 3 credits per semester until successful Doctoral Defense. The entire PhD program is meant primarily for full-time scholars only. Scholars having a GPA below 2.80 during PhD course work shall be put on probation. Other IBA standard rules for scholars on probation shall apply. Scholars with a CGPA below 2.5 will drop out of the program. This CGPA condition will come into effect once a scholar has taken at least 4 courses.

2. GRE (International)/GAT Subject Test

All PhD scholars also have to pass either GRE (International) or GAT subject test. This test has to be cleared so that the candidate can be accepted as a Doctoral Candidate. If a GRE subject test is not available in the scholar's selected area, a replacement to this test may be devised by the IBA with approval from the Higher Education Commission.

3. Comprehensive Exam

After successful completion of the course work requirement, all scholars are required to appear in a comprehensive exam. The objective of the comprehensive exam is to assess a scholar's readiness to complete doctoral research in an area of concentration. The result of the comprehensive exam is a grade of pass or fail with recommendations for removing any

deficiencies. Scholars must pass the comprehensive exam before being advanced to candidacy, i.e., passing the dissertation proposal exam. The comprehensive exam must be attempted for the first time no later than one year after completing all course work requirements.

Scholars who fail the comprehensive exam may request reexamination within 60 days of receiving notice of the exam result. The request should be made in writing to the concerned Associate Dean. If the scholar fails again or does not request reexamination within 60 days, the scholar will be dismissed from the program.

3. PhD Proposal Defense

All PhD scholars must pass the PhD Proposal Defense within three years of admission to the PhD program. The PhD Comprehensive Examination will constitute satisfactory progress and successful presentation of preliminary doctoral research conducted during the first three years of doctoral studies.

The PhD Comprehensive Examination will be conducted by the *DRC*. The *DRC* may invite other experts in the field to the Proposal Defense. A maximum of two attempts will be allowed for the Proposal Defense. A scholar who has successfully defended the PhD Proposal will be formally declared a *Doctoral Candidate*.

4. Research Papers

PhD candidates must have their research conducted at IBA (as part of their Dissertation credits) accepted by two internationally refereed journals that have been approved by the DRC. The research papers must be accepted prior to the Dissertation Defense.

5. Dissertation Defense

After successful completion of the doctoral research, the candidate will be asked by the DRC to present the draft of the PhD Dissertation to the DRC in the prescribed format.

After approval of the PhD dissertation draft by the DRC, the PhD dissertation draft will be sent to two overseas external examiners, to be selected by the DRC, for approval. After the approval of the PhD dissertation by the external examiners, the candidate will be asked to appear for his PhD dissertation defense by making a formal presentation of his PhD dissertation to the DRC. The DRC may invite other experts in the field to the final examination. After the Dissertation Defense, the DRC may require changes to be incorporated by the doctoral candidates within a specific amount of time and to be resubmitted to the DRC for final approval.

6. Summary

The PhD degree is awarded after candidates have satisfied the DRC that their thesis is a substantial original contribution to knowledge and have also demonstrated a high degree of competence in areas of knowledge related to their specialization.

The overall requirements for the PhD degree are summarized as follows:

- Satisfactory completion of graduate-level courses with an overall CGPA of at least 2.8/4.0.

- Satisfactory performance in GRE/GAT subject test, based on HEC guidelines.
- Satisfactory performance in Comprehensive Examination.
- Acceptance of research work in 2 internationally refereed journals
- Submission and defense of a thesis, embodying the results of original research
- Any other conditions imposed by HEC from time to time.

IV. PhD Program Committees and Doctoral Faculty

1. Supervision of PhD work

The PhD study shall be supervised by the Dissertation Committee, which will comprise of two PhD faculty-members along with PhD candidates advisor who shall act as the convener to the committee. The candidate shall be advised on courses work and the dissertation work mainly by the advisor while other members of the Dissertation Committee may also be consulted.

PhD Program Committees

a. DRC

The purpose of the DRC is to conduct the Comprehensive Exam; bring the dissertation to a prescribed level and format and to have the Dissertation Defense conducted for each PhD candidate.

b. Dissertation Committee

Separate Dissertation Committees are formulated for each Doctoral Candidate that are responsible to look after the progress of individual PhD scholars. It comprises of three PhD faculty members including the advisor of the candidate who shall be the convener of the Dissertation Committee. The Dissertation Committee is entrusted to advise the PhD candidates on all academic matters. The Dissertation Committee is formed on the recommendation of the Postgraduate Research Coordination Committee.

The processes to form the Dissertation Committee must be initiated by the PhD scholar by selecting a PhD advisor who must be a full time faculty at the IBA FCS.

