National Textile University Faisalabad

Graduate study is an investment for future. Select NTU, and study with best and brightest students from diverse backgrounds to pursue your passion and develop your career.

INVEST IN YOUR FUTURE

As a graduate student at NTU, you will study alongwith talented students in research oriented environment under the supervision of highly qualified faculty. NTU has strong and historical connection with industry therefore, our graduates are employer's first choice in market.

Graduate Prospectus-2018

Graduate Studies & Research Office

بسم اللہ الرحمن الرحیم

شروع اللہ کے نام سے جو بڑا مہربان اور نہایت رحم والا ہے

In The Name of Allah the Most Beneficent, the Most Merciful

Graduate Admission (Fall-2018)

Contents

Prof. Dr. Tanveer Hussain

Welcome Message from the Rector

Role of universities is immensely important in creating new knowledge and inventing new technologies for the benefit of humankind as well as in equipping students with suitable knowledge, skills and behavior that not only make them excel in their occupations but also in their general life, ultimately leading to the development of a peaceful and prosperous world. The purpose of education is to help mankind in the pursuit of self-actualization, in addition to the fulfilment of physiological, social and self-esteem needs. Good education includes not only the vocational development but also the cognitive, spiritual, emotional and social development of people.

National Textile University is one of the most rapidly rising universities in Pakistan. Our teaching philosophy at NTU is student-oriented and our focus is to develop professional competence as well as good character in our graduates. The educational objectives of our programs not only include suitable knowledge and skills components but also the inculcation of desirable behavioural attributes in the students, such as: self- motivation, initiative and drive, passion for achieving goals, creativity, flexibility and adaptability, self-confidence, dependability, trustworthiness, fairness, empathy, politeness, integrity and conscientiousness etc.

We offer plenty of curricular and extracurricular opportunities to enable our students to recognize and actualize their intellectual potentials and help them in acquiring key employability skills, such as effective communication, information management, critical thinking and problem solving. I am looking forward to your joining NTU to explore endless opportunities for your personal development and professional growth. I pray for your bright future and success in every walk of life.

Welcome to

NTU

The University

The dawn of history of National Textile University (NTU) rooted back from 1954 as the Institute of Textile Technology, an excogitate effort of national industrialist prognosticators. The President of Pakistan, Field Marshall Muhammad Ayub Khan, laid the foundation stone of the Institute on 12th October 1959.

A Board of Trustees with the Minister of Industries as Chairman and nominees of the donor companies as members was constituted to manage the affairs of the Institute. In 1965, the Institute was granted affiliation by the University of Engineering & Technology, Lahore. Subsequently, the Institute was renamed as National College of Textile Engineering and it executed its functioning with Board of Governors led by Federal Minister of Industries as Chairman, seven members from Federal Government and three members from All Pakistan Textile Mills Association (APTMA). The college was granted a charter by the Government of Pakistan for establishing the National Textile University (NTU) on November 15, 2002.

Since its inception in 2002, NTU has been the premier Institute of textile education in the country, meeting the technical and managerial human resource needs of entire textile industry of Pakistan by retaining crucial link between university and business world. NTU has strived to achieve the aim of imparting world class education while encouraging research and intellectual growth in the country. As a result, NTU has played a key role in setting high standards f academics and produce professionals to compete in the world.

NTU imparts extraordinary academic and social skills among students to face challenges of the time and become the next generation of leaders believing in its motto “Innovate and Lead”. NTU has close collaboration with the world renowned universities to promote research and innovation. The hallmark of NTU is that within a short period of ten years, it is now among top universities of the country. On the face of fast changing and diverse world, the National Textile University stands firm to offering new programmes in relevant, emerging fields for the people of Pakistan and the wider world.

The Momentous City of Faisalabad

The National Textile University is situated in the third largest historic city of Faisalabad also known as 'Manchester of Pakistan, the world famous place for its cotton export industry and agriculture production. Indeed, a thriving hub of business and industry, the city with its old beautiful name of Lyallpur, a tribute which was given to Sir James Lyall, Lt. Governor of Punjab, for his services rendered for the lower Chenab Valley during the colonization period. The design of the city was prepared by Captain Papuan Young C.I.E, the colonization officer.

Later, Lyallpur was named "Faisalabad" after the late King Faisal of Saudi Arabia to commemorate deep friendship which exists between the two great Islamic countries of the world. The famous clock tower of Faisalabad has eight streets/bazaars leading from it and was designed in a pattern to form Union Jack, presenting a magnificent example of town planning. The city is located in the province of Punjab to the west of Lahore, the provincial capital, situated 360 kilometers south of the Federal Capital Islamabad. Faisalabad is surrounded by major agricultural areas such as, Hafizabad and Sheikhupura towards north and northeast, Okara and Sahiwal towards east and southeast, and Jhang and Toba Tek Singh towards west and southwest. City District Faisalabad consists of eight towns, which are: Lyallpur town, Madina town, Jinnah town, Iqbal town, Samundri town, Tadianwala town, Jaranwala town, and Chak Jhumra town.

The city has two public libraries and an art council to promote art and culture and a number of cinemas to provide entertainment. A cultural museum is currently established to promote both the national and international culture. The hockey and cricket stadiums of the city host national and international matches. Moreover, international airport, dry port and industrial zone are linked with the Motorway and other national highways to facilitate this hub of industrial activities.

Aims and Objectives

The aim is to develop the Textile Industry and Human Resources of Pakistan and make Pakistan an active player in the world economy.

- ✓ NTU is committed to information revolution in every aspect of its activities.
- ✓ NTU will continue to strengthen its profile as a high standard University.
- ✓ NTU aims to collaborate with industry and produce high quality research and provide excellent educational services within the field of its mission.
- ✓ NTU is committed to launching and establishing facilities for postgraduate studies in textile and allied fields.

Facilities

Transport

The University provides pick and drop services to the students and staff from the campus to different parts of the city according to the approved routes.

Student Accommodation

The University is a residential institution and has facilities to accommodate majority of students on the campus. There are two hostels for boys and an independent hostel for girls to accommodate about 450 students. Resident students are provided furnished accommodation comprising cubicles and dorms. Telephone lines are provided to every hostel. Each hostel is provided independent mess and common room.

Health Care

A clinic supervised by a devoted medical officer has been setup on the campus to provide health care facilities to students, employees & their dependent family members.

IT Center

Established in 2008, IT Center is a centrally air-conditioned building having 06 computer labs, video conferencing room, meeting room and faculty/staff offices. Department has following infrastructure and responsibilities.

- Management of Data-center
- Fiber optic sites connectivity
- Layer 03 Networks and Virtual LANs
- Active Directory Logins and Home Drives
- Controller bases Wireless LAN to Campus and Hostels
- Secure and high speed internet access through Firewalls
- Web Apps like Faculty Profiles, Course Evaluation, Distributed Websites and Email Management
- Dream spark Microsoft Software
- Printing Services for Students
- Video conferencing
- IT Training for university staff

NTU Library

NTU Library is housed in a two-story building and holds a unique collection of almost 22453 information resources in textile engineering and allied disciplines. The library has subscribed 35 international and national textile journals in print format and has bound archives of core textile and Applied Sciences journals, some of them starting from 1918 to date. Electronic access to more than 40,000 peer reviewed titles is also available through HEC Digital Library Program. The library acquires a variety of resources in print, audiovisual and electronic formats to support study and research in the university and has a wide range of services, including borrowing, reference, user advisory, information literacy (IL), OPAC, photocopying, indexing, TOC alert etc.

The library is one of the few in the country that has implemented standardized integrated software for library automation. Library World, Version 3.02 developed by CASPR Inc., is currently in use at NTU Library. The library provides electronic services through an electronic services lab that has ten computers. The library web pages provide information about its staff, rules & regulations, information services, collection, NTU student's projects, CDRoms, virtual library links, etc. The Virtual Library contains categorized links to websites of textile and general media, product sourcing and trade associations, research centers and institutes, universities and colleges, trade directories, computer and technology for textiles, electronic resources and databases and open access journals and resources. Campus-wide access to a large number of electronic resources is available through HEC Digital Library.

Services

National Textile University Library is providing excellent knowledge resources, services and facilities to fulfill the teaching, learning and research needs of its faculty members, students, staff and a large number of users

belonging to the textile community in Pakistan.

Information Literacy/ Continuing Education

The library is providing information literacy services to its patrons by organizing seminars and practical workshops to enhance the learning skills of students, researchers as well faculty members. In this regard teachers/library community of different institutes has visited NTU library several times.

Library Hours

Library opens seven days a week according to the following schedule:

Monday – Thursday	8:30 a.m. to 9:00 p.m.
Friday	8:30 a.m. to 4:40 p.m.
Saturday & Sunday	2:00 p.m. to 9:00 p.m.

There will be one-hour Prayer/Lunch break, as notified by the administration.

Borrowing Privileges

- Students/ Staff Members/ Teaching Assistant and Research Associate can borrow three books for 21 days.
- Faculty Members can borrow fifteen books for a semester or 90 days.
- Borrowing facility is not available to NTU Alumni and students referred from other institution however other library services are available accordingly.
- Some material, such as reference books, press clippings, CD-ROMs, current issue of periodicals, or any other publication marked as Reference/Reserved will not be circulated/issued.

Online Catalogue (OPAC)

In 2011, the library has uploaded its data (books, journals, CDs, thesis and reports) on web. Now the users can search the required title/material everywhere, even though their cell phones at university website www.ntu.edu.pk/library.

Digital Library

National Textile University libarary has subscribed more than 11,600 peer reviewed leading international journals and 40,000 online books available through National Digital Library Program of Higher Education Commission, Islamabad. Users can browse, search and link to find the exact information looking for, fast.

Memberships

The Textile Institute, UK

In support of NTU Library mission, the library has acquired Corporate Membership of the Textile Institute since 2013 to facilitate our patrons in their academic activities. Corporate Membership allows organizations to keep up to date with what is happening in the textile industry locally, nationally and globally. This includes for potential partners for strategic alliances.

Through the TI's extensive global network members benefit from contacts with textile professionals worldwide. Corporate Members of the Textile Institute are afforded many diverse benefits as part of their membership making it useful to both industrial & Academic organizations.

World Textile Abstracts Database (Online)

Since last few years the library has subscribed online research database namely "World Textiles" by EBSCO publishing for students, researchers and faculty members to help them in their research activities the access is available within the NTU campus.

World Textiles provides data from 1970 to present. Current coverage of over 340 international journals and provides archival coverages of several 100 additional journal titles, books and reports.

FACULTY OF ENGINEERING & TECHNOLOGY

Introduction

Faculty of Engineering & Technology is the largest of the four faculties of National Textile University, offering the University's flagship undergraduate and postgraduate programmes in textiles and advanced materials. The faculty has some of the most advanced and sophisticated laboratories in the country, highly qualified faculty members and well-trained laboratory staff.

Research facilities

Our research facilities include:

Fiber Production Labs

- Comprising melt spinning, wet spinning and electrospinning.

Yarn Production Labs

- Comprising blow room, card, drawing frame, roving frame, ring frame, compact spinning, open-end spinning and auto-coner.

Weaving Labs

- Comprising single-end warping, sizing, and sample loom. Industrial-scale shuttle looms, rapier looms, projectile looms, air-jet looms and electronic jacquard.

Knitting Labs

- Comprising circular knitting machines, flat knitting machine, gloves knitting machine, socks knitting machine and braiding machine.

Textile Processing Labs

- Comprising IR dyeing machine, HT- dyeing machine, yarn package dyeing machine, jigger machine, jet machine, soft-flow machine, winch machine, pad-steam dyeing machine, pad-thermosol dyeing machine, stenter, calender, flat-bed printing machine, rotary printing machine, plasma treatment, autoclave and coating machine.

Garment Production Labs

- CAD system for pattern digitizing and plotting, specialized sewing machines and garment washing machines.

Testing and Characterization Labs

- Comprising FT-IR spectrophotometer, UV-VIS-NIR spectrophotometer, atomic absorption spectrometer, UV-Visible spectrophotometer, Gel permeation chromatography, rheometer, differential scanning calorimeter, zeta-sizer, electro-kinetic potential analyzer, tensiometer, compound microscope, stereo microscope, USB microscope, scanning electron microscope, X-Ray diffractometer, sweating guarded hotplate, air permeability tester, universal fabric tensile tester, single fiber tensile strength tester, Uster yarn evenness tester, Tensorapid single yarn strength tester, fabric flammability tester, LOI indexer, pneumatic fabric stiffness tester, fabric thickness tester, fabric touch tester, hydrostatic-head tester, water repellency tester, Kawabata KES-FB2 bending tester, KES-FB3 compression tester, KES-FB4 surface tester, KES-F7 Thermolabo II.

Research Areas

Advanced Materials

- Advance polymeric and composite materials; nanostructures/nanoscale materials and nano devices; shape memory polymers and other functional materials

Engineered Textile Structures & Composites

- Linear fiber assemblies, woven fabrics, knitted fabrics, braided fabrics, nonwovens, fiber reinforced composites

Textile Surface Modification and Chemical Treatments

- Coloration, finishing, coating, enzyme, plasma and other novel functional treatments of textiles

Clothing Engineering

- Tactile and thermo-physiological comfort; sizing, fit and fashion; engineering functional apparel

Technical Textiles

- Medical, protective, sports and smart textiles

Textile Machinery and Instrument Design

- Design and development of textile sensors, machinery, instrumentation and control systems

Textile Modeling and Simulation

- Modeling & simulation; expert systems; image analyses; numerical analyses; computer aided design

Energy, Environment and Sustainability in Textiles

- Development of energy efficient, eco-friendly and sustainable textile products and processes

Faculty Research Interests

Prof. Dr. Tanveer Hussain, PhD (UK)

- Functional Materials including Nanofibers and Nanoparticles; Comfort & Protective Properties of Textiles; Textile Dyeing, Finishing and Coating; Modelling and Predicting Textile Behaviour; Medical Textiles

Dr. Zulfiqar Ali, PhD (Pakistan)

- Fiber Assemblies, Medical, Protective and Sports Textiles, Machinery Development and Modeling

Dr. Yasir Nawab, PhD (France)

- Advanced Materials, Engineered Textile Structures & Composites, Technical Textiles, Textile Machinery and Instrument Design, Textile Modeling and Simulation

Dr. Zafar Javed, PhD(Finland)

Garments Manufacturing and Garments Machinery Design

Dr. Talha Ali Hamdani, PhD (UK)

- Technical and Smart Textiles

Dr. Waseem Ibrahim, PhD (UK)

- Textile Dyeing & Printing; Photochromic and Thermochromic colorants; Advance Material, Textile surface modification and chemical treatments, Technical Textiles

Dr. Rashid Masood, PhD (UK)

- Biomaterials for Healthcare, Flame Retardant Materials; Microencapsulation Technology, Surface Modification of Textiles; Plasma Technologies for Textiles; Medical and Healthcare Textiles

Dr. Abdur Rehman, PhD (UK)

- Textile Surface Modification and Chemical Treatments

Dr. Munir Ashraf, PhD (France)

- Nanomaterials, Surface functionalization, Synthesis and Application of Functional Dyes and Finishes

Dr. Abher Rasheed, PhD (France)

- Clothing Engineering & E Textiles, Quality

Dr. Adul Basit, PhD (France)

- Polymer Fibers, Smart Materials, Advanced Materials and Polymer Composites

Dr. Sheraz Ahmed, PhD (France)

- Textile Fibres, Natural Fibre reinforced composites, Technical Textiles, Textile Machine design and Instrumentation

Dr. Zubair Khaliq, PhD (South Korea)

- Polymer Physics, Polymer Rheology, Advanced Polymer Materials, Technical Textiles and Fiber Assemblies

Dr. Kahif Iqbal, PhD (UK)

- Synthesis of Micro and Nan encapsulated materials, Textile Dyeing and dye chemistry, Surface Chemistry and modification of Textiles, Melt Spinning, Modeling and Simulation using Finite Element, Functional Textile including smart materials, Advanced Textile Chemistry with Environmental Chemistry.

Dr. Muhammad Ali Afzal, PhD (France)

- Textiles Machinery and Instrument design, Technical Textiles, Engineered Textile Structures & Composites, Advanced Materials, Clothing Engineering, Textile Modeling and Simulation.

Dr. Muhammad Bilal Qadir, PhD (South Korea)

- Nonomaterials, Nano Composites and their application in energy devices like Solar Cells, Batteries, and Super Capacitor. Functional nanomaterials, Functional & Smart Textiles, Technical Textiles, Surface modification of Nanomaterials, Yarn Manufacturing, Functionalized Fibers, Fabric Comfort, Fancy Yarns.

Dr. Muhammad Babar Ramzan, PhD (South Korea)

- Mathematical Modeling and optimization, Statistical Modeling and Process Control, Quality Management Project Management, Lean Manufacturing and Six Sigma.

Dr. Hafiz Shahzad Maqsood, PhD (Czech Republic)

- To explore some greener processes for the oxidation of natural cellulose fibres from the waste of spinning industry.

  Our target utility of these oxidized fibres is composites or medical industry.

Dr. Abdul Jabbar, PhD (Czech Republic)

- Textile/fiber reinforced composites, Bio composites, Nan composites, Surface modification of natural fibers, Textiles/composites for personal protection, Nonwoven textiles, Yarn Engineering, Structure property relationship of spun yarns.

Dr. Amjid Javed, PhD (South Korea)

- Materials engineering, surface engineering of textiles, nanomaterials, biomaterials, plasma technology, polymer and and carbon thin films.

Dr. Hafsa Jamshaid , PhD (Czech Republic)

- Protective Textiles, Comfort Properties of Textiles, Advanced Materials, Textile Structures, Composites & Nano composites, Textile Machinery and Instrument Design.

Dr. Ahsan Nazir, PhD (France)

- Electrospun Materials (Medical Applications, Energy Applications, Filteration, Protective Applications,

Antimicrobial, Photo catalysis, Sensors)

- Clothing Comfort (Thermo physiological comfort, Sensorial comfort, Sensery evaluation).

Dr. Zulfiqar Ahmad Rehan, Ph.D (Saudi Arabia)

Nanomaterials, Polymeric Membranes, Water Purification, Nan-Composite

MS Programmes

Faculty of Engineering and Technology offers six MS programmes, viz. MS Textile Engineering and MS Advanced Materials Engineering, MS Textile Technology, MS Textile Chemistry, MS Advanced Clothing & Fashion and MS Polymer Science & Engineering. Each MS is a 2 years degree programme consisting of 24 credit hours of course work and 6 credit hours of research work. The structure of each MS Programmes is given as follows:

1. MS TEXTILE ENGINEERING

Semester-Wise Layout of Courses

Semester I

Sr.No	Code	Course Title	Credit Hours
1	TE-5071	Advanced Materials	3
2	TE-5072	Technical Textiles	3
3	TE-5077	Composite Technology	3
4	RM-5071	Research Methodology	3
		Total	12

Semester II

Sr.No	Code	Course Title	Credit Hours
1	TE-5073	Advance Textile Process & Quality Control	3
2	TE-5074	Nonwoven Technology	3
3	TE-5075	Medical Textiles	3
4	TE-5076	Protective Textiles	3
		Total	12

Semester III & IV

Sr.No	Code	Course Title	Credit Hours
1	TE-6079	Research Thesis	6
		Total Credit Hours of the Program	30

2. MS ADVANCED MATERIALS ENGINEERING

Semester I

Sr.No	Code	Course Title	Credit Hours
1	TE-5071	Advanced Materials	3
2	TE-5072	Technical Textiles	3
3	TE-5077	Composite Technology	3
4	RM-5071	Research Methodology	3
		Total	12

Semester II

Sr.No.	Code	Course Title	Credit Hours
1	AME-5071	Nano Materials	3
2	AME-5072	Smart Materials	3
3	AME-5074	Mechanics of Materials	3
4	AME-5073	Advance Characterization Techniques	(2-1-3)
		Total	12

Semester III & IV

Sr.No.	Code	Course Title	Credit Hours
1	TE-6079	Research Thesis	6
		Total Credit Hours of the Program	30

Eligibility Criteria

MS Textile Engineering

1. BS Textile Engineering or equivalent degree from HEC/PEC recognized institution with a minimum CGPA 2.00/4.00 or 3.00/5.00 in semester system or 60% marks in annual/term system.
2. The applicant must pass NTU-GAT (General) test conducted by National Textile University, as per HEC guidelines and adopted by Advanced Studies and Research Board of NTU, Faisalabad with a minimum of 50% cumulative score.
3. The applicant must not be already registered as a student in any other academic program in Pakistan or abroad.

MS Advanced Materials Engineering

1. BS Textile/Materials/Polymer/Mechanical/Chemical Engineering or any other equivalent degree from HEC/PEC recognized institution with a minimum CGPA 2.00/4.00 or 3.00/5.00 in semester system or 60% marks in annual/term system.
2. The applicant must pass NTU-GAT (General) test conducted by National Textile University, as per HEC guidelines and adopted by Advanced Studies and Research Board of NTU, Faisalabad with a minimum of 50% cumulative score.
3. The applicant must not be already registered as a student in any other academic program in Pakistan or abroad.

Merit Criteria

Admission merit will be prepared according to the following criteria:

MS Textile Engineering		MS Advanced Materials Engineering	
BS Textile Engineering	60% weightage	BS or Equivalent	60% weightage
NTU-GAT (General)	30% weightage	NTU-GAT (General)	30% weightage
Interview	10% weightage	Interview	10% weightage

Course Specifications

TE–5071: Advanced Materials

The objective of this course is to give the students an overview of various types of materials used for advanced engineering applications. The students will learn about the properties and applications of various polymeric, ceramic, metallic, bio- and composite materials ranging from nanoscale to macro scale. In addition to various physical and mechanical properties, various functional aspects of the materials will also be covered in the course including: shape memory effect, self-healing, phase change, fire retardant behavior and energy harvesting properties.

TE–5072: Technical Textiles

Technical textiles comprise textile materials and products which are manufactured and used primarily for their performance and functional features rather than for their aesthetics. Global technical textiles market is estimated to be of worth US$150 billion. The objective of this course is to give the students a broad and detailed overview of the market size, manufacturing technologies, properties and end- uses of different categories of technical textiles, including: textiles used in agriculture, horticulture and forestry; textiles for buildings and construction; technical components of clothing; textiles used in civil engineering; household technical textiles; textiles used in filtration, cleaning and process industries; textiles used for healthcare and hygiene; textiles used in automobiles, railways and aerospace; textiles used for environmental protection; textiles used for packaging;

textiles for personal and property protection; and textiles used in sports and leisure.

TE–5073: Advanced Textile Process and Quality Control

The course aims at strengthening students' conceptual understanding in the areas of Six Sigma and Statistical Process Control. The students will be able to learn different tools for process definition and discovery, process measurement, process analysis, process re- design and improvement, and process control.

TE-5074: Nonwoven Technology

Nonwoven materials are used worldwide in a variety of applications, including construction, apparel, hygiene products, wet wipes, medical dressings, automotive end uses, geotextiles, home furnishings, and filtration. Hence, knowledge of how nonwoven fabrics are structured, manufactured and engineered for required end-uses is important and relevant in various industries. Nonwovens are advantageous because of their ease of manufacture, versatility, and low production cost compared to other textile manufacturing methods. The objective of this course is to introduce students to the nonwoven textiles and their manufacturing processes, characterization & testing methods. The course covers various web formation, web bonding and finishing methods. An overview of product developments in key application areas is also integral part of the course.

TE–5075: Medical Textiles

This modules aims to furnish students with the advanced specialized knowledge and skills required for the design and development of polymer and fiber-based products for use in the medicine and healthcare. It progresses students' knowledge and skills required for designing new medical products, devices and processes. The module covers materials/ tissue engineering, non-implantable materials (wound dressings, hygiene products), healthcare environment materials (surgical gowns), materials to reduce healthcare associated infection, therapeutic drug delivery technologies as well as fundamental aspects of legal and ethical issues involved within the medical practices.

TE–5076: Protective Textiles

The focus of this course is the development and characterization of textiles for protection from fire and heat, cold, water and wind, ballistics, cuts and stabbing, microbes and odour, particulate matter, static charge, ultra-violet radiation, chemical, biological, nuclear and electrical hazards. The course deals with the selection of suitable raw materials for protective textiles as well as their manufacturing and testing techniques.

TE–5077: Composites Technology

Composites are the materials of 21st century. They have vast applications in sports, defence, automotive, aerospace engineering, medical sciences, building/ construction material and many other sectors. This course is designed to provide student thorough knowledge of fundamental issues of fibres reinforced composites. Students will develop the understanding how composites are made from different fibres and how the inherent properties and layout of fibres affect the mechanical behavior of composites. They will also learn the techniques used to characterize the structure and properties of composites materials. They will also gain the practical experience of making fibre reinforced composites and characterize their behavior through mechanical properties.

RM–5071: Research Methodology

The overall aim of this course is to enable the students to identify a research area, identify a research problem, formulate research question, conduct literature survey, formulate research hypothesis, design research experiments, graphically present, analyze and interpret the experimental data, and draw valid conclusions. Additionally, the students will be able to write a research proposal, critically analyze research papers, and write a short literature review with proper citations and referencing. The students will practice relevant statistical tools and techniques using a statistical software package. The students will also become familiar with plagiarism and other ethical issues in research, patents, copyrights and trademarks, thesis and research paper writing styles.

AME–5071: Nanomaterials

This course introduces the fundamental principles needed to understand the behavior of materials at the nanometer scale and the principles of electrostatic and steric stabilization. It provides an introduction to different types of nanoscale materials i.e. zero dimension, one dimension and two dimension nanostructures. Homogeneous and heterogeneous nucleation and subsequent growth of nanostructures are discussed in detail. It also covers the physical and chemical techniques to synthesize nanostructures/ nanomaterials and their characterization techniques like x-ray techniques, scanning probe microscopy, scanning electron microscopy, transmission electron microscopy etc. The effect of size on properties of materials like mechanical, electrical, optical, melting point etc as well as application of nanomaterials in diverse field is included in this course.

AME–5072: Smart Materials

This course has been designed to develop students' knowledge of smart materials and intelligent textiles. The students will gain a critical understanding of mechanisms giving rise to the characteristics and beneficial properties of smart materials as well as the technological applicability and limits of smartmaterials.

AME–5073: Advanced Characterization Techniques

This course gives an introduction to different physical, chemical and mechanical characterization techniques, including XRD, SEM, TEM, chromatography, infrared spectroscopy, UV/Vis spectroscopy, atomic absorption spectroscopy, tensile testing, impact testing, bending,shear and hardness testing.

AME–5074: Mechanics of Materials

Mechanics of materials is a branch of applied mechanics that deals with the behaviour of solid bodies subjectedto various types of loading. This course deals with stress-strain behaviour of different materials, testing techniques, constitutive equations, micromechanics,modelling and simulation techniques for structural analysis.

TE–6079: Research Thesis/AME-6079

The Research Project module will enable the students to bring together the knowledge and skills acquired in the earlier modules to investigate a selected topic reviewing the literature, presenting seminars and preparing material in the form of a publication. The project will demonstrate the student's capabilities to perform independently but supervised research to solve practical problems utilizing the theoretical knowledge and analytical skills attained. The overall purpose of the module is to develop in the students an understanding of the steps involved in planning and conducting a research project and in communicating the findings both orally and in writing. The project work can be undertaken in an industrial concern, where possible, ensuring both the relevance to the employer, access to appropriate facilities, and allowing sufficient time to be spent on the practical work. Alternatively, projects could be based and carried out at the university. In case of collaboration with other national and international research institutes and universities the final semester research projects can be completed at mother and collaborated organization.

3. MS TEXTILE TECHNOLOGY

Program Objectives

The MS Textile Technology program aims to provide advanced knowledge of textile technology, machine design and quality management. It will also help in developing the skills of investigation of a research problem related to industrial operations. The MS Textile Technology program will offer each student a solid product and process focused education in manufacturing for the large textile industry. Graduate of this program can build a successful professional career in a wide range of job functions as well as a diverse set of industries.

Program Outcomes

MS Textile Technology program aims at achieving the following learning outcomes:

- Ability to apply knowledge of advance textile technologies to enhance the quality and production capacities of industrial units.
- Ability to design and develop solutions for products, components or processes that meet specified needs of target market.
- Ability to communicate and interface effectively with all stakeholders; sales & marketing and manufacturing etc. and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
- Ability to demonstrate technological knowledge to boost the growth of textile sector and help the society as an individual and team leader for the betterment of processes, quality and production in global business.
- Ability to function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings.
- Ability to sort out problems, take feasible decisions and bring solutions with improvement in quality and production

using statistical tools.

- Ability to design robust process, identify and provide sustainable answers for the issues in the process, and can design new products.

Eligibility Criteria

1. A candidate seeking admission to MS Textile Technology must possess a BS Textile Engineering Technology or BS Textile Science or M.Sc Fiber Technology or equivalent degree from HEC recognized institution with a minimum CGPA 2.00/4.00 or 3.00/5.00 in semester system or 60% marks in annual/term system.
2. The applicant must pass NTU-GAT (General) test conducted by National Textile University, as per HEC guidelines and adopted by Advanced Studies and Research Board of NTU, Faisalabad with a minimum of 50% cumulative score.
3. The applicant must not be already registered as a student in any other academic program in Pakistan or abroad.

Merit Criteria

Admission merit will be prepared according to the following criteria:

BS or Equivalent	60% weightage
GAT (General)	30% weightage
Interview	10% weightage

Total Credit Hours

For award of MS Textile Technology, candidates must need to complete total credit hours of 30 out of which 24 credit hours of course work and 6 credit hours for research work/thesis.

Study Duration

The minimum duration of study will be 4 semesters and maximum of 8 semesters as per HEC guidelines.

MS Thesis Evaluation

The MS thesis will be evaluated by one Ph.D. expert of the relevant field from external university/institute in addition to departmental evaluation committee.

Plagiarism Test

The plagiarism test must be conducted on the dissertation before its submission to the external expert as per HEC criteria.

Scope of the Degree

The graduates of this program would be able to get job and progress opportunities in diverse areas, some of them include:

1. Technical professionals for textile industry having in depth knowledge of advanced textile operations and can be able to provide research based solutions regarding operational problems
2. Teaching and research in domain of technology at university/post graduate college level.
3. Research and Development in public and private sector organizations.
4. Production, planning and quality management in public and private sector organizations.
5. Higher studies and research in the field of textiles and relevant interdisciplinary fields.

Semester-Wise Layout of Courses

Semester	Course Title	Category	Credit Hours
1	Advanced Fiber, Filament & Yarn Manufacturing Technologies	4 Compulsory courses	2-1-3
	Advance Fabric Manufacturing Technologies		2-1-3
	Advanced Textile Processing Technologies		2-1-3
	Advanced Clothing Technologies		2-1-3

Semester	Course Title	Category	Credit Hours
2	Research Methodology	4 Compulsory courses	3-0-3
	Technical Textiles		3-0-3
	Production, Planning and Control in Textiles		3-0-3
	Advanced Characterization Techniques		2-1-3
Semester	**Course Title**	**Category**	**Credit Hours**
3	Research Thesis	Compulsory	0-3-3
4	Research Thesis	Compulsory	0-3-3

Note:

- MS students will have to pass the 24 credit hours courses and 6 credit hours thesis.
- Department can offer any course from the list of approved courses on the availability of resources.
- Summer semester will not be offered.
- Other details of semester activities are as follows.

Assignments	One assignment per credit is generally conducted by teachers for each subject.
Quizzes	One quiz per credit of course are conducted by each teacher.
Presentations	Teacher can ask students to present a specific topic generally once in a subject.
Projects	Teacher can allot small project individually or in groups as per the scope of subject.
Exams	Two exams, at mid and end of semesters, are conduct for each subject.

List of Offered Courses

Sr. No.	Code	Course Title	Category	Credit Hours
1.	TT-5061	Advanced Fiber, Filament & Yarn Manufacturing Technologies	Compulsory	3(2-1)
2.	TT-5062	Advanced Fabric Manufacturing Technologies	Compulsory	3(2-1)
3.	TT-5063	Advanced Textile Processing Technologies	Compulsory	3(2-1)
4.	TT-5064	Advanced Clothing Technologies	Compulsory	3(2-1)
5.	RM-5071	Research Methodology	Compulsory	3(3-0)
6.	TE-5072	Technical Textiles	Compulsory	3(3-0)
7.	AME-5073	Advanced Characterization Techniques	Compulsory	3(2-1)
8.	TT-5065	Production, Planning and Control in Textiles	Compulsory	3(3-0)
9.	TT-6061	Research Thesis	Compulsory	6(0-18)

Course Specifications

TT–5061: Advanced Fiber, Filament & Yarn Manufacturing Technologies

The aim of this course is to enhance the skill in the field of advanced textile technology. The course will be focus on the recent developments in the field of fiber technology and yarn manufacturing. The course will cover the advance fiber manufacturing range from nano-fibers to high performance technical fibers, conventional fibers as well as exotic fibers, conventional and recent yarn manufacturing techniques. The students will also learn about the specialty yarns.

Module / Week-1	Conventional Fiber Technologies And Their Potential Advantages
Module / Week-2	Conventional Yarn Manufacturing Technologies And Their Technical Aspects
Module / Week-3	Advancements And Modifications In Conventional Fiber And Yarn Manufacturing Processes
Module / Week-4	Advanced Fiber And Yarn Technologies And Their Technical Advantages
Module / Week-5	Advance Fiber And Yarn Manufacturing Technologies
Module / Week-6	High Performance Fibers Introduction
Module / Week-7	Structure, Types And Applications Of Technical Fibers

Module / Week-8	Carbon Fiber Development, Its Types And Applications
Module / Week-9	Polyamide Fiber Fabrication
Module / Week-10	High Performance Polyethylene Fiber Development
Module / Week-11	Other High-Modulus And High-Tenacity Fiber Development
Module / Week-12	Nano Fiber Technology And Its Applications
Module / Week-13	Development Of Nano Fibers With Different Manufacturing Technologies
Module / Week-14	Electrospinning Technology And Its Future
Module / Week-15	Introduction To Exotic Fibers, Their Types And Applications
Module / Week-16	Selection And Implication Of Best Material And Structure Analysis

Recommended Books:

1. Advances in Filament Yarn Spinning of Textiles and Polymers, Dong Zhang, 2014
2. High performance fibers, J W S Hearle, 2001
3. Manufactured Fiber Technology, V.B. Gupta, V.K. Kothari, 2012
4. Fundamentals of Spun Yarn Technology, C.A. Lawrence, 2003

TT-5062: Advanced Fabric Manufacturing Technologies

The aim of this course is to educate the students about latest advancements in fabric manufacturing technologies introduced in the world. The course contents include conventional fabric manufacturing techniques like weaving & knitting with focus on conventional fabrics as well as specialty weaving and knitting, newest fabric manufacturing techniques like nonwoven and braiding, nonwoven manufacturing technology and multi-dimensional technical fabric technologies.

Course Schedule		
Week	**Module**	**Intended Learning Outcomes**
Module / Week-1	Circular Weaving	Explain The Basics And Production Process Of Circular Weaving.
Module / Week-2	Multiphase Weaving	Describe The Objectives And Discuss Technical Aspects Of Multiphase Weaving Loom.
Module / Week-3	Inkle Weaving	Demonstrate The Working Of Card/Tablet Weaving, Pick Up Weaving, Kumihimo Weaving, Narrow Weaving And Seat Belts Weaving
Module / Week-4	Spacer Fabrics	Explain The Basic Concept And Process Flow Of Spacer Fabrics
Module / Week-5	Non-Crimped Fabrics (NCF'S)	Explain The Objectives And Basic Concepts Of Non-Crimped Fabrics.
Module / Week-6	Leno Fabric Weaving	Describe The Basic Concept And Structure Of Leno Fabric Weaving.
Module / Week-7	Sear Sucker Fabrics	Describe The Techniques Used For Sear Sucker Fabric Weaving.
Module / Week-8	Terry Towels Weaving	Identify Different Parts Of A Terry Towel Loom And Explain Pile Forming Motion.
Module / Week-9	Tapestries	Discuss The Basic Concept And Technicalities Involved In Weaving Of Tapestry Fabrics.
Module / Week-10	Double Cloth Weaving	Explain Double Cloth Fabrics And Weave Design Used To Produce It.
Module / Week-11	Metal Mesh Weaving	Summarize The Basic Concept And Weaving Of Metal Mesh.
Module / Week-12	3-D Weaving	Explain The Basic Concept Of 3-D Weaving.
Module / Week-13	Warp Knitting	Explain The Warp Knitting Techniques Tricot And Rachel.

Module / Week-14	Fully Fashioned Garment Knitting	Describe The Elements Needs For The Production Of Fully Fashioned Knitted Garment
Module / Week-15	Specialty Knitting	Explain The Socks And Gloves Knitting Machines And Process.
Module / Week-16	Advances In Nonwoven Fabrics	Discuss Latest Advancements In Web Formation And Web Bonding

Recommended Books:

1. Principles of Woven Fabric Manufacturing, Abhijit Majumdar, 2016
2. Principles of Fabric Formation, Prabir Kumar Banerjee, 2014
3. Hand book of weaving by Sabit Adanur, 1St (2000), CRC Press
4. Principles of Weaving by Marks and Robinson, 1st (1976), The Textile Institute.
5. Woven Textile Structures by B.K. Behra and Hari, 1st (2010) Wood head publishing
6. Knitting Technology by DJ Spencer, 3rd (2001) Wood head publishing
7. Research journals

TT– 5063: Advanced Textile Processing Technologies

This course provide knowledge about the advancements and latest technologies introduced in fabric processing and their application areas. The conventional fabric processing techniques will also be included along with state of the art technologies. The topics include preparatory processes, advancements in dyes and dying processes, dying operations, processes to develop fabrics with improved aesthetic and functional properties, testing of textile performance using chemical and instrumental methods.

Course Schedule	
Module / Week	**Intended Learning Outcomes**
Module / Week-1	Introduction To Agents Driving Advancements In Textile Wet Processing; Sustainability And Functionality. What Are Sustainable Textiles? What Are Functional Textiles?
Module / Week-2	Advancements In Pretreatment Of Textiles; Enzyme Biotechnologies For Pretreatment Of Textiles; Desizing, Scouring And Bleaching. Comparison Of Conventional And Advanced Technologies. Application Of Plasma Technology In Pretreatment.
Module / Week-3	Mercerization Of Textiles; Caustic And Ammonia. Comparison Of Both Techniques. Advancement In Machines.
Module / Week-4	Advancements In Textile Dyeing. Approaches To Enhance Dye Fixation On Textiles And Reduce Effluent. Advancements In Highly Fixing Dyes; Differences Among Mono, Bi And Poly Functional Dyes.
Module / Week-5	Advanced Techniques For Dyes; IR Dyeing Technology, Supercritical Carbon Dioxide Dyeing Technology, Advancements In Machinery To Reduce Textile Effluent And Enhance Fixation.
Module / Week-6	Rotary Printing Of Textiles; Pigment Printing, Reactive Printing, Vat Printing, Disperse Printing, Transfer Printing, Screen Printing Auxiliaries. Digital Printing Of Textiles; Printing Inks, Advancements In Digital Printing.
Module / Week-7	Finishing Of Textiles To Impart Aesthetics; Soft Finishes, Calendaring, Emerizing, Sheering, Bio Polishing, Fragrance Finishes, Mosquito Repellent Finishes, Antistatic Finishes.
Module / Week-8	Finishing Of Textiles To Impart Functionalities; Water And Oil Repellent Finishes, Antibacterial Finishes, Fire Retardant Finishes, Moisture Management Finishes, Thermo Regulating Finishes

Recommended Books:

1. Textile Processing and Properties: Preparation, Dyeing, Finishing and Performance, T.L. Vigo, 2013
2. Guide to Wet Textile Processing Machines, J.N. Shah, 2015
3. Textile Processing with Enzymes, A Cavaco-Paulo, G Gubitz, 2003

TT–5064: Advanced Clothing Technologies

This course will be about the latest advancements in garment manufacturing. The ergonomic study will also be considered to be a part of this course. This course elaborates the key features and techniques used for garment manufacturing for financial growth and development of industry along with customer based product assembly line optimization studies. The course content also include material sourcing, preproduction operations, production planning, latest technologies and equipment for production, garment style and fit evaluation, advanced marker modes and spreading modes and evaluation of patterns, seams, stitch types on product quality.

Course Schedule		
Week	**Module**	**Intended Learning Outcomes**
1	Overview Of Apparel Industry And Types Of Articles	At The End Of This Week, The Students Will Be Able To: ✓ Understand The Structure Of The Apparel Manufacturing Industry In Pakistan As Well As Around The World ✓ Explain The Supply Chain Of The Apparel Industry. ✓ Differentiate Between Various Clothing Articles.
2	Product Development	At The End Of This Week, The Student Should Be Able To: ✓ Explain Product Development Concept Including Pre-Adoption Phase, Line Adoption Phase And Post Adoption Phase ✓ Explain Design Development In Apparel Including Concept Board, Groups, Items, Design Elements And Design Principles.
3	Advances In Apparel Product Development	At The End Of This Week, The Students Will Be Able To: ✓ Process Model For Clothing Product Development ✓ Models Of New Product Development ✓ Product Development Tools And Application Areas ✓ Product Lifetime Management (PLM) ✓ Demand-Led New Product Development
4	Merchandizing	At The End Of This Week, The Student Should Be Able To: ✓ Introduction To The Process Of Merchandizing ✓ Summarize The Various Steps Involved In Developing A Sample Garment. ✓ Explain The Various Types Of Samples Being Prepared In The Apparel Manufacturing (From Customer Approvals To Bulk Orders Confirmation)
5	Garment Preparatory Processes	At The End Of This Week, The Student Should Be Able To: ✓ Introduction To Garment Preparatory Processes ✓ Explain The Presentation Of Fabric Like Open Width, Doubled, Tubular, Rolled, Wound, Plaited, Etc. ✓ Lay Planning, Digitizing, Grading And Marker Making
6	Advances In Garment Preparatory Processes	At The End Of This Week Student Should Be Able To: ✓ Key Issues Affecting Apparel Sizing And Fit ✓ Importance And Development Of Size Charts ✓ Applications Of Technological Advancements ✓ Types Of Body Scanning Technology ✓ Advantages And Disadvantages Of Body Scanning Technology

		✓ Computerized Pattern Making In Garment Prosecution
7	Production Processes (Spreading)	At The End Of This Week, The Students Should Be Able To: ✓ Explain The Spreading, Spread Or Lay ✓ Explain Different Types Of Lay/Spread Like Single Ply, Multi-Ply, And Stepped Lay. ✓ Explain Spread/Lay Height Limitations ✓ Explain Various Methods Of Spreading Being Used In The Industry Like Manual Method, Spreading Carriage Method, And Automatic Spreading Machine Method. ✓ Explain Spreading Modes Like Face To Face, Face One Way, Etc ✓ Explain Spreading Quality, Setup For Spreading, Spreading Equipment's, Spreading Time And Cost. ✓ Spreading Automates
8	Production Processes (Cutting)	At The End Of This Week, The Students Should Be Able To: ✓ Explain Cutting Accuracy, Cutting Quality And Cutting Equipment ✓ Explain Cutting Machine Types And Cutting Methods ✓ Explain The Various Steps Involved In Preparation For Sewing Including Marking, Shading, Bundling, Numbering, Etc ✓ Advancements In Cutting Equipment
Mid-Semester Examination		
9	Production Processes (Sewing)	At The End Of This Week, The Students Should Be Able To: ✓ Explain Different Types Of Seams (Superimposed Seams, Lapped Seams, Bound Seams, Flat Seam) ✓ Explain Different Types Of Stitches (Class 100, Class 300 Etc) ✓ Explain The Types And Applications Of Sewing Thread Like Spun Threads, Monofilament Threads, Multifilament Threads, Monochord Thread, Texturized Thread, And Core-Spun Threads On Apparel Articles. ✓ Explain The Sewing Thread Selection Criteria Including Features Like Sewability, Size, Strength, Twist, Seam Performance, Color Availability And Fastness, Put-Up Type And Size, Service And Quality, Thread Cost. ✓ Understand The Use Of Alternatives To Thread Like Adhesive And Welding Technologies.
10	Production Processes (Sewing)	At The End Of The Week, The Students Should Be Able To: ✓ Sewing Machine Fundamentals ✓ Explain The Machine Casting I.E. The Machine Outer Covering And The Types Of Sewing Machines On The Basis Of Machine Bed. ✓ Explain The Sewing Machine Lubrication System. ✓ Explain The Stitch Forming Mechanism Of The Sewing Machine (The Parts And Devices Like Thread Control Devices, Needles, Bobbins, Cases & Hooks, Looped, Spreader, Throat Plate, Tongue And Chaining Devices.

Recommended Books:

1. Apparel Manufacturing: Sewn Product Analysis, 4/E, Glock, 2005
2. Design of Clothing Manufacturing Processes: A Systematic Approach to Planning, Scheduling and Control, Jelka Gersak, 2013

RM-5071: Research Methodology

The overall aim of this course is to enable the students to identify a research area, identify a research problem, formulate research question, conduct literature survey, formulate research hypothesis, design research experiments, graphical presentation, analyze and interpret the experimental data, and draw valid conclusions. Additionally, the students will be able to write a research proposal, critically analyze research papers, and write a short literature review with proper citations and referencing. The students will practice relevant statistical

tools and techniques using a statistical software package. The students will also become familiar with plagiarism and other ethical issues in research, patents, copyrights and trademarks, thesis and research paper writing styles.

Recommended Books:

1. New Product Development in Textiles: Innovation and Production, L. Home, 2016
2. Textiles for Sustainable Development, Rajesh D. Anandjiwala, 2007

TE–5072: Technical Textiles

Technical textiles comprise textile materials and products which are manufactured and used primarily for their performance and functional features rather than for their aesthetics. Global technical textiles market is estimated to be of worth US$150 billion. The objective of this course is to give the students a broad and detailed overview of the market size, manufacturing technologies, properties and end-uses of different categories of technical textiles, including: textiles used in agriculture, horticulture and forestry; textiles for buildings and construction; technical components of clothing; textiles used in civil engineering; household technical textiles; textiles used in filtration, cleaning and process industries; textiles used for healthcare and hygiene; textiles used in automobiles, railways and aerospace; textiles used for environmental protection; textiles used for packaging; textiles for personal and property protection; and textiles used in sports and leisure.

Course Schedule	
Module / Week	**Intended Learning Outcomes**
Module / Week-1	Introduction, market size and scope
Module / Week-2	Technical organic fibers including high strength, high modulus, high chemical and combustion resistance fiber, high performance inorganic fibers
Module / Week-3	Technical yarn types and structures
Module / Week-4	Technical woven fabric structures
Module / Week-5	Technical knitted fabric structures
Module / Week-6	Technical nonwoven fabric structures
Module / Week-7	Finishing of technical textiles
Module / Week-8	Coating of technical textiles
Module / Week-9	Dyeing of technical textiles
Module / Week-10	Heat and flame protection
Module / Week-11	Textile reinforced composite materials
Module / Week-12	Waterproof breathable fabrics
Module / Week-13	Textiles in filtration
Module / Week-14	Textiles in civil engineering and geo-textiles
Module / Week-15	Medical textiles
Module / Week-16	Protective textiles

Recommended Books:

1. Handbook of Technical Textiles: Technical Textile Applications, A. Richard Horrocks, Subhash C. Anand, 2016
2. Technical Textiles Yarns, R. Alagirusamy, A. Das, 2010

AME-5073: Advanced Characterization Techniques

The objective of this course is to introduce the concept of textile material characterization methods, interpretation of results and the importance of the compliances. The course aims at strengthening students' conceptual as well as practical knowledge in the field of testing and characterization of textile materials. This will also help the students in handling the different problems faced in the industry efficiently. They can perform preventive quality enhancing measure rather than the corrective ones. The focus will be on tools and

techniques that are related to quality enhancement and proper utilization of the resources. The Students will gain in-depth knowledge of conventional and advance characterization techniques. They will learn the methods to evaluate their physical and chemical properties to ensure quality of intermediate and end products in textile processes. The students will also learn about different compliances regarding the textile industry. The requisite for these compliances and how to effectively achieve these requisites. The topics will include scanning electron microscope, transmission electron microscope, atomic force microscope, x-ray diffraction, rheometer, thermal analysis, atomic spectroscopy, chromatography, NMR, FTIR and UV-Vis spectroscopy.

Course Schedule	
Module / Week	**Intended Learning Outcomes**
Module 1	Scanning electron microscope
Module 2	Atomic force microscope
Module 3	X-Ray Diffraction
Module 4	Rheometer and viscometer
Module 5	Thermal analysis: DTA
Module 6	Thermal analysis: DSC
Module 7	Atomic spectroscopy
Module 8	Chromatography: Gas chromatography
Module 9	Chromatography: HPLC
Module 10	Chromatography: HPLC-II
Module 11	FTIR
Module 12	UV-Vis spectroscopy
Module 13	NMR-I
Module 14	NMR-II
Module 15	NMR-III
Module 16	Mass spectroscopy

Recommended Books:

1. Materials Characterization Techniques, Sam Zhang, Lin Li, Ashok Kumar, CRC Press, 2008
2. Advance Textile Testing Techniques, S. Ahmad, A. Rasheed, A. Afzal, F. Ahmad, 2017

TT–5065: Production, Planning and Control in Textiles

The course enables the students to design of inventory & other relevant systems, different textile production planning models & capacity requirement planning. The course includes Analysis and design of inventory, Deterministic and stochastic inventory models, production, and scheduling control systems, Material Requirement Planning (MRP), Master Production Scheduling (MPS), and Aggregate Planning. It will also provide key knowledge about Warehouse, Importance of warehouse, Types of warehouse, Layout planning of warehouse, warehouse security, safety and maintenance, Warehouse operations, introduction to warehouse management system, functions of warehouse management system, a step towards intelligent WMS. Introduction to Lean Manufacturing will also be included in this course.

Course Schedule		
Week	**Module**	**Intended Learning Outcomes**
1	Introduction	At The End Of This Week, The Students Will Be Capable To: ✓ Basic Terminologies In PPC ✓ Role Of PPC Department ✓ Order Receiving ✓ Understanding A Techpack ✓ Role Of IE In PPC
2	Introduction	✓ Coordination Of PPC With Spinning ✓ Coordination Of PPC With Weaving/Knitting ✓ Coordination Of PPC With Textile Processing

3	MRP	✓ Material Requirement Planning ✓ Bill Of Materials ✓ Material Consumption Determination ✓ Time & Action Plan
4	Work & Method Study	✓ Define Work Study ✓ Describe Importance Of Work Study ✓ Explain Work Study As Direct Means Of Raising Productivity ✓ Define Method Study ✓ Understand Factors Involved In Method Study ✓ Recording Techniques Of Method Study ✓ Evaluate Any Ongoing Task W.R.T. Method Study
5	Work Measurement & Time Study	✓ Define Work Measurement ✓ Explain Advantages And Purpose Of Work Measurement ✓ Understand Techniques Of Work Measurements ✓ Define Time Study ✓ Identify Basic Time Study Equipment ✓ Explain Steps In Making Time Study ✓ Record All Information Related To The Operation Under Consideration ✓ Prescribe And Standardization Of Measured Operation Time
6	Learning Curves	✓ Define Learning Curves ✓ Be Acquainted With History Of Learning Curves ✓ Different Approaches Of Calculating Time ✓ Producing Learning Curves And Setting Standards ✓ Calculate And Determine Time Required To Do A Job, Learning Rates Of An Organization, Process Or Individual Using Learning Curves.
7	Line Balancing	✓ Define Line Balancing ✓ Line Balancing Using Operator Skill History ✓ Reduce Line Setting Time For Assembly Line
Mid-Semester Examination		
9	Layout	✓ Define Layout Planning ✓ Layout Types And Flexibility At Work ✓ Designing Process And Product Layouts ✓ Define Material Handling
10	Operation Breakdown	✓ Define The Term Operation Breakdown ✓ Important Considerations For Making Operation Breakdown Bulletin And Machine Selection ✓ Techniques And Tools Used For Operation Breakdown
11	Operation Breakdown	✓ Exercise Of Making Operation Breakdown Of Different Top Garment Products: I. T-Shirt II. Polo-Shirt III. Dress-Shirt
12	Operation Breakdown	✓ Exercise Of Making Operation Breakdown Of Different Bottom Garment Products: I. Slacks II. Boxer Short III. Trousers
13	Operation Breakdown	✓ Exercise Of Making Operation Breakdown Of Different Made-Ups Products:

		I. Overall II. Box Pleated Curtin
12	Operation Breakdown	✓ Exercise Of Making Operation Breakdown Of Different Bottom Garment Products: IV. Slacks V. Boxer Short VI. Trousers
13	Operation Breakdown	✓ Exercise Of Making Operation Breakdown Of Different Made-Ups Products: III. Overall IV. Box Pleated Curtin
14	Calculations Of Industrial Engineering In Garment Industry	✓ Formulas Of IE : I. Thread Consumption Calculation II. Capacity Calculation III. Production Target Calculation IV. Productivity Calculation V. Performance Calculation
15	Calculations Of Industrial Engineering In Garment Industry	✓ Formulas Of IE : I. Efficiency Calculation II. WIP Calculation In Cutting, Sewing And Finishing III. Manpower Calculation IV. Machine Calculation
16	Time Based Costing	✓ Understand Apparel Industry From Process Costing And Pricing Strategies Perspective. I. Define The Basic Logics For Costing Of Apparel Products II. Produce General Steps & Sequence Of Apparel Costing(Procedures) III. Calculate Yarn And Fabric Requirements For Different Products Of Knits/Woven IV. Compute Cost Of Different Finishing Processes V. Dying Process Ii. Printing Process Iii. Embellishments VI. Understand The Cutting And Sewing Operations Cost VII. Compute Cutting And Sewing Costs VIII. Compare And Analyze The Difference Between Different Sewing IX. Operation Costs X. Tabulate And Calculate Trims And Accessories Costs XI. Understand About The Costs Incurred Due To Packaging And Shipment Of Cargo.
✓ **End Semester Examinations**		

Recommended Books:

1. The Planning and Scheduling of Production Systems: Methodologies and applications, Abdelhakim Artiba, Salah E. Elmaghraby, 2012
2. Innovative Quick Response Programs in Logistics and Supply Chain Management, T. C. Edwin Cheng, Tsan-Ming Choi, 2010
3. Textiles Technology, Julie Messenger, Helen Wilson, 2003

TT- 6061: Research Thesis

The Research Project module will enable participants to bring together the knowledge and skills acquired in the earlier modules to investigate a selected topic reviewing the literature, presenting seminars and preparing material in the form of a publication. The project will demonstrate the student's capabilities to perform independently but supervised research to solve practical problems utilizing the theoretical knowledge and analytical skills attained.

The overall purpose of the module is to develop an understanding of the steps involved in research and development process and interpretation of the findings both orally and in writing. The research projects will be allotted to the students after the approval by the Research Committee.

4. MS TEXTILE CHEMISTRY

Program Objectives

The MS Textile Chemistry Program aims to provide advanced training in all fields of textile chemistry like dyeing, printing and finishing with in depth knowledge of the chemicals being used in textile processing industry and their environmental implications. The students will be trained to conduct independent investigations of problems which textile processing industry of Pakistan is currently facing and find their solutions. The program emphasizes the development of students' potential for research and the technical and analytical skills needed for the design of new products and processes which are sustainable.

Eligibility Criteria

1. A candidate seeking admission in MS Textile Chemistry must possess a 16 years of education i.e BS in Textile Processing/Chemistry/Applied Chemistry/Industrial Chemistry degree or its equivalent with a minimum of CGPA 2.00/4.00 in semester system or 60% in annual/term system from an HEC recognized institute/university.
2. The applicant must pass NTU-GAT (General) test conducted by National Textile University, as per HEC guidelines and adopted by Advanced Studies and Research Board of NTU, Faisalabad with a minimum of 50% cumulative score.
3. The applicant must not be already registered as a student in any other academic program in Pakistan or abroad.

Merit Criteria

Admission merit will be prepared according to the following criteria:

BS or Equivalent	60% weightage
GAT (General)	30% weightage
Interview	10% weightage

Credit Hours

For award of MS Textile Chemistry, candidates must need to complete total credit hours of 30 out of which 24

credit hours of course work and 6 credit hours for research work/thesis.

Study Duration

The minimum duration of study will be 4 semesters and maximum of 8 semesters.

Thesis Evaluation

The thesis will be evaluated by one PhD expert of the relevant field from external university/institute in addition to internal examiner.

Plagiarism Test

The Plagiarism Test must be conducted on the Dissertation before its submission to the external expert as per HEC criteria.

Available Chemistry/Textile Chemistry Labs

1. Textile Processing Department Lab
2. National Textile Research Centre
3. Chemistry Laboratory (CL)
4. Chemistry Research Laboratory (CRL)
5. Dyes and Chemicals Synthesis Laboratory

Semester-Wise Layout of Courses

Semester-I

Sr. No.	Code	Course Title	Credit Hours
1	TP-5001	Chemistry of Dyes and Pigments	3(2,1)
2	TP-5002	Chemistry of Fibrous Polymers	2(2,0)
3	TP-5003	Surface Chemistry	2(2,0)
4	TP-5004	Textile Auxiliaries	2(2,0)
5	TP-5005	Advanced Analytical Techniques	3(2,1)
		Total	12

Semester II

Sr. No.	Code	Course Title	Credit Hours
1	TP-5006	Coloration of Textiles	4(3,1)
2	TP-5007	Functionalization of Textiles	4(3,1)
3	TP-5008	Sustainability in Textiles	2(2,0)
4	TP-5009	Research Methodology	2(2,0)
		Total	12

Semester III & IV

Sr. No.	Code	Course Title	Credit Hours
1	TP-6001	Research Project	6(0,4)
		Total Credit Hours of the Program	30

Note:

- MS Textile Chemistry students will have to pass the 24 credit hours courses and 6 credit hours' thesis.
- Summer semester will not be offered.
- Internal assessments include a seminar, quizzes and assignments of every student in each subject.
- Number of activities are double to the number of credit hours of each subject.

Course Specifications

TP-5001: Chemistry of Dyes and Pigments

The overall objective of this course is to give students the general description of dyes & pigments, chemistry of dyes & pigments and their synthesis on lab scale as well as on industrial scale. The students will learn the nomenclature of dyes, different chromophoric system, classification of dyes according to their chemical structure, classification of dyes w.r.t. their application, the physico-chemical interaction between dyes and

fibrous materials. The students will also learn the chemistry and synthesis of different types of organic, inorganic pigments and advance pigments like thermochromics and photochromic pigments. This course will also cover the synthesis and application of novel dyes with added functionality to impart UV-absorbent, antimicrobial and water repellency characteristics to the textiles.

TP-5002: Chemistry of Fibrous Polymers

The overall objective of this course is to impart knowledge about the chemistry, behavior and properties of natural, synthetic and smart fibrous materials. The students will learn the manufacturing, formation of all kind of fibres with technological advancement and the relation of their chemistry to the performance. The students will also learn the chemistry and behavior of smart, technical and high performance fibres and their application in their specific fields. At the end of this course, the students will be able to select fibres for all kind of textile applications ranging from apparel and sportswear to technical and protective textiles.

TP-5003: Surface Chemistry

The course treats the properties of interface and colloidal system such as adsorption, wettability, dispersion and electrical double layer etc., with emphasis on textile surfaces. It covers surface free energy, capillarity, wetting and water contact angle. The electrical aspects of surfaces such as electrical double layer, stern layer, electrophoresis electroosmosis, streaming potential and zeta potential. Double layer interaction (DLVO theory) are also included. Adsorption isotherms such as the laws of Nernst, Freundlich and Langmuir, and Fick's law will be discussed.

TP-5004: Textile Auxiliaries

This course will focus on the chemistry and mechanism of reactions of various auxiliaries used in textile industry. These auxiliaries include sizing and desizing agents, detergents, surfactants, scouring agents, bleaching agents, dyeing auxiliaries, printing chemicals and finishing agents. The students will acquire from fundamental to advanced knowledge of these textile chemical agents.

TP-5005: Advanced Analytical Techniques

The overall objective of this course is to provide knowledge for the evaluation of textile substrates. This course will give an introduction to different physical, chemical and mechanical characterization techniques, including XRD, SEM, TEM, chromatography, infrared spectroscopy, UV/Vis spectroscopy, atomic absorption spectroscopy, tensile testing, impact testing, bending, shear and hardness testing. The student will also learn the use of differential scanning calorimetry and zeta sizer to measure zeta potential of different textiles.

TP-5006: Coloration of Textiles

This course will cover the application of different dyes on variety of textiles substrates. The students will learn the physical aspects of dyeing, the properties of polymeric fibrous w.r.t. dyeing behavior, theory of machine involved in batch- wise and continuous dyeing process, union dyeing, blend dyeing containing smart and technical textiles. The course will focus on advanced printing techniques such digital printing of textile substrates and its application. The students will also gain the knowledge of thermodynamic aspect of dyeing including adsorption isotherm. During this course, students should be able to define and optimize recipe and parameters to develop the dyeing process of particular substrate. At the end of this course the students will be able to dye different types of textiles including fibres, yarn, knitted fabric, woven fabric and technical textiles made of different fibrous materials.

TP-5007: Functionalization of Textiles

The overall objective of this course is to teach students about the surface preparation, modification and surface treatments of textiles. The students will learn the different techniques of functionalization such as physical vapor deposition, chemical vapor deposition, surface grafting, enzymatic surface modifications etc. The students will also learn the surface functionalization using plasma treatment, nanoparticles to impart different functionality to textiles such as antibacterial, super hydrophobicity, moisture management and self- cleaning characteristics. At the end of this course the students will be able to prepare textiles with multi functionality in

different fields of life such as active wear, sportswear, medical textile and protective textiles.

TP-5008: Sustainability in Textiles

This course covers fundamentals of sustainability and implications of materials and processes used in textile wet processing industry. The student study a range of sustainability principles that address lifecycle assessment, including eco- footprint analysis, embedded energy and environmental impact of textile dyeing and finishing processes. The students will also be introduced to sustainable textile fibers, enzyme biotechnologies for sustainable textile processing, key sustainability issues in textile dyeing and environmentally friendly plasma technologies for textiles. It also covers latest technologies for sustainable textile dyeing.

TP-5009: Research Methodology

The overall aim of this course is to enable the students to identify a research area, identify a research problem, formulate research question, conduct literature survey, formulate research hypothesis, design research experiments, graphically present, analyse and interpret the experimental data, and draw valid conclusions. Additionally, the students will be able to write a research proposal, critically analyse research papers, and write a short literature review with proper citations and referencing. The students will practice relevant statistical tools and techniques using a statistical software package. The students will also become familiar with plagiarism and other ethical issues in research, patents, copyrights and trademarks, thesis and research paper writing styles.

TP-6001: Research Project

The Research Project module will enable the students to bring together the knowledge and skills acquired in the earlier modules to investigate a selected topic reviewing the literature, presenting seminars and preparing material in the form of a publication. The project will demonstrate the student's capabilities to perform independently but supervised research to solve practical problems utilizing the theoretical knowledge and analytical skills attained. The overall purpose of the module is to develop in the students an understanding of the steps involved in planning and conducting a research project and in communicating the findings both orally and in writing. The project work can be undertaken in an industrial concern, where possible, ensuring both the relevance to the employer, access to appropriate facilities, and allowing sufficient time to be spent on the practical work.

Alternatively, projects could be based and carried out at the university. In case of collaboration with other national and international research institutes and universities the final semester research projects can be completed at mother and collaborated organization. The Research Project module will enable the students to bring together the knowledge and skills acquired in the earlier modules to investigate a selected topic reviewing the literature, presenting seminars and preparing material in the form of a publication. The project will demonstrate the student's capabilities to perform independently but supervised research to solve practical problems utilizing the theoretical knowledge and analytical skills attained. The overall purpose of the module is to develop in the students an understanding of the steps involved in planning and conducting a research project and in communicating the findings both orally and in writing.

The project work can be undertaken in an industrial concern, where possible, ensuring both the relevance to the employer, access. to appropriate facilities, and allowing sufficient time to be spent on the practical work. Alternatively, projects could be based and carried out at the university. In case of collaboration with other national and international research institutes and universities the final semester research projects can be completed at mother and collaborated organization.

5. MS ADVANCED CLOTHING & FASHION

Program Objectives

The MS Advanced Clothing & Fashion program will aim to integrate design, theory, problem-solving, and research in relation to the problems of sewn products industry. The objectives of this program are to:

- ✓ Apply creative problem-solving techniques to develop sustainable solutions to contemporary issues challenging the sewn products industry.
- ✓ Give students an exposure of modern and advanced industrial developments, research methodologies and their applications in industrial environment
- ✓ Develop novel approaches to solve technological problems and shortcomings
- ✓ Appreciate technological, environmental, economical and cultural factors that may influence, manufacturing design, processing conditions and mode of applications
- ✓ Strengthen the capabilities of graduates in production, quality, research and development activities in sewn products industry
- ✓ Establish and strengthen linkage with the industry for the mutual benefits

Eligibility Criteria

1. A candidate seeking admission to MS Advanced Clothing & Fashion must possess a BS Textile Engineering, BS Textile Engineering Technology, BS Textile Science, BS Apparel Technology, Bachelor of Fashion Design, Bachelor of Textile Design or 16 years equivalent degree from HEC recognized institution with a minimum CGPA 2.00/4.00 or 3.00/5.00 in semester system or 60% marks in annual/term system.

2. The applicant must pass NTU-GAT (General) test conducted by National Textile University, as per HEC guidelines and adopted by Advanced Studies and Research Board of NTU, Faisalabad with a minimum of

50% cumulative score.

3. The applicant must not be already registered as a student in any other academic program in Pakistan or abroad.

Merit Criteria

Admission merit will be prepared according to the following criteria:

BS or Equivalent	60% weightage
GAT (General)	30% weightage
Interview	10% weightage

Study Duration

The minimum duration of study will be 4 semesters and maximum of 8 semesters as per HEC guidelines.

MS Thesis

The topic for MS thesis will be assigned to the students by departmental research committee. MS thesis will be evaluated by one Ph.D. expert of the relevant field from external university/institute in addition to departmental research committee.

Plagiarism Test

The plagiarism test must be conducted on the dissertation before its submission to the external expert as per HEC criteria.

Total Credit Hours

For award of MS Advance Clothing & Fashion, candidates must need to complete total credit hours of 30 out of which 24 credit hours of course work and 6 credit hours for research work/thesis.

Semester-Wise Layout of Courses

Semester-I (Common Subjects)

Sr.No	Code	Course Title	Credits Hours
1	GM-5041	Advances In Sewn Product Industry	3-0-3
2	GM-5042	Clothing Comfort	2-1-3
3	GM-5043	Quality Management In Clothing	2-1-3
4	GM-5044	Research Methodology	2-1-3

Courses for Clothing Specialization

Sr.No.	Code	Course Title	Credit Hours
1	GM-5045	Performance Clothing	3-0-3
2	GM-5046	Product Development: Innovative & Best Practices	3-0-3
3	GM-5047	Lean Six Sigma	3-0-3
4	GM-5048	Project Management In Clothing	3-0-3
5	GM-6041	Research Thesis-I	0-3-3
6	GM-6042	Research Thesis-II	0-3-3

Courses for Fashion Specialization

Sr.No.	Code	Course Title	Credit Hours
1	FD-5091	Clothing Project Design & Practice	3-0-3
2	FD-5092	Fashion Trend & Information Analysis	3-0-3
3	FD-5093	Fashion Material Creative Design	3-0-3
4	FD 5094	Fashion Brand Management	0-3-3
5	FD 6091	Research Thesis-I	0-3-3
7	FD 6092	Research Thesis-II	0-3-3

Scope of the Degree

The graduates of this programme would be able to get job and progress opportunities in diverse areas, some of them include:

1. Technical professionals for sewn products industry (home textiles, garments, leather, shoe industry etc).
2. Research and Development in public and private sector organizations.
3. Higher studies and research in the field of clothing and relevant interdisciplinary fields.
4. Teaching and research at university/post graduate college level.

Available Labs

1. Pattern Making Laboratory
2. Computer Aided Manufacturing Laboratory
3. Basic sewing Laboratory
4. Advanced Sewing Laboratory
5. SMART Textile Laboratory
6. Comfort Laboratory (NTRC)
7. Textile Testing Laboratory

6. MS Polymer Science & Engineering

The MS Polymer Science and Engineering Program aims to provide a technology-based polymer engineering education through the specially designed courses and the extracurricular research training, students will have a good knowledge about the development and prospect of polymer science & engineering within emerging scientific intersecting fields like photonic, magnetic functional polymer materials, biomedical polymer materials, polymeric membrane for separation as well as fine polymer materials, and furthermore, develop abilities of scientific research, product development, education and technical management.

Program Outcomes:

In the past half century, there has been a great increase in the importance of Polymer Science and Engineering to our society, especially in polymer sector like synthetic fibres, plastics, rubbers, composites etc. as a back bone of country's economy. The need for trained, polymer scientist/engineer at all levels is on the rise as the use of advanced chemicals, materials and process has spread to almost all polymer sectors. Nowadays, technological, engineering and business problems are often of such complexity that they require a high level of product development and research. Whereas in the past polymer field was generally restricted to the conventional chemical processing and the field was not so much grown. Today there is an ever-growing demand for polymer expertise in all related fields of polymer, as well as in finance and business management. The department of polymer engineering has launched the program of MS Polymer Science and Engineering by keeping in view the following learning outcomes:

- To train the manpower required to deal with the problems faced by the polymer industry through advance knowledge and skills so as to achieve reduced costs, flexibility and high quality.
- To have more in-depth study of research projects of applied nature which are already going on in the existing engineering faculties of National Textile University.
- To elevate the industry based research in the field of polymer science and engineering.