2. Full-time PhD Faculty at the IBA FCS

Following is a partial list of PhD faculty at the IBA FCS with a brief profile. Further details of research conducted by the faculty are also available on the IBA website www.iba.edu.pk.

Dr. Ahmed A. Shah

Dr. Ahmed Ali Shah obtained his M. Sc. (Applied Mathematics & Statistics) from Karachi University and Ph. D. (Numerical Analysis) from the University of Kent at Canterbury, England under C. O. T. Scholarship of Government of Pakistan. He has more than 29years experience of teaching of Mathematics, Business Mathematics, Operations Research, Statistics and Computer Applications in England, South Asia and South East Asian Countries. Dr. Shah's strong research interests in the field of Numerical Analysis are the study of differential equations, numerical integration, design of algorithms and their applications in Computer Science and Business Development Strategies. He has successfully designed packages namely OAHM, GRSIM and GSMNSEM for the solution of non-symmetric systems of linear equations. The Codes are written in FORTRAN and are published in International Journals of Numerical Analysis. **Areas of interest: Numerical Analysis, Numerical Computing, Cryptography.**

Dr. Nasir Touheed

Dr. Touheed is Professor at the IBA FCS, and has a Ph.D from University of Leeds, England, UK; He also has a M.Sc in Applied Mathematics, University of Karachi and a M.A in Mathematics, and MS in Operations Research, University of California, Los Angeles. Dr. Touheed has worked as an Associate Professor and the Chairman of the Department of Computer Science, Karachi University. He has more than thirty seven years of teaching experience at the University of Karachi. He is presently chair of the IBA central purchase committee. Dr. Touheed is the author of 15 research publications, and is currently also a member of the Ph.D Steering Committee looking after the Ph.D program at IBA. **His areas of research include Parallel Processing, Operations Research, Numerical Analysis, Data Warehousing Data Mining and Web Sciences.**

Dr. Sajjad Haider

Dr. Haider is an Associate Professor of Computer Science and is also an Associate at the Faculty of Engineering and Information Technology, University of Technology, Sydney. He received his MS and PhD in Information Systems and Information Technology from George Mason University in 2002 and 2005, respectively. He has an MCS in Computer Science and B.Sc. (Hons.) in Statistics from University of Karachi. During 2005 to 2007 Dr. Haider worked for Fannie Mae as a Consultant in Predictive Analytics in the US. Dr. Haider has published around three dozen research papers in international journals and conferences. He is also the recipient of best paper awards from the International Council on Systems Engineering (INCOSE, USA) and Command & Control Research & Technology Symposium. He secured first class first positions in B.Sc. (Hons.) and MCS. He also received the best graduate scholar award from George Mason University. He was awarded the best teacher award by Higher Education Commission. **His research interests are in the areas of Artificial Intelligence, Probabilistic Reasoning, Cognitive Robotics, Computational Intelligence, Machine Learning and Data Mining.**

Dr. Shakeel A. Khoja

Dr. Khoja is a Commonwealth Academic Fellow. He received his Ph.D. from the University of Southampton, UK, in 2001. He has a professional career of over 15 years and has over forty research publications to his credit. Dr. Khoja's research work includes exploring new avenues of multimedia and web applications for extracting knowledge and information among various real world paradigms. His work mostly involves investing tools for integrated cross-media content and concept based browsing, retrieval and navigation for distributed multimedia. The challenges lie in the information models, structures, semantics and knowledge representations within a system, and the ways in which they are reasoned about and used. The contextual information itself can be in respect to a person (such as Adaptive Hypertext, Pervasive of Mobile systems, e-Learning, and Narrative systems) or to a machine (such as on the Semantic Web and via contextual services on the Semantic Grid). Dr. Khoja has worked as Senior Research Fellow at University of Southampton, U.K, and as Head of Engineering programs at Bahria University for 5 years. Shakeel is also a HEC approved PhD supervisor and a senior member of IEEE and ACM. **His research interests include Multimedia, E-Learning, Web Sciences, Semantic Web and Internet Programming.**

Dr. Sayeed Ghani

Dr. Sayeed Ghani has a B.S. from MIT and M.S. and Ph.D from Columbia University in Electrical Engineering. His field of expertise is in Wireless and Mobile communications. He is presently Associate Dean of the Faculty of Computer Science at IBA and has also been a member of the Board of Governors of IBA. Dr. Ghani also has over 12 years of industry experience prior to joining IBA in 2001 as Chairman of the Center for Computer Studies. Dr. Ghani has worked as a Member of Technical Staff at NYNEX Science & Technology in the US, where he was heavily involved in the Standards process of high-speed data services and ATM networks. He has been employed as IT Head for ABN AMRO Bank and State Life Insurance Corporation of Pakistan. Dr. Ghani has also been a pioneer in introducing VSAT and Internet services in Pakistan and has been involved in various software development projects throughout his career. He has also worked at GTE Labs and the MIT Laboratory for Computer Science in the US and Lever Brothers in Pakistan. Dr. Ghani has a number of publications in leading IEEE journals and conferences and has presented papers and conducted seminars in various forums in both the US and Pakistan. His current research interests at IBA include simulation and performance analysis of wireless networks, performance issues in Mobile Ad hoc, WiMAX, LTE and Wireless Sensor Networks. He is presently also supervising four PhD scholars. **His research interests include Mobile Adhoc Networks, simulation, performance analysis of networks.**

Dr. Wasim A. Khan

Dr. Wasim A. Khan obtained PhD in Operations Research from University of Sheffield, England, U.K in 1990. After his graduation he remained involved in teaching and research at leading institutes of Pakistan including Ghulam Ishaq Khan Institute of Engineering Science & Technology, National University of Science & Technology (NUST) and Karachi Institute of Information Technology (KIIT). He remained associated with Crescent Software (CresSoft) for two years and has vast experience of software project management in Tick-IT environment. He has several research publications to his credit. Dr. Khan is a chartered engineer of engineering council (UK), a corporate member of Institute of Mechanical Engineer (IMechE), UK, Corporate member of Institution of Electrical and Electronics Engineers (IEEE), USA, and a member of IEEE Computer Society. In November 2007, Dr. Khan achieved the prestigious status of Fellow of the Institution of Mechanical Engineers (FIMechE). He is author of more than two dozen research papers and has written 3 books published by international publishers like Talyor and Francis and Springer-Verlag. **His areas of special interest include Operations Research, Virtual Manufacturing and Education Management.**

Dr. Zaheeruddin Asif

Dr. Asif is the Programs Director of FCS. He did his PhD from Temple University and Masters from Institute of Business Administration, Karachi. Dr. Asif has more than 2 decades of teaching and research experience. He has played an instrumental role in initiating CS/MIS related courses at IBA. He is also a member of the Academic Board. Dr. Asif has published several peer-reviewed, conference, workshop and journal papers and has worked on several large governmental research projects. He has a strong experience in Analysis, Design, Project Management, and IT training. **His areas of interest include Online communities, virtual collaboration, online deliberative communications, philosophy of information systems, IS security, ERP systems and IS evaluation.**

V. PhD Courses Description

Following is a partial list of courses relevant to the PhD program.

CSE561 Advanced Artificial Intelligence

This course discusses a breadth of advanced issues in artificial intelligence including but not limited to data mining, machine learning, probabilistic reasoning, evolutionary computation and computer vision. The emphasis on different topics may vary from one offering to the next. The primary audience of this course is those scholars who are not doing specialization in the AI track but are interested in the application of AI in different fields (computer networks, human computer interaction, software engineering, etc.). Being a graduate level course, scholars are expected to read a lot of recent research papers and do a research project – preferably on application of AI techniques in a field of their choice.

CSE563 Mobile Robotics:

This course presents an overview of robotics and addresses the engineering and programming techniques that governs the working of mobile robots. The course primarily addresses the motion planning aspect of mobile robots and covers the topics of Robot kinematics, Inverse kinematics, Differential motion and velocities and trajectory planning. An overview of sensors, actuators, and feedback control system is also provided to scholars, and an exposure of some contemporary happenings in robotics, including autonomous mobile robots, humanoid robotics etc is also a part of this course.

CSE566 Software Quality Assurance

This course addresses process considerations in software systems development. It discusses advanced material in software planning, mechanisms for monitoring and controlling projects, and leadership and team building. Furthermore, it provides knowledge and understanding of the concepts, principles, techniques, and tools that are used in the management of software projects. Some the topics included are Size and Cost Estimation, Schedule Plan, Risk Management, Quality Management and Configuration Management. Scholars work in a team to develop a project plan for a small project according to the established standards based on best practices of the global IT industry.

CSE567 Requirement Engineering

Scholars will learn to gather correct, concise, clear and complete set of requirements. Some of the topics included in this course are requirements engineering process, requirements elicitation and analysis, requirements validation and requirements management. Moreover, advance topics such as Model Based Verification and Formal Specification techniques will also be discussed in class. Scholars will apply the acquired knowledge to document requirements for a software application.

CSE568 Software Project Management

This course deals with lifecycle of Software Project Management, Project Planning,

Software estimation, software project schedules, reviewing work products, system requirements, project automation, software metrics, testing, bugs and diagnosis, change configuration, managing organization, team and project, software process improvement. This course will enable scholars to have a complete view of Project Management, as described by PMBOK.