- To fill the space of more advanced polymer scientist and engineer as far as sensitivity and demand of region is concerned.
- To establish and enhance academia-industrial linkage for producing quality research of international repute.
- In addition to above social concern, department has worked out in detail as far as employment perspectives of graduates are concerned.

Eligibility Criteria

1. A candidate seeking admission in MS Polymer Science and Engineering must possess one of the following with a minimum of CGPA 2.00/4.00 or 3.00/5.00 in semester system or 60% in annual/term system from HEC recognized institute/university:

   B.Sc. /BE Engineering (Polymer/Materials/Chemical/Textile/Mechanical/Petroleum/Environmental), BS (Hons) Chemistry, Physics and Environmental Sciences, M.Sc. (Chemistry, Physics, Environmental Sciences)

2. The applicant must pass NTU-GAT (General) test conducted by National Textile University, as per HEC guidelines and adopted by Advanced Studies and Research Board of NTU, Faisalabad with a minimum of 50% cumulative score.
3. The applicant must not be already registered as a student in any other academic program in Pakistan or abroad.

Merit Criteria

The merit will be calculated as per following criteria:

• BS Engineering or BS (Hons.) / B.Sc. + M.Sc.	60% / (30+30) % weightage
• GAT (General):	30% weightage
• Interview:	10% weightage

Total Credit Hours

For the award of MS Polymer Science & Engineering degree, candidates must need to complete total 30 credit hours (24 for course work and 06 for research thesis).

Study Duration

The minimum duration of study will be 4 regular semesters and maximum of 8 regular semesters.

MS Thesis Evaluation

The MS Thesis will be evaluated by one expert of the relevant field from external university/institute in addition to departmental evaluation committee.

Plagiarism Test

The Plagiarism Test must be conducted on the Dissertation before its submission to the external expert as per HEC criteria.

Scope of the Degree

The graduates of MS Polymer Science and Engineering may pursue their careers and progress opportunities in diverse areas including:

- Polymer producing companies, Rubber products manufacturing companies, petroleum refineries, composite manufacturing industries, synthetic fibre industries, polymer processing and fabrication units.
- Scale-up of new synthetic chemistry from laboratory development to pilot plant and large-scale production.
- Teaching and research at university/post graduate college level in disciplines of polymer science & engineering, materials science & engineering and polymer chemistry etc.

- Research and product development in public and private sector organizations (current hot topics include biodegradable polymers and compatibilizers for recycling polymers).
- Research and process development in polymer processing.

Semester-Wise Layout of Courses

The structure of MS Polymer Science and Engineering programme is given as follows:

Semester-I

Sr.No	Code	Course Title	Credit Hours
1	PSE-5071	Polymers Science, Engineering & Applications	3
2	PSE-5072	Advanced Characterization Techniques	3 (2-1)
3	PSE-5073	Polymer Matrix Composites	3
4	RM-5071	Research Methodology	3
		Total	12

Semester-II

Sr.No	Code	Course Title	Credit Hours
1	PSE-5075	Mechanics of Polymers	3
2	PSE-5077	Polymer Rheology & Viscoelasticity	3
3	PSE-5076	Elastomeric Materials & Processes	3
4	PSE-5074	Polymer Membrane Design & Applications	3
		Total	12

Semester III & IV

Sr.No	Code	Course Title	Credit Hours
1	PSE-6071	Research Thesis	6
		Total Credit Hours of the Program	**30**

List of Courses

Sr.No.	Code	Course Title	Credit Hours
1	PSE-5071	Polymers: Science, Engineering & Applications	3
2	PSE-5072	Advanced Characterization Techniques	3 (2-1)
3	PSE-5073	Polymer Matrix Composites	3
4	RM-5071	Research Methodology	3
5	PSE-5074	Polymer Membrane Design and Applications	3
6	PSE-5075	Mechanics of Polymers	3
7	PSE-5076	Elastomeric Materials & Processes	3
8	PSE-5077	Polymer Rheology & Viscoelasticity	3
9	PSE-5078	Polymer Chemistry	3
10	PSE-5079	Polymer Process Technologies	3
11	PSE-5080	Nano-Materials Engineering	3
12	PSE-5081	Separation Processes	3
13	PSE-5082	Compounding Principles & Polymer Blending	3
14	PSE-5083	Advanced Functional Polymers	3
15	PSE-5084	Polymer Coatings and their Applications	3
16	PSE-5085	Advanced Polymer Engineering	3
17	PSE-5086	Nanotechnology	3
18	PSE-5087	Mold Design	3
19	PSE-5088	Advanced Polymer Composites	3
20	PSE-5089	Modelling and Simulation of Polymers	3

Course Specifications

PSE-5071: Polymers: Science, Engineering & Applications

This course covers the introduction of macromolecules (Polymers), polymer raw materials, structure property relationship of polymers, polymer crystallinity, polymer reactions, techniques of polymerization, engineering and specialty polymers, elastomers, polymer composites and recycling of polymers. Moreover, how plastics, rubber, and fibers are synthesized, processed into useful materials, characterized, and compounded with fillers and other additives to improve performance for specific applications.

PSE-5072: Advanced Characterization Techniques

This course introduces the fundamental theoretical framework for diffraction, spectroscopy and imaging methods used in the structural and compositional characterization of engineering materials. The laboratory portion of the course offers intensive instruction in the most widely practiced x-ray diffraction (XRD) methods for materials evaluation, and an introduction to electron microscopy using a scanning electron microscope (SEM) an energy dispersive spectrometer (EDS), and a transmission electron microscope (TEM), chromatography, infrared spectroscopy, UV/Vis spectroscopy, atomic absorption spectroscopy. Moreover, this course also emphasis on Mechanical testing, Thermal testing, chemical testing and Electrical testing of polymeric materials. The course will include several visits to the materials lab and an experimental term project.

PSE-5073: Polymeric Matrix Composites

This course describes about introduction of composite material, naming and classification of composite materials, molding methods of composite materials, Review of elasticity of anisotropic solids characterization of composite materials, Application of composite materials, the progress of composite materials, and importance of composite materials in 21st century.

RM-5071: Research Methodology

The overall aim of this course is to enable the students to identify a research area, identify a research problem, formulate research question, conduct literature survey, formulate research hypothesis, design research experiments, graphically present, analyze and interpret the experimental data, and draw valid conclusions. Additionally, the students will be able to write a research proposal, critically analyze research papers, and write a short literature review with proper citations and referencing. The students will practice relevant statistical tools and techniques using a statistical software package. The students will also become familiar with plagiarism and other ethical issues in research, patents, copyrights and trademarks, thesis and research paper writing styles

PSE-5074: Polymer Membrane Design and Applications

The course will describe in detail membrane separation technology and wide range of applications including water treatment and desalination. The course covers: global water shortages and need for membrane technology. Basic membrane types and their preparation Microfiltration, ultrafiltration, nanofiltration and reverse osmosis membrane processes and current applications in water treatment. Characteristic properties of membranes, Methods of testing.

PSE-5075: Mechanics of Polymers

This course covers the basics of mechanics, mechanical behavior of polymers, various kinds of stresses and strains, stress-strain diagram, concepts of viscoelasticity, linear viscoelasticity, stress relaxation, temperature dependence of relaxation modulus, stress relation as a function if molecular configurations, creep, linear viscoelastic creep, creep compliance as a function of time, mechanical models, mathematical models and mechanical testing of polymers.

PSE-5076: Elastomeric Materials & Processes

The course will focus on introduction to elastomeric materials, Classification of elastomers, Mastication process, Compounding ingredients for rubbers, Rubber blends, Thermoplastic elastomers, Processing, Design of elastomeric products, Comparison of Elastomer Properties. Data sources, Recycling and reuse of elastomeric

materials. The course will also focus on application of elastomeric material in different industry.

PSE-5077: Polymer Rheology & Viscoelasticity

Definition and measurement of the material functions of complex fluids, continuum mechanics of stress and deformation, constitutive equations derived from both continuum and molecular theories, interrelation of material functions for both shear and elongational flows, linear and nonlinear elasticity and viscoelasticity, material functions of important classes of polymeric fluids, the role of rheological properties in material characterization and polymer processing.

PSE-5078: Polymer Chemistry

Introduction to the synthesis of polymers and the mechanism of polymerization processes. Fundamental principles of polymer chemistry. Step-growth polymerization and network formation (theory of gelation). Chain-growth homo-polymerization and copolymerization by radical-, ionic-, and coordination type catalysts. Synthesis of block and graft copolymers. Structure of polymers and their application. Polymers and the environment, polymer recycling.

PSE-5079: Polymer Process Technologies

Technology and processing of synthetic resins (PU, PP, PE, etc), adhesive and sealants; Chemistry of Adhesives, Paints and Coatings; Polyurethane Foams, and Polymer Fibers; Surface preparation for adhesion, primers and coupling Agents. Process Techniques for various polymers for the following uses as synthetic fibers, adhesives, foams, plastics, synthetic rubber & surface coating compounds. Properties of polymers and their chemical structure, Polymer compounding, use of additives for improvement of qualities / properties of polymers.

PSE-5080: Nano-Materials Engineering

The course will be structured as a series of integrated lecture and discussion sessions that review foundational concepts in nanoscience in the context of recent research breakthroughs. Introduction to nanomaterials with an emphasis on their fabrication, structures, properties & applications. Special attention will be paid to carbon-based nanomaterials, including carbon nanotubes and graphene and Bionanomaterials. A range of techniques for characterizing nanomaterials (such as diffraction, microscopy & spectroscopy) will also be introduced.

PSE-5081: Separation Processes

An introduction to the principles and applications of diffusional separation processes involving gas-liquid, liquid-liquid and solid-liquid systems in equilibrium-stage and continuous-contact operations. Phase equilibria and the role of diffusion are also covered. The course includes design of separation processes for process industry and for clean technology, as well as the application of the methods to other systems - in particular environmental systems. Throughout emphasis is placed on problem solving and illustrative worked examples.

PSE-5082: Compounding Principles & Polymer Blending

Compounding materials considerations & evaluations, thermodynamics of miscibility and relationship to structure of components, polymer additives used in compounding, effect of additives on specific properties of polymers, dispersive and distributive mixing, compatibilization, blending procedures, compounding techniques, influence on mechanical properties and structure-property relationship of polymers.

PSE-5083: Advanced Functional Polymers

The course will focus on advance study of Nanostructured polymers, Chemistry in Polymer Science, Polyelectrolytes, Liquid crystalline polymers, Dendrimers, Fluorinated polymers, Supramolecular polymers, Environmentally responsive polymers, Polymers in cosmetic care/pharmaceutics, Polymer Hybrids.

PSE-5084: Polymer Coatings and their Applications

The course will cover the following areas: colloidal and interfacial chemistry of Coatings and Polymeric Materials, polymer synthesis, adhesion, surface and interfacial spectroscopy of Coatings and Polymeric Materials, rheology, nanomaterials design and synthesis, and surface chemistry and their application in industry. The course will also

emphasis on special polymer coatings.

PSE-5085: Advanced Polymer Engineering

This course offers extensive study of engineering analysis and design techniques for synthetic polymers. Treatment of materials properties selection, mechanical characterization, and processing in design of load-bearing and environment-compatible structures are covered. Moreover dependence of properties on molecular structure & microstructure. Polymer rheology. Unit processing operations, formulation & uses of polymers, mechanical properties, degradation & failure methods

PSE-5086: Nanotechnology

Introduction to Nanotechnology provides a broad overview of nanotechnology, discussing the fundamental science of nanotechnology and its applications to engineering, biomedical, and environmental fields. The course provides a background of the understanding, motivation, implementation, impact, future, and implications of nanotechnology. Other specialist topics in nanotechnology. The course will also discuss specific applications of nanotechnology in electronic devices, biomedical fields, environmental solutions, and energy production.

PSE-5087: Mold Design

The course will cover the fundamentals of injection mold design and give the student and understanding of mold types, basic mold construction, mold design and function. Topics include: shrinkage allowances, gate locations, cooling, runner balancing, stripper plates slide molds, two and three plate designs as well as molding machine considerations. Over the semester, the students will have the experience of collaborating to develop a complete mold design from scratch. Hands-on examination of parts, molds, and drawings are featured as well as CAD demos and a plant tour.

PSE-5088: Advanced Polymer Composites

This course aims to provide background knowledge of polymer and a basic understanding of modern polymer composites. The class will be balanced between science and engineering in the main subjects and prepare the students for further advances in the field of polymer and polymer composites. The module will teach polymer engineering related to structure-process-property relationship, fiber enforcement for engineering polymer composites, composite interface/interphase and micromechanics of polymer composites.

PSE-5089: Modeling & Simulation of Polymers

This course introduces the introduction to modelling and simulation, system analysis, classification of systems, system theory basics, its relation to simulation, model classification: conceptual, abstract, and simulation models, heterogeneous models, methodology of model building, simulation systems and languages, means for model and experiment description, principles of simulation system design, parallel process modelling, using Petri nets and finite automata in simulation, models o queuing systems, discrete simulation models, model time, simulation experiment control, continuous systems modelling, overview of numerical methods used for continuous simulation.

System Dymola/Modelica, combined simulation, the role of simulation in digital systems design, special model classes, models of heterogeneous systems, cellular automata and simulation, checking model validity, verification of models, analysis of simulation results, simulation results visualization. Model optimization, generating, transformation, and testing of pseudorandom numbers, stochastic models, Monte Carlo method, and overview of commonly used simulation systems.

Research Thesis I & II

The research project module will enable the students to bring together the knowledge and skills acquired in the earlier modules to investigate a selected topic reviewing the literature, presenting seminars and preparing material in the form of a publication. The project will demonstrate the student’s capabilities to perform independently but supervised research to solve practical problems utilizing the theoretical knowledge and analytical skills attained.

The overall purpose of the module is to develop in the students an understanding of the steps involved in planning and conducting a research project and in communicating the findings both orally and in writing. The project work can be undertaken in an industrial concern, where possible, ensuring both the relevance to the employer, access to appropriate facilities, and allowing sufficient time to be spent on the practical work. Alternatively, projects could be based and carried out at the university. In case of collaboration with other national and international research institutes and universities the final semester research projects can be completed at mother and collaborated organization.

PhD Textile Engineering

Aims and Objectives

- To enhance the intellectual development of PhD scholars through creativity, analytical thinking, critical analysis, and innovative problem-solving.
- To carry out research of international standard aimed at advancing the scientific and technological knowledge globally.

Eligibility Criteria

- MS Textile Engineering or equivalent with minimum CGPA 3.00/4.00 or 3.50/5.00 in semester system, 60% marks in annual system.
- Candidate must have PEC registration
- Candidate will have to pass NTU GAT (Subject) test within minimum 70 marks.
- It is mandatory to pass interview in order to compete on merit.
- Applicant must not be already registered as a student in any other academic program in Pakistan or abroad.

Admission Criteria

- The admission merit list will be prepared according to the following criteria:

1.	M.Sc./MS/Equivalent	50 % weightage
2.	B.Sc./BE/Equivalent	30% weightage
3.	Interview result	10 % weightage
4.	Publication/relevant experience	10% weightage

Programme Structure

The PhD Textile Engineering Programme is a 4 years degree programme consisting of 18 credit hours of course work and 30 credit hours of research work.

Semester-Wise Layout of Courses

Semester I

Sr.No.	Code	Course Title	Credit Hours
1	TE-7101	Advanced Statistical Methods for Research	3
2	TE-7102	Recent Development in textile Engineering	2
3	TE-7103	Modern testing and Characterization Methods	3
4	TE-7104	Prototype / Review Paper	1
		Total	9

Semester II

Sr.No.	Code	Course Title	Credit Hours
1	TE-7XXX	Elective – I	3
2	TE-7XXX	Elective – II	3
3	TE-7XXX	Elective – III	3
		Total	9

Semesters III-VIII

Sr.No		Course Title	Credit Hours
		Research Thesis	30
		Total Credit Hours of the Program	48

List of Elective Courses

Sr.No.	Research Areas	Electives
1	Advanced Materials	Advanced polymeric materials; Nano composites; Biomaterials for healthcare; Advancesin shape memory polymers; Nanofibers and nanoparticles; Flame retardant materials; Functional materials for textiles; Microencapsulation technology.
2	Engineered textilestructures & composites	Engineering textiles; Advances in yarn spinning technology; Specialist yarn and fabric structures; 3-D Fibrous assemblies; Advances in weaving and knitting technologies; Nonwovens for technical textiles; Design and manufacture of textile composites; Mechanics of fibrous assemblies; Heat and mass transfer in porous media.
3	Textile surface modification and chemical	Advances in dyeing and finishing of technical textiles; Functional finishes for textiles; Smart textile coatings and laminates; Surface modification of textiles; Plasma technologies for textiles; Digital printing of textiles.
4	Clothing engineering	Science in clothing comfort; Smart clothes and wearable technology; Advances in apparel production; Clothing biosensory engineering; Clothing appearance & fit; Biomechanical engineering of textile and clothing.
5	Technical Textiles	Medical and healthcare textiles; Smart fibers, fabrics and clothes; Functional textiles for protection and performance; Textiles in sports; High performance textiles and their applications.
6	Textile machinery and instrument	Instrumentation and control; Applied mechatronics; Mechatronic design in textile engineering; Design of textile machines; Mechanics and calculations of textile machinery
7	Textile modeling and simulation	Simulation in textile technology; Modeling and predicting textile behavior; Soft computing in textiles; Finite element analysis in textiles; Modeling, simulation and control of dyeing process; Advance CAD systems for textile and clothing; Modeling in Matlab
8	Energy, environmentand sustainability in	Sustainable textile production; Recycling in textiles; Environmental impact of textiles; Energyharvesting materials

FACULTY OF SCIENCE

The Faculty of Science consists of two departments namely the Department of Computer Science and Department of Applied Science. Department of Computer Science is committed to train and produce graduates who have extensive knowledge of the demanding fields that can be helpful for both national and international industries such as in Software Design and Management, Computational Bioinformatics, Computer Networks, Database Systems, Artificial Intelligence and Multimedia/Computer Graphics/ Image Processing. Both departments offers MS and PhD programs.

DEPARTMENT OF COMPUTER SCIENCE

Introduction

Department of Computer Science is committed to train and produce graduates who have extensive knowledge of the demanding fields that can be helpful for both national and international industries such as in Software Design and Management, Computational Bioinformatics, Computer networks, Database Systems, Artificial Intelligence Multimedia/Computer Graphics/ Image Processing and parallel Computing. The Department of Computer Science offers MS Computer Science, MS Software Engineering and PhD Computer Science at postgraduate level.

1. MS COMPUTER SCIENCE

The Faculty of Science offers 2-years MS in Computer Science (MSCS) and MS Software Engineering programs comprising 24 credit hours of course work and 6 credit hours of research work.

Aims and Objectives

The programme objectives of the master's degree in Computer Science are:

- To prepare students for the increasingly sophisticated application of computers to the needs of industry andsociety.
- To prepare students for research, teaching and further graduate studies in computer science.
- To prepare students for leadership roles in their industrial career.
- To provide students with graduate level course work in computer science that supplement the curriculum in other disciplines.

Eligibility Criteria

1. BS Computer Science/BS Information Technology/BS Software Engineering /M.Sc Computer Science / IT or 16 years equivalent education from HEC recognised university/institute with a minimum CGPA 2.00/4.00 or first division in annual system.

2. The applicant must pass NTU-GAT (General) test conducted by National Textile University, as per HEC guidelines and adopted by Advanced Studies and Research Board of NTU, Faisalabad with a minimum of 50% cumulative score.

3. The applicant must not be already registered as a student in any other academic program in Pakistan or abroad.

Merit Criteria

Admission merit will be prepared according to the following criteria:

- BS or Equivalent 60% weightage
- NTU GAT (General) 30% weightage
- Interview Marks 10% weightage
- Practical experience preferable

Programme Structure

MSCS is a 2-year programme spread over 4 semesters. Each semester has at least 18 weeks including one week for mid semester and one week for end semester examination. MSCS programme has 30 credit hours in total i.e. 24 credit hours course work and 6 credit hours for research thesis. Each MSCS student must has to complete 12 credits from 4 core courses, 12 credits from elective courses and 6 credits of research work to achieve the MSCS degree. The scheme of studies for MSCS programme is as under.

Semester I

Code	Course Title	Credit Hours
CSC-5071	Advanced Algorithm Analysis	3
CSC-XXXX	Advanced Computational Theory	3
CSC-XXXX	Elective-I	3
CSC-XXXX	Elective-II	3
	Total	12

Semester II

Code	Course Title	Credit Hours
CSC-5073	Elective-III	3
CSC-XXXX	Elective-IV	3
CSC-XXXX	Elective-V	3
CSC-XXXX	Elective-VI	3
	Total	12

Semester III

Code	Course Title	Credit Hours
CSC-6072	MS Thesis	3
	Total	3

Semester IV

Code	Course Title	Credit Hours
CSC-6072	MS Thesis	3
	Total Credit Hours of the Program	30

Course Specification

CSC-5070: Advanced Computational Theory

Automata theory, formal languages, Turing machines, computability theory and reducibility, computational complexity, determinism, non-determinism, time hierarchy, space hierarchy, NP completeness, selected advanced topics.

CSC-5071: Advanced Algorithm Analysis

Advanced algorithm analysis including the introduction of formal techniques and the underlying mathematical theory. NP-completeness. Search Techniques. Randomized Algorithms. Heuristic and Approximation Algorithms. Topics include asymptotic analysis of upper and average complexity bounds using big-O, little-o, and theta notation. Fundamental algorithmic strategies (brute-force, greedy, divide-and-conquer, backtracking, branch-and-bound, pattern matching, and numerical approximations) are covered. Also included are standard graph and tree algorithms. Additional topics include standard complexity classes, time and space tradeoffs in algorithms, using recurrence relations to analyze recursive algorithms, non-computable functions, the halting problem, and the implications of non-computability. Algorithmic animation is used to reinforce theoretical results. Upon completion of the course, students should be able to explain the mathematical concepts used in describing the complexity of an algorithm, and select and apply algorithms appropriate to a particular situation.

CSC-5072: Advanced Operating Systems

This course will cover Introduction to Characterization of Modern Operating Systems; file systems, memory management techniques, Process scheduling and resource management. In System Models architectural models, Interprocess Communication, Issues of Security in Distributed Systems (Partial coverage), Distributed File System, Concurrency Control in Distributed Systems; Problems of Coordination and Agreement in Distributed Systems Replication, Advantages and requirements, Fault-tolerant services, Mobile and Ubiquitous Computing.

CSC-5076: Digital Signal Processing

One- and N-dimensional signals and systems, Sampling theorem, Discrete-time Fourier transform, discrete Fourier transform, fast Fourier transform, z-transforms, stability and minimum phase signals/systems, Linear filtering of signal, Time domain, Difference equations and convolution, Impulse invariance, bilinear transform, FIR filter design, 2D filterdesign, Statistical signal processing, Stochastic signals, correlation functions and power density spectra, Optimal filtering, Wiener filters, Adaptive filters, LMS and array processing.

CSC-5077: Parallel and Distributed Computing

Why use parallel and distributed systems? Why not use them? Speedup and Amdahl's Law, Hardware architectures, multiprocessors (shared memory), networks of workstations (distributed memory), clusters (latest variation). Software architectures, threads and shared memory, processes and message passing, distributed shared memory (DSM), distributed shared data (DSD). Possible research and project topics, Parallel Algorithms, Concurrency and synchronization, Data and work partitioning, Common parallelization strategies, Granularity, Load balancing, Examples, parallel search, parallel sorting, etc. Shared-Memory Programming, Threads, Pthreads, Locks and semaphores, Distributed-Memory Programming, Message Passing, MPI, PVM. Other Parallel Programming Systems, Distributed shared memory, Aurora, Scoped behaviour and abstract datatypes, Enterprise, Process templates. Research Topics.

CSC-5078: Control Systems and Robotics

Review of classical control analysis methods. Nyquist stability criterion. Classical design using frequency domain methods, phase lead and lag controllers, PID controllers. Relay auto tuning. Introduction to state space methods. State space models, state transformations, solution of the state equations. Controllability and observability. Design using state feedback. LQR design, pole placement, use of observers. Introduction to robotics. Transducers, actuators and robot control.

CSC-5079: Real Time Operating Systems

The principles of real-time and embedded systems inherent in many hardware platforms and applications being developed for engineering and science as well as for ubiquitous systems, including robotics and manufacturing, interactive and multimedia, immersive and omnipresent applications. Real-time and quality of service system principles, understand real-time operating systems and the resource management and quality of service issues that arise, and construct sample applications on representative platforms. Platforms range from handheld and mobile computersto media and real-time server systems. Platforms may also include specialized systems used in application- specific contexts, such as autonomous robotics, smart sensors, and others.

CSC-5080: Advanced Networking

Review of basic concepts, The OSI Model, packet and circuit switching, network topology, ISDN. The TCP/ IP protocol stack, IP, ARP, TCP and UDP, DNS, ICMP, Internet Addressing, Routing, IP Multicast, RSVP, Next Generation IP – Ipng, Wireless, Radio basics, Satellite Systems, WAP, current trends, Issues with wireless over TCP. Congestion Control, Control vs. Avoidance. Algorithms, Congestion in the Internet. Mobile IP, Voice over IP (VoIP), VPNs, Network Security. Management, Quality of Service (QoS), network vs. Distributed systems management Protocols, web-based management.

CSC-5081: Network Security

Introduction, Cryptology and simple cryptosystems, Conventional encryption techniques, Stream and block ciphers, DES, More on Block Ciphers, The Advanced Encryption Standard. Confidentiality, Message authentication, Hash functions, Number theory and algorithm complexity, Public key Encryption. RSA and Discrete Logarithms, Elliptic curves, Digital signatures. Key management schemes, Identification schemes, Dial-up security. E-mail security, PGP, S-MIME, Kerberos and directory authentication. Emerging Internet security standards, SET, SSL and IPsec, VPNs, Firewalls, Viruses, Miscellaneous topics.

CSC-5082: Topics in Computer Networking

This course offers an advanced introduction and research perspectives in the areas of switch/router architectures, scheduling for best-effort and guaranteed services, QoS mechanisms and architectures, web protocols and applications, network interface design, optical networking, and network economics. The course also includes a research project in computer networking involving literature survey, critical analysis, and finally, an original and novel research contribution. Typical topics can be listed below, Overview of packet switching networks and devices. Fundamentals of Internet Protocol (IP) networking. Route lookup algorithms. Router architecture and performance.

Detailed operation of Internet routing protocols such as Open Shortest Path First (OSPF) and Border Gateway Protocol (BGP). Integrated and differentiated network service models. Traffic Engineering (TE) concepts and m e c h a n i s m s including label assignment, label distribution, and constraint-based routing algorithms. Multi-protocol label switching and its generalization. Quality of service mechanisms for multimedia and real-time communications. TE-based routing and signaling protocols. Fundamentals of per-flow and aggregate scheduling algorithms. Application-level and network- level signaling protocols for data, voice, and video communications. Resource signaling and resource reservation protocols. Worst-case analysis for multimedia networking.

CSC-5083: Network Administration

Through completion of this course, students will be able to plan, install, and configure a Web Server, manage, monitor, and optimize a Web Server, and design and implement a Web Site on the Web Server created.

CSC-5074: Wireless Networks

This course covers fundamental techniques in design and operation of first, second, and third generation wireless networks, cellular systems, medium access techniques, radio propagation models, error control

techniques, handoff, power control, common air protocols (AMPS, IS-95, IS-136, GSM, GPRS, EDGE, WCDMA, cdma2000, etc), radio resource and network management. As an example for the third generation air interfaces, WCDMA is discussed in detail since it is expected to have a large impact on future wireless networks. This course is intended for graduate studentswho have some background on computer networks.

CSC-5084: Network Performance Evaluation

This is an advanced course in networks and protocols. Analytical, simulation and experimental methods should be used to evaluate and design networks and protocols. Investigate network management tools and techniques.

CSC-5085: Theory of Programming Languages

Introduction and History, Syntax and Semantics, Control Structures, Types, Logic Programming, Functional Programming and Lambda calculus, Concurrent and Distributed Programming, Dataflow, Object-oriented Programming.

CSC-5086: Advanced Compiler Design I

An in-depth study of compiler backend design for high-performance architectures. Topics include control-flow and data-flow analysis, classical optimization, instruction scheduling, and register allocation. Advanced topics include memory hierarchy management, optimization for instruction-level parallelism, modulo scheduling, predicated and speculative execution. The class focus is processor- specific compilation techniques, thus familiarity with both computer architecture and compilers is recommended

CSC-5087: Advanced Compiler Design II

The course should consist of one or two major projects. Theoretical study should depend on the level of the first course Design I and the student needs.

CSC-5088: Intelligent User Interfaces

The increasing complexity of software and the proliferation of information makes intelligent user interfaces increasingly important. The promise of interfaces that are knowledgeable, sensitive to our needs, agile, and genuinely useful has motivated research across the world to advance the state of the art and practice in user interfaces that exhibit intelligence. The text covers the topic well.

CSC-5089: Multimedia Database

Introduction, Overview of Relational and Object- Relational Data Representations, Text/Document Databases, Multidimensional Data Structures, similarity based search (spatial, image, audio), XML Databases, Temporal Data Models, Logical Frameworks

CSC-5090: Computer Vision

Concepts behind computer-based recognition and extraction of features from raster images. Applications of vision systems and their limitations. Overview of early, intermediate and high level vision, Segmentation, region splitting and merging, quadtree structures for segmentation, mean and variance pyramids, computing the first and second derivativesof images using the isotropic, Sobel and Laplacian operators, grouping edge points into straight lines by means of the Hough transform, limitations of the Hough transform, parameterisation of conic sections. Perceptual grouping, failure of the Hough transform, perceptual criteria, improved Hough transform with perceptual features, grouping line segments into curves. Overview of mammalian vision, experimentalresults of Hubel and Weisel, analogy to edge point detection and Hough transform, Relaxation labelling of images, detection of image features, grouping of contours and straight lines into higher order featuressuch as vertices and facets. Depth measurement in images

CSC-5091: Rich Internet Applications

This course covers the concept and technology evolution regarding the internet applications and the use of interface tools. Mainly, the course can focus on any one of the technologies of modern day, for example,

macromedia's FLASH. However, the course will use the concepts of data structures, object oriented programming, programming languages and the software design and engineering to develop projects of medium to large magnitude

CSC-5092: Requirement Engineering

Definition of requirements engineering and role in system development, Fundamental concepts and activities of requirements engineering, Information elicitation techniques, Modeling scenarios Fundamentals of goal-oriented requirements engineering, Modeling behavioral goals, Modeling quality goals, Goal modeling heuristics, Object modeling for requirements engineering, Object modeling notations, Object modeling heuristics, Identifying objects from goals, Modeling use cases and state machines, Deriving operational requirements from goals, Requirements Specification, Requirements verification and validation Management of inconsistency and conflict, requirements engineering risks, the role of quality goals in the requirements selection process, Techniques for requirements evaluation, selection and prioritization, Requirements management, Requirements traceability and impact analysis.

CSC-5093: Software System Architecture

Definition and overview of software architecture, the architecture business cycle, Understanding and achieving quality attributes, Attribute-driven design, Documenting software architecture, Evaluating software architecture, Architecture reuse Life-cycle view of architecture design and analysis methods, The QAW, a method for eliciting critical quality attributes, such as availability, performance, security, interoperability, and modifiability, Architecture Driven Design, Evaluating a software architecture (ATAM, CBAM, ARID), Principles of sound documentation, View types, styles, and views, Advanced concepts such as refinement, context diagrams, variability, software interfaces, and how to document interfaces, Documenting the behavior of software elements andsoftware systems, Choosing relevant views, Building adocumentation package

CSC-5094: Software System Quality

What Is Software Quality, Quality Assurance, Quality Engineering, Software Testing, Testing, Concepts, Issues, and Techniques, Test Activities, Management, and Automation, Coverage and Usage Testing Based on Checklists and Partitions, Input Domain Partitioning and Boundary Testing, Coverage and Usage Testing Based on Finite-State Machines and Markov Chains, Control Flow, Data Dependency, and Interaction Testing, Testing Techniques, Adaptation, Specialization, and Integration. Quality Assurance Beyond Testing, Defect Prevention and Process Improvement, Software Inspection, Formal Verification, Fault Tolerance and Failure Containment, Comparing Quality Assurance Techniques and Activities. Quantifiable Quality Improvement, Feedback Loop and Activities for Quantifiable Quality Improvement, Quality Models and Measurements, Defect Classification and Analysis.

- Risk Identification for Quantifiable Quality Improvement, Software Reliability Engineering. Sample labs and assignments
- Use of automated testing tools
- Testing of a wide variety of software
- Application of a wide variety of testing techniques
- Inspecting of software in teams, comparison andanalysis of results

CSC-5095: Research Study

The students have to perform meta analyses of 25-30 research papers selected in current research topics in International Journals. Topic and papers will be selected with approval from the instructor. Conference papers are not allowed for review. Students have to read all such papers and prepare the analysis related to models, methods, findings and come up with what has been done related to selected area of research and research gaps if any are explicitly identified with future work.

CSC-5096: Software Case Tools,Applications

The students will be appraised of, Case tools , techniques, CASE in software development process,

Traditional CASE methodologies, Emerging CASE methodologies, OO Design, Specific CASE tools, specialized design tools, Managing CASE methodologies. As part of course, students will be assigned a real life problem for development through CASE tools.

2. MS SOFTWARE ENGINEERING

Program Objectives

The educational objectives of MSSE program are:

- To provide high level technical knowledge in the core areas as well as the focused areas of Software Engineering
- To prepare students for research and further graduate studies in computer science
- To establish the interest and ability for independent lifelong and dynamic learning in graduates
- To prepare students for becoming a valuable asset for industry with special focus on Textile industry

Program Outcomes

Graduates of the MSSE program will be able to:

1. Apply proper theoretical and practical knowledge of software requirements engineering and software systems design. This includes feasibility analysis, negotiation, and good communication with stakeholders.
2. Self-learn new models, techniques, and technologies as they emerge.
3. Analyze the current significant software technology; articulate its strengths and weaknesses, and improvements.
4. Recognize the relationships between core body of knowledge in software engineering and other related engineering disciplines (e.g. systems and computer engineering) and to be able to apply software engineering techniques to solve problems in related engineering disciplines.
5. Reconcile conflicts in software project objectives, finding acceptable compromises within limitations of cost, time, and organization's core business.
6. Carry out literature review, develop research proposal, and conduct research in specific topics related to software engineering core areas/develop an approach to analyze and solve specific software engineering problem.

Eligibility Criteria

1. Candidates must have 16 years of education i.e. BS in Computer Science/Bachelor of Computer Science/MSc in Computer Science, BSIT, BSSE 4 year, BS Telecommunication or equivalent from HEC

recognized university/ Institute with a minimum CGPA 2.00/4.00 or first division in annual system.

2. The applicant must pass NTU-GAT (General) test conducted by National Textile University, as per HEC guidelines and adopted by Advanced Studies and Research Board of NTU, Faisalabad with a minimum of 50% cumulative score.
3. The applicant must not be already registered as a student in any other academic program in Pakistan or abroad.

Merit Criteria

- Admission merit will be prepared according to the following criteria:

1. BS or Equivalent — 60% weightage
2. NTU GAT (General) Test: — 30% weightage
3. Interview Marks — 10% weightage
4. Practical experience (preferable)

Semester-Wise Layout of Courses

Semester I

Sr.No.	Code	Course Title	Credit Hours
1	SEC-5071	Software Requirement Engineering	3
2	SEE-XXXX	Elective-I	3
3	SEE-XXXX	Elective-II	3
		Total	**9**

Semester II

Sr.No.	Code	Course Title	Credit Hours
1	SEC-5073	Software Quality Assurance	3
2	SEE-XXXX	Elective-III	3
3	SEE-XXXX	Elective-IV	3
		Total	**9**

Semester III

Sr.No.	Code	Course Title	Credit Hours
1	SEE-XXXX	Elective-V	3
2	SEE-XXXX	Elective-VI	3
3	SEC-6072	MS Thesis	3
		Total	**9**

Semester IV

Sr.No.	Code	Course Title	Credit Hours
1	SEC-6072	MS Thesis	3
		Total Credit Hours of the Program	**30**

List of Elective Courses

Sr.No.	Code	Course Title	Credit Hours
1	SEE-6071	Software System Architecture	3
2	SEE-6072	Software Risk Management	3
3	SEE-6073	Software Measurement and Metrics	3
4	SEE-6074	Software Configuration Management	3
5	SEE-6075	Reliability Engineering	3
6	SEE-6076	Component Based Software Engineering	3
7	SEE-6077	Design Patterns	3

8	SEE-6078	Complex Networks	3
9	SEE-6079	Agent Based Modelling	3
10	SEE-6080	Formal Methods	3
11	SEE-6081	Software Engineering Ontologies	3
12	SEE-6082	Semantic Based Software Engineering	3
13	SEE-6083	Model Driven Software Development	3
14	SEE-6084	Software Process Engineering	3

Course Specifications

SEE-5071: Software Requirements Engineering

Role of requirements engineering in system development, Fundamental concepts and activities of requirements engineering, Information elicitation techniques, Fundamentals of goal-oriented requirements engineering, Modeling behavioral goals, Modeling quality goals, Goal modeling heuristics, Deriving operational requirements from goals, Requirements Specification, Requirements verification and validation, Management of inconsistency and conflict, requirements engineering risks, requirement change control board and process, the role of quality goals in the requirements selection process, Techniques for requirements evaluation, selection and prioritization; Requirements management; Requirements traceability and impact analysis.

Reference Books:

1. Software Requirements, Karl E. Wiegers, Microsoft Press, 2003(or Latest Edition).
2. Software Requirements Specification, David Tuffley, CreateSpace Independent Publishing Platform, 2010 (or Latest Edition).
3. System Requirements Engineering, Loucopoulos and Karakostas, McGraw-Hill, 1995(or Latest Edition).
4. Requirements Engineering: Processes and Techniques, Gerald Kotonya and Sommerville, John-Wiley Sons, 1998 (or Latest Edition).

SEE-5073: Software Quality Assurance

What Is Software Quality: Quality Assurance, Quality Engineering Software Testing: Testing: Concepts, Issues, and Techniques, Test Activities, Management, and Automation, Coverage and Usage Testing Based on Checklists and Partitions, Input Domain Partitioning and Boundary Testing, Coverage and Usage Testing Based on Finite-State Machines and Markov Chains, Control Flow, Data Dependency, and Interaction Testing, Testing Techniques: Adaptation, Specialization, and Integration. Quality Assurance Beyond Testing: Defect Prevention and Process Improvement, Software Inspection, Formal Verification, Fault Tolerance and Failure Containment, Comparing Quality Assurance Techniques and Activities. Quality Assurance Beyond Testing: Defect Prevention and Process Improvement, Software Inspection, Formal Verification, Fault Tolerance and Failure Containment, Comparing Quality Assurance Techniques and Activities. Quantifiable Quality Improvement: Feedback Loop and Activities for Quantifiable Quality Improvement, Quality Models and Measurements, Defect Classification and Analysis. Risk Identification for Quantifiable Quality Improvement, Software Reliability Engineering.

Reference Books:

1. Software Quality Engineering: Testing, Quality Assurance, and Quantifiable Improvement, Jeff Tian, Wiley-IEEE Computer Society Press, 1st Edition, 2005(or Latest Edition).
2. Mastering Software Quality Assurance: Best Practices, Tools and Techniques for Software Developers", Murali Chemuturi, J. Ross Publishing, 2010 (or Latest Edition).

MS (SE) Elective Courses

SEE-6071: Software System Architecture

Definition and overview of software architecture, the architecture business cycle, Understanding and achieving quality attributes, Attribute-driven design, Documenting software architecture, Evaluating software architecture, Architecture reuse Life-cycle view of architecture design and analysis methods, The QAW, a method for eliciting critical quality attributes, such as availability, performance, security, interoperability, and modifiability,

Architecture Driven Design, Evaluating a software architecture (ATAM, CBAM, ARID), Principles of sound documentation, View types, styles, and views; Advanced concepts such as refinement, context diagrams, variability, software interfaces, and how to document interfaces; Documenting the behavior of software elements and software systems; Choosing relevant views; Building a documentation package, Future of Software Design, Architecture Description Languages, Introduction to AADL , AADL: Continued , Testing Architectures, Feature Modeling in SPLs, Testing a Family of Products.

Reference Books:

1. Software Architecture: Foundations, Theory, and Practice, Taylor, Medvidovic, and Dashofy, Wiley, 1st Edition, 2009(or Latest Edition).
2. Architecting Software Intensive Systems: A Practitioners Guide, Anthony J. Lattanze, Auerbach Publications, 2008(or Latest Edition).
3. Software Architecture in Practice, Bass, Clements, and Kazman, 2nd Edition, Addison-Wesley Professional, 2003(or Latest Edition).
4. Evaluating Software Architectures: Methods and Case Studies, Clements,Kazman, Klein, Addison-Wesley Professional, 2001(or Latest Edition).
5. Software Product Lines: Practices and Patterns, P. Clements and L.Northrup, Addison-Wesley, 2002(or Latest Edition).

SEE-6072: Software Risk Management

Risk-Management Discovery, Risk-Management Process, Process steps, inputs, and outputs, Methods and tools, reusable process component. Risk-Management Infrastructure, Training metrics, establishing a baseline for quantitative process improvement, infrastructure, there is no strategic plan in place to institutionalize risk management. Senior managers, engineering managers, and change agents should benefit from these organizational building blocks. Risk-Management Implementation, standard process, Risk management activities, lifecycle planning, budgeting, scheduling, and staffing. Crisis and Control, risk-management evolution stages, Effective and ineffective practices.

Reference Book:

Managing Risk: Methods for Software Systems Development, Elaine M.Hall, Addison-Wesley (or Latest Edition).

SEE-6073: Software Measurements & Metrics

Introduction to foundations of measurement theory, models of software engineering measurement, software products metrics, software process metrics and measuring management. Measurement theory (overview of software metrics, basics of measurement theory, goal-based framework for software measurement, empirical investigation in software engineering). Software product and process measurements (measuring internal product attributes: size and structure, measuring external product attributes: quality, measuring cost and effort, measuring software reliability, software test metrics, object-oriented metrics) Measurement management.

Reference Books:

1. A Rigorous and Practical Approach Software Metrics, N.E. Fenton, S.L.Pfleeger, PWS Publishing (or Latest Edition).
2. Metrics and Models in Software Quality Engineering, Stephen H.Kan, Addison-Wesley Professional (or Latest Edition).
3. Software Engineering Measurement, John C. Munson, Auerbach Publications (or Latest Edition).

SEE-6074: Software Configuration Management

Source Code Management, Build Engineering, Environment Configuration, Change Control, Release Management, Deployment, Architecting Your Application for CM, Hardware Configuration Management, Rightsizing Your Processes, Overcoming Resistance to Change, Personality and CM: A Psychologist Loods at the Workplace, Learning From Mistakes, Establishing IT Controls and Compliance, Industry Standards and Framework.

Reference Books:

1. Software configuration management handbook, Alexis Leon, Artech House, 2005 (or Latest Edition)

2. Software Configuration Management Patterns: Effective Teamwork, Practical Integration, Stephen P. Berczuk, Brad Appleton, Addison Wesley, 2004 (or Latest Edition).

SEE-6076: Component Based Software Engineering

Introduction to CBSE, Reuse, Basic Concepts in CBSE, Modeling components with UML, Open-COM component model, Fractal component model, Component Models and Technology, Component contracts component specification techniques, Component integration and Predictable composition, Service Oriented Computing - Key Concepts and Principles, SOA.

Reference Books:

1. Component Software: Beyond Object Oriented Programming, Clemens Szyperski, Second Edition, Addison Wesley, 2002 (latest ed.).
2. Building reliable component based software systems, Ivica Crnkovic, Magnus Larsson. Artech House, 2002 (latest ed.).
3. Service-oriented Computing: Semantics, Processes, Agents, Munindar P.Singh and Michael N. Huhns, 2005 (latest ed.)

SEE-6077: Design Patterns

Overview of Object-Oriented Analysis and Design, Design Patterns (Concepts, Major issues, Reuse of ideas), Creational Patterns, Structural Patterns, Behavioral Patterns. Applications of design patterns for: Organization of Work, Access Control, Service Variation and Service Extension, Object Management and Adaptation, Architectural Patterns, Patterns for Distribution, Patterns for Interactive Systems, Adaptable Systems. Frameworks and Patterns, Idea of frameworks, Patterns for flexibility, achieving benefits of frameworks, Failures of frameworks.

Reference Books:

1. Design Patterns: Elements of Reusable OO Software, Ralph Johnson, John Vlissides, Richard Helm, Erich Gamma, Addison-Wesley Professional, 1994 (latest ed.)
2. Pattern Hatching: Design Patterns Applied, Vlissides, Addison-Wesley Professional, 1998.

SEE-6078: Complex Networks

What are networks and why networks, Erdos-Renyi random, small-world and scale-free network models, Calculation of basic measures in networks, Degree and eccentricity Centrality, Shortest path between start and end nodes, case study of calculation, Clustering coefficient, Matching index and case study, Network tools overview, Pajek, Network Workbench, Gephi, Visone, Cytoscape, Centibin, Network Simulation (Agent-based simulation of networks), Biological networks, Social Networks, Scientometric study using Networks, Modelling Communication Networks as graphs/networks, Disk Graph models such as WSNs.

Reference Books:

1. Dynamical Processes on Complex Networks, Alain Barrat, Marc Barthélemy, Alessandro Vespignani, Cambridge University Press, 2012.(latest ed.)
2. The Structure and Dynamics of Networks, Mark Newman, Albert-Lazlo Barabasi, Duncan J. Watts, Princeton University Press, 2006 (latest ed.)
3. Exploratory Social Network Analysis with Pajek (Structural Analysis in the Social Sciences), Wouter De Nooy, Andrej Mrvar and Vladimir Batagelj, Cambridge University Press, Second Edition, 2011 (latest ed.)
4. Analysis of Biological Networks (Wiley Series in Bioinformatics), Björn H.Junker and Falk Schreiber, Wiley-Interscience, 2008 (latest ed.)

SEE-6079: Agent-Based Modeling

Introduction to Agent-based Models, Introduction to NetLogo, Describing ABMs, First ABM Development, Animation to Science, Model Verification & Validation, Emergence, Adaptive Behavior, Prediction, Cognitive AB Computing Framework, Complex Network Modeling, Exploratory AB Modeling, Descriptive AB Modeling, Validated AB Modeling.

Reference Books:

1. Agent-Based and Individual-Based Modeling: A Practical Introduction by Steven F. Railsback and Volker Grimm, 2011 (latest ed.).
2. Managing Business Complexity: Discovering Strategic Solutions with Agent-Based Modeling and Simulation, Michael J. North and Charles M.Macal, 2007.

SEE-6080: Formal Methods

Introduction to Formal methods, Introducing Z, Elements of Z, Logic, Using Predicates in Z, Schemas and Schema Calculus, Formal Reasoning, Case Studies in Z, Computer Graphics and Computational Geometry. Rule-Based Programming, Graphical User Interface, Safety-Critical Protection System, Modeling Large Systems, Object-Oriented Programming Model and Z, Concurrency and Real-time, Refinement, Program Derivation and Formal Verification, Converting Z into Code.

Reference Books:

1. The Way of Z: Practical Programming with Formal Methods by Jonathan Jacky, Cambridge University Press (November 28, 1996). ISBN-10:0521559766
2. Z: An Introduction to Formal Methods by Antoni Diller, Wiley; 2nd Edition (July 27, 1994). ISBN-10: 0471939730
3. Model Checking by Edmund M. Clarke Jr., Orna Grumberg, Doron A.Peled , MIT Press, 1st Edition (1999). ISBN-13: 978-0262032704.
4. Reactive Systems: Modelling, Specification and Verification by Luca Aceto, Anna Ingólfsdóttir, Kim Guldstrand Larsen and Jiri Srba, Cambridge University Press (August 13, 2007). ISBN-10: 0521875463
5. Fundamentals of Algebraic Specifications: Equations and Initial Semantics, H. Ehrig & B. Mahr, Springer-Verlag (1985), ISBN 0-387-13718-1.
6. Systems and Software Verification: Model-Checking Techniques and Tools. By B. Berard, M. Bidoit, A. Finkel, F. Laroussinie, A. Petit, L.Petrucci, and P. Schnoebelen, Springer, 1st Edition , 2001. ISBN-10:3642074782
7. Algebraic Specifications in Software Engineering by I. Van Horebeek & J.Lewi, Springer; 1st Edition (December 19, 1989). ISBN-10: 3540516263

3. Ph.D COMPUTER SCIENCE

The Faculty of Science offers 4-year PhD Programme in Computer Science comprising 18 credit hours of course work and 30 credit hours of research work.

Aims and Objectives

- To promote high achievement in theoretical and practical problems within the field of computer science and to address the burgeoning education demands for graduates and professionals with advanced Computer Science education.
- To offer students a solid background in core areas and exposure to cutting-edge research in computer science.
- To improve the qualifications, skills and expertise of teachers and researchers in order to provide highly competent professionals to various public and private universities.

Eligibility Criteria

1. MS/M.Phil Computer Science/IT/Software Engineering or equivalent with minimum CGPA 3.00/4.00 or 3.50/5.00 in semester system or 60% marks in annual system.
2. The applicant must pass NTU-GAT (Subject) test conducted by National Textile University, as per HEC guidelines and adopted by Advanced Studies and Research Board of NTU, Faisalabad with a minimum of 70% cumulative score.
3. It is mandatory to pass interview in order to compete on merit.
4. Applicant must not be already registered as a student in any other academic program in Pakistan or abroad.

Merit Criteria

Admission merit will be prepared according to the following criteria:

- M.Sc./MS/Equivalent 50 % weightage
- B.Sc./BE/Equivalent 30% weightage
- Interview result 10 % weightage
- Publication/relevant experience 10% weightage

- The selected candidates will be given an acceptance letter by the Graduate Studies & Research Office.
- The students shall pay their dues within the stipulated time, failing which their admission shall be liable to be cancelled.

Programme Structure

The PhD Computer Science Programme is a 4 years degree programme consisting of 18 credit hours of course workand 30 credit hours of research work. The department offers PhD degree with the research emphasis on followingresearch areas:

- Data Science
- Artificial Intelligence
- Information Systems
- Networking and Communication
- Machine Learning and Computer Vision
- Human Computer Interaction

Scheme of Studies

Semester I

Code	Subject Title	Credit Hours
CSC-7018	Research Seminar	3
CSC-XXXX	Advanced Research Methods	3
CSC-XXXX	Elective-I	3
	Total Credit Hours	9

Semester II

Code	Subject Title	Credit Hours
CSC-XXXX	Elective-II	3
CSC-XXXX	Elective-III	3
CSC-XXXX	Elective-IV	3
	Total Credit Hours	9

Semesters III-VIII

	Subject Title	Credit Hours
	Research Thesis	30

(This list is not exhaustive and new courses can be added to this category at any time depending upon availability ofthe instructor)

List ofCourses

Sr. No.	Code	Course Title	Credit Hours
1	CSC-7001	Modeling of Web Information Systems	3
2	CSC-7002	Data Warehousing	3
3	CSC-7003	Peer-To-Peer Systems	3
4	CSC-7004	Multimedia Retrieval Techniques	3

Sr. No.	Code	Course Title	Credit Hours
5	CSC-7005	Metadata for Information Resources	3
6	CSC-7006	Information Privacy and Access Control	3
7	CSC-7007	Ubiquitous Information Interaction	3
8	CSC-7008	Human Information Interaction	3
9	CSC-7009	Information Architecture	3
10	CSC-7010	Collaborative Data Mining	3
11	CSC-7011	Communication Networks	3
12	CSC-7012	Advances in Next Generation Networks	3
13	CSC-7013	P2P-based Information retrieval	3
14	CSC-7014	Advanced Software Architecture	3
15	CSC-7015	Artificial Intelligence	3
16	CSC-7016	Advanced topics in Machine Learning	3
17	CSC-7017	Evolutionary Computation	3
18	CSC-7018	Research Seminar	3

Courses Contents

CSC-7001: Modeling of Web Information Systems

Web modeling concepts; Modeling the Web applications for requirements engineering; Content modelling; Navigation modeling (Hypertext, Access structure); Modeling the presentation for the end user; Model driven development and model driven architecture; Evolution of the Web, Web 1.0 (visual Web), Web 2.0 (Social Web), and Semantic Web (the Web of metadata); Hypertext patterns; Persistence of HT patterns; O&M of Web applications.

CSC-7002: Data Warehousing

Overview of the course and a brief history; Data Warehouse Architecture; Extract Transform Load; Data Cleansing Algorithms; Hot and Cold Data; Data Warehouse support for OLAP and Data Mining; Active Data warehousing; Semantic Data warehousing; Oraclesolution Teradata solution; Case Studies.

CSC-7003: Peer-To-Peer Systems

Overview of P2P Systems and brief history; Taxonomy of P2P Networks/Systems and Analysis of popular P2P Systems; Analysis of unstructured P2P Systems; Analysis of structured P2P Systems; Search Efficiency;P2P-based content delivery; Security and Reliability;Replication in peer-to-peer systems; Anonymity in peer-to-peer systems; Social, Legal and Privacy aspectsof P2P Systems.

CSC-7004: Multimedia Retrieval Techniques

Multimedia content and motivations for multimedia retrieval; Issues of multimedia Retrieval. Multimedia retrieval models; Content-based image retrieval; Content-based video retrieval; Content-based audio retrieval: audio representations, audio feature extraction; Query modalities and similarity measures; Analysis of existing multimedia retrieval systems, retrieval evaluation criteria, relevance feedback; current trends in Multimedia Retrieval.

CSC-7005: Metadata for Information Resources

Overview of the course and Metadata; History of schemes and metadata communities; Functions and Types of metadata; Metadata Structure and Characteristics: Semantics, syntax, and structure; Metadata creation process models; Interoperability; Metadata Integration and Architecture: Warwick Framework; Resource Description Framework; Open Archives Initiative; Encoding Standards (Markup Languages): Introduction and history of markup; Metadata use of markup languages; Document Type Definitions (DTD); Structural metadata Data Control Standards: Resource Identifiers; Data Registries; Controlled vocabularies; Name authority control (ISAAR and FRANAR); A-Core; Encoded Archival Description (EAD), Text Encoding Initiative (TEI); Metadata Evaluation: User needs; Quality control issues; Evaluation methods; Educational Metadata: Instructional Management

Systems (IMS); Learning Object Metadata (LOM); Gateway to Educational Materials (GEM); Government Information Locator Service (GILS); Visual Resources Metadata: Categories for the Description of Works of Art (CDWA); Visual Resources Association (VRA) Core; Computer Interchange of Museum Information (CIMI).

CSC-7006: Information Privacy and Access Control

Privacy, Privacy policies; Privacy enforcement; Adaptive privacy management; Access control mechanisms; Different access control models such as Mandatory, Discretionary, Role-Based and Activity-Based; Accesscontrol matrix model; Harrison-Russo-Ullman modeland undecidability of security; Confidentiality modelssuch as Bell-LaPadula; Integrity models such as Biba and Clark-Wilson; Conflict of interest models such as the Chinese Wall.

CSC-7007:Ubiquitous Information Interaction

Information Interaction; Seminal ideas of ubiquitouscomputing; Tangibility and Embodiment; Social computing; Privacy; Critical and cultural perspectives; Mobility and Spatiality; Mobile Technology in the Messy Now; Infrastructure; Seams, seamlessness,seamfulness; Evaluating Interaction of Ubicomp systems.

CSC-7008: Human Information Interaction

Overview of the course and a brief history; Types and structures of information resources; Types and structures of vocabularies; Information retrieval & Interaction in information retrieval Search engines, Digital libraries; Search techniques and effectiveness; Advanced searching Web search and the invisible web; Information seeking behavior; User modeling ; Mediation between searchintermediaries and users; Evaluation of search sourcesand results; Result Presentation to users; Keeping up: sources for life-time learning.

CSC-7009: Information Architecture

Introduction and Overview of the course. Process of Web development; Information behavior & the web. Content design and organization systems; Copyright issues labeling systems; Writing for the Web. Navigation design; Search systems. Page design; Multimedia. Web usability evaluation & testing. Accessibility for users with disabilities. Global audiences; Web standards & policies. Weblogs, Intranets, Websites for mobile devices; Web design software; Web Content Management Systems. Metadata; Search engines.

CSC-7010: Collaborative Data Mining

Overview of the course and a brief history; Overview of Distributed Database systems; Importance and usage of collaboration; Web Data Resources; A brief introduction to over lay networks; Remote Collaboration; Collaborative Data Mining Guidelines; Parallel Data Mining; Grid-based Data Mining; Collaborative mining over social networks; Collaborative mining in P2P Networks; Collaborative data mining case studies.

CSC-7011: Communication Networks

Overview of the course & research activities in computer networks; Communication Networks & Services; Overview of network simulations; Layered architecture; Congestion Control and Traffic Management; Wireless, Mobility and Cross layer concepts; Switching & Routing;Quality of Service (QoS); Multicast; Peer-to-Peer (P2P) and Overlay Networks; Content Distribution in P2P Networks; Multimedia Information & Networking; Network Measurement.

CSC-7012: Advances in Next Generation Networks

Next Generation Internet/Networks: Convergence to IP; Network Technologies and Architectures; Quality of Service; Multimedia protocols; Policy routing; Future Internet; Network traffic optimization; Next Generation Internet and broadband deployment; Advances in wireless mobile networks; Advances in sensor networks; Management of Next Generation Networks.

CSC-7013: P2P-based Information retrieval

Overview of the Information Retrieval Systems; Multimedia & its characteristics; P2P Systems & its characteristics; Content searching/locating in P2P systems; Emerging coding standards for information; Architecture of P2P-

basedinformationretrieval; Privacy & security issues in P2P-based information retrieval; Current research trends in P2P-based information retrieval.

CSC-7014: Advanced Software Architecture

Re-use in architectures: Software product lines, evaluation and validation of product lines, product line testing, re-use in product lines; Service oriented architectures (SOAs): SOA concepts, risks and challenges, quality attributes and SOAs, evaluating and testing SOAs; Architectural evaluation: Methods for architectural analysis, Comparison of methods; Architectural evolution and reconstruction: Models ofsoftware evolution, analysis and metrics for evolution, Techniques and tools for architecture reconstruction; Architectures in dynamic environments: Modeling and analyzing dynamic software architectures; Self-healing architectures: The need for self-healing, approaches for self-healing.

CSC-7015: Artificial Intelligence

This course considers ideas and techniques from Artificial Intelligence. It first introduces a range of search algorithms that are used throughout AI. It thenexamines applications and techniques of AI, includingrule-based systems for embodying human expertise, algorithms for planning and problem solving, natural language processing, methods for machine learning,and neural nets and other computation intelligence techniques.

CSC-7016: Advanced Topics in Machine Learning

Introduction Overview of machine learning, Machine learning applications and examples, Reinforcement learning, Elements of reinforcement learning, Model based learning, Temporal difference learning, Generalization, Genetic Algorithms, Genetic operators, fitness function, Hypothesis space search, Genetic programming, Support Vector Machines, Optimal separating hyperplane, softmargin hyperplane, kernel functions, SVMs for regression, Combining learners, Voting, Bagging, Boosting, Assessing and Comparing Classification Algorithms, Cross-validation and resampling, Measuring error, Assessing performance, Comparing multiple classification algorithms.

CSC-7017: Evolutionary Computation

Evolutionary Computation can be considered as a sub- field of Artificial Intelligence. Evolutionary algorithms are inspired in the principles of natural selection and genetics. This course explores how principles from theories of evolution and natural selection can be used to construct machines that exhibit nontrivial behavior. In particular, the course covers techniques from genetic algorithms, genetic programming, and learning classifier systems for developing software agents capable of solving problems as individuals and as members of a larger community of agents.

CSC-7018: Research Seminar

This course offers a substantial introduction relevant to doctoral work in student's research area. The course provides directed and supervised investigation of selected topics. Each week Research papers related to the topic will be discussed, and presented in a seminar format. This course progresses as a series of seminars, each presenting a different paper(s). It prepares students to review studies of other researchers in the field, and allows them to become more knowledgeable about methods appropriate to their dissertation research.

DEPARTMENT OF APPLIED SCIENCES

Introduction of Department of Applied Sciences

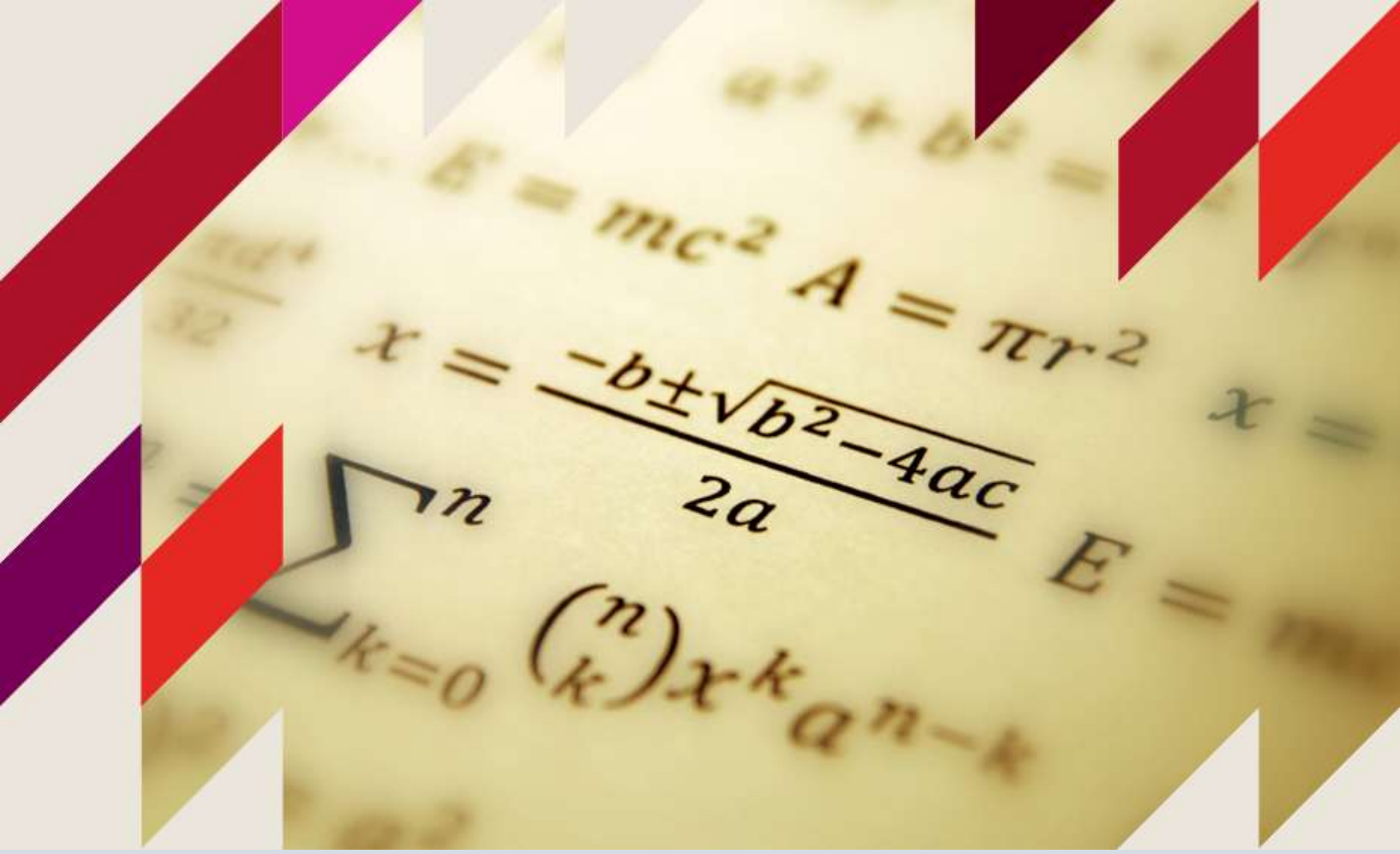
The National Textile University (NTU), Faisalabad is mandated to develop the scientific manpower and technical capability nationwide in order to achieve a speedy economic development of the country. As an academic institution, it offers and supports the programs that could bring about the effective fulfilment of its goals. Department of Applied Sciences being a part of Faculty of Science determines, promotes and facilities multidisciplinary research. Our faculty members are involved in research intra-departmental and inter- departmental. We have also active research collaborations with other institutes of the region and local industries. The faculty members have completed several research projects funded by national agencies including Higher Education Commission and several research projects are under progress. The department has state of the art research and academic laboratories equipped with sophiscated research facilities.

Brief Introduction to MS Mathematics

Department of Applied Sciences is committed to train and produce graduates that have extensive knowledge to the demanding fields that can be helpful for both national and international institutions. The department aims to offer MS Mathematics program with research alongside taught courses. The main objective of this program is to create self-motivated mathematicians who can fulfill the demand of current challenging fields. This program would be based on applied research to prepare students for professional career in research to facilitate academic and commercial sectors. In addition to that the program will provide a unique opportunity to graduates to strengthen their knowledge and work in scientifically multi-disciplines. These researchers could also have ability to help out different industry related problems through knowledge of mathematical modeling and scientific computational techniques. Especially in textile industry, problems would be modelled and solved to achieve reduced costs, flexibility and high quality.

Brief Introduction to Ph.D Chemistry

The National Textile University (NTU), Faisalabad is mandated to develop the scientific manpower and technical capability nationwide in order to achieve a speedy economic development of the country. As an academic institution, it offers and supports the programs that could bring about the effective fulfillment of its goals. As such, it is asked to help produce the critical mass of scientists in the field of Chemistry that will catalyze the development of NTU. Department of Applied Sciences being one of the basic academic divisions of NTU, has always been striving for the realization of this mandate. One manner of achieving this is to offer Ph.D Chemistry Program, in addition to its specific tasks of undertaking basic, applied, and mission oriented researches.



MS MATHEMATICS

The Department of Applied Sciences offers 2-years MS Mathematics comprising 24 credit hours of course work and 6 credit hours of research work.

Aims and Objectives

- To inculcate habits of creative thinking and critical analysis.
- To make the student appreciate the uniqueness of mathematics a tool of having the power of generalization and applications.
- To develop ability in students to formulate a problem using the language of mathematics.
- To equip students with the mathematical techniques and solutions to indigenous problems faced by industries, business and financial organizations with a special focus on textile industry.
- To strengthen academia-professional- society bonding by tailoring the courses and the trainings offered according to needs of the end-user.

Eligibility Criteria

1. M.Sc/BS in Pure Mathematics/Applied Mathematics/Computational Mathematics (minimum 16 year education) or its equivalent with minimum CGPA 2.00/4.00 in semester system or 60% in annual system/term system from an HEC recognized institute/university.

2. The applicant must pass NTU-GAT (General) test conducted by National Textile University, as per HEC guidelines and adopted by Advanced Studies and Research Board of NTU, Faisalabad with a minimum of 50% cumulative score.

3. The applicant must not be already registered as a student in any other academic program in Pakistan or abroad.

Admission Process

Admission merit will be prepared according to the following criteria:

Intermediate	10% weightage
BS Mathematics/B.Sc. + M.Sc.	40/20+20% weightage
NTU-GAT (General) Test	40% weightage
Interview	10% weightage

Program Structure and Course Contents

MS Mathematics is spread over a minimum of 4 semesters and maximum of 8 semesters. Each semester has at least 18 weeks including one week for mid semester examination and one week for final examination. MS Mathematics program has 30 credit hours in total including 24 credit hours of course work and 6 credit hours for research thesis.

The scheme of studies is given as under:

Scheme of Studies

Semester I

Code	Course Title	Credit Hours
MA -5013	Partial Differential Equations	3
MA -5009	Riemannian Geometry	3
MA-5023	Advanced Numerical Analysis	3
MA-50XX	Core Course-I	3
	Total	12

Semester II

Code	Course Title	Credit Hours
MA-5015	General Relativity-I	3
MA-5051	Integral Transform	3
MA-5053	Structural Dynamics	3
MA-50XX	Elective Course-I	3
TEX-5078	Functional Textile	Audit Course
	Total	12

Semester III and IV

Code	Course Title	Credit Hours
MA-5090	Research Thesis	6(3+3)
	Total Credit Hours of the Program	30

Note:

- MS students will have to pass 24 credit hours courses and 6 credit hours thesis.
- Department can offer any course from the list of approved courses based on the availability of resources.
- Summer semester will not be offered.
- Internal assessments include seminars, quizzes and assignments of every student in each subject. At least oneseminar per student per subject is compulsory.
- Number of assessment activities is double to the number of credit hours of each subject.