CSE569 Web Engineering

The aim of this course is to teach the scholars the technologies and techniques for creating large-scale hypertext information systems on the WWW. Based on recent hypertext research and current WWW standards it will address the issues of publishing individual documents and sites together with the problems of global information management. Course topics will include, principles of web architecture, web information design, searching the web graph, factors that have led development of the web in its present form and current trends in the development of hypertext in the web.

CSE571 Advanced Theory of Computation

The objective of this course is to read advanced topics of the core area of computer science which enables scholars to focus on the study of abstract models of computation. These abstract models allow the scholars to assess via formal reasoning what could be achieved through computing when they are using it to solve problems in science and engineering. The course exposes scholars to the computability theory, as well as to the complexity theory. The goal is to allow them to answer fundamental questions about problems, such as whether they can or not be computed, and if they can, how efficiently.

The course defines advanced computation models and their properties, and the necessary mathematical techniques to prove more advanced attributes of these models. The scholars will be able to express computer science problems as mathematical statements and to formulate proofs. Upon completion of this course the scholars are expected to become proficient in key topics of theory of computation, and to have the opportunity to explore the current topics in this area.

CSE572 Formal Methods

The aim of this course is to expose scholars to mechanized formal tools which help ensure correctness and hence reliability of computer systems. Scholars will learn about the theory underlying model checking and will gain experience with model checking tools. Upon completion of this course the scholar will be able to demonstrate knowledge and understanding of temporal logics, theoretical underpinnings of model checking and model-checking tools and their uses.

CSE573 Advanced Computer Architecture

Comprehensive coverage of the architecture and system issues that confront the design of a high performance workstation/PC computer architectures with emphasis on quantitative evaluation. Topics covered in this course are Quantitative Principles of Computer Design, Instruction Set Principles and Examples, Advanced Pipe-lining and Instruction-Level Parallelism, Memory-Hierarchy Design, Storage Systems, Interconnection Networks and Multiprocessors.

CSE575 Advanced Human Computer Interaction

This course aims to give scholars an understanding of how interactive systems are developed. The hardware and software issues that determine the usability of an interactive computer system will also be read in this course. Humans are the key deciding factor to make a computer system successful. This course discusses the key issues and their solutions to make a system more human friendly. Effective design is reliant upon understanding the human context in which a new artifact has to fit. This course provides the necessary knowledge and skills to design, prototype and evaluate usable human-computer interaction in both its narrow sense (the user interface) and its broad sense (information systems, people, organisations, even societies and cultures). It further provides a strategic grounding in both theory and good practice for scholars to make effective use of applying HCI principles to IS design in their professional work.

CSE576 Usability Engineering

This course introduces methods for usability engineering alongside basic concepts of usability and the design of human computer interfaces. One of the prime requirements of any software is Usability; however the term usability has many facets. Usability is not only determined by the design of the human computer interface, but also by the underlying task model and data model of the software. In practice, usability is determined by a development process that takes users, their environment and tasks into account. The course relies on practical exercises during which participants learn to apply usability engineering methods. In this way participants gather the necessary skills required for improving the usability of their software systems. The course enables participants to apply selected usability engineering methods in their own projects in order to improve the usability of the software systems they develop.

CSE577 Interaction Design

This course provides theoretical knowledge and practical experience in the fundamental aspects of Interaction Design. The course focuses on the process of designing the user experience by examining works of interface design from the perspective of psychology, graphic design, and human-computer interaction conceptual frameworks. Topics included are: concept and planning of Interaction Design, Prototyping, User testing, Market Testing, Iteration, Product Specifications, Production Matrixes, Follow-up and maintenance.

CSE578 GUI Design

This course introduces design and analysis methods for Graphical User Interface design. Relevant perceptual psychology is introduced, and guidelines for user interface design are derived. Design methods are discussed. Analysis of interfaces by experimentation on humans is described. Exploring effective Web applications design through theory and hands-on exercises, exploring user interaction characteristics and incorporating them in application design is also covered in this course.

CSE579 Multimedia and Multi-Modal Systems

This course will extensively cover the growing field of multimedia by introducing advanced programming on different multimedia applications. Topics covered in this

course are Multimedia Authoring tools, Graphics and Image data representation, color in image and video, fundamental concepts of digital audio and video, data compression, video compression, MPEG I and II video coding, media communication and retrieval and content based retrieval in digital libraries

CSE651 Advanced Analysis of Algorithms

This is an advanced level course on algorithms that will cover topics such as review of Models of Computation, Dynamic Programming, Greedy Algorithms, Graph Algorithms, Branch and Bound, Network Flow, Algorithmic Game Theory, NP-Completeness, Approximation Algorithms, Random Algorithms, Markov Chain Monte Carlo Method, Linear programming, Coding theory, String algorithms, Mathematical algorithms, and Local search.