LIST OF COURSES

Sr. No.	Code	Course Title	Credit Hours
1	MA -5001	Commutative Algebra-I	3
2	MA -5002	Homological Algebra-I	3
3	MA -5003	Commutative Algebra-II	3
4	MA -5004	Homological Algebra-II	3
5	MA -5005	Banach Algebra	3

6	MA -5006	Advanced Complex Analysis-I	3
7	MA -5007	Advanced Complex Analysis-II	3
8	MA -5008	Topological Vector Spaces	3
9	MA -5009	Riemannian Geometry	3
10	MA -5010	Integral Equations	3
11	MA -5011	Inequalities Involving Convex Functions	3
12	MA -5012	Harmonic Analysis	3
13	MA -5010	Integral Equations	3
14	MA -5011	Inequalities Involving Convex Functions	3
15	MA -5012	Harmonic Analysis	3
16	MA -5013	Partial Differential Equations	3
17	MA -5014	Numerical Solutions of Ordinary Differential Equation	3
18	MA -5015	General Relativity-I	3
19	MA -5016	Graph Theory	3
20	MA -5017	Combinatorics	3
21	MA -5018	Research Methodology	3
22	MA -5019	Non-Newtonian Fluid Mechanics	3
23	MA -5020	Advanced Analytical Dynamics	3
24	MA -5021	Numerical Solutions of Partial Differential Equations	3
25	MA -5022	Functional Analysis	3
26	MA -5023	Advanced Numerical Analysis	3
27	MA -5024	Mathematical Techniques	3
28	MA -5025	ODEs and Computational Linear	3
29	MA-5026	Group Theory	6
30	MA -5027	Advanced Mathematical Physics	3
31	MA -5028	Theory of Spline Functions-I	3
32	MA -5029	Theory of Spline Functions-II	3
33	MA -5030	Mathematical Modeling-I	3
34	MA -5031	Mathematical Modeling-II	3
35	MA -5032	Design Theory	3
36	MA -5033	Minimal Surfaces	3
37	MA -5034	General Relativity-II	3
38	MA -5035	Classical Field Theory	3
39	MA -5036	Electrodynamics-I	3
40	MA -5037	Electrodynamics-II	3
41	MA -5038	Magneto Hydrodynamics-I	3
42	MA -5039	Magneto Hydrodynamics-II	3
43	MA -5040	Quantum Field Theory	3
44	MA -5041	Lie Algebra & Lie Groups	3
45	MA -5042	Computer Aided Geometric Designing	3
46	MA-5043	Electrodynamics-I	6
47	MA -5044	Electrodynamics-II	3
48	MA -5045	Acoustics	3
49	MA -5046	Fluid Dynamics	3
50	MA -5047	Fluid Mechanics	3
51	MA -5048	Mathematical Techniques for BVPs	3
52	MA -5049	Advanced Analytical Dynamics	3
53	MA -5050	Variational Inequalities	3
54	MA -5051	Integral Transform	3

55	MA -5052	Inequalities involving Convex Functions	3
56	MA -5053	Structural Dynamics	3
57	MA -5054	Special topics in Advanced Mathematics-I	3
58	MA -5055	Special topics in Advanced Mathematics-II	3
59	TEX -5078	Functional Textile (An audit course for MS Mathematics)	3
60	MA -5090	Research Thesis	3

Course Contents

MA -5001: Commutative Algebra-I

Integral domains, unit, irreducible and prime elementsin ring, Types of ideals, Quotient rings, Rings of fractions, Ring homomorphism, Euclidean domains. Construction of formal power series ring R[[X]] and polynomial ring R[X] in one indeterminate. Polynomialextension of Noetherian domains, Quotient ring of Noetherian rings, Ring of fractions of Noetherian rings.Valuation map and Valuation rings.

MA -5002: Homological Algebra-I

Revision of basic concepts of Ring theory and Module Theory, Modules, Homomorphism and exact sequences. Product and co-product of Modules. Comparison of free Modules and Vector Spaces Projective and injective Modules. Hom and Duality Modules over Principal ideal Domain Notherian and Artinian Module and Rings Radical of Rings and Modules Semi-simple Modules.

MA -5003: Commutative Algebra-II

Guass Theorem, Quotient of a UFD, Nagata Theorem.Divisor classes, Divisor class monoid, divisor class group, Divisorial ideals, divisors, Krull rings, AtomicDomains, Domains Satisfying ACCP, Bounded Factorization Domains, Half Factorial Domains, FiniteFactorization Domains: Group of divisibility G(D) of adomain D, G(D) and FFD.

MA -5004: Homological Algebra-II

Tensor products of modules, Singular H o m o l o g y flate Modules. Categories and factors cogenerator. Finitely related (finitely presented) Modules. Pure ideals of a ring pure submodules and pure exact sequences. Hereditary and Semihereditary rings. Ext. and extensions, Axioms Tor and Torsion, universal co- efficient theorems. Hilbert Syzygy theorem, Serre's theorem, mixed identities.

MA -5005: Banach Algebra

Banach Algebra: Ideals Homomorphisms, Quotient algebra, Wiener's lemma. Gelfand's Theory of Commutative Banach Algebras. The notions of Gelfand's Topology, Radicals, Gelfand's Transforms. Basic properties of spectra. Gelfand-Mazur Theorem, Symbolic calculus: differentiation, Analytic functions. Integration of A-Valued functions. Normed rings. Gelfand Naimark theorem.

MA -5006: Advanced Complex Analysis-I

Analytic continuation, equicontinuity and uniform boundedness, normal and compact families of analytic functions, external problems, harmonic functions and their properties, Green's and von Neumann functions and their applications, harmonic measure conformal mapping and the Riemann mapping theorem, the Kernelfunction,functionsofseveralcomplexvariables.

MA -5007: Advanced Complex Analysis-II

Holomorphicfunctions, Extensionofanalyticfunctions, Levi-convexity: The Levi form, Geometric interpretation of its signature, E.E. Levi's theorem, Connections with Kahlerian geometry, Elementary properties of plurisub harmonic functions. Cohomology, complex manifolds. The d.operators, the Poincare Lemma and the Dolbeaut Lemma, The Cousin problems, introduction to Sheaftheory.

MA -5008: Topological Vector Spaces

Vector spaces, Topological vector spaces, product spaces, quotient spaces, bounded and totally bounded sets, convex sets and compact sets in topological vector spaces, closed hyperplanes and separation of convex sets, complete topological vector spaces, mertizable topological vector spaces, normed vector spaces, normable topological vector spaces and finite dimensional spaces. Locally convex spaces: Convex and compact sets in locally convex spaces, bornological spaces, barreled spaces, spaces of continuous functions, spaces of indefinitely differentiable function, the notion of distributions, nuclear spaces, montal spaces, Schwartz spaces, (DF)-spaces and Silva spaces.

MA-5009: Riemannian geometry

Definition and examples of manifolds. Differential maps. Submanifolds. Tangents. Coordinate vector fields. Tangent spaces. Dual spaces. Multilinear functions. Algebra of tensors. Vector fields. Tensor fields. Integral curves. Flows. Lie derivatives. Brackets. Differential forms. Introduction to integration theory on manifolds. Riemannian and semi Riemannian metrics. Flat spaces. Affine connection. Parallel translations. Covariant differentiation of tensor fields. Curvature and Torsion tensors. Connection of a semi- Riemannian tensor. Killing equation and Killing vector fields. Geodesics. Conformal transformations and the Weyl tensor.

MA -5010: Integral Equations

Existence theorems, intergral equations with Kernels. Applications to partial differential equations. Integral transforms, Wiener-Hopf techniques.

MA-5011: Inequalities Involving ConvexFunctions

Jensen's and related inequalities, Some general inequalities involving convex functions, Hadamard's inequalities, Inequalities of Hadamard type I, Inequalities of Hadamard type II, Some inequalities iInvolving concave functions, Miscellaneous inequalities.

MA -5012: Harmonic Analysis

Topology. Sets and Topologies. Separation axioms and related theorems. The Stone- Weierstrass theorem. Cartesian products and weak topology. Banach spaces. Normed linear spaces. Bounded linear transformations. Linear functionals. The weak topology for X*.Hilbert space. Involution on ß (H). Integration. The Daniell integral. Equivalence and measurability. The real LP-spaces. The conjugate space of LP. Integration on locally compact Hausdorff spaces. The complex LP – spaces. Banach Algebras. Definition and examples. Function algebras. Maximal ideals. Spectrum, adverse Banach algebras, elementary theory. The maximal ideal space of a commutative Banach algebra. Some basic general theorems.

MA -5013: Partial Differential Equations

Cauchy's problems for linear second order equationsin n-independent variables. Cauchy Kowalewski Theorem. Characteristics surfaces. Adjoint operations, Bicharacteristics Spherical and Cylindrical Waves. Heat equation. Wave equation. Laplace equation. Maximum-Minimum Principle, Integral Transforms.

MA -5014: Numerical Solutions of Ordinary Differential Equations

Theory and implementation of numerical methods for initial and boundary value problems in ordinary differential equations One-step, linear multi- step, Runge-Kutta, and Extrapolation methods; convergence, stability, error estimates, and practical implementation, Study and analysis of shooting, finite difference and projection methods for boundary valueproblems for ordinary differential equation.

MA -5015: General Relativity-I

Original formulation of Special Relativity. The null cone. Review of Electromag netism. The principles of General Relativity. The Einstein field equations. The stress - energy momentum tensor. The vacuum Einstein equations. Birkhoff's theorem. The Reissner-Nordstrom solution. The Kerr and the Kerr -Newmann solution. The Newtonian limit of Relativity. The Schwarzschild exterior solution and relativistic equations of motion. The classical tests of Relativity. Linearized gravity and gravitational waves. Foliations. Symmetries of Spacetimes.

MA -5016: Graph Theory

Fundamentals. Definition. Paths cycles and trees. Hamilton cycles and Euler circuits. Planer graphs. Flows, Connectivity and Matching Network flows. Connectivity and Menger'stheorem. External problems paths and Complete Subgraphs. Hamilton path and cycles. Colouring. Vertex colouring Edge Coloring.
Graph on surfaces.

MA -5017: Combinatorics

Elementary concepts of several combinatorial structures. Recurrence relations and generating functions. Principle of inclusion and exclusion. Latin squares and SDRs. Steiner systems. A direct construction. A recursive construction. Packing and covering.Linear algebra over finite fields. Gaussian coefficients. The Pigeonhole Principle. Some special cases. Ramsey's theorem. Bounds for Ramsey numbers and applications. Automorphism groups and permutation groups. Enumeration under group action.

MA -5018: Research Methodology

Scientific statements, hypothesis, model, Theory & Law, Types of research, Problem definition, objectives of the research, research design, data collection, data analysis, Interpretation of results, validation of results, Literature search, Formal research proposal, budgeting and funding, sampling, systematic sampling, Stratified sampling, cluster sampling, Convenience sampling, judgment sampling, quota sampling, snow ball sampling , Identifying variables of interest and their interactions, Operating characteristic curves, power curves, Surveys and field trials, Submission of a paper, role of editor, Peer-review process, importance of citations, impact factor, Plagiarism, protection of your work from misuse, Simulation, need for simulation, types of simulation, Introduction to algorithmic research, algorithmic research problems, types of algorithmic research, problems, types of solution procedure.

MA -5019: Non-Newtonian Fluid Mechanics

Classification of non-Newtonian fluids, Rheological formulae (time-independent fluids, thixotropic fluids and viscoelastic fluids), variable viscosity fluids, cross viscosity fluids, the deformation rate, viscoelastic equation, materials with short memories, time dependent viscosity, the Rivlin-Ericksen fluid, basic equations of motion in rheological models. The linear viscoelastic liquid, Couette flow, Poiseuille flows, the current semi-infinite field. Axial oscillatory tube flow, angular oscillatory motion, periodic transients, basic equations in boundary layer theory, orders of magnitude, truncated solutions for viscoelastic flow, similarity solutions, turbulent boundary layers, stability analysis.

MA-5020: Advanced Analytical Dynamics-I

Equations of dynamic and its various forms, equations of Langrange and Euler, Jacobi's elliptic functions and the qualitative and quantitative solutions of the problem of Euler and Poisson. The problems of Langrange and Poisson. Dynamical systems. Equations of Hamilton and Appell. Hamilton-Jacobi theorem. Separable systems. Holder's variational principle and its consequences.

MA-5021: Numerical Solutions of Partial Differential Equations

Boundary and initial conditions, Polynomial approximations in higher dimensions, Finite Element Method: The Galerkin method in one and more dimensions. Error bound on the Galarki method, the method of collocation, error bounds on the collocation

MA-5025: ODEs and Computational Linear Algebra

Method, comparison of efficiency of the finite difference and finite element method. Finite Difference Method: Finite difference approximations. Applications to solutions of linear and non-linear partial differential equations appearing in physical problems.

MA -5022: Functional Analysis

Separation properties. Hahn-Banach theorem. Banach algebras theorem (Introduction). Linear mappings. Finite dimensional spaces. Metrization. Boundedeness and continuity. Seminorms and local convexity. Baire category theorem. The Banach-Steinhaus theorem. The open mapping theorem. The closed graph theorem. Bilinear mappings. The normed dual of normed spaces. Adjoints.

MA -5023: Advanced Numerical Analysis

Introduction. Euler'smethod. The improved and modified Euler's method.Runge-Kutta method. Milne's method. Hamming's methods. Initial value problem. The special cases when the first derivative is missing. Boundary value problems. The simultaneous algebraic equations method. Iterative methods for linear equations. Gauss-Siedel method. Relaxation methods. Vector and matrix norms. Sequences and series of matrices. Graph Theory. Directed graph of a matrix. Strongly connected and irreducible matrices. Grerschgoin theorem. Symmetric and positive definite matrices. Cyclic-Consistently ordered matrices. Choice of optimum value for relaxation parameter. Introduction. Euler's method. The improved and modified Euler's method. Runge-Kutta method. Milnes method. Hammign's methods. Initial value problem. The special cases when the first derivative is missing. Boundary value problems. The simultaneous algebraic equations method. Iterative methods for linear equations. Gauss-Siedel method. Relaxation methods. Vector and matrix norms. Sequences and series of matrices. Graph Theory. Directed graph of a matrix. Strongly connected and irreducible matrices. Grerschgoin theorem. Symmetric and positive definite matrices. Cyclic-Consistently ordered matrices. Choice of optimum value for relaxation parameter.

MA-5024: Mathematical Techniques

Green's function method with applications to wave- propagation. Solution of algebraic equations by perturbation methods. Evaluation of integrals by expansion of integrands. Laplace methods. The method of stationary phase. The methods of steepest descent. Solution of the linear damped oscillator equation by perturbation methods. The WKB approximation. Variational problems with variable end points. Corner conditions. Sufficient conditions for minimum. The Ritz method and its applications. A survey of transform techniques. Wiener-Hopf technique with applications to diffraction problems.

MA-5026: Group Theory

Elementary concepts. Symmetric and alternating groups of finite degree. Order of a permutation. Orbits of the symmetric and alternating groups. Stabilizer subgroups and transitive groups. Free products of group. Group amalgams and their embeddability in groups. Generalized free product of groups. Permutational product of groups. Cartesian product of groups. Wreath product of groups. Multiplicative group of a finite field. Projective line over finite fields. Projective and linear groups through action.

MA-5027: Advanced Mathematical Physics

Nonlinear ordinary differential equations, Bernoulli's equation, Riccati equation, Lane- Emden equation, Nonlinear Pendulum, Duffing's equation, Pinney's equation, Perturbation theory, Bogoliubov-Krilov method. Linear partial differential equations, classification, initial and boundary values problems, Fourier analysis, Heat equation, Wave equation, Laplace equation etc. Integral equations, classification, integral transform separable kernels, singular integral equations, Wiencr-Hopf equations, Fredholm theory, series solutions. Variational methods, The Euler- Lagrange equations, Solutions to some famous problems, Sturm-Liouville Problem and variational principles, Rayleigh-Ritz Methods for partial differential equations. Matrix algebra, method of Faddeev, Caley- Hamilton' theorem function of matrices. Functions of matrices, Kronecker and Tensor product, special matrices.

MA-5028: Theory of Spline Functions-I

Parametric Curves: Affine Maps: Translation, Rotation, Reflection, Stretching, Scaling and shear. Barycentric combination. Convex combination. Convex Hull. Forms of parametric curves: Algebraic form, Hermite form, Control point form, Bernstein Bezier form and their matrix forms. Algorithm to compute Bernstein Bezier form. Properties of Bernstein Bezier form: Convex Hull property. Affine invariance property, Variation diminishing

property. Rational quadratic form. Rational cubic form. Tensor product surface. Spline Functions: Natural splines. Cardinal splines. Periodic splines on uniform mesh. Representationof spline and its different forms. Natural spline and periodic spline in terms of polynomials and power truncated functions. Odd degree spline. Existence theorem. Existence and uniqueness of natural and periodic spline. Remainder theorems.

MA-5029: Theory of Spline Functions-II

Interpolatory cubic splines. The representation of s in terms of the values Mi=s(2)(xi), i=0,1,2,…,k. The representation of s in terms of the values mi=s(1)(xi), i=0,1,2,…,k. Quadratic Hermite spline. Theorems regarding error analysis. Theorems regarding to Convergence of the D1, D2, natural and periodic splines. End conditions for cubic Hermite spline interpolation. E(α)-cubic splines.

MA-5030: Mathematical Modeling-I

Introduction to Modelling. Collection and interpretation of data. Setting up and developing models. Checking models. Consistency of models. Dimensional analysis. Discrete models. Multivariable models. Matrix models. Continuous models. Modelling rates of changes. Limiting models. Graphs of functions as models. Periodic models. Modelling with difference equations. Linear, Quadratic and Non-Linear Models.

MA-5031: Mathematical Modeling-II

Modeling with Differential Equations: Exponential growth and decay. Linear, non-linear systems of differential equations. Modeling with integration. Modeling with random numbers: Simulating qualitative random variables. Simulating discrete random variables. Standard models. Monte Carlo simulation. Fitting models to data. Bilinear interpolation and Coons patch.

MA-5032: Design Theory

Basic definitions and properties, related structure. The incidence matrix, graphs, residual structures. The Bruck-Ryser-Chowla theorem. Singer groups and difference sets. Arithmetical relations and Hadamard 2- designs. Projective and affine planes. Latin squares, nets. Hadamard matrices and Hadamard 20 design. Biplanes, strongly regular graphs. Cameron's theorem and Hadamard 3- desings. Steiner triple systems. The Mathieu groups.

MA-5033: Minimal Surfaces

Regular surfaces: Differentiable functions on surfaces. The tangent plane. Geometric definition of area. Gaussian and mean curvature. Curvature in local coordinates. Ruled and minimal surfaces: Historical survey and introduction to the theory of minimal surfaces. Basic minmal surface properties. Topological and physical properties. Stable and unstable minimal surfaces. Two dimensional minimal surfaces in three dimentional space. Helecoid, catenoid and conoid. Harmonic approximation to area. Nambu- Goto action.

MA-5034: General Relativity-II

Black holes. Coordinate and essential singularities. Horizons. Coordinates passing through horizons. The Kruskal and the Carter-Penrose (CP) diagrams for the Schwarzschild geometry. The maximal extension. The Einstein-Rosen bridge. Wormholes. The CP diagram for the RN metric. The no-hair and cosmic censorship hypotheses. Gravitational forces about black holes. Black hole thermodynamics. Observational status and central black holes. Kaluza-Klein theory. Problems of quantum gravity. Quantization in curved space backgrounds and Hawking radiation. Isometries. Homotheties and their significance in Relativity.

MA-5035: Classical Field Theory

Review of continuum mechanics. Solid and fluid media. Constitutive equations and conservation equations. The concept of a field. The four- dimensional formulation of fields and the stress- energy momentum tensor. The scalar field. Linear scalar fields and the Klein-Gordon equation. Non- linear scalar fields and fluids. The vector fields. Linear massless scalar fields and the Maxwell field equations. The electromagnetic energy momentum tensor. Electromagnetic waves. Diffraction of waves. Advanced and retarded potentials. Multipole expansion of

the radiation field. The massive vector (Proca) field. The tensor fields. The massless tensor field and the Einstein field equations. Gravitational waves. The massive tensor fields. Coupled field equations.

MA-5036: Electrodynamics-I

Maxwell's equations. Electromagnetic wave equation. Boundary conditions. Waves in conducting and non-conducting media. Reflection and polarization. Energy density and energy flux. Lorentz formula. Wave guides and cavity. Resonators. Spherical and cylindrical waves. Inhomogeneous wave equation. Retarded potentials. Lenard Wiechart potentials. Field of uniformly moving point charge. Radiation from a group of moving charges. Field of oscillating dipole. Field of an accelerated point charge.

MA-5037: Electrodynamics-II

General angular and frequency distributions of radiation from accelerated charges. Thomson scattering. Cherenkov radiation. Fields and radiation localized oscillating sources. Electric dipole fields and radiation. Magnetic dipole and electric quadruple fields. Multipole fields. Multipole expansion of the electromagnetic fields. Angular distribution sources of muiltipole radiation. Spherical wave expansion of a vector plane wave. Scattering of electromagnetic wave by a conducting sphere.

MA-5038: Magnetohydrodynamics-I

Equations of electrodynamics. Equations of Fluid Dynamics. Ohm's law. Equations of magneto hydrodynamics. Motion of a viscous electrically conducting fluid with linear current flow. Steady state motion along a magnetic field. Wave motion of an ideal fluid. Magneto-sonic waves. Alfven's waves. Damping and excitation of MHD waves. Characteristics lines and surfaces. Kinds of simple waves. Distortion of the profile of a simple wave. Discontinuities. Simple and shock waves in relativistic magnetohydrodynamics. Stability and structure of shock waves. Discontinuities in various quantities. Piston problem. Oblique shock waves.

MA-5039: Magnetohydrodynamics-II

Flow of an ideal fluid past magnetized bodies. Fluid of finite electrical conductivity flow past a magnetized body. Theory. Bllard's Theory. Earth's field. Turbulent motion and dissipation. Vorticity anology. Effects of molecular structure. Currents in a fully ionized gas. Partially ionized gases. Interstellar fields. Dissipation in hot and cool clouds.

MA-5040: Quantum Field Theory

Classical field theory, Lagrangian mechanics, variational principle, vibrating stings, classical field theory, Lorentz transformations, Lorentz group, classical scalar fields, Klein-Gordon equation, complex scalar fields, energy-momentum tensor, electromagnetic field, Maxwell's equations, spinor field, Dirac equation, symmetries and conservation laws, Noether's theorem, translation invariance. Quantization of fields, canonical quantization of fields, quantization of scalar fields, particle interpretation of quantum field theory. Interacting Quantum Fields, perturbation theory, time ordering, decay rate of an unstable particle, higher order perturbation theory, Wick's theorem second order perturbation theory, renormalization.

MA-5041: Lie Algebra & Lie Groups

Definitions and examples of Lie algebras, ideals and quotients Simple, solvable and nilpotent Lie algebras radical of a Lie algebra, Semisimple Lie algebras; Engel's nilpotency criterion; Lie's and Cartan theorems Jordan-Chevalley decomposition Killing forms Criterion for semisimplicity, product of Lie algebras; Classification of Lie algebras upto dimension 4; Applications of Lie algebras.

MA-5042: Computer Aided Geometric Designing

Linear interpolation, piecewise linear interpolation blossoms, barycentric coordinates in the plane, the de Casteljau algorithm, properties of Bezier curves, Bernstein polynomials, composite Bezier curves, degree elevation, the variation diminishing property, degree reduction, Polynomial curve constructions: Aitken's Algorithm, Lagrange Polynomials, Lagrange interpolation, cubic Hermite interpolation, Point-normal interpolation, B-Spline curves: B-spline segments, curves, Knot insertion, degree elevation, Greville Abscissae,

smoothness. Constructing Splines Curves: Greville interpolation, modifying B-Spline curves, cubic spline interpolation, the minimum property, piecewise cubic interpolation. Rational Bezier and B-Spline Curves: Rational Bezier curves, Rational Cubic B- spline curves.

MA-5043: Elastodynamics-I

Cartesian tensors, Orthogonal rotation of axes, Transformation equations. Translation and rotation, Different orders of tensors. Algebra of tensors, Inner and outer multiplication of tensors, Symmetric and anti-symmetric tensors. Different types of tensors, Tensor Calculus. Differentiation and integration of tensors, application to vector analysis, Integral theorems in tensor form. Deviators, types of solid Material, Stress vector and stress tensor, Analysis of strain, displacement vector, Lagrangian strain tensor, Physical interpretation of strain components. Basic equation of theory of Elasticity. Generalized Hooke's law. Types of bodies. Physical interpretation of Lame's constants. Navier's equation.

MA-5044: Elastodynamics-II

Derivation of equation of motion, Helmotz theorem, components of displacement in terms of potentials. Strain components, stress components, Waves and vibrations in strings. Waves in long string, Reflection and transmission at boundaries. Free vibration of a finite string. Forced vibration of a string. The string on an elastic base dispersion. Pulses ina dispersive media. The string on a viscous sub grade.

MA-5045: Acoustics

Fundamentals of vibrations. Energy of vibration. Damped and free oscillations. Transient response of an oscillator vibrations of strings, membrances and plates, forced vibrations. Normal modes, Acoustic waves equation and its solution, equation of state, equatin of cout, Euler;s equations, linearized wave equation, speed of sound in fluid, energy density, acoustic intensity, specific acoustic impedance, spherical waves, transmission, transmission from one fluid to another (Normal incidence) reflection at a surface of solid (normal and oblique incidence). Absorption and attenuation of sound waves in fluids, pipes cavities waves guides; underwater acoustics.

MA-5046: Fluid Dynamics

Euler's equation of motion. Viscosity. Navier- Stoke's equations and exact solutions. Dynamical similarity and Reynold's number. Turbulent flow. Boundary layer concept and governing equations. Reynold's equations of turbulent motion. Magneto hydrodynamics. MHD equations. Fluid drifts. Stability and equilibrium problems.

MA-5047: Fluid Mechanics

Navier-Stoke's equation and exact solutions, dynamical similarity and Reynold's number, Turbulent flow, Boundary layer concept and governing equations, laminar flat plate boundary layer: exact solution, momentum, integral equation, use of momentum integral equation for flow with zero pressure gradient, pressure gradient in boundary-layer flow, Reynold's equations of turbulent motion. Magnetohydrodynamics, MHD equations, fluid drifts, stability and equilibrium problems.

MA-5048: Mathematical Techniques for BVPs

Green's function method with applications to wave- propagation. Regular and singular perturbation techniques with applications variational methods. A survey of transform techniques: Wiener-Hopf technique with applications to diffraction problems.

MA-5049: Advanced Analytical Dynamics

Equations of dynamic and its various forms, equations of Langrange and Euler, Jacobi's elliptic functions and the qualitative and quantitative solutions of the problem of Euler and Poisson. The problems of Langrange and Poisson. Dynamical system. Equations of Hamilton and Appell. Hamilton-Jacobi theorem. Separable systems. Holder's variational principle and its consequences.

MA-5050: Variational Inequalities

Variational problems, existence results for the general implicit variational problems, implicit Ky Fan's inequality for monotone functions, Jartman stampacchia theorem for monotone for compact operators, Selection of fixed points by monotone functions, Variational and quasivariational inequalities for monotone operators.

MA-5051: Integral Transform

Laplace transform, Application to integral equations, Fourier transforms, Fourier sine and cosine transform, Inverse transform, Application to differentiation, Convolutions theorem, Application to partial differential equations, Hankel transform and its applications, Application to integration, Mellin transform and its applications.

MA-5052: Inequalities involving Convex Functions

Jensen's and related inequalities, general inequalities involving convex functions, Hadamard's inequalities, Inequalities of Hadamard type I, Inequalities of Hadamard type II, Some inequalities involving concave functions, Miscellaneous inequalities.

MA-5053: Structural Dynamics

Formulation of Equation of Motion, Free Vibration of Undamped SDOF Systems, Free Vibration of Damped SDOF Systems, SDOF System Characterization, Undamped Harmonic Response, Damped Harmonic Response, Identification of Structural Damping, Harmonic Base Motion and Accelerometers, Period Loads and the Fourier Series, Impulsive Loads and Shock Spectra, Numerical Integration Methods, Earthquakes and Response Spectra, Seismic Design Spectra, Multiple Degree-of-Freedom Systems (MDOF), Modeling Distributed Parameter Systems, Static Condensation and Consistent Mass Matrices, Generalized Eigenvalue Problems, Rayleigh Quotient and Orthonormality of Modes, Modal Superposition, Damping in MDOF Systems, Modal Participation and Contributions, Seismic Response of MDOF Systems.

MA-5054:Special Topics in Advance Mathematics-I

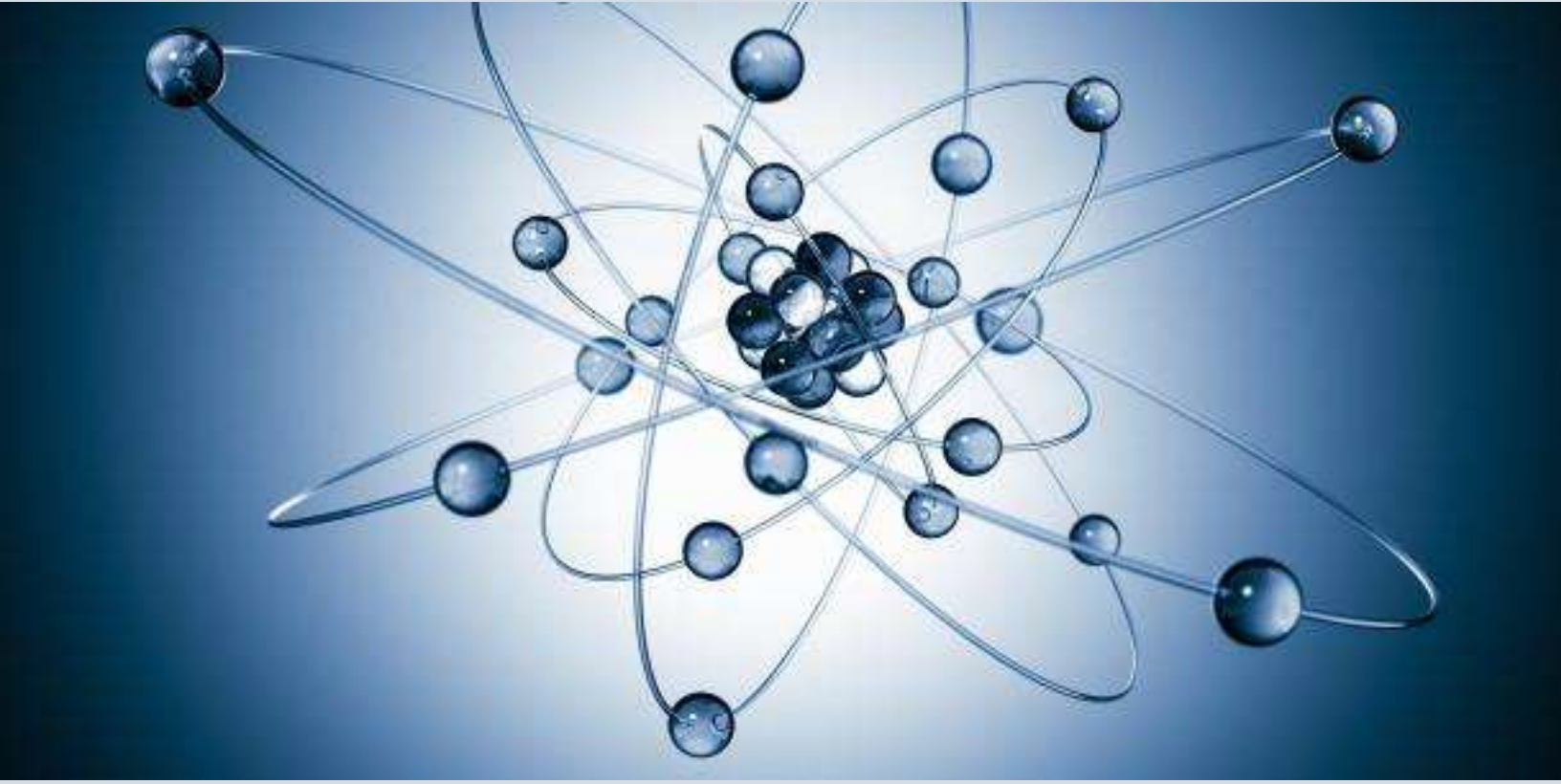
The course contents should be specified from time to time by the resource person with consultation of the Chairman, Department of Applied Sciences.

MA-5055: Special topics in Advanced Mathematics-II

The course contents should be specified from time to time by the resource person with consultation of the Chairman, Department of Applied Sciences.

TEX -5078: Functional Textile

Basics of textiles and raw materials, Preparatory processes of Spinning, Types of yarns and spinning, Mathematical Modeling regarding fiber and yarn properties, Woven Fabric Production, Knitted Fabric Production, Mathematical Modeling regarding fiber, yarn and woven fabric properties, Mathematical Modeling regarding fiber, yarn and knitted fabric properties, Nonwoven fabric formation and operations, Introduction to textile processing, Pretreatment and dyeing of textiles, Printing and finishing of textiles, Application of mathematical modelling in textile processing, Clothing Product design and development, Clothing preparatory processes, Clothing manufacturing processes, Applications of mathematical modeling in clothing.



MS PHYSICS

Program Objectives

The MS Physics Program aims to provide advanced training in science and technology of various branches of Physics with an aim to train students with latest technologies, and to conduct an independent investigation of a research problem and establish new industry-academia linkages.

Eligibility Criteria

1. BS/M.Sc. in Physics (minimum 16 years of education) degree or its equivalent with a minimum CGPA of 2.00/4.00 in semester system or 60% in annual system / Term system from an HEC recognized institute/university.
2. The applicant must pass NTU-GAT (General) test conducted by National Textile University, as per HEC guidelines and adopted by Advanced Studies and Research Board of NTU, Faisalabad with a minimum of 50% cumulative score.
3. The applicant must not be already registered as a student in any other academic program in Pakistan or abroad.

Merit Criteria

Admission merit will be prepared according to the following criteria:

• Intermediate	10% weightage
• BS Physics /B.Sc. + M.Sc.	40 / 20%+20% weightage
• NTU-GAT (General) Test	40% weightage
• Interview	10% weightage

Total Credit Hours

For award of MS Physics, candidates must need to complete total credit hours of 30 out of which 24 credit hours of course work and 6 credit hours for research work/thesis.

Study Duration

The minimum duration of study will be 4 semesters and maximum of 8 semesters. Each Semester has at least 18 weeks including 1 week for mid semester and 1 week for final examination.

MS Thesis Evaluation

The MS thesis will be evaluated by one external Ph.D. examiner of the relevant field taken from external university \ institute in addition to departmental evaluation committee.

Plagiarism Test

The Plagiarism Test must be conducted on the Dissertation before its submission to the external expert as per HEC criteria.

Scope of the Degree

The MS Physicist would be able to get a good job in the diverse fields, some of them include:

1. Teaching and research at university/post graduate college level in the departments of Physics.
2. Research and Development in public and private sector organizations.
3. Product development in public and private sector organizations.
4. Higher studies and research in Physics and the relevant fields.

Semester Wise Layout of Courses

Semester-I

Sr.No	Code	Course Title	Credit Hours
1	PH-5001	Methods of Mathematical Physics	3(3-0)
2	PH-5002	Quantum Mechanics	3(3-0)
3	PH-5003	Electrodynamics	3(3-0)
4	PH-5004	Classical Mechanics	3(3-0)
		Total	12

Semester-II

Sr.No	Code	Course Title	Credit Hours
1	PH-7005	Statistical Physics	3(3-0)
2	-	Elective-I	3(3-0)
3	-	Elective -II	3(3-0)
4	-	Elective - III	3(3-0)
		Total	12

Semester III & IV

Sr.No	Code	Course Title	Credit Hours
1	PH-5090	MS Thesis	6
		Total Credit Hours of the Program	30

Note:

- MS students will have to pass the 24 credit hours courses and 6 credit hours thesis.
- Department can offer any course from the list of approved courses on the availability of resources.
- Summer semester will not be offered.
- Internal assessments include a seminar, quizzes and assignments of every student in each subject.
- Number of activities (quizzes, assignment, presentations etc.) will be double to the number of credit hours of each subject.

LIST OF OFFERED COURSES (24 credit to be taken in 2 semesters)

*PH-5001, PH-5002, PH-5003, PH.5004, PH-5005 are compulsory courses.

Sr.No	Code	Course Title	Credit Hours
1	PH-5001	Methods of Mathematical Physics	3(3-0)
2	PH-5002	Quantum Mechanics	3(3-0)
3	PH-5003	Electrodynamics	3(3-0)
4	PH-5004	Classical Mechanics	3(3-0)
5	PH-5005	Statistical Physics	3(3-0)
6	PH-5006	Methods and Techniques of Experimental Physics	3(3-0)
7	PH-5007	Magnetism And Magnetic Material	3(3-0)
8	PH-5008	Material Science	3(3-0)
9	PH-5009	Thin Film Deposition Techniques	3(3-0)
10	PH-5010	Fundamentals Of Nano-Science	3(3-0)
11	PH-5011	Semiconductor Physics	3(3-0)
12	PH-5012	Physics Of Solar Cell	3(3-0)
13	PH-5013	Atomic Physics	3(3-0)
14	PH-5014	Atomic Spectroscopy	3(3-0)
15	PH-5015	Reservoir Physics	3(3-0)
16	PH-5016	X-Ray Crystallography	3(3,0)
17	PH-5017	Solid State Electronic Devices	3(3,0)
18	PH-5018	Growth And Characterization Of Solids	3(3,0)
19	PH-5019	Plasma Physics	3(3,0)
20	PH-5020	Special Topics In Advanced Physics-I	3(3,0)
21	PH-5021	Special Topics In Advanced Physics-Ii	3(3,0)
22	PH-5090	Research Thesis	6(0-18)
		Total Credit hours	30

Course Specifications

PH-5001: Methods of Mathematical Physics

Fourier series: Introduction and general properties, convergence of trigonometric series, Integral transform development of the Fourier integral, Fourier transform, inversion theorems, Fourier transform of derivatives, Laplace transform, Laplace transform of derivatives, inverse Laplace transform. Differential equations: Separation of variables in three dimensions, Boundary value problems, Green's functions, Integral transforms, generating functions and integral equations. Calculus of variations: dependent and independent variables, Euler-Lagrange equation and applications, several independent and dependent variables, Diffusion equation, Heat Equations, Wave equations, some nonlinear equations, Klein-Gordon equation, sine-Gordon equation Burgers equation, Backlund transformation, Tensor and vector fields, Differential geometric methods.

Recommended Books:

- Arfken & Weber, (2012), Mathematical Methods for Physicists: A comprehensive guide, Academic Press, 7th edition.
- K. F. Riley and M. P. Hobson,(2006), Mathematical Methods for Physics and Engineering: A Comprehensive Guide, Cambridge university Press, 3rd edition
- Chris McMullen,(2012) An Advanced Introduction to Calculus-Based Physics (Mechanics), create space, 1st edition
- Sadri Hassani, (2013), Mathematical Physics: A Modern Introduction to Its Foundations, Springer, 2nd edition
- Tai L. Chow, (2002), Mathematical Methods for Physicists, Cambridge University Press, 1st edition.
- G. B. Arfken and H. J. Weber, (1995), Mathematical Methods for Physicists, Academic Press, New York.

- G. Stephenson and P. M. Radmore, (1990), Advanced Mathematical Methods for Engineering and Science Students, Cambridge University Press.

PH-5002: Quantum Mechanics

Waves and particles: Introduction to fundamental idea of Quantum mechanics. Electromagnetic waves and photons; Light quanta and the plank-Einstein relations, wave particle duality, Analysis of young double slit experiment, Quantum unification of two aspect of light, The Principle of spectral decomposition, Material particle and matter waves; The de Broglie relations, Wave functions: the Schrodinger equation, Quantum description of a particle Wave packets; Free particle, Form of the wave packet at given time, Heisenberg uncertainty relation, Time evolution of free wave packet, Particle in a time independent Scalar potential; Separation of variables. Stationary states, one dimensional square potential. Order of magnitude of the wave length associated with the material particle, Constraints imposed by the uncertainty relation, the uncertainty relation and the atomic parameters, An experiment illustrating the uncertainty relation, A simple treatment of a two dimensional wave packet, the relation between one and three dimensional problem, One dimensional Gaussian wave packet: spreading of wave packet, Stationary state of a particle in one dimensional square well, behaviour of wave packet at a potential step. The mathematical tool of quantum mechanics: The postulates of quantum mechanics: Spin1/2 particle: The one-dimensional harmonic oscillator: General properties of angular momentum in Quantum mechanics: Particle in a central potential: the hydrogen atom:

Recommended Books:

- Quantum Mechnics (Vol. 1) by Claude Cohen-Tannoudji, Bernard Diu,Frank Laloe, Wiley-VCH, 1992.
- Modern Quantum Mechanics (2nd Edition) by J. J. Sakurai, Jim J.Napolitano, Addison-Wesley, 2010.
- Principles of Quantum Mechanics (2nd Edition) by R. Shankar, Plenum Press, 1994.
- Quantum Mechanics by Dirac, P. A. M (Oxford University Press

PH-5003: Electrodynamics

Introduction to Electrostatics:

Coulomb's Law , Electric Field , Gauss's Law , Differential Form of Gauss's Law , Another Equation of Electrostatics and the Scalar Potential ,Surface Distributions of Charges and Dipoles and Discontinuities in the Electric Field and Potential , Poisson and Laplace Equations, Green's Theorem, Uniqueness of the Solution with Dirichlet or Neumann Boundary Conditions Formal Solution of Electrostatic Boundary-Value Problem with Green Function, Electrostatic Potential Energy and Energy Density; Capacitance, Variational Approach to the Solution of the Laplace and Poisson Equations, Relaxation Method for Two-Dimensional Electrostatic Problems

Boundary- Value Problems in Electrostatics-I:

Method of Images, Point Charge in the Presence of a Grounded Conducting Sphere, Point Charge in the Presence of a Charged, Insulated, Conducting Sphere, Point Charge Near Conducting Sphere at Fixed Potential, Conducting Sphere in a Uniform Electric Field by Method of Images, Green Function for the Sphere; General Solution for the Potential, Conducting Sphere with Hemispheres at Different Potentials, Orthogonal Functions and Expansions, Separation of Variables; Laplace Equation in Rectangular Coordinates, A Two-Dimensional Potential Problem; Summation of Fourier Series, Fields and Charge Densities in Two-Dimensional Corners and Along Edges, Introduction to Finite Element Analysis for Electrostatics.

Boundary- Value Problems in Electrostatics-II:

Laplace Equation in Spherical Coordinates, Legendre Equation and Legendre Polynomials, Boundary-Value Problems with Azimuthal Symmetry, Behaviour of Fields in a Conical Hole or Near a Sharp Point, Associated Legendre Functions and the Spherical Harmonics, Addition Theorem for Spherical Harmonics, Laplace Equation in Cylindrical Coordinates; Bessel Functions, Boundary-Value Problems in Cylindrical Coordinates, Expansion of Green Functions in Spherical Coordinates, Solution of Potential Problems with the Spherical Green Function. Expansion, Expansion of Green Functions in Cylindrical Coordinates, Eigenfunction Expansions for Green Functions, Mixed Boundary Conditions, Conducting Plane with a Circular Hole, Multi-poles, Electrostatics of Macroscopic Media, Dielectrics: Multi-pole Expansion, Multi-pole Expansion of the Energy of a Charge Distribution in an External Field, Elementary Treatment of Electrostatics with Ponderable Media, Boundary-

Value Problems with Dielectrics, Molecular Polarizability and Electric Susceptibility, Models for Electric Polarizability, Electrostatic Energy in Dielectric Media. Magnetostatics, Faraday's Law, Quasi-Static Fields: Introduction and Definitions, Biot and Savart Law, Differential Equations of Magnetostatics and Ampere's Lawn Vector Potential, Vector Potential and Magnetic Induction for a Circular Current Loop, Magnetic Fields of Localized Current Distribution, Magnetic Moment, Force and Torque on and Energy of a Localized Current Distribution in an External Magnetic Induction , Macroscopic Equations, Boundary Conditions on B and H, Methods of Solving Boundary-Value Problems in Magnetostatics, Uniformly Magnetized Sphere, Magnetized Sphere in an External Field; Permanent Magnets, Magnetic Shielding, Spherical Shell of Permeable Material in a Uniform Field, Effect of a Circular Hole in a Perfectly Conducting Plane with an Asymptotically Uniform Tangential Magnetic Field on One Side, Numerical Methods for Two-Dimensional Magnetic Fields, Faraday's Law of Induction , Energy in the Magnetic Field, Energy and Self- and Mutual Inductances, Quasi-Static Magnetic Fields in Conductors; Eddy Currents; Magnetic Diffusion, Maxwell Equations, Macroscopic Electromagnetism, Conservation Laws: Maxwell's Displacement Current; Maxwell Equations, Vector and Scalar Potentials, Gauge Transformations, Lorenz Gauge, Coulomb Gauge, Green Functions for the Wave Equation , Retarded Solutions for the Fields: Jefimenko's Generalizations of the Coulomb and Biot- Savart Laws; Heaviside-Feynman Expressions for Fields of Point Charge, Derivation of the Equations of Macroscopic Electromagnetism, Poynting's Theorem and Conservation of Energy and Momentum for a System of Charged Particles and Electromagnetic Fields, Poynting's Theorem in Linear Dissipative Media with Losses, Poynting's Theorem for Harmonic Fields; Field Definitions of Impedance and Admittance, Transformation Properties of Electromagnetic Fields and Sources Under Rotations, Spatial Reflections, and Time Reversal, On the Question of Magnetic Monopoles, Discussion of the Dirac Quantization Condition , Polarization Potentials (Hertz Vectors).

Recommended Books:

- Classical Electrodynamics by J. D. Jackson (3rd Edition), Wiley 1998.
- J.D. Jackson. John, (2000), Classical Electrodynamics, Wiley, 3rd edition.
- J.B. Marion and M.A. Heald, (1994), Classical Electromagnetic Radiation, Thomson Brooks**.**

PH-5004: Classical Mechanics

Survey of the elementary principles, Variational principles and Lagranges's equations, Oscillations, The classical mechanics of the special theory of relativity, Hamiltonian equations of motion, canonical transformations, Hamilton-Jacobi theory and Action angle variable, Classical Chaos, Canonical perturbation theory, Introduction to the Lagrangian and Hamiltonian formulations for continuous systems and fields, Classical mechanics of liquids and deformable solids; stress, deformation and strain flow.

Recommended Books:

- Classical Mechanics (3rd Edition) by Herbert Goldstein, Charles P. Poole
- Jr., and John L. Safko, Pearson International Edition, 2001.

PH-5005: Statistical Physics

Intensive and extensive quantities, thermodynamic variables, thermodynamic limit, thermodynamic transformations. Classical ideal gas, first law of thermodynamics, application to magnetic systems, heat and entropy, Carnot cycle. Second law of thermodynamics, absolute temperature, temperature as integrating factor, entropy of ideal gas. Conditions for equilibrium, Helmholtz free energy, Gibbs potential, Maxwell relations, chemical potential. First-order phase transition, condition for phase coexistence. The statistical approach: phase space, distribution function, microcanonical ensemble, the most probable distribution, Lagrange multipliers. Maxwell-Boltzmann distribution: pressure of an ideal gas, equipartition of energy, entropy, relation to thermodynamics, fluctuations, Boltzmann factor. Transport phenomena: collisionless and hydrodynamic regimes, Maxwell's demon, non-viscous hydrodynamics, sound waves, diffusion, conduction, viscosity. Quantum statistics: thermal wavelength, identical particles, Fermi and Bose statistics, pressure, entropy, free energy, equation of state, Fermi gas at low temperatures, application to electrons in solids and white dwarfs. The Bose gas: photons, phonons, Debye specific heat, Bose-Einstein condensation, equation of state, liquid helium. Canonical and grand canonical ensembles, partition function, connection with thermodynamics, fluctuations.

minimization of free energy, photon fluctuations, pair creation. The order parameter, Broken symmetry, Ising spin model, Ginsburg Landau theory, mean-field theory, critical exponents, fluctuation-dissipation theorem, correlation length, universality.

Recommended Books:

- Introduction to Statistical Physics, Kerson Huang, (Taylor and Francis, 2001).
- Statistical Mechanics, Raj Kumar Pathria, 2nd edition (India, 1996).

PH-5006: Methods and Techniques of Experimental Physics

Basics of X-ray diffraction, X-ray spectra, Bragg's law and importance, construction and operation of diffractometer, data analysis, Qualitative (Hannawalt method), Quantitative (matrix flushing methods). Characterization techniques, Basics of spectroscopy and importance, Lambert-Beer's law, Construction and Operation of spectrophotometer, Radiation detection (Detectors), Data analysis. Construction and Operation of Scanning Electron Microscope, Construction and Operation of Atomic Force Microscope, Construction and Operation of Transmission Electron Microscope and sample preparation techniques. Vacuum techniques, Production of vacuum (Vacuum pumps), Measurements of vacuum (Gauges), Leak detection.

Recommended Books:

- Hem Raj Verma, (2007), Atomic and Nuclear Analytical Methods: XRF, Mössbauer, XPS, NAA and Ion-Beam Spectroscopic Techniques, Springer
- Horst Czichos and Tetsuya Saito, (2006), Handbook of Materials Measurement Methods, Springer
- Adolfo Avella and Ferdinando Mancini,(2016), Strongly Correlated Systems: Experimental Techniques (Springer Series in Solid-State Sciences)
- Marc De Graef and Thomas Lucatorto, (2001), Advances in Surface Science, Volume 38 (Experimental Methods in the Physical Sciences), Academic Press
- Richard Wrolfson and Jay M. Pasachoff, (1999), Physics for Scientists and Engineers, Published by Addison Wesley / Longman Inc.
- B.D. Cullity, (1978), Elements of X-ray Diffraction, Published by Addison-Wesley Publ. Co. Inch. USA.
- R.L. Horovitz and V. A. Johnson, (Latest Edition), Methods of Experimental Techniques, Acadmic press.
- D. William, (Latest Edition), Methods of Experimental Techniques, Academic press.
- J. Goldstein, (2003), Scanning Electron Microscopy and X-Ray Microanalysis, 3rd edition, Springer London.
- David Bernard Williams and C. Berry Carter, (2009), Transmission Electron Microscope, 2nd edition, Springer.

PH-5007: Magnetism and Magnetic Materials

Introductory magnetism**:** Review of diamagnetism and paramagnetism, Pauli paramagnetism. Wave functions of magnetic ions (3d, 4f), spin-orbit coupling, crystal field effects. Ferro and Antiferromagnetism**:** Basic Phenomenon, Mean Field Theory, Thermodynamics of ferromagnetic systems. Quantum mechanical treatment, Exchange interactions, Indirect exchange (super exchange). Spin excitations, spin waves, magnons, application to the temperature dependences of magnetization and specific heat. Band ferromagnetism. Criteria for band ferromagnetism, examples of metallic ferromagnets. Anti-Ferromagnetism: Basic phenomenon, Mean Field treatment. Types of Antiferromagnets, Parallel and perpendicular susceptibilities, Spin flop transition. Ferrites and Applications of ferrites. Domain Structures and related properties of ferromagnets: Magnetic Anisotropy, basic phenomenology. Uniaxial, Cubic and surface Anisotropies. Magnetization in soft and hard magnets.

Recommended Books:

- David Jiles, (2015), Introduction to Magnetism and Magnetic Materials, CRC Press, 3rd edition
- J. M. D. Coey, (2010), Magnetism and magnetic materials, Cambridge University Press.
- Kannan M. Krishnan, (2016), Fundamentals and Applications of Magnetic, Oxford University Press
- Nicola A. Spaldin, (2010), Magnetic Materials: Fundamentals and Applications, Cambridge University press, 2nd edition
- D.C. Jiles, (2013), Introduction to Magnetism and Magnetic Materials, Springer

- Stephen Blundell, (2001), Magnetism in Condensed Matter, Oxford Press.
- Amikam Aharoni, (1998), Introduction to the theory of Ferromagnetism, Oxford Press.
- R. Skomski and J. M. D. Coey, (1999), Permanent Magnetism, IOP Publishing.

PH-5008: Material Science

Bonding in Elemental Materials Covalent, Metallic and van der Waals Bonding), Bonding in Multielement Materials (Ionic, Mixed Ionic-Covalent Bonding, Hydrogen Bonding), Effects of Nature of Bonding on Materials Properties. Basic Structural and Symmetry Concepts, Concept of Diffraction in a Periodic Lattice, Structural Information from X-ray Diffraction and other Diffraction Techniques. Crystal Structures of Metals and Ceramic Materials. Point Defects (vacancies, interstitials, impurities, F-centers) and their stability Line and Extended Defects (Dislocations, Grain Boundaries, Stacking Faults, Interfacial, Surface and Volumetric Defects). Effect of Defects on the Properties of Materials.: Amorphous Materials / Glasses (Glass formation, Glass Transition and Crystallization of Glasses, Various Glass Forming Systems). Random Closed Packing in Metallic Glasses, Continuous Random Network in Covalent Glasses. Basic Concepts, Equilibrium Phase Diagrams, Phase Transformations – Basic Concepts, Kinetics, Metastable versus Stable Transformations, Microstructure Development, Precipitation and Dispersion Hardening, Multi Component and Multi Phase Systems, Alloys, Equilibrium Structures, Phase Separation.

Recommended Books:

- William D. Callister and David G. Rethwisch, (2013), Materials Science and Engineering: An Introduction, Wiley, 9th edition
- James F. Shackelford, (2014), Introduction to Materials Science for Engineers, Pearson, 8th edition
- U.C. Jindal, (2012), Material Science and Metallurgy, Pearson
- William Smith and Javad Hashemi, (2009), Foundations of Materials Science and Engineering, McGraw Hill, 5th edition
- William D. Callister and David G. Rethwisch, (2016), Fundamentals of Materials Science and Engineering, Wiley, 5th edition
- William D. Callister, (2014), Materials Science and Engineering: An Introduction, Wiley, 9th edition
- W.D. Callister, (2007), an Introduction Materials Science and Engineering, publisher John Wiley & Sons Inc.
- J.I. Gersten and F. W. Smith, (2001), The Chemistry of Materials, publisher John Wiley& Sons Inc.
- M.W. Barsoum, (2003), Fundamentals of Ceramics, IOP Publishing Ltd.
- Richard Zallen, (1998), Theory of Amorphous Solids, publisher John Wiley & Sons Inc.
- D.I. Bower, (2002), An Introduction to Polymer, publisher Cambridge University Press, Cambridge.
- M. Ohring, (2002), Materials Science of Thin Films, (2nd edition) publishers Academic Press.

PH-5009: Thin Film Deposition Techniques

Nanofabrication (Nanofabrication competencies, optimizing structure-property relationships, Integrating PNPA into nanofabrication). Thin film techniques (Sputter deposition, Plasma deposition, CVD, Spin coat techniques, Surface modifications and treatments). Molecular Engineering of Surfaces (Surface derivation, Chemical treatments, Electro-polishing). Overview of MEMS. Powder metallurgy and sintering (Powder metallurgy, Ceramic preparation). Nano-particle fabrication (Synthesis Techniques, Characterization and Safety issues).

Recommended Books:

- Hartmut Frey and Hamid R Khan, (2015), Handbook of Thin Film Technology, Springer
- Krishna Seshan, (2012), Handbook of Thin Film Deposition, Elsevier, 3rd edition
- K.S. K.S Sree Harsha , (2006), Principles of Vapor Deposition of Thin Films ,Elsevier
- Charlee Fansler, (2008), Aluminum Nitride Thin Films: Deposition for Fabrication, Characterization and Fabrication of Surface Acoustic Wave, VDM Verlag Dr. Müller
- Md. Habibur Rahman Habib and Md.Harun-Or- Rashid, (2013), Thin Film Deposition: Theory & Applications in Solar Cell, Lambert academic Publishing
- John E. Mahan, (2000), Physical Vapor Deposition of Thin Films, Wiley
- Yuan Lin, (2016), Advanced Nano Deposition Methods,Wiley-VCH

- Kiyotaka Wasa , (2012), Handbook of Sputter Deposition Technology: Fundamentals and Applications for Functional Thin Films, Elsevier, 2nd edition
- Milton Ohring, (2001), Materials Science of Thin Films, Academic Press, 2nd edition
- K.L. Chopra, (1983), Thin film Phenomena, McGraw-Hill Book Co.
- Leon I. Massel & R. Glang, (1981), Handbook of Thin Film Technology, McGraw-Hill Book Co.
- J.L. Vossen & W. Kern, (1991), Thin Film Processes, Academic Press.
- Peter Martin, (2011), Introduction to Surface Engineering and Functionally Engineered Materials, John Wiley & Sons.
- Jamal Takadoum, (2010), Materials and Surface Engineering in Tribology, John Wiley & Sons.
- Peter M. Martin, William Andrew, (2009), Handbook of Deposition Technologies for Films and Coatings, Science Applications and Technology.

PH-5010: Fundamentals of Nanoscience

Introduction: Nanoscience vs. Nanotechnology, Sense of Scale: Macro, micro, nano, Nano in Nature: Historical Perspective. Nano Optics: In Nature (butterfly wings), Thin films interference and light interaction, LED light, wavelengths, energy and bandgaps, Nano-applications. Surface Treatments: Hydrophobic vs. Hydrophilic, Lipid bi-layers, Nano-applications, Material Structure (Crystallography): Solids-Amorphous, polycrystalline, crystalline,Miller Indices. Many faces of carbon: fullerenes (graphene, Buckey-balls, CNT), amorphous and diamonds, Surface Area (SA) to Volume (V), The relationship between SA and V, SA: V ratio of nanoparticles vs micro and macro systems,The effects of this ratio to nanotechnology with Nanotechnology applications . Physical properties at the nanoscale: In nature (Abalone Shells, Lipid bi-layers, Gecko, Spider Webs), Contact forces:Density, Buoyancy and Surface Tension with Nanoapplications. Nanotechnology Devices:Lab-on-a-chip,Microfluidics,BioMEMS and DNA Microarrays, The Borg. Future Trends.

Recommended Books

- Kurt W. Kolasinski, (2012), Surface Science: Foundations of Catalysis and Nanoscience, WILEY
- Masaru Kuno, (2011), Introductory Nanoscience: Physical and Chemical Concepts Garland Science, 1st edition.
- Hans-Eckhardt Schaefer, (2010), Nanoscience: The Science of the Small in Physics, Engineering, Chemistry, Biology and Medicine, Springer
- Chris Binns, (2010), Introduction to Nanoscience and Nanotechnology, WILEY
- Gabor L. Hornyak and H.F. Tibbals, (2008), Introduction to Nanoscience and Nanotechnology, CRC press
- Marc J. Madou, (2011), Fundamentals of Microfabrication and Nanotechnology, CRC press, 3rd edition
- Terry L. Alford and L.C. Feldman, (2007), Fundamentals of Nanoscale Film Analysis, Springer
- Gabor L. Hornyak, Introduction to Nanoscience, ISBN-13: 978-1420048056.
- Alain Nouailhat,(2008), An Introduction to Nanoscience and Nanotechnology, ISTE Ltd.
- Challa S, S. R. Kumar, (2006), Nanomaterial Toxicity, Health, and Environmental Issues.
- Daniel L. Schodek, Paulo Ferre, (2009), Nanomaterials, Nanotechnologies and Design" An Introduction for Engineers.

PH-5011: Semiconductor Physics

Introduction/Elementary Properties of Semiconductors, Crystal Structure, Atomic Bonding, Intrinsic and Extrinsic Semiconductors, Energy Bands, Density of States, Nearly Free Electron Model, Kronig-Penny Model, Energy Bands for Intrinsic and Extrinsic Semiconductors. Semiconductor Statistics: Fermi-Dirac Statistics, Carrier Concentrations in Thermal Equilibrium in Intrinsic Semiconductors and Semiconductors with Impurity Levels. Transport Phenomena: Constant Relaxation Time, Electrical conductivity, the Hall Effect, Transverse Magnetoresistance, Scattering Mechanisms The Boltzmann Equation: The Boltzmann Transport Equation, Conductivity and Magneto-conductivity in Parabolic and Ellipsoidal Bands, Thermoelectric and Thermomagnetic Effects, Quantum Transport Excess Carriers in Semiconductors: Diffusion processes, Diffusion and Drift of Carriers, The Continuity Equation, Direct and Indirect Recombination of Electrons and Holes, Steady State Carrier Injection, Optical Absorption, Interband Transitions, Photoconductivity, Luminescence. Metal-

Semiconductor Contacts and PN-Junction Theory: Ohmic, Blocking and Neutral Metal-Semiconductor Contacts, PN-Junction under Equilibrium Conditions, Forward and Reverse-Biased Junctions, Reverse-Bias Breakdown, Deviations from the Simple Theory.

Recommended Books

- Peter YU and Manuel Cardona, (2010), Fundamentals of Semiconductors: Physics and Materials Properties, Springer, 4th edition.
- E. H. Nicollian and J. R. Brews, (2003), MOS (Metal Oxide Semiconductor) Physics and Technology, Wiley Classic library.
- Donald A. Neamen, (2011), Semiconductor Physics and Devices: Basic Principles, McGraw-Hill, 4th edition.
- Udo W. Pohl, (2015), Epitaxy of Semiconductors: Introduction to Physical Principles, Springer.
- Dieter K. Schroder, (2015), Semiconductor Material and Device Characterization, Wiley-IEEE Press, 3rd edition.
- Simon M. Sze and Kwok K. Ng, (2006), Physics of Semiconductor Devices, Wiley-Interscience, 3rd edition.
- J.-P. Colinge and C.A. Colinge, (2002), Physics of Semiconductor Devices, Kluwer Academic Publishers.
- W. Tom Wenckebach, (1999), Essentials of semiconductor, 1st edition, Willey and sons.

PH-5012: Physics of Solar Cells

Review of Semiconductor properties: Introduction to Energy Sources, Crystal Structure and Orientations, Forbidden Energy Gaps, Probability of Occupation of Allowed States, Electrons and Holes, Energy Density of Allowed States, Densities of Electrons and Holes, Band Model of a Group IV Semiconductors, Group III and V Dopants, Location of Fermi Level in Doped Semiconductors, Carrier Transport through Drift and Diffusion. Interaction of Light with Semiconductors, Recombination Processes. p-n Junction Diodes and Other Devices Structures: Electrostatic of p-n Junctions, Junction Capacitance, Carrier Injection, Diffusive Flow in Quasi-Neutral Regions, Dark and Illuminated Characteristics, Homojunctions, Semiconductor Heterojunctions, Metal-Semiconductor Heterojunctions, Low-Resistance Contacts, MIS Solar Cells, Photo electrochemical Cells, Materials and Structural Characteristics affecting Cell Performance, Short-Circuit Current Limits & Losses, Open-Circuit Voltage Limits & Losses, Effect of Temperature, Fill Factor Losses, Efficiency Measurement and its Improvements. Solar cell advancements and characterization techniques.

Recommended Books

- Peter Wurfel, (2009), Physics of Solar Cells: From Basic Principles to Advanced Concepts, Wiley-VCH, 2nd edition
- Jenny Nelson, (2002), The Physics of Solar Cells (Properties of Semiconductor Materials), Imperial College Press, 1st edition
- Lewis M. Fraas and Larry D. Partain, (2010), Solar Cells and Their Applications, Wiley, 2nd edition
- Rolf Brendel, (2003), Thin-Film Crystalline Silicon Solar Cells: Physics and Technology, Wiley-VCH, 1st edition
- Martin A. Green, (1982), Solar Cells Operating Principles, Technology and System Applications, Prentice-Hall, Inc.
- G.D. Rai, Khanna, (1991), Solar Energy Utilization, Publishers-Dehli.
- Richard C. Neville, (1978), Solar Energy Conversion: The Solar Cells, Elsevier Scientific Publishing Company.
- Chenming Hu & Richard M. White, (1983), Solar Cells from Basic to Advanced Systems, McGraw Hill Book Company.

PH-5013: Atomic Physics

One-electron atoms: Energy levels and wave functions of hydrogen atom. Fine and Hyperfine Structure. Extension to other single valence electron atoms Two-electron atoms. Helium atom. Independent particle model. Energy level structure, Configuration interaction, Doubly excited states and inner-shell excitations. Many electron atoms. Auto-ionization. Fano's description for an isolated auto-ionizing resonance. Multi-channel Quantum Defect Theory. Multi-channel Quantum Defect Theory (Cooke and Cromer approach). Interaction between two closed channels, one open and one closed channels. Photoionization cross sections.

Angular Momentum. Angular Momentum Coupling Schemes (LS, LK, jK and jj), Spherical Tensor Operators. Angular Momentum Algebra (3j, 6j and 9j symbols), Wigner Eckart Theorem. Atoms in External fields: Hydrogen Atom in electric field (spherical and parabolic states, energy levels, field ionization). Nonhydrogenic atoms (Quantum defects and energy levels, avoided crossings and "classical' ionization. Landau Zener Effect and pulsed field ionization).

Recommended Books:

- B.H. Bransden and C.J. Joachain, (2003), Physics of Atoms and Molecules, Pearson, 2nd edition
- Wolfgang Demtröder, (2011), Atoms, Molecules and Photons: An Introduction to Atomic-, Molecular- and Quantum Physics, Springer, 2nd edition
- Vasant Natarajan, (2015), Modern Atomic Physics, CRC Press
- C.J. Foot Atomic, (2005), Spectroscopy, 1st Edition, Oxford University Press.
- S. Svanberg, (2004), Atomic and Molecular Spectroscopy, 4th Ed. Springer.
- P.F. Bernath, (2005), Spectra of Atoms and Molecules, 2nd. Ed. Oxford.
- Bransden and Joachain, (1985), Theory of Atoms and Molecules, Springer.
- Heckmann and Trabert, (1995), Atomic Spectroscopy,Springer.
- W. Demtroeder, (2004), Laser Spectroscopy, Springer.

PH-5014: Atomic Spectroscopy

Spectra of alkali metals, doublet fine structure, two electron atom, Zeeman and Paschen-Back effect, X-ray spectra, general factors influencing spectral line width and line intensities, Molecular symmetry, irreducible representation, Magnetic Fields (Classical Methods of Coherent Spectroscopy: RF resonance spectroscopy, level crossing spectroscopy, Anti-crossing spectroscopy, Quantum Beats and wave packets). Atoms in Intense radiation fields. Multiphoton Absorption, Above threshold Ionization, High Harmonic Generation Laser Cooling and Trapping. Doppler Cooling, Optical molasses and traps, Sub Doppler Cooling.

Recommended Books

- Rita Kakkar, (2015), Atomic and Molecular Spectroscopy: Basic Concepts and Applications, Cambridge University Press, 1st edition.
- Terry L. Meek, (2010), Introduction to Spectroscopy, Atomic Structure and Chemical Bonding, University of the West Indies Press.
- Sune Svanberg, (2013), Atomic and Molecular Spectroscopy: Basic Aspects and Practical Applications, Springer, 4th edition.
- S. Svangerg, (2004), Atomic and Molecular Spectroscopy, 4th Ed, Springer.
- P.F Bernath, (2005), Spectra of Atoms and Molecules, 2nd Ed. Oxford.
- Bransden and Joachain, Longman, (1985), Theory of Atoms and Molecules, Wiley and sons.
- Heckmann and Trabert, (1995), Atomic Spectroscopy, Springer.
- J. Michael Hollas, (2004), Modern Spectroscopy, Springer.

PH-5015: Reservoir Physics

Petro (porosity, permeability, saturation, capillary phenomena), properties of fluids (water, oil, gas) and an introduction to reservoir. It will present the interpretation of well tests, types of recovery mechanisms (multi-phase flow, primary and secondary recovery) and the field development. Reservoir Characterization and Modeling. The workflow of reservoir characterization and modeling as routinely used in the oil industry. The presentation will be illustrated by practical work using actual data. Deterministic and stochastic modeling, volumetric calculation and uncertainties will be discussed at each stage, with a focus on geology, seismic and geostatistical methods. On shore and offshore hydrocarbon exploration methods. Shallow water and deep water exploration problems.

Recommended Books:

- Dr. Oliver C. Mullins, (2008), The Physics of Reservoir Fluids: Discovery Through Downhole Fluid Analysis, Schlumberger press

- Xuetao Hu and Shuyong Hu, (2016), Physics of Petroleum Reservoirs, Springer Mineralogy
- Tarek Ahmed PhD PE, (2010), Reservoir Engineering Handbook, Gulf Professional Publishing, 4th edition
- W. William Murray Telford, W. M. Telford, Robert Edward Sheriff, (1999), Applied Geophysics, 2nd edition, Wiley.
- D.S Parasnis (1962), Principles of Applied Geophysics, London, Wiley, New York.
- Carl August Heiland, (1963), Geophysical explorations, Prentice-Hall geology series Hafner Pub. Co.

PH-5016: X-ray Crystallography

Crystal systems, Bravais lattices and Miller indices, Point Group, space groups and systematic absences, Structure Vs lattices, Optical diffraction and the Laue and Bragg experiments, The Ewald construction, Powder diffraction techniques, Reciprocal lattices and Diffraction, Mathematical definition of reciprocal lattices and geometrical relationships to direct (Bravais)-lattices, Role of reciprocal lattice in diffraction-the condition for constructive interference, Structural factors, Integrated intensities and the phase problem, Patterson technique and direct methods, Systematic absences and symmetry, Structure refinement, least squares, Debye-Waller factors, Data collection, unit cell and symmetry, Intensities, Data reduction, Structure solutions, Finishing Touches.