CSE652 Knowledge Discovery and Data Mining

This course offers the state-of-the-art in knowledge discovery and data mining from a research as well as a practical perspective. Classification and clustering techniques, features ranking and selection, association rules and text mining, performance evaluation of different techniques and data visualization are studied in detail. Scholars are expected to implement many of the above techniques and to use available open source and commercial softwares to analyze extremely large data sets. A significant amount of time will be spent on the current research issues in data mining. Being a graduate level course, it is expected that scholars have a decent background in databases, artificial intelligence and statistics.

CSE654 Combinatorial Optimization

The course provides a detailed overview of different quantitative methods for solving constrained optimization problems. Combinatorial optimization deals with finding the best solution to a particular problem given the available resources and known constraints. The topics include linear, non-linear programming, integer programming, Game theory and Dynamic Programming.

CSE655 Probabilistic Reasoning

This course provides an in-depth analysis of Bayesian Belief Networks which have become the tool of choice for reasoning under uncertainty. The course focuses on the syntax and semantics of Bayesian Networks and how to use BNs to model and analyze uncertain situations. Models that aim to integrate time and uncertainty such as dynamic Bayesian networks, dynamic Influence Nets, Markov Nets as well as the learning of structure and parameters of a Bayesian network will be discussed in detail. The course is intended for graduate level CS scholars and a significant amount of time will be spend on the current research issues in the field of probabilistic reasoning. Scholars are expected to use various softwares and develop their own tool to implement various reasoning and learning algorithms.

CSE656 Computational Intelligence

The course presents the fundamentals of computational intelligence. Topics included are evolutionary algorithms, particle swarm optimization, ant colony optimization, artificial immune systems, artificial neural networks, fuzzy systems and hybridization

of the above techniques. The course focuses on the applications of these techniques on real world problems and shows how they are designed, implemented and analyzed for a given a problem domain. Real world applications include portfolio optimization in financial domain, control and strategy optimization in robotics, route optimization in path planning and network traffic flows, and so on. A significant amount of time will be spent on the current research issues in computational intelligence. This is a programming intensive course and scholars are expected to spend a significant amount of time on implementing all the techniques studied in the course and applying them on a significantly complex problem of their choice.

CSE657 Essentials of Theoretical Computer Science

This course is about the part of theoretical computer science that studies the *limits* of what can be done with computing machines.

The course is divided into three parts, corresponding three ways of modeling computations. In the **first part** we consider the model of *finite state automata*. This is a very simple model, and it captures only a small set of algorithms. Its advantage is that it captures algorithms used in parsing and string matching and it is simple enough that we can understand it inside out. In the **second part** we see how all conceivable discrete computing devices can be simulated by Turing machines, a conceptually simple abstract device, and we consider the model of Turing machines that always solve the given problem, even though they can take arbitrary time. This is too powerful a model, in the sense that there are problems which are intractable in any practical sense but that can be solved in such a model. Its generality makes it easier to study, and in fact a lot is known about this model too. **Finally**, we come to the study of *polynomial time* computations, a sensible model of the computations that can actually be realized in practice. Being the most realistic, this is also the most messy field of study, and our ignorance far outweighs our understanding here. (And million dollar price awaits the solver of the main open question in this field.) Meanwhile, complexity theorist have already proved several very beautiful, and sometimes unexpected, results in the past thirty-five years, and we will see a few of them.

CSE660 Computer Vision

Computer Vision is a study in algorithms, tools and techniques that enable computers to extract information out of digital images. Computer Vision is being used extensively for driving autonomous vehicles, planetary exploration, life-saving medical imaging techniques, enhancing the Human-Computer-Interaction experience and preservation of accumulated human wisdom by digitizing books. This course will offer an introduction to the core concepts, some industrial-strength tools and recent breakthroughs in Computer Vision. By the end of this course, scholars should be able to analyze problems in Computer Vision, break them into simpler problems, associate these simpler problems to established solution techniques, design efficient algorithms using these established techniques and make computer programs based on these algorithms.

Mobile Computing

This course presents an extensive overview of the technical as well as business aspects of mobile computing and wireless communications. Main topics to be covered

are: mobile applications, mobile computing platforms, wireless networks, architectures, security, and management, of mobile computing and wireless communications. The role of wireless Internet and Mobile IP is reviewed and the mobile computing platforms are examined with a discussion of wireless middleware, wireless gateways, mobile application servers, WAP, i-mode, J2ME, BREW, Mobile Internet Toolkit, and Mobile Web Services.

Wireless Communication

The objective of this course is to provide the scholar with an adequate understanding of the prevalent Mobile Wireless Networks. The course will discuss the protocol reference model(s) that relate to Mobile Wireless Communication Systems. It will mainly cover the physical, data link, and the application layers from user plane perspective as they apply to mobile wireless networks in use today. Additionally, it will cover the management and control plane functions.