Recommended Books:

- Gregory S. Girolami, (2015), X-ray Crystallography, Univ Science Books
- Mark F.C. Ladd and Rex A. Palmer, (2003), Structure Determination by X-ray Crystallography, Springer, 4th edition
- Yoshio Waseda and Eiichiro Matsubara, (2011), X-Ray Diffraction Crystallography: Introduction, Examples and Solved Problems, Springer
- Mark Ladd and Rex Palmer, (2013), Structure Determination by X-ray Crystallography: Analysis by X-rays and Neutrons, Springer, 5th edition
- Dennis W. Bennett, (2010), Understanding Single-Crystal X-Ray Crystallography, Wiley-VCH, 1st edition
- George H. Stout and Lyle H. Jensen, (1989), X-ray structure determination, A Practical
- Guide.
- Christopher Hammond, (2001), The Basics of Crystallography and Diffraction, Oxford University Press, 2nd edition
- Michael M. Woolfson, (1997), An Introduction to X-ray Crystallography, Cambridge University Press.
- B.D. Cullity and S.R. Stock, (2000), Elements of X-ray Diffraction, Prentice Hall (3rd Edition).

PH-5017: Solid State Electronic Devices

Semiconductor Materials, Bulk Crystal Growth, Epitaxial Growth Introduction to Physical Models, Experimental Observations (The Photoelectric Effect), The Bohr Model, Quantum Mechanics, Atomic Structure (The hydrogen atom)Excess Carriers in Semiconductors (Optical Absorption, Luminescence, and Diffusion of carriers) junctions: Fabrication of p-n Junctions (Diffusion, Rapid Thermal Processing, Ion Implantation, Chemical Vapor Deposition, Photolithography, Etching, Metallization), Forward and Reverse-Biased Junctions, Metal Semiconductor Junctions, Heterojunctions field effect transistors: Transistor Operation, The Junction FET, The Metal-Semiconductor FET, The Metal-Insulator-Semiconductor FET, The MOS Field-Effect Transistor bipolar junction transistors: Fundamentals of BJT Operation, Amplification with BJTs, BJT Fabrication, Switching, Frequency Limitations, Heterojunction Bipolar Transistors optoelectronic devices: Photodiodes, Light-Emitting Diodes, Lasers, Semiconductor Lasers power devices: The p-n-p-n Diode (Basic Structure, The Two-Transistor Analogy), The Semiconductor Controlled Rectifier, Insulated Gate Bipolar Transistor, integrated circuits: Types of Integrated Circuits - micro- and nanometer scale devices, Monolithic and Hybrid Circuits, Monolithic Device Elements (CMOS Process Integration, SOI), Charge Transfer Devices (The Basic CCD, Applications of CCDs), ULSI (Logic Devices, Semiconductor Memories).

Recommended Books:

- Ben Streetman, (2014), Solid State Electronic Devices, PHIL, 7th edition.
- Gary J. Rockis, (2012), Solid State Devices and Systems, Amer Technical Pub, 4th edition.

- K. Bhattacharya and Rajnish Sharma, (2014), Solid State Electronic Devices, Oxford University Press, 2nd edition.
- Christo Papadopoulos, (2013), Solid-State Electronic Devices: An Introduction, Springer.
- Safa Kasap, (2005), Principles of Electronic Materials and Devices, McGraw-Hill Education, 3rd edition.
- B.G. Streetman and S. Banerjee, (2000), Solid State Electronic Devices, Prentice Hall.
- C.Y. Chang and S.M. Sze, (2000), ULSI Devices, John Wiley and Sons Inc.
- M. Shur, (1990), Semiconductor Devices, Prentice Hall.

PH-5018: Growth and Characterization of Solids

Imperfections in crystals impurities. Vacancies. Grain boundaries. Dislocations. Stacking faults. Frenkel and Schottky disorder. Color centers. Polymers and ceramics. Elastic and plastic deformation. Annealing effect of imperfection on the mechanical properties of materials. Modulation spectroscopy for optical properties in solids. Crystal optics. Stress induced optical anomalies. Kinetic ordering and disordering. Ferroelectric crystals. Chemical anisotropy. Ordering of solid solution. Crystal growth. , Quantum wells, Multiquantum wells structures and super lattices, Doping super lattices, Band structure engineering of semiconductor super lattices, Quantum well lasers, Use of quantum wells in enhancement of the efficiency of solar cells, MBE, its role in forming low dimensional structures, Classical Hall Effect, Quantum Hall Effect.

Recommended Books:

- J.B. Ketterson, (2016), The Physics of Solids, Oxford University Press, 1st edition
- Walter A. Harrison, (1989), Electronic Structure and the Properties of Solids: The Physics of the Chemical Bond, Dover Publications
- A N Christensen, F Leccabue, (1987), Crystal Growth and Characterization of Advanced Materials, Proceedings of the International School on Crystal Growth and Characterization of Advanced Materials, La Habana, Cuba
- Ivan V Markov, (2003), Crystal Growth for Beginners: Fundamentals of Nucleation, Crystal Growth and Epitaxy, Imperial College Press
- Ashcroft and Mermin, (1976), Introduction to Solid State Physics, Saunders College.
- C. Kittel, (1996), Introduction to Solid State Physics, 8th Edition Published by nawarajbhandari.
- J. M. Ziman, (1972), Principles of the Theory of Solids, Cambridge University Press.
- László Mihály, Michael C Martin, (2009), Solid State Physics, 2 edition Wiley-VCH.

PH-5019: Plasma Physics

Introduction to plasma, occurrence of plasmas in nature, concept of temperature, Debye shielding, criteria for plasmas, applications of plasma. Single particle motion, motion of charged particles in uniform E and B fields, motion of charged particles in non-uniform E and B fields, motion of charged particles in time varying E and B fields, adiabatic invariants. Plasmas as fluids, relation of plasma to ordinary electromagnetic, the fluid equation of motion, equation of continuity, the complete set of fluid equations, plasma approximations. Waves in plasmas, representation of waves, group velocity, plasma oscillations, electron plasma waves, sound waves, ion waves, validity of plasma approximation, comparison of ion wave and electron wave, electrostatic electron oscillations perpendicular to B, electrostatic ion waves perpendicular to B, the lower hybrid frequency, EM waves with Bo=0, EM waves perpendicular to Bo, cutoffs and resonances, EM waves parallel to Bo, hydro-magnetic waves, magneto-sonic waves, basic nuclear fusion reaction rates and power density, radiation losses from plasmas, operational conditions, Lawson criteria, magnetic confinement fusion, inertial confinement fusion.

Recommended Books:

- Umran S. Inan and Marek Gołkowski, (2011), Principles of Plasma Physics for Engineers and Scientists, Cambridge University Press
- Anthony L. Peratt, (2014), Physics of the Plasma Universe, Springer, 2nd edition
- J. A. Bittencourt, (2010), Fundamentals of Plasma Physics, Springer, 3rd edition
- James E. Drummond, (2013), Plasma Physics, Dover Books on Physics

- J. A. Bittoncourt, (2004), Fundamentals of Plasma, third edition, Springer-Verlag.
- P.M. Bellan, (2008), Fundamentals of Plasma, Cambridge University Press.
- Francis F. Chen, (1984), Introduction to Plasma and controlled fusion, (second edition), academic Press.
- Peter A. Sturrock, (1994), Fundamentals of Plasma, Cambridge University Press.
- R. O. Dendy, (1990), Plasma Dynamics, Clarendon Press – Oxford.

PH-5020: Special Topics in Advanced Physics-I

The course contents should be specified from time to time by the resource person with consultation of the Chairman, Department of Applied Sciences.

PH-5021: Special Topics in Advanced Physics-II

The course contents should be specified from time to time by the resource person with consultation of the Chairman, Department of Applied Sciences.

Ph.D CHEMISTRY

Aims and Objectives

- To carry out research of international standard aimed to advance the global scientific and technological knowledge.
- To enhance the intellectual development of PhD graduates through creativity, analytical thinking, critical analysis, and innovative problem solving.
- To equip students with the Chemistry techniques to solve indigenous problems of industrial organizations with a special focus on textile industry.
- To strengthen academia-professional-world bonding by tailoring the courses and the trainings offered according to needs of the end-user.

Admission Criteria

1. MS/M.Phil Chemistry or equivalent degree with minimum CGPA 3.00/4.00 or 3.50/5.00 in semester system or 60% marks in annual system.
2. The applicant must pass NTU-GAT (Subject) test conducted by National Textile University, as per HEC guidelines and adopted by Advanced Studies and Research Board of NTU, Faisalabad with a minimum of 70% cumulative score.
3. It is mandatory to pass interview in order to compete on merit.
4. Applicant must not be already registered as a student in any other academic program in Pakistan or abroad.

Merit Criteria

Admission merit will be prepared according to the following criteria:

- M.Phil./MS Chemistry — 50 % weightage
- M.Sc./BS Chemistry — 30 % weightage
- Publications/relative experience — 10 % weightage
- Interview result — 10 % weightage

2. An HEC or other scholarship holder will be given preference for admission.

Duration of the Program

- The minimum period for completion of PhD program shall be 3 years, one year for 18 credit hours course work and two years for research, the period shall be counted from the commencement of course work.
- The maximum permissible period for submission of PhD thesis will be 16 semesters (8 Years) including course work. After 10 semesters, the scholar will cease to be the student of the university and shall not be eligible for readmission.

Semester-wise Workload

- The PhD candidate has to take PhD level course work of minimum 18 credit hours with the consent of his/her supervisor.
- The course contents are proposed by the concerned Faculty Board of Studies, recommended by the Advanced Studies and research Board (ARSB) and approved by the Academic Council.

Semester I

Code	Course Title	Credit Hours
CH-XXXX	Elective Course – I	3
CH-XXXX	Elective Course – II	3
CH-XXXX	Elective Course – III	3
	Total	9

Semester II

Code	Course Title	Credit Hours
CH-XXXX	Elective Course – IV	3
CH-XXXX	Elective Course – V	3
CH-XXXX	Elective Course – VI	3
	Total	9

Semesters III-VIII

Code	Course Title	Credit Hours
CH-9090	Research Thesis	30
	Total Credit Hours of Program	48

Research Paper Requirement

Before final submission of thesis for evaluation, the PhD scholar would have to publish at least one research paper from his/her research, as first author, in an Internationally Abstracted Journal, recognized by the HEC, Pakistan. Only published paper are acceptable for the award of PhD degree.

Course Contents of the Program

LIST OF ELECTIVE COURSES

(This list is not exhaustive and new courses can be added to this category at any time depending upon the

availablefacilities/requirements after due approval.)

Code	Course	Credit Hours	Credit Hours
1	CH-9001	Advanced Physical Chemistry	3
2	CH-9002	Inorganic Materials Chemistry	3
3	CH-9003	Physical Organic Chemistry	3
4	CH-9004	Nuclear Magnetic Resonance in Organic Chemistry	3
5	CH-9005	Advanced Mass Spectrometry	3
6	CH-9006	Advanced Polymer Chemistry	3
7	CH-9007	Special Organic Materials	3
8	CH-9008	Advanced Photochemistry	3
9	CH-9009	Advanced Surface Chemistry	3
10	CH-9010	Chemistry of Advanced Composite Materials	3
11	CH-9011	Advanced Applied Chemistry	3
12	CH-9012	Applied Environmental Chemistry	3
13	CH-9013	Nanochemistry	3
14	CH-9014	Biophysical Chemistry	3
15	CH-9015	Advanced Chemical Treatment of Textiles	3
16	CH-9016	Advanced Textile Chemistry	3
17	CH-9017	Advanced Analytical Techniques	3
18	CH-9090	Research Thesis	18

Details of Elective Courses

CH-9001: Advanced Physical Chemistry

Chemical Thermodynamics: Thermodynamic properties interrelations: Maxwell's equations; flow of fluids. Phase equilibrium: Non-ideal gas and liquid mixtures; chemical reaction equilibria. Chemical Kinetics: Reactions in solutions: Diffusion-controlled reactions; applications of transition state theory; solvent effects on polar and ionic reactions; salt effects on reactions. Chain reactions: Features of chain mechanisms; branching chain and oscillating reactions. Determination of reaction orders; Product catalyzed reactions; series reaction with reversible step; prior- equilibrium and improved steady-state approximation. Solutions: Interactions in solutions: multicomponent systems; preferentialm solvation.Solvents:Their characterization; microscopic structure of solvent and solvates. Molecular dynamics and microscopic structure; different techniques of molecular dynamical calculations. Theories and laws related to solutions. Macroscopic properties of solutions.

CH-9002: Inorganic Materials Chemistry

Introduction to inorganic materials, Application and interpretation of powder X-ray diffraction data of materials, The synthesis of inorganic materials – Solid statereactions, Precursor, solutionandsol-gelmethods, Solid-gas reactions, Hydrothermal method, CVD, Aerosol process, Low temperature method, Transition metal oxides, Electronic, magnetic and optical properties of inorganic materials, Nonstoichiometric compounds, Zeolites, intercalation in layer materials and solid electrolytes, Some recent developments in inorganic material chemistry.

CH-9003: Physical Organic Chemistry

History and development: Evolution of a hybrid discipline, energychanges during chemical reactions, theory and principles related to kinetics and equilibrium processes. Correlation of structure and reactivity: Hammett equation and other linear free energy relationships. Hückel molecular orbital (HMO) method: Correlation of HMO parameters with molecular properties, alternant and nonalternant hydrocarbons and their properties. Correlation of structure and activity: Use of molecular descriptors, Hansch analysis, Craig plots, Topliss scheme in establishing SAR. FMO method: Concept of Frontier orbitals and its application for explaining chemical reactivity.

CH-9004: Nuclear Magnetic Resonance in Organic Chemistry

Spin couplings: Spin coupling in different spin systems. Double resonance experiments: Spin decoupling in

1H- and C13- NMR spectroscopy, suppression of solvent signal, 1H BB decoupling, gated decoupling, 1H off-resonance decoupling. 1D NMR experiments with complex pulse sequence: The J-modulated spin echo, SPI, INEPT and DEPT experiments. 2D NMR Spectroscopy: Introduction, theory and presentation of 2D spectrum. 2D J-resolved NMR spectroscopy: Homo- and hetero-nuclear 2D J-resolved NMR spectroscopy. 2D shift-correlated NMR spectroscopy: H,H-COSY, H,C-COSY, NOESY, ROESY, HMBC, HMQC and TOCSY experiments. Applications: NMR use as a tool for structure elucidation and stereochemical assignments.

CH-9005: Advanced Mass Spectrometry

Introduction: Aims and scope, theory and basic terminology. Instrumentation: Instrumental design, ionization techniques, types of analyzers and detectors. Applications: Modes of fragmentation of various organic compounds, interpretation of mass spectra of unknown organic compounds.

CH-9006: Advanced Polymer Chemistry

Mechanism and kinetics: Step growth, free radical addition polymerization, ionic polymerization, Ziegler-Nattapolymerization. Molecular weight determination: Different methods used to determine the absolute and relative molecular weights of polymers. Structure- property relationship. Reactions of synthetic polymers. Polymer degradation and stability: Special emphasis on thermal and photo-degradation. Polymer interactions. Polymer solutions: Expansion factor in solutions; physical parameters affecting the chain dimensions; theta conditions. Theories of polymer solutions; phase separation and fractionation; solubility parameters; criteria for solubility. The polymerization processes and techniques, polymer additives (plasticizers, stabilizers and fillers). Polymers characterization.

CH-9007: Special Organic Materials

Organic dyes: Chromophore structure, synthesis of azodyes and cyanins, reactive vs. direct textile dyes, Chemiluminescence, photochromocs, color photography. Liquid Crystals: definition, classification: thermotropic/lyotropic, calamitic/discotic, nematic/ smectic columnar, synthesis and orientation, liquid crystal displays (LCD's), liquid crystal polymers. Electronic materials: Types of organic semi-conductors, polyacetylenes, and polyparaphenylenes, band structure, synthesis, electroluminescence and light emitting diodes (LED's).

CH-9008: Advanced Photochemistry

Principles of photochemistry: Primary and secondary chemical processes. Electron transfer in photochemistry: Collisional and coulombic modes, effect of temperature, eximers and exiplexes, the SET photochemistry, quantum yields. Kinetics and energetic of photochemical reactions: Mechanism of photochemical reactions, intersystem crossing, flash photolysis, mass spectrometric methods. Experimental methods in photochemistry: Low, medium and high pressure mercury lamps, resonance lamps, actinometers, phototubes, sources of high intensity flashes of light, laser and synchrotron radiations. Photolytic studies: Aqueous and non-aqueous systems, effects of radiations on solids. Applications in daily life and industry: Picosecond and femtosecond flash photolysis, Supramolecular photochemistry.

CH-9009: Advanced Surface Chemistry

Solid-liquid interface: Wetting, heat of wetting, thermodynamic description of an interface, Gibbs-Duhem equation for an interphase, Gibbs adsorption isotherm, adsorption from solutions (dilute, liquid mixtures, non-electrolytes, electrolytes, etc.) at solid- liquid interface, detergency and flotation. Study of liquid interfaces: Kelvin's and Laplace equations. Technical catalysis: Catalyst preparation techniques, catalytic reactors, supported metal catalysts, industrial applications of heterogeneous catalysts. Catalysis for steam-reforming, CO- & CO2-methanation, water-gas shift, Fischer-Tropsch synthesis reactions. Catalysts for syntheses of: ammonia, nitric acid, chemical fertilizers etc.

CH-9010: Chemistry Advanced Composite Materials

Introduction: Definitions and classification of composite materials, natural composites, property enhancement by reinforcement and orientation, matrix interface, synthetic fibers, processing of composites. Examples: Metallic,

ceramic and polymeric matrices, interface reactions. Properties: Mechanical and thermal properties of composite materials, stress relaxation and creep studies, dynamical mechanical properties, toughening mechanisms and mechanical failure in polymeric composites.

CH-9011: Advanced Applied Chemistry

The importance of chemical industries for the economic development of Pakistan; chemistry of ceramics and its processing; the agrochemical industry; chemistry of structural adhesives; dyes and pigments; chemistry of silicone technology; chemistry of fuel technology; corrosion; quality control (analytical and statistical). Various aspects of the energy and raw material supply, cost calculations to improve yield and to reduce pollution. Industrial techniques and quality control. Equipment for large-scale manufacturing. Conversion of a lab. process to a pilot plant and then plant procedure. Industrial catalysis. Inorganic and organic processes. Products of fermentation process. Preparation of chemical products from small molecules. Pesticides, herbicides and pharmaceuticals. The environmental impact of a process.

CH-9012: Applied Environmental Chemistry

Atmospheric Chemistry: Atmospheric structure: Natural constituents, anthropogenic emissions and atmospheric pollution. Air quality criteria pollutants: Sources, dispersion models and sinks of atmosphericpollutants. Measurement and monitoring methods: Gaseous pollutants and particulate matter in the atmosphere, dry and wet depositions. Photochemical smog-formation: Types and effects. Acid rain: Causes, effects and control. Ozone Chemistry: Stratospheric ozone production and depletion, causes and significance of ozone hole, catalytic and non-catalytic processes, effects of UV on the biosphere. Global warming: Greenhouse gases, production, control and future trends of greenhouse gases, consequences of global warming. Control management: Standards and legislation regarding the atmospheric pollution. Aqueous Chemistry: Aquatic environment: hydrological cycle, water quality criteria, physical, chemical and biological characteristics of water, utilization, contamination and protection of water resources, collection and preservation of water samples. Physico-chemical analysis of water: Fresh water bodies, stratification and turn-over. Water pollution: Soap, detergents and agricultural sprays. Water management: Policies and tools. Deposition of sediments: Trace metals in the hydrocycle and sediments, quantification of environmental impact in sediments.

CH-9013: Nanochemistry

Nanomaterials: Classification; structure and bonding; size dependent properties of mater; arrangements in 3D, 2D and.1D. Specific heats and melting points of nano-crystalline materials. Semiconductor nanocrystals: Spinels; quantum dots. Alloy semicondictors and their synthesis. Metal nanoparticles, double layers. Nanoparticle stability; charge transfer. Optical properties: Light absorption by colloids; dielectric response; size effects, electron transfer; temperature effects. Magnetism: Magnetic susceptibility and permeability: diamagnetism; paramagnetism; Langevin model; quantum effects. Ferromagnetism, Curie-Weiss law. Antiferro- magnetism: Ferri-magnetism. Magnetic anisotropy. Magnetic domains. Hysteresis. Super-paramagnetism. Nanomaterials synthesis: Chemical and catalytic aspects of nanocrystals. Nanotechnology: Synthesis techniques. Applications.

CH-9014: Biophysical Chemistry

Thermodynamic aspects: Simple molecules, macromolecules, colloidal particles in solution. Bioenergetics: Association of biopolymers. Lipids and biological membranes: Membrane transport, membrane potential. Characterization of Macromolecules: Moving-boundary sedimentation, zonal sedimentation, density gradient sedimentation, viscosity measurement, electrophoresis, isoelectric focusing. Structure of proteins and nucleic acids: Folding/unfolding of proteins and nucleic acids. Enzymology: Kinetics of enzyme catalysis, mechanisms of enzyme catalysis. Experimental techniques: Protein NMR, MRI, X-ray crystallography of proteins, electron microscopy of macromolecular assemblies.

CH-9015: Advanced Chemical Treatment of Textiles

This course includes the detailed study of different chemical treatments of textile materials including pre-treatments, coloration, modification along with comprehensive study of synthetic chemistry of different

chemicals used in textile processing. The course also includes the characterization of treated textile materials using advanced analytical techniques.

CH-9016: Advanced Textile Chemistry

Chromophore structure; synthesis and applications of azo, anthraquinones, phthalocyanines, vat, indigo polymethine and nitro dyes; Reactive vs. direct textile dyes, Chemiluminescence, photochromocs, color photography; high technology applications. Textile surface modifications; Multifunctional finishing;Textile surface characterization; Development of textiles fortechnical applications.

CH-9017: Advanced Analytical Techniques

Diffraction methods: Origin of X-ray spectra: Energy levels, Moseley's law. The absorption spectrum: Mass absorption coefficient. Instrumentation: X-ray generation, sources, wavelength dispersive devices, energy dispersive devices, detectors, sample preparation methods, working principle, analytical applications of X-ray absorption, X-ray fluorescence, particle induced X-ray emission, auger emission spectroscopy. Introduction, single crystal X-ray diffraction (XRD) of small molecules and macromolecules including natural systems, powder X-ray diffraction (XRD) of small molecules and macromolecules, measurement of lattice parameters, measurement of B-values, determination of space group, calculation of electron density map. Electron microscopy: Introduction, scanning electron microscopy (SEM), transmission electron microscopy (TEM), measurement of I/Q values, single particle 3-D reconstruction. Thermal Analysis: Theory and instrumentation: Thermogravimetry (TG), differential thermal analysis (DTA), differential scanning calorimetry (DSC). Quantitative interpretation: TGA, DTA and DSC curves. Kinetic and thermodynamic parameters. Applications: DTA, TGA in cements, catalysts, clays, minerals, biological materials, drugs, polymers and textiles.

FACULTY OF MANAGEMENT SCIENCES

Introduction

Faculty of Management Sciences (FMS) is playing an important role in imparting quality business education in the region. The faculty aims to develop theoretical and practical understanding among students about core business curriculum so that the students can effectively use this knowledge in contemporary business world. The faculty take pride in developing awareness among students about social and ethical considerations so that they take into account moral consequences in decision making. One of the major goals is to produce individuals with good leadership skills with a blend of knowledge related to management, marketing and textiles. Teaching faculty is fully committed to provide exciting, challenging and rewarding experiences to students during their studies, and to make every possible effort to help them in reaching their full potential.

MBA 3.5 Years (Including 2 Years BBS Degree)

MBA 3.5 Years degree program is designed for students with 14 years of education and aims to produce business executives with an excellent understanding of the business world. The students enrolled in this program have the option to either receive Bachelor of Business Studies (BBS) after completion of 60 credit hours or continue in MBA (3.5 Years) program. In essence, BBS degree is similar to old MBA (16 Years) degree program. BBS degree holders are eligible for admission in MBA (1.5 Year) as well as in MS Business Administration (1.5 year) program.

Programme Objectives:

1. To develop theoretical and practical understanding of core business curriculum among students so that they apply this knowledge in contemporary business world.
2. To develop oral communication and effective business writing skills of students so that they communicate effectively and precisely at the workplace and give effective presentations by using state of the art technology.
3. To develop analytical thinking of students so that they learn to break down complex problems for effective decision making in contemporary business workplace settings.
4. To develop social and ethical considerations of students so that they take into account moral consequences in decision making
5. To develop leadership and entrepreneurial skills of students so that they apply them in today's multicultural and teamwork oriented workplace settings to effectively reach organizational goals through their co-workers.

Eligibility Criteria

14 years (B.A, B.Sc, B.Com etc) or equivalent degree from HEC recognized University / Institute with minimum 2.00 / 4.00 CPGA or 50% marks in annual system. ((merit will be made through 100% weightage of graduate marks).

Semester-I

Sr.No	Code	Course Title	Credit Hours
1	MA-1004	Business Mathematics	3
2	ACCT-1081	Financial Accounting-I	3
3	ECON-1081	Principles of Micro Economics	3
4	MGT-1081	Principles of Management	3
5	MIS-1081	Computer Application for Managers	3(2-1)
		Total	15

Semester-II

Sr.No	Code	Course Title	Credit Hours
1	MKT-1081	Principles of Marketing	3
2	ECON-2082	Principles of Macro Economics	3
3	ACCT-2082	Financial Accounting-II	3
4	MGT-3082	Organization Behavior	3
5	BUS-2082	Business Communications	3
		Total	15

Semester-III

Sr.No	Code	Course Title	Credit Hours
1	MA-2003	Statistics for Business	3
2	FIN-2081	Business Finance	3
3	MKT-2082	Marketing Management	3
4	HRM-2081	Human Resource Management	3
5	ACCT-3083	Cost Accounting	3
		Total	15

Semester-IV

Sr.No	Code	Course Title	Credit Hours
1	FIN-3082	Financial Management	3
2	MIS-3082	Management Information System	3
3	BUS-3085	Business Research & Report Writing	3
4	LAW-3081	Business & Corporate Law	3
5	MGT-4085	Entrepreneurship	3
		Total	15

Semester-V

Sr.No	Code	Course Title	Credit Hours
1	MGT-6090	Financial Reporting and Analysis	3
2	MGT-6091	Research Methods	3
3	MGT-6093	Strategic Marketing	3
4	MGT-6097	Strategic HR & Leadership	3
		Total	12

Semester-VI

Sr.No	Code	Course Title	Credit Hours
1	MGT-6098	Applied Corporate Finance	3
2	MGT-6099	Cases in Management	3
3	-	Elective-I	3
4	-	Elective-II	3
		Total	12

Semester-VII

Sr.No	Code	Course Title	Credit Hours
1	-	Elective-III	3
2	-	Elective-IV	3
3	-	Final Year Project (Written report and presentation as output of practical work with the industry)	3
		Total	9
		Total Credit Hours of the Programme	**93**

Note: Institute may shuffle or substitute the sequence of courses during the program.

MS BUSINESS ADMINISTRATION (Marketing, HRM & Finance)

Eligibility Criteria

A candidate must have 16 Years relevant Business Education BBA-BSTMM-MBA-M.Com or 16-years relevant equivalent degree from HEC recognized University / Institute with minimum 2.00/4.00 CGPA in semester system or 60% in annual system.

Merit Criteria

- BBA (4 Years), BSTMM (4 Years) BBS, M.Com or 16 year equivalent degree — 60% weightage
- NTU-GAT (General) Test — 30% weightage
- Interview — 10% weightage

Note: Non-Business graduates can also apply for admission. However, they will be required to complete 30 to 36 credit hours of deficiency courses as per HEC roadmap for non-business graduates before starting a regular program of MS degree.

Programme Objectives

The programme objectives are:

1. To develop in students the skills of analysis, synthesis, and evaluation in the context of business decisions.

2. To develop in students an awareness of the changing and integrated nature of business problems and the ability to explore and deal with those problems.
3. To develop in students the ability to identify and evaluate the ethical, global, and societal implications of doing Research.
4. To develop in students the importance of research orientation and focus on academic research having practical applications in real life.
5. To develop hands-on experience with analytical tools and software that are widely applied in Business Research.
6. To develop in students an ability to communicate the analysis and findings of a research project in an efficient manner to decision makers and policy makers.

Programme Duration

It is 1 ½-Year program spread over 3 semesters. Each semester has 18 week including one week for mid semester and one week for end semester examination.

Programme Structure for MS Business Administration (1.5 Year)

Semester-I

Sr.No	Code	Course Title	Credit Hours
1	MGT-6091	Advance Research Methods	(3-0-3)
2	MGT-6092	Strategic Finance	(3-0-3)
3	MGT-6093	Strategic Marketing	(3-0-3)
4	MGT-6094	Organization Theory & Design	(3-0-3)
		Total	12

Semester-II

Sr.No	Code	Course Title	Credit Hours
1	MGT-6095	Project Management	(3-0-3)
2	MGT-6096	Leadership and Organizational Behavior	(3-0-3)
3	-	Elective-I	(3-0-3)
4	-	Elective-II	(3-0-3)
		Total	12

Semester-III

Sr.No	Code	Course Title	Credit Hours
1	-	Elective-III	(3-0-3)
2	-	Elective-IV	(3-0-3)
3	-	Thesis / Dissertation	(6-0-6)
		Total	12

Note: Institute may shuffle or substitute the sequence of courses during the program.

Course Specifications

ACCT-1081: Financial Accounting-I

The primary aim of Financial Accounting is to provide students with an introduction to the process and function of financial reporting. While a large proportion of the course is aimed at understanding accounting as a process, taking a preparers' perspective, we will also seek to develop an understanding of the importanceof the role of accounting in today's society.

MGT-2082: Marketing Management

Marketing management course is geared toward providing an understanding of the rationale for marketing decisions from a managerial perspective and the manipulation of marketing mix to achieve business goals. Practically marketing management encompasses activities such as demand creation and Stimulation, positioning, product differentiation, and product and brand management among others. All these activities involve planning, analysis, and decision-making. This course will require the integration of theory and practice. Students will have to make strategic marketing decisions based on analytical techniques they have learned in this course. They will have to devise a marketing plan

that is based on a sound conceptual framework, and with a focus on its practical applicability.

MGT-1081: Principles of Management

This is an introductory course about the management of organizations. It provides instructions on principles of management that have general applicability to all types of enterprises; basic management philosophy and decision making; principles involved in planning, organizing, leading, and controlling; and recent concepts in management. The principles learned in this course will allow the student to effectively work with and through others in an organization. The course will also encourage the students to explore and inquire the applicability of western management principles and theories in local settings. Besides, the course will discuss the Islamic perspective of managing businesses and organizations.

FIN-3082: Financial Management

Financial Management course aims at imparting knowledge about the fundamental concepts and tools of financial management. It emphasizes the importance of financial management skills to individuals and enterprises. You are expected to gain an initial understanding of the finance function in an organization, the role of the finance manager and the financial environment in which the firm operates. The financial environment covers the understanding of financial and capital markets along with the broad orientation of macroeconomic factors affecting the business. The emphasis will remain on developing the skills for planning, appraising and evaluating the investment, financing and operating decisions.

HRM-2081: Human Resource Management

This course is basically designed to provide students the basic understanding of key HRM functions, which include HR planning, recruitment & selection, compensation, performance evaluation, and training & development. Since human resource provides a competitive advantage that ultimately has a vital role in success and effectiveness of any organization, this course emphasizes on the understanding of the basic concepts of managing human resource and their applications in today's organizations. The course is designed to help the students understand if western human resource management theories and practices have any relevance to the local settings. The course will also discuss the Islamic perspective of managing human resource. It will shed light on the basic tenets of human resource management given by Qura'n and Sunnah. The students will also be encouraged to compare and contrast the human resource practices suggested in their text books and the practices critical for achieving success from indigenous perspective.

LAW-3081: Business & Corporate Law

The course basically deals with the introduction of those commercial laws which are directly or indirectly related to Business. It includes a short study of contract law, partnership Act, companies' ordinance and Negotiable instrument The emphasis in this course is to introduce the students with the basic concepts of conventional business law and its implementation in the contemporary financial institutions. The course is outlined in such a way to show the basic philosophy of conventional Business Law along with some example from case study.

BUS-2082: Business Communication

This course enhances your communication skills. It further builds on the experience and exposure necessary to develop outstanding presentations & communication talents. It examines the theoretical and practical concepts of public speaking. The course will also help you to create a standing and authority through well applied dialectic.

BUS-3085: Business Research & Report Writing

This course is designed to give an overview of the principles and methods of business research: identification of research question, development of theoretical framework and model, securing the respondents, making a test investigation, sampling, collecting data, types and errors of collected data, tabulating and analyzing the information, interpreting the findings and stating the conclusion through a series of class projects. Practical experience is offered to the students on how research techniques and procedures are applied to solve the business problems. This course is also designed to

encourage the students to explore the application of theories that have been predominantly developed in Western cultures by using different research method techniques. An understanding of the relevance of Western research for local practice would help students to explore various business related problems and their plausible solutions from indigenous perspective. The course will also help the students in understanding the importance of the business research as a management decision tool and in dealing with various business-related theoretical and applied problems.

MGT-6092: Strategic Finance

The aim of this course is to examine the theoretical underpinnings of corporate finance and see how they are applied. The material is a continuation of what was taught in the first year Financial Management course. There will be more emphasis on "how corporate financing is really done'. The emphasis of Financial Management course was on skill development while this course emphasis is on theoretical and conceptual understanding of financial management function and its application in real life scenario.

MGT-6095: Project Management

Projects have been part of the human scene since civilization started, yet the practice of project management is quite recent. The concepts and toolsrequired to plan, organize, implement, and evaluate a project are equally applicable to such diverse ventures as launching of a space shuttle, developing curriculum in primary education, or organizing a trekking trip to the K-2 base camp. The purpose of this course is to expose students to the real-life issues in project management, and equip them with necessary tools to resolve these issues. Use of quantitative techniques is supplemented by softer skills of leadership and humanresource management.

MGT-6091: Advance Research Methods

This course emphasis is on the research design, instrument development, data collection techniques and methods of evaluation in applied settings. Additionally to business research methodology contents, students also become of familiar with the policy implications of business research outcomes. It is intended to introduce students' ways of conceptualizing problems, designing research, collecting data, and interpreting those data. It also examines implications and consequences of choices among alternative approaches. On the successful completion of this course students should be able to acquaint with research processes and assumptions and they can introduce alternative methods and logics of inquiry which will make students more discriminating consumers of others'research and promote the development of their research. They will develop research skills which will be required for planning and executing research projects, including; conducting literature review, articulating research questions, justifying a research approach and methodology, designing a study and selecting specific methods and techniques appropriate for answering the questions and conducting data collection, analyzing data and presenting research results. The key topics includes, research methods in management sciences, research problems and how to explore them and how to conduct literature search, research paradigms and approaches-assumptions of positivist, interpretive and critical approach, quantitative research methods, survey based research, statistical modeling techniques, selecting statistical packages tutorials (SPSS etc), qualitative research methods, ethnographic research, cross-paradigm and multi method research, writing the research proposal and structure, from research question to research design- justifying the methodology and writing strategies.