Information Security

The purpose of this course is to introduce scholars to the fundamental concepts and issues of information security. Basic principles for information security; threats and defenses; cryptography; introduction to network security and security management are covered in this course. By the end of this course the scholar should be able to understand the importance of information security in software systems, understand what a security policy is and what are the major mechanisms for implementing security policies, have a background in information security sufficient for the study of computer networking, be familiar with the major educational resources available for information security and be able to effectively present ideas about information security in written, oral, and web formats.

ICT511 Advanced Computer Networks

This course will cover advanced concepts in computer network such as: Advanced Internet addressing (CIDR and NAT), End-to-end protocols, Multicast Address resolution server, Multi protocol over ATM, IP Switching / Tag Switching, Multi protocol label Switching(MPLS), scheduling and congestion control in the Internet, Quality of service in the Internet, Internet Routing Architecture, Border Gateway Protocol (BGP), Resource ReSerVation Protocol (RSVP), IP version 6, Wi-Fi and Wi-Max, and Mobile IP.

ICT512 Advanced Web Technologies

To deliver in-depth knowledge of the basic concepts and general principles associated with web application development, illustrating specific technologies. To provide an understanding of different concepts, architectures, techniques, and infrastructures for service oriented computing in web development. The course explains the principles and practice of web services. It provides a comprehensive overview of state of the art web services and associated disciplines, relating concepts to practical examples and emerging standards.

ICT512 Advanced Web Technologies

To deliver in-depth knowledge of the basic concepts and general principles associated with web application development, illustrating specific technologies. To provide an understanding of different concepts, architectures, techniques, and infrastructures for service oriented computing in web development. The course explains the principles and practice of web services. It provides a comprehensive overview of state of the art web services and associated disciplines, relating concepts to practical examples and emerging standards.

ICT552 Computer Communication Networks – I

Architecture of network protocols and performance evaluation of networks. Scholars are expected to have a strong mathematical background and an understanding of probability theory. Topics discussed will include: layered protocols, data link layer, transport layer, high-speed packet switching, queuing theory, Local, Metropolitan and Wide Area Networking; flow and congestion control and routing. Prerequisites: CSE243 or equivalent; introductory probability course.

ICT555 Distributed Systems

This course deals with an in-depth understanding of Distributed Systems. Distributed system is a computer system consisting of several independent computers, connected by a network, that can work together to perform a task or provide a service. Typical examples include: the World Wide Web, networked file systems, DNS, and massive multiprocessor supercomputers. This course focuses on the principles, techniques, and practices relevant to the design and implementation of such systems. The course takes a systems-oriented view of distributed systems, concentrating on infrastructure software and providing hands-on experience implementing distributed systems. The main objectives of this are: to present the principles underlying the functioning of distributed systems; to create an awareness of the major technical challenges in distributed systems design and implementation; to expose scholars to modern and classic technology used in distributed systems and their software; to expose scholars to past and current research issues in the field of distributed systems; and to provide experience in the implementation of typical algorithms used in distributed systems.

ICT650 Wireless and Mobile Networking – I

Architecture and design of cellular systems with emphasis on support of high-speed wireless data, and high-performance packet radio networks. Overview of mobile and wireless networking, fundamental concepts in mobile wireless systems: propagation and fading, cellular systems, channel assignment, handoff. Third and Fourth Generation cellular networks. The course will also focus on research issues in multiple access techniques, cellular system design, and ad-hoc wireless networking. Prerequisites: ICT552 or ICT651.

ICT651 Computer Communication Network & Simulation

Focus on issues concerned with Broadband networks and protocols; ATM. Traffic

characterization and modeling: Markov-modulated Poisson and Fluid Flow processes; application to voice, video, and images. Traffic Management in ATM networks: admission and access control, flow control. ATM switch architectures; input/output queuing. Quality of service (QoS) concepts.

Prerequisites: ICT552 or ICT651.

ICT652 Topics in Communication Networks

This is an advanced PhD level course that focuses on research issues in data and telecommunications networks. Scholars taking this course must already have selected their PhD research topics and will be required to present their ongoing research in a series of presentations. Discussions will be focused around individual research topics and literature review. The objective of the course shall be to cover in depth individual research topics and to develop these into publishable research. Term and Final exams shall also be conducted based on topics of common interest.

ICT657 Modeling and Simulation of Networks

This is an advanced PhD level course focusing on developing working models of network protocols for research purposes and writing simulation code of these protocols. Scholars taking this course must already have selected their PhD research topics and will be required to present their ongoing research simulations along with their results in a series of presentations. Discussions will be focused on modeling, implementing and simulating protocols based on individual scholar research areas. The objective of the course shall be to create simulations of their proposed network protocols and to convert the results into publishable research. Term and Final exams shall also be conducted based on modeling and simulation topics of common interest. Prerequisites: ICT552 or ICT651.