MGT-6093: Strategic Marketing

Strategic Marketing Management is an advance level Marketing course. The aim of the course is to develop a strategic thinking approach tomarketing. It aims to help students understand how companies compete using marketing strategy and its correlates focusing on achieving a competitive advantage for the firm by creating customer value and leveraging the firm's marketing resources in the most efficient and effective manners. It builds upon the basic concepts of Marketing, which the students have learned in their previous marketing courses and to prepare students to grasp the complex issues of specialized courses like Business policy, etc. In this course students are exposed to a dynamic world of marketing activities using a number of approaches and to enable the students to understand the practical issues that are critical to develop performance orientation. Principles, concepts and analytical tools are taught employing real life examples from both Pakistan's and international corporate world. This will enable the

students to develop skills and competency to apply analytical tools and develop appropriate strategic marketingplans and manage its implementations. After takingthis course students are better equipped, both mentally and academically; they understand variousterms and concepts and understand how and when to apply them. It prepares them to take on the real life challenges and to add value to the organization for which they will work.

MGT-6094: Organization Theory & Design

Business is changing at break-neck speed so managers must be increasingly active in reorganizing their firms to gain a competitive edge. Organizational Theory, Design, and Change continue to provide students with the most up-to-date and contemporary treatment of the way managers attempt to increase organizational effectiveness. Organization theory and design gives us the tools to evaluate and understand how a huge, powerful firm like Lehman Brothers can die and a company like Bank of America can emerge almost overnight as a giant in the industry. It enables us to comprehend how a band like the Rolling Stones, which operates like a highly sophisticated global business organization, can enjoy phenomenal success for nearly half a century, while others with equal or superior talent don't survive. Organization theory helps us explain what happened in the past, as well aswhat may happen in the future, so that we can manageorganizations more effectively.

ECON-1081: Principles of Microeconomics

This course is designed to introduce fundamental microeconomics concepts and techniques applicable as tools for rational economic decision-making within the micro frameworks. The course aims to demonstrate the relevance and usefulness of economic analysis to real world business situations. Emphasis is placed on optimal decisions making within the firm and the strategic relationship with other business. The goal of the course is to provide an introduction to microeconomics. Using microeconomics theory, the students will be able to understand the concepts of demand and supply, the price determination in the market, firm behavior and the structure of the markets.

MA-1004: Business Mathematics

This course is built upon the mathematical concepts, principles, and techniques that are useful in business management. The primary objectives of the course are to enhance students' competency in the application of mathematical concepts in solving business management problems and to improve their level of quantitative approach.

MKT-1081: Principles of Marketing

This course is designed to introduce foundations of marketing as they relate to the whole business enterprise. This course will focus on developing an understanding of the major marketing concepts. The objective of this course, specifically, is to enhance the conceptual knowledge of marketing as applicable to decision making process with a focus on tactical marketing mix decisions. Further, it will provide the student with a comprehensive framework to evaluate marketing decisions and to create successful marketing initiatives. The course, will, therefore, provide an understanding of the principles of marketing about the product and services including the planning process, organizing the marketing functions, implementing the marketing decisions keeping in mind the ethical, legal and societal consideration.

ECON-2082: Principles of Macroconomics

This course aims at giving students knowledge about the working of a mixed economy at the aggregate level under pinning of aggregate output and income determination, key macro-economics problems and major policy debate. The underlying themes are extended to find out how the disciplines of national income, macroeconomics in the closed and open economy, macroeconomics stabilization policies, macro-economic components (consumption, saving, private investment, interest, etc.), public finance, money, and banking link up with conventional macroeconomics.

ACCT-2082: Financial Accounting-II

This course is built upon the Financial Accounting Course in the sense that it provides advanced treatment of basic techniques learned in the first course of Financial Accounting. It mainly focuses on the company

accounts and their understanding in the context of the IAS and companies ordinance 1984.

MGT-3082: Organizational Behavior

Organizational behavior (OB) is an interdisciplinary field drawing from numerous disciplines including psychology, sociology, anthropology, economics, organization theory, statistics, and many others. Efficient management of human resources within organizations requires an understanding of various behavior and processes. Managers need to know why people behave as they do about their jobs, their work groups, and their organizations. This knowledge of individuals' perceptions, motivational attitudes and behavior will enable managers not only to understand themselves better but also to adopt appropriate managerial policies and leadership styles to increase their effectiveness. The focus of instruction will move progressively through the individual, group and organizational levels of behavior and will examine the interrelationships of behavioral phenomena among these levels. Additionally, concepts such as motivation, communication and leadership and their relevance to organizational behavior will be examined in detail. The course is also designed to help the students understand if Western Organizational Behavioral theories and practices have any relevance to the local settings. The course will also discuss the Islamic perspective of understanding and directing human behavior in a specific direction.

MA-2003: Statistics for Business

The main objectives of the course are to enhance students' competency in the application of statistics to solve business management problems and to improve their level of quantitative sophistication for further advanced business analysis.

FIN-2081: Business Finance

Business Finance course aims to imparting knowledge about the very basic concepts and tools of Business Finance. It emphasizes the importance of Business Finance skills to individuals and enterprises. It deals with the finance function in an organization, the role of the finance manager and the financial environment in which the firm operates. The financial environment covers the understanding of financial and capital markets along with the broad orientation of macro-economic factors affecting the business. The emphasis will remain on developing the skills for planning, appraising and evaluating the investment, financing and operating decisions.

ACCT-3083: Cost Accounting (3-0-3)

The Course deals with examining Cost Accounting as a tool for providing information for manufacturing, Internal reporting, external reporting as well as for managerial decision making. The broad course objectives are to help students to understand the central concepts of Cost Accounting, the methods of conducting data analysis preparation of reports for managerial decision making.

MIS-3082: Management Information System

This is a fundamental course for the students of business administration. The course is designed to give the concept of information systems and their importance for business success. Different information technology applications in business to manage better and how it will provide support to decision makers for strategic business decisions will be discussed. Different applications like hospital information systems, corporate information systems, city information systems, crime information and control systems, Transaction process system etc. will be discussed.

MGT-4085: Entrepreneurship

With more than half of the new jobs being created in the world economy by small businesses, the particular problems and experiences encountered in starting and developing new enterprises are clearly worth studying. This course of Entrepreneurship has been designed to provide the participants with an overall understanding of the concept of entrepreneurship and small business management. Participants will be prepared to start, survive, and succeed in their businesses.For those who consider becoming part of a big traditional business, while working for someone else, as a viable career option, it is hoped that participation in this course will orient them towards thinking and acting more entrepreneurially and creatively in the great business ambiance. Thus, regardless of their plans and hopes, this course can benefit them greatly in how

they think and act, from an entrepreneurial viewpoint, in the future. The course puts a strong emphasis on the development of a real world, workable, implementable business plan that applies the proper methods, techniques, and skills needed for successfully developing and growing a new venture. While some theory will be explored, the major thrust of this course will be to ensure that the primary product of the course, the Business Plan, and other assignments which have immediate and real world application. This course is about learning of risk and failure and growing from it. It is about learning to forge one's ideas into workable business concepts, commit them to paper, and flesh them out into a reasonable form that can be tested to see if it could stand up to the demands of the market. The students must write at a top level, argue the potential of their ideas, and convince investors that their ideas are worth being born in the marketplace.

MGT-6094: Organization Theory & Design

Business is changing at break-neck speed so managers must be increasingly active in reorganizing their firms to gain a competitive edge. Organizational Theory, Design, and Change continue to provide students with the most up-to-date and contemporary treatment of the way managers attempt to increase organizational effectiveness. Organization theory and design gives us the tools to evaluate and understand how a huge, powerful firm like Lehman Brothers can die and a company like Bank of America can emerge almost overnight as a giant in the industry. It enables us to comprehend how a band like the Rolling Stones, which operates like a highly sophisticated global business organization, can enjoy phenomenal success for nearly half a century, while others with equal or superior talent don't survive. Organization theory helps us explain what happened in the past, as well as what may occur in the future so that we can manage organizations more effectively.

MGT-6096: Leadership and Organizational Behavior

This course is designed to sharpen the ability to diagnose and solve a range of organizational challenges. Through readings, lecturer, cases, and experiential exercises, student will investigate concepts from the social sciences that are useful for understanding the organizational process, and apply these frameworks to particular situations with the view of rendering a given company. Students will also acquire an understanding of frameworks covering leadership, team roles, and group development as well as theories addressing leadership, conflict resolution, and team decision making. Practical knowledge will enable participants to understand the tools, techniques, skills and leadership style required to supervise individuals and manage a team and their performance effectively by giving them appropriate and constructive feedback.

MIS-1081: Computer Application for Managers

Computer Applications for Manager is developed to introduce the first year students to the world of computers and software applications. This course will provide a foundation on which they can build a reliable and useful knowledge of computer application for the manager. Students through class room lectures, application program demonstrations, and hands-on training students, will learn, how to use Microsoft Office applications and explore and examine the fundamentals of computer hardware and software. The class will also explore the relationship between information technologies, society and interpret how computer technology can benefit businesses, policy makers, and educational institutes.

MGT-6099: Cases In Management

This course is an integrative and interdisciplinary course. Cases in Management is an interesting course to teach because the problems and issues of management cover the whole spectrum of business, including finance, marketing, management, management information systems, production operations, economics, and statistics .It covers the key concepts, tools, and principles of strategy formulation and competitive analysis. It is concerned with managerial decisions and actions that affect the performance and survival of business enterprises. It assumes a broad view of the environment that includes buyers, suppliers, competitors, technology, the economy, capital markets, government, and global forces. Students analyze firms in different industries, make objective strategic decisions for companies, and justify those decisions through oral or written communication.

MGT-6097: Strategic HR & Leadership

This course is planned for leaders aiming to improve their effectiveness by developing the human resource potential of their organization in order to achieve business and strategic objectives. This subject identifies and evaluates the alignment of human resource management with business strategy and the role of the leaders in this process. A range of concepts, theories and models which aim to integrate the various functional areas of human resource with business strategy will be examined. Both the theoretical and practical application of issues associated with HR practices and the changing role of leaders will also be discussed. This course uses a combination of theory and practical application of core concepts. Participants will be engaged in discussions of real life situations allowing them to gain a strong grip on the knowledge and skills needed for leadership development. The course debates the primary reasons for leadership derailment and the new paradigm skills that can help organizations to avoid it. It also Explain how leadership has evolved and how historical approaches apply to the practice of the traditional functions of management and the fundamental differences between leadership and management.

MGT-6090: Financial Reporting and Analysis

In professional practice, the corporate executive has to be competent in financial accounting and reporting. The emphasis is normally on accounting for purpose rather than on detailed accounting techniques. He needs to understand the significance and relevance of accounting information and the process by which it is acquired. His core responsibilities also include compliance with legal and stakeholder requirements, including financial statements. In the boardroom, he contributes to the analysis, presentation, and interpretation of corporate financial performance and results, including the implications for the organization, shareholders, and different stakeholders and for effective corporate governance. The aim of this course is to develop the knowledge and skills necessary for students to understand and supervise the execution of these professional responsibilities.

MGT-6098: Applied Corporate Finance

This course will provide a thorough grounding in recent developments in applied corporate finance. The course involves a study of the applied corporate finance literature and case studies. It will examine valuation techniques, capital structure, and payout policy, raising capital, going public, financial risk management by firms, corporate governance, takeovers, and insolvency. This course also focuses on practical applications relating to the theory of financial decision making. Case studies, empirical evidence, and current issues in the financial media are used to illustrate key decisions made by managers of the firm. One of the aims is to develop students' ability to make judgments in a realistic setting and to develop the capacity to articulate judgments both orally and in writing.

Academic Rules

1. MS Programmes (All)

1.1 Course/Research Project Registration

Students shall be required to register for the courses/research projects before the start of each semester as announced by the university. Any change in course registration shall be allowed only in the first two weeks of the semester. A regular student is required to take 9 credit hours per semester. However, a student can take maximum12 credit hours, if she/he is graduating in that semester.

1.2 Withdrawal of Course(s)

1.2.1 A Student, with the permission of the incharge graduate studies and research may be allowed to withdraw a course/s within 10 weeks of the commencement of semester.

1.2.2 Students shall be awarded grade "W" for the respective course/s if withdrawn within the 10 weeks of the semester with prior permission from the University.

1.2.3 Course/s withdrawn within 10 weeks shall be recorded on the transcript with a grade "W".

1.2.4 Non attendance will not constitute an official withdrawal.

1.3 Attendance Requirement

Students shall be required to maintain a minimum of 75 % of class attendance in each course, adhere to the universityacademic calendar and attend regularly all lectures, seminars, discussions and field work as may be specified for a course in a semester. Failure to meet attendance requirement shall render the students ineligible for appearing inthe final examination of the concerned course and "F" grade shall be awarded for the course.

1.4 Academic Evaluation

Formative feedback on coursework will be given on regular basis. In order to give appropriate feedback, all assignments submitted by deadlines, will be returned to the students within the specified period. The following shall be scheduled during a semester for the purpose of academic evaluation of students:

Quiz Tests:	Quiz tests shall be conducted at irregular intervals through the semester, with or without intimation.
Assignments:	Assignments relative to the course shall be given during the semester.
Mid Semester Exam:	A 2-hour written test shall be conducted during the semester after 8 week of studies.
End Semester Exam:	A 2-3-hour written test shall be conducted at the end of 16 weeks of studies.
Projects:	Project is a research work aimed at assessing the ability of a student to translate the theoretical knowledge acquired during the academic programme into practical use to create new knowledge/product/process for the benefit of the mankind and economical development of the country.

The weightage of the examinations quizzes and assignments shall be as under:

- Quizzes/Assignments 30 %
- Mid-Semester Examination 30 %
- End-Semester Examination 40 %

End semester examination is mandatory, irrespective of the total marks obtained in quizzes, assignments and mid semester examination.

1.5 Unfair Means in Examination

Any student found cheating or using unfair means in the examination (mid/final exams, quizzes, assignments, practicals and research projects) will be dealt severely which may lead to expulsion from the university. The university regulations relating to the use of Unfair-Means and Academic Dishonesty in the Examinations-2016 will be applicable to such cases.

1.6 Repetition of Courses

Students may repeat the courses in which they obtained an F, D, D+ or C grade. In such case, all grades achieved by the student shall appear on the transcript. The cumulative grade point average for a semester shall be calculated by substituting old grades with the grades obtained after repetition of courses. The students are not allowed to repeat courses for improvement of grades except probationer students with D, D+ and C grades.

1.7 Incomplete Research Project

An"I" grade is given to a student in a research project, if the student does not complete project requirements within the prescribed time-limits, and the supervisory committee is satisfied that it was because of the circumstances beyond the control of the student. Incomplete grade"I" shall not be considered in GPA/CGPA calculations. However, it is the responsibility of the student to complete the remaining work of the research project in the given time period, failing which the "I" grade shall be converted to "F" grade.

1.8 Make-up Examination

If a student fails to appear in the Mid Semester or End Semester Examination due to unavoidable circumstances that is the death of blood relations (Parents, Grandparents, brother or sister), Personal severe accident, or illness (hospitalization) (onus of proof entirely on the student) but otherwise complies with other course requirements such as attendance, completion of assessment activities, then on the recommendations of the course(s) teacher(s) and In charge of the programme. The make-up examination may be arranged after the approval of make-up examination committee duly constituted by the competent authority of the university. Any such examination, if allowed, shall be held within three weeks of the examination of which the student is defaulter.

1.9 Semester Drop Rules

If a student drops a semester with the prior permission and approval of the university in the first week of thesemester the tuition fee shall be refunded. Students dropping semester after the first week shall not be allowed to get any refund. If a student drops a semester without formal approval of the university, his/her admission shall standcancelled.

1.10 Promotion Rules

The minimum requirement for promotion to the second semester of the programme shall be SGPA of 1.00 in the firstsemester. If a student obtains SGPA less than 1.00 in the first semester, he/she shall be ceased to be on the roll of theuniversity and shall not be eligible for the admission in the same programme of the University in future.

1.11 Probation Rules

For graduation, the minimum qualifying CGPA is 2.50. Whenever a student's CGPA is below 2.50 in any semester,the student will be on 1st probation. If the student does not improve/maintain to CGPA 2.50 in any subsequent semester, he/she will be on final probation. If the student does not come out of the final probation by achieving theminimum CGPA of 2.50 in the next regular semester, the student shall be expelled and cannot be re-admitted in the programme.

1.12 Degree Requirements & Duration

All MS programm students must have a minimum CGPA 2.50/4.00 to achieve the degree of their respective programms. The minimum duration of a MS program (except MS Business Administration 3 Semester-1.5 Year) is 4 regular semesters and maximum of 8 regular semesters (4 Years) as per HEC.

PhD Programmes

1.3 Course Work

1.3.1 Semester Schedule

- Registration and orientation — 1 day
- Classes — 8 weeks
- Mid-Semester Examination — 9th week
- Classes — 8 weeks
- Final Examination — 18th week
- Semester Break — 2 weeks

1.3.2 Medium of Instructions

- The medium of instructions as well as of examinations shall be English.
- The student should have good English reading, writing and speaking skills.

1.3.3 Course Work Load

- The PhD candidate has to take PhD level course work of 18 credits.
- The candidate shall choose the elective courses with the consent of his/her PhD Supervisors.
- One credit hour stands for at least one hour class contact per week per semester. For practical/lab work,3 contact hours shall be considered equivalent to one credit hour.

1.3.4 Attendance Requirement

- In order to be eligible to sit in the end semester exam, a student must have attended minimum 75% of the lectures.

1.3.5 Residency Requirement

- PhD programme comprises full-time course work and research work.
- Study leave is mandatory for in-service candidates enrolled in PhD

1.3.6 Examination, Grading and Evaluation of Course Work

- There shall be two examinations for each course (mid-semester and end-semester) along with quizzes /assignments/seminars, etc.
- The break-up of the marks in each course will be as follows:
  - Mid-semester examination — 30%
  - Assignments/quizzes/seminars etc. — 30%
  - End-semester examination — 40%.
- The results of each course shall be submitted within one week of the examination.
- The results shall be notified by the Controller of Examination (COE) within one week of the examination.
- The student must obtain a minimum grade point 2.50/4.00 in each subject throughout the course work and maintain a minimum CGPA of 2.50/4.00.
- If a student obtained less than 2.50/4.00 grade point, he/she may be allowed to repeat the course(s) for one time only.
  If a student still fails to obtain a grade point of 2.50, he/she will be removed from the roll of the university.

Grading Criteria

Student's performance is evaluated by following grading criteria.

Course grades (letter grades) are awarded to students based on their relative performance in the course. If the student's strength of class is twenty (20) or more then grades are calculated using statistical methods, recommended by HEC for relative grading system (HEC's "Policy Guidelines for Uniform Implementation of Semester Based Examination System - 2015"). If the class strength is less than twenty (20), then absolute grading system is used.

Relative Grading System

Following grading criteria is used for relative grading system (in case of class strength is 20 or more)

Letter Grade	Grade Point	Remarks
A+	4.00	Exceptional
A	4.00	Outstanding
A-	3.66	Excellent
B+	3.33	Very Good
B	3.00	Good
B-	2.66	Above Average
C+	2.33	Average
C	2.00	Satisfactory
C-	1.66	Pass
D+	1.33	Low Pass
D	1.00	Marginal Pass
F	0.00	Fail
I	--	Incomplete
W	--	Course Withdrawn

Absolute Grading System

Following absolute grading system will be used in case class strength is less than twenty (20).

Marks (%)	Grade Point	Letter	Remarks
90 and Above	4.00	A+	Exceptional
85-89.9	4.00	A	Outstanding
80-84.9	3.66	A-	Excellent
75-79.9	3.33	B+	Very Good
71-74.9	3.00	B	Good
68-70.9	2.66	B-	Above Average
64-67.9	2.33	C+	Average
61-63.9	2.00	C	Satisfactory
58-60.9	1.66	C-	Pass
54-57.9	1.33	D+	Low Pass
50-53.9	1.00	D	Marginal Pass
Below 50	0.00	F	Fail
	--	I	Incomplete
	--	W	Course Withdrawn

- "W" stands for withdrawn course and has no grade point equivalent and credit hours for withdrawn courses will not be count towards the credit hours taken in the semester.
- "I" stands for incomplete course.
- Fraction of marks in a course shall be upto 2 digits.

1.3.7 Comprehensive Examination

- On successful completion of the coursework, there will be a comprehensive examination within next semester of the completion of the course work.
- It shall consist of Written and Oral Examinations (70% : 30%).
- Student shall chose three courses from the courses he/she has taken during course work, minimum one course shall be chosen from the core course and minimum one from the elective courses.
- The examination committee will consist of concerned Dean / HoD, concerned faculty Director, Director, Graduate studies & research and subject experts / teachers whose subjects have been chosen by the students.
- The written examination shall be of two hours containing three equal parts from the chosen subjects.
- Oral examination will be conducted by the examination committee within one month of qualifying Written Exam.
- To pass the comprehensive examination minimum 70% marks are required.
- In case the student fails in the first attempt, one more chance will be given to pass the comprehensive examination within the next two months. If a student does not qualify the comprehensive examination in the second attempt, he/she will be dropped out from the PhD programme.
- The course work and comprehensive exam must be completed within initial two years of the programme.

1.3.8 Computation of Semester GPA and CGPA

Computation of semester grade point average (GPA) and cumulative grade point average (CGPA)

$$GPA = \frac{\text{Sum over Courses in Semester (Course Credit Hours x Grade Point Earned)}}{\text{Total Semester Credit Hours}}$$

Semester Grade Point Average (GPA) and Cumulative Grade Point Averages (CGPA) will be calculated using the following relationships:

$$CGPA = \frac{\text{Sum over all taken Courses in all Semesters (Course Credit Hours x Grade Point Earned)}}{\text{Total Credit Hours Taken in all Semester}}$$

2.2.2 Synopsis

- After successfully passing the comprehensive examination, a student shall prepare a synopsis/research proposal for PhD research work within maximum of the next 3 semesters according to the guidelines forsynopsis write up prepared by the university.
- Before beginning the practical research work, the student must successfully defend his/her synopsis through presentation before the ASRB.
- In case of changes in the scope of the research during research work, approval shall be sought on the prescribed form from the ASRB.

2.2.3 Research

- The research work will be of 30 Credits.
- Minimum one research paper should have been published in HEC approved journal before submission of thesis/dissertation for defence.

2.2.4 Progress Report

It shall be mandatory for the researcher to submit detailed biannual progress report by the end of each semester through his/her supervisors to the Controller of Examination for onward transmission to ASRB for evaluation.

2.2.5 Thesis Writing

- The PhD thesis must be written in British English as per the recommended format.

- The thesis must afford evidence of originality and have a distinct contribution to knowledge, shown by the discovery of new facts/knowledge.
- It must not include research work for which degree has been conferred on anybody in this or any otheruniversity.

Sub Committee of ASRB

Following sub-committee acts on behalf of Advanced Studies & Research Board of NTU to recommend PhD examiners (external & Internal) and recommend award of degree. Constitution of the committee is as under:

1. Director GSR (Convener)
2. Dean Academics (Member)
3. Concerned Dean (Member)
4. Concerned HoD (Member / If applicable)
5. Concerned Supervisor (Member)
6. Concerned Director Graduate Programs (Secretary)

This committee presents report regarding its recommendation in the upcoming meeting of ASRB.

2.2.6 Appointment of Examiners (Existing)

- ASRB recommends to the Rector/VC a panel of external examiners, 3 local and 3 foreign from technologically advanced countries, for evaluation of PhD thesis.
- The Rector appoints 2 national and 2 foreign external examiners out of the recommended panel for thesis evaluation.

2.2.7 Thesis Evaluation

- The Director GSR gets the thesis evaluated within maximum of **6** months after the date of submission to his office. Before forwarding the thesis to the examiner, the Director GSR arranges to conduct plagiarism test for the thesis.
- If any of the examiner suggests minor modifications/revision, this should be incorporated by the students within 3 months and certified by the supervisors.
- No viva voce is held unless all the examiners recommend the thesis for defense.
- If any of the examiners finds that the thesis is wholly inadequate or requires major modifications, the candidate will be asked for additional research work for maximum one year.
- The same examiner, who suggests modification of the thesis, shall evaluate the revised version of the thesis.

2.2.8 Final Thesis Defence

- The final defense may be open to the public.
- The scholar shall be required to undergo a viva-voce examination to be conducted by a panel comprising three examiners (two external and one internal) appointed by the Rector/VC from a list recommended by the ASRB.
- If a scholar fails to satisfy the examiners in the viva-voce, they shall direct the scholar to defend the thesis for the second time within a period of 6 months.
- If the scholar passes the viva-voce, the executive committee/syndicate, on the recommendations of the ASRB, will approve the reports of the examiners for the thesis and oral examination and award of the degree of DOCTOR OF PHILOSPHY on the relevant subject to the candidate. However, the Rector, in anticipation to the approval by the executive committee/syndicate, is authorized to approve the award of degree to a candidate who successfully defended thesis. However, action of the Rector shall be reported to the executive committee/syndicate in the next meeting for confirmation.

2.3 PhD Duration

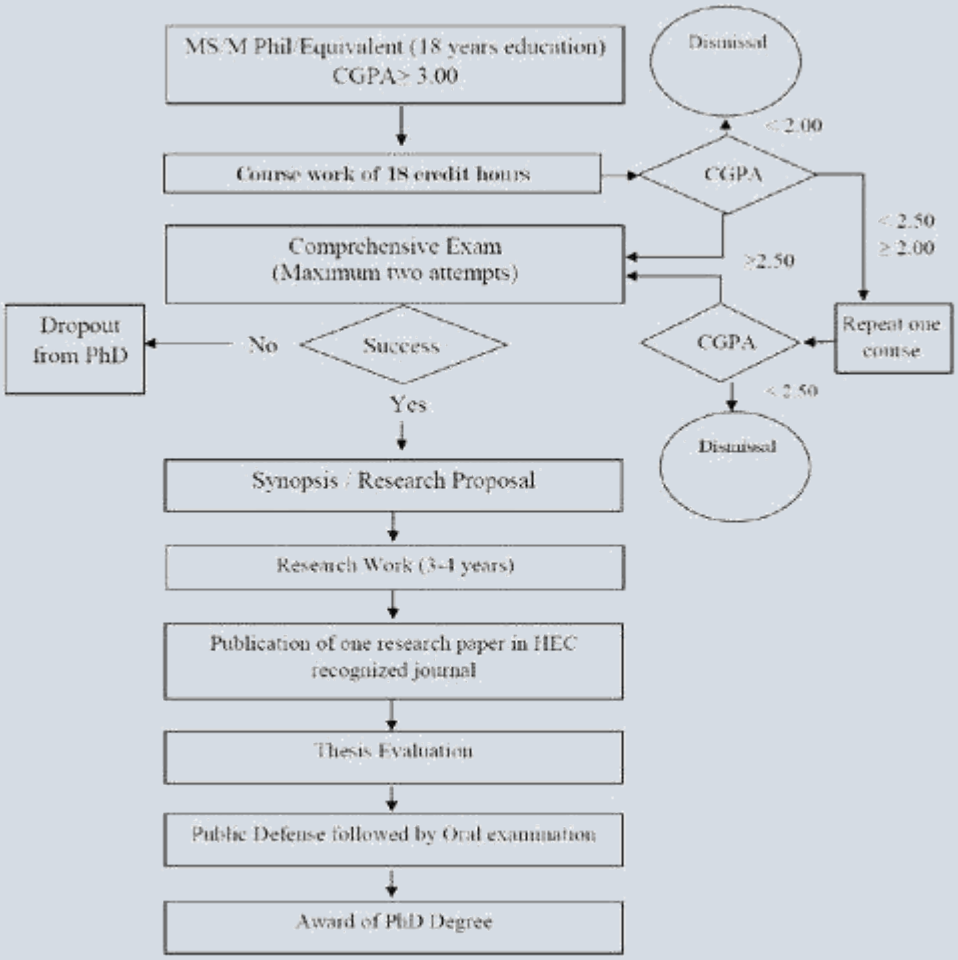
- The minimum period for completion of PhD programme shall be minimum 3 years (as per HEC), one year for 18 credit hours course work and two years for research. The period shall be counted from the commencement of semester for 18 credit hours course work.

- The maximum permissible period for submission PhD thesis will be 8 years (as per HEC).

2.4 Cancellation of PhD Registration

- PhD registration shall be cancelled by the Controller of Examination on the recommendation of the ASRB followed by the approval of the Rector/Vice-Chancellor, if the scholar:
  - Earns two consecutive adverse feedbacks from the ASRB on his progress report.
  - Does not complete the course work with the required CGPA.
  - Does not qualify the comprehensive examinations even in the second attempt.
  - Does not meet 75% attendance criteria.
  - Is guilty of misconduct.
- The aggrieved scholar may file an appeal against the cancellation of PhD registration to the Academic Council within a period of 30 days. Academic Council will give him/her an opportunity to be heard in person. However, the decision of the Academic Council will be final and will not be questioned in any court of law.

2.5 Flow Chart for Award of a Ph.D Degree



Fee of Structure of MS Programs

(Except MBA 3.5 Year and MS Business Administration 1.5 Year)

FEE TYPE	Semester-wise Amount in PKR			
	1st	2nd	3rd	4th
Tuition Fee	27,000	27,000	18,000	18,000
Admission Fee	20,000	-	-	-
Degree Fee	-	-	-	5,000
Certificate Verification Fee	2,000	-	-	-
Processing Fee	-	5,000	-	-
University Security	5,000	-	-	-
Red Crescent Donation	100	-	-	-
University Card Fee	300	-	-	-
Library Fee	1,000	1,000	1,000	1,000
Examination Fee	3,000	3,000	3,000	3,000
Medical Fee	2,000	2,000	2,000	2,000
Student Activity Fund	2,000	2,000	2,000	2,000
Endowment Fund	1,000	1,000	1,000	1,000
Transport Fee*	5,000	5,000	5,000	5,000
TOTAL	**68,400**	**46,000**	**32,000**	**37,000**

PhD Textile Engineering, PhD Computer Science & PhD Chemistry

FEE TYPE	Semester-wise Amount in PKR							
	1st	2nd	3rd	4th	5th	6th	7th	8th
Tuition Fee	27,000	27,000	18,000	18,000	18,000	18,000	18,000	18,000
Admission Fee	20,000	-	-	-	-	-	-	-
Degree Fee	-	-	-	5,000	-	-	-	-
Certificate Verification Fee	2,000	-	-	-	-	-	-	-
Processing Fee	-	5,000	-	-	-	-	-	-
University Security	5,000	-	-	-	-	-	-	-
Red Crescent Donation	100	-	-	-	-	-	-	-
University Card Fee	300	-	-	-	-	-	-	-
Library Fee	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Examination Fee	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000
Medical Fee	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000
Student Activity Fund	-	-	-	-	-	-	-	-
Endowment Fund	-	-	-	-	-	-	-	-
Transport Fee*	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000
TOTAL	65,400	43,000	29,000	34,000	29,000	29,000	29,000	29,000

*** There is no Transport Fee for Hostel Resident but they will pay hostel charges**

MBA (3.5 Years) including BBS (2-Years)

FEE TYPE	Semester-wise Amount in PKR						
	1st	2nd	3rd	4th	5th	6th	7th
Tuition Fee	27,500	27,500	27,500	27,500	27,500	27,500	27,500
Admission Fee	20,000	-	-	-	-	-	-
Degree Fee	-	-	-	5,000	-	-	-
Certificate Verification Fee	2,000	-	-	-	-	-	-
Processing Fee	-	5,000	-	-	-	-	-
University Security	5,000	-	-	-	-	-	-
Red Crescent Donation	100		-	-	-	-	-
University Card Fee	300		-	-	-	-	-
Library Fee	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Examination Fee	3,000	3,000	3,000	3,000	3,000	3,000	3,000
Medical Fee	2,000	2,000	2,000	2,000	2,000	2,000	2,000
Student Activity Fund	2,000	2,000	2,000	2,000	2,000	2,000	2,000
Endowment Fund	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Transport Fee*	5,000	5,000	5,000	5,000	5,000	5,000	5,000
TOTAL	68,900	46,500	41,500	46,500	41,500	41,500	41,500

MS Business Administration (1.5 Years)

FEE TYPE	Semester-wise Amount in PKR		
	1st	2nd	3rd
Tuition Fee	36,000	36,000	36,000
Admission Fee	20,000	-	-
Degree Fee	-	-	5,000
Certificate Verification Fee	2,000	-	-
Processing Fee	-	5,000	-
University Security	5,000	-	-
Red Crescent Donation	100	-	-
University Card Fee	300	-	-
Library Fee	1,000	1,000	1,000
Examination Fee	3,000	3,000	3,000
Medical Fee	2,000	2,000	2,000
Student Activity Fund	2,000	2,000	2,000
Endowment Fund	1,000	1,000	1,000
Transport Fee*	5,000	5,000	5,000
TOTAL	**77,400**	**55,000**	**55,000**

*** There is no Transport Fee for Hostel Resident but they will pay hostel charges**

Thesis Delay Fine Policy

1. If a student submit his/her thesis after minimum duration of degree period / submitting all regular semester dues following thesis delay fine will be charged:

   i. Rs. 5,000/- only will be charged as thesis delay fine in 4th semester* (for MS Business Administration students only)

   All Other MS Programs:

   ii. Rs. 5,000/- only will be charged as thesis delay fine in 5th semester*
   iii. Rs. 6,000/- only will be charged as thesis delay fine in 6th semester*

   **Examination Fee will be charged separately*

2. While if a student who will register / repeat any previous subject/s alongwith thesis, 1/3rd of tuition fee of last regular semester will also be charged other than above fine.

3. Ph.D student who have submitted his/her final thesis in Graduate Office for internal / external evaluation, will not be charged any dues.

Refund Policy

Students who desire to leave their studies from the university will be refunded the dues as per existing refund policy of HEC, Islamabad according to the following rules:

1. If any student applies for the refund of university dues paid by him/her up to 7th day of commencement of classes, he/she will be refunded full (100 %) deposited dues except the admission fee of Rs.20,000/-(Subject to clearance from all the departments).

2. If any student applies for the refund of deposited university dues from 8th to 15th day of commencement of classes, then he/she will be refunded security deposited and half (50%) fee (Subject to clearance from all the departments).

3. If any student applies for the refund of paid university dues from 16th day of the commencement of classes, only his/ her amount of security will be refunded (Subject to clearance from all the departments).

Note:

% age of fee shall be applicable on all components of fee, except for security and admission charges.

Time line shall be calculated continuously, covering both weekdays and weekend.

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