MIS502 Operations & Technology Management

Technology is becoming an indispensable tool for companies to stay competitive in the fast changing business environment of today and there is an increasing demand for effectively introducing and managing technology in the corporate world. The course will cover the management of business systems that produce goods, as well as those that provide services. It will discuss key issues in Operations Management including Lean Production, Six Sigma, 5S, JIT, Kaizen, and Continuous Process Improvement and explore the implementation of technology to solve operational problems. It will provide tools for analyzing business processes for improvement and for incorporating and managing technology to provide sustainable competitive advantage to the organization.

MIS503 Enterprise Integration

This course provides scholars with the theories, models, and analytic techniques required to develop solutions for integrating heterogeneous information systems. Basic concepts that must be applied to enable diverse applications developed in different environments under a variety of rules and standards to process cooperatively will be explored and illustrated. This course serves as a focused introduction to the concept that information systems must be utilized (i.e., re-used) rather than redeveloped and will give consideration to the role of users and the impact

of information systems on those people.

Independent and group assignments will provide the scholars with the opportunity to investigate Enterprise Integration solutions from the Web and in use in local environments

MIS513 Information Industry Structure & Competitive Strategy

This course draws upon the most recent experience in the impact of information technology upon diverse industries, ranging from securities trading to consumer packed goods relating. It integrates the experience with relevant theory to develop a theory of competitive strategy for electronic commerce, and for information-based strategies more generally. It is not tools and techniques course or a quantitative analysis course; likewise it is not a technology or an implementation course. It provides a focused and modern complement to strategic planning.

MIS541 SAP ABAP Programming I

The first section of this course comprises of Introduction to SAP ABAP, SAP architecture, and ABAP Development workbench tools. The second section deals with study of ABAP workbench in detail, which includes, study of flow of an ABAP program, ABAP workbench, ABAP dictionary, ABAP language elements, data retrieval, subroutines and ABAP events. The third section of this course is based on in-depth study of ABAP dictionary, including study of data objects, performance, input checks, object dependencies, views, search and performance monitoring.

MIS542 SAP ABAP Programming II

This course is divided into three sections. The first part deals with Object Oriented paradigm in SAP ABAP. Object Oriented Programming techniques, Repository Objects, Exception handling and RTTS are covered in the first part of this course. The second part is advanced ABAP and covers topics such as ABAP runtime, types and data objects, internal tables and function groups. The third part deals with developing user dialogs within ABAP. This section covers topics such as screen programming, program interface, screen elements, lists and context menus.

MIS552Advanced DataWarehousing

Data warehouses are databases of a specific kind that periodically collect information about the activities being performed by an organization. This course will discuss advanced topics of data warehousing in order to provide a detailed knowhow of the subject to the scholar. Topics included in this course are: discussion on conventional data warehousing techniques, spatial data warehousing techniques, temporal data warehouses, designing conventional data warehouses, designing spatial and temporal data warehouses, and ongoing research in ware housing.

MIS553 Social Computing Applications

The course will focus on the new area of Social Computing and its Applications, which is becoming quite popular and important these days. The course will examine a sampling of the social, technical and business challenges social web sites must solve to be successful, teach scholars how to use high-level tools to analyze, design or build online communities, and help them understand the social impact of spending at

least part of their lives online.

VI. Research Labs at Faculty of Computer Science

As one of Pakistan's leading research institutions, Faculty of Computer Science (FCS) at IBA offers the best possible environment in which to undertake postgraduate research. A scholar conducting Masters or Doctoral research will be attached to one of the following research labs, which will not only offer a stimulating environment and allow scholars to gain rigorous research training, but will also provide interaction with enthusiastic and highly committed people.

- Telecommunications Research Lab (TRL)
- Artificial Intelligence Lab
- Distributed Computing Lab
- Digital Futures Lab

Telecommunications Research Lab (TRL) at the Faculty of Computer Science focuses on research being conducted by the faculty members and Ph.D. scholars in the areas of wireless and mobile networks. Specific topics under current research include: performance analysis, modeling and simulation of Mobile Ad Hoc Networks (MANETs); call admission control in integrated wireless 802.11e voice and data networks; routing issues in MANETs, and Wireless Sensor Networks, performance analysis and simulation of cluster based Wireless Sensor Networks using Bayesian Networks, as well as research in Layer 2 and Layer 3 protocols for MANETs and VANETs.

The TRL is equipped with modern simulation tools such as Qualnet v5.0, NS2 and Matlab which are heavily used for conducting research. During 2010/11 the TRL plans to expand research into cutting edge areas such as Long Term Evolution (LTE) with the acquisition of OPNET simulation software and also creation of a Wireless Sensor research lab. The FCS is also in the process of adding a modern Cisco based networking lab focusing on core routing issues, network security and VoIP for both its postgraduate and undergraduate scholars during 2010/11.

Faculty members at FCS contributing to the TRL are frequent contributors to publications in international conferences and journals. PhD scholars also frequently attend international workshops and training sessions that contribute to their self development skills in using simulation tools as well as in gaining hands on experience with advanced networking devices.

Artificial Intelligence Lab at IBA endeavors to provide a platform for young researchers and experienced professionals to manifest their innovative capabilities through development of sophisticated research projects. Being established in 2008, AI LAB at IBA is a dynamically growing research centre focusing in the core areas of AI namely Probabilistic Reasoning, Data Mining/Machine Learning, Semantic Web, Computational Intelligence, Cognitive/Educational Robotics and Applications of AI in Economics and Finance. Currently the following projects are actively being developed at the lab:

- BNOSA (Bayesian Network and Ontology based Semantic Annotation) is a

framework for semantic annotation of unstructured, ungrammatical and incoherent data sources using Ontology and Bayesian networks. It can be accessed and tested via the lab website.

- IBAyes is a probabilistic reasoning tool that allows its users to model uncertain situations and to perform inference using Bayesian networks and Influence Nets. It is freely available for download on the lab website.
- Several educational robotics related projects have been initiated by the lab. This includes incorporation of a hands-on robotics exposure in the course on Artificial Intelligence. Starting from Fall 09, a senior level course, Introduction to Game Programming and Robotics, has been introduced in the BS(CS) curriculum. During the course, scholars work on different programming languages to design and control robots to perform various tasks intelligently with the help of its sensors. Recently a series of workshop for high school scholars has also been initiated. The purpose is to expose our youth to the exciting field of Robotics/Artificial Intelligence. The lab is also actively collaborating with international universities and aim to participate in World Robocup Soccer in the coming years.
- An Anti-Money Laundering System (AMLS) is currently under development in partnership with Credit-Chex, a consumer credit bureau services and total risk management solution provider. Once fully developed, AMLS would serve as a decision support tool and would aid financial institutions and State Bank in identifying suspicious financial transactions and in curbing anti money laundering activities.

Distributed Computing Lab at IBA is exploring new and exciting topics in a multitude of areas related to meta-computing, distributed systems, collaboration technologies, and networking. Projects focusing on distributed frameworks for co-operative resource sharing and collaboration and peer-to-peer networks are being carried out.

Digital Futures Lab at IBA will be working on innovation of learning and teaching, new pedagogies for computer based learning and mobile learning methods. The lab will also focus on research carried out in context of social computing, that contributes to compelling and effective social interactions. Research projects carried out at this lab will focus on development and application of innovative technologies for localized contexts and environments.

VII. Other Research Facilities

1. IT Infrastructure

The IT infrastructure has in the recent past been improved considerably with addition of over 400 state of the art PCs, a high speed Internet with a bandwidth of 4 Mbps, and a fully deployed wireless LAN across both the campuses.

2. IBA Intranet

An IBA Intranet has been created which provides numerous useful links to scholars and faculty at IBA. These include links to over 17,000 research journals (available via HEC digital library program), 40,000 e-books, a fully automated Library Management System (LMS), an IBA Research Portal (IRP), a Campus Management System (CMS) among other sites.

3. IBA Research Portal (IRP)

The IBA Research Portal is accessible via the IBA intranet. At present over 350 papers written by IBA scholars and faculty have been put in the IRP, which provides a fully searchable and downloadable resource for all scholars and faculty at IBA.

4. New Library website and Virtual Library

A new library website and a virtual library website has been successfully launched. This is accessible from the main IBA website; the virtual library designated as the 'Online Resource Center' provides links to online databases, research reports, magazines, newspapers, online books and other useful reference sites worldwide.

5. ICICT Conference

A major International Conference on ICT is a key event to propagate research at IBA. The conference has been organized since 2005 and this year the 4th International Conference on ICT (ICICT 2011) was organized on July 23-24 at IBA Main Campus. The earlier conferences of this series were organized in 2005, 2007 and 2009. The ICICT series is a fully reviewed, multi-topic, International Conference on ICT. Proceedings of the original research papers are published and are also available via the IEEE international online database. A number of international delegates and prominent national speakers have participated in these conferences.

VIII. Contact Us

For further information, please contact:

- PhD(Computer Science) Program Office, Faculty of Computer Science, IBA, City Campus, Garden/Kiyani Shaheed Road, Karachi-74400
- Tel: 111-422-422 x 1838,1840, E-Mail: info@iba.edu.pk, Website: www.iba.edu.pk