Prospectus BS & MS 2015

Department of Mathematics
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Director’s Message

My message is quite simple but implies continuous struggle for change. On every “to-day” we should dream of better “tomorrow”. Sukkur IBA is determined to become the center of Excellence for achieving the goal of betterment of Sindh, prosperity of Pakistan and welfare of the world at large.

Don’t complain of darkness light a candle.

Nisar Ahmed Siddqui
Director
Sukkur IBA
Mission statement of Sukkur-IBA

The mission of Sukkur IBA is “to contribute and serve community by imparting knowledge through innovative teaching and applied research at the global levels of excellence. We aim to establish and sustain a competitive meritorious environment by strengthening faculty and using state of the art technology to produce graduates with analytical, leadership skills and entrepreneurial spirit, who possess global outlook and are conscious of ethical values”.
Mission of Mathematics Department

The mission of Mathematics Department is to increase understanding and the ability to apply mathematics through in-depth study and endowing them with broad and diverse knowledge in the mathematical sciences, and to conduct the cutting edge research in Applied Mathematics. Faculty and advanced graduate students will coach undergrad and graduate students to create and upgrade their computational and analytical aptitudes. These aptitudes will create very qualified students who can enter beneficial professions in industry, institutions, and research in Pakistan as well as globally.
Departmental Goals & Objectives

We strive to make an impact on the discipline of Mathematics and on the broader community through the following goals:

- To be a resource in the Mathematical sciences for other disciplines whose own activities have an ever-increasing need for the power of the Mathematics.
- To work closely not only with colleagues from other discipline within Sukkur IBA but also with colleagues from the local schools and community colleges who share the responsibility of ensuring the flow of a mathematically literate and confident generation of new students.
- To embrace the notion such that change such as is manifested in computer technologies and educational reforms can be beneficial enhance learning and enrich the intellectual environment.

Undergraduate Program

➢ BS - Applied Mathematics

Limited access of poor people to quality education in Mathematics and increasing rate of unemployment has resulted in many socio-economic problems in the country. We strongly believe that using modern mathematical techniques and the targeting market and industrial needs, BS Mathematics program can produce more positive result. We will provide a successful BS Mathematics Program for community development at Sukkur IBA which will prove itself fruitful by bringing the change in the society.

Goals & Objectives of BS-Mathematics

To develop the quantitative skills of students:

- To enhance the knowledge of students to move to higher levels of independent learning
- To utilize Mathematics as a tool in various field of Industrial and Applied Sciences.
- To provide quality education with modern and scientifically tools so that graduates may possess globally outlook
- We take initiative from foundation semester in THP, Regular semester will start from Fall.
Eligibility Criteria for Admission:

- HSC (Pre-Engineering Group) or equivalent with 50% marks.
- Applicant has to appear and qualify SUKKUR IBA written test and interview.

Requirement:

Duration of program: 4 years (8 semesters); students NOT from the Pre-Engineering Group have to attend intensive courses in Mathematics, Physics and Chemistry during the semester breaks of first and second years depending on their deficiencies.
- Students cannot get the degree of BS before completing 4 years of study.

Total credit hours: 136 (maximum 18 hours per semester)
Compulsory Courses: 6 (11 credit hours)
Humanities Course: 1 (3 credit hours)
Core Courses: 24 (72 credit hours)
Minor Courses: 8 (24 credit hours)
Electives A: 4 (12 credit hours) [Electives in Specialization]
Electives B: 2 (6 credit hours); mathematics courses outside
Class Size: 50 (maximum) for lectures; 25 (maximum) for tutorial and laboratory session.

Drop out policy

- If any student is dropped during 1st or 2nd year of program, he/she can rejoin the program from the 1st semester without appearing in the entry test.
- If any of the students is dropped during 3rd or 4th year of program, he/she may regulate under term back policy.
Mathematics Club

- Mathematics club is the wing of Mathematics department that for inter college competition in Pakistan.
- To enhance the ability to apply Mathematics in various field of Science, Engineering, Economics, Finance, Business etc by taking various Exams, Quizzes, with prizes for the motivation of students.
  - Successfully we organized the 1st Mathematics competition among the students of THP 2013. Five laptops are distributed among the top 5 positions for their motivation.
  - Successfully we organized the 2nd Mathematics competition among the students of THP 2014. Sixteen laptops are also distributed among the top 3 group for their motivation.
  - 1st Intra-University Mathematics Olympiad Competition 2014 at SIBA.
  - 2nd Intra-University Mathematics Olympiad Competition 2015 at SIBA.
Fees Structure for Undergraduate Program

NOTE SHEET

Subject: Approval for the revised fees structure of BS Mathematics for fall 2015 at Sukkur IBA.

It is submitted that admission for BS Mathematics for fall 2015 through direct test Foundation Semester and Talent Hunt Program 2015 has been completed.

It is recommended that those students who are eligible for the admission in BS Mathematics for fall 2015, they may be allowed to pay following fees per semester.

Detail of the revised fees structure of Program per semester.

<table>
<thead>
<tr>
<th>Particulars</th>
<th>Financial Year 2015-2016</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>BS Mathematics</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>Admission Fees</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>Tuition Fee</td>
<td>20,000</td>
<td></td>
</tr>
<tr>
<td>SISC Contribution</td>
<td>1,000</td>
<td></td>
</tr>
<tr>
<td>Library Security (Refundable)</td>
<td>2,000</td>
<td></td>
</tr>
<tr>
<td>Total Fee Structure</td>
<td>23,000</td>
<td></td>
</tr>
</tbody>
</table>

It is submitted for approval and order.

Submitted for Approval:

HoD Mathematics Department
Sukkur IBA

Approved By:

Director
Sukkur IBA
# COURSES Schema BS - Mathematics

## First Year

<table>
<thead>
<tr>
<th>Semester 1</th>
<th>Course Code</th>
<th>TITLE</th>
<th>CREDIT HOURS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MATH-111</td>
<td>Calculus-I</td>
<td>3 + 0</td>
</tr>
<tr>
<td></td>
<td>MATH-112</td>
<td>Linear Algebra</td>
<td>3+0</td>
</tr>
<tr>
<td></td>
<td>HUM-111</td>
<td>Functional English/English Structure I</td>
<td>3 + 0</td>
</tr>
<tr>
<td></td>
<td>PHY-111</td>
<td>General – A1/Applied Physic I</td>
<td>2 + 1</td>
</tr>
<tr>
<td></td>
<td>ECO-101</td>
<td>General – B1/Introduction to Micro Economic</td>
<td>3 + 0</td>
</tr>
<tr>
<td></td>
<td>HUM-112</td>
<td>Islamic Studies</td>
<td>2+0</td>
</tr>
<tr>
<td></td>
<td>HUM-113</td>
<td>Ethics</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TOTAL</td>
<td></td>
<td>16 + 1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Semester 2</th>
<th>Course Code</th>
<th>TITLE</th>
<th>CREDIT HOURS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MATH-121</td>
<td>Number Theory</td>
<td>03 + 0</td>
</tr>
<tr>
<td></td>
<td>MATH-122</td>
<td>Calculus -II</td>
<td>03 + 0</td>
</tr>
<tr>
<td></td>
<td>PHY-121</td>
<td>General – A II/ Applied Physic II</td>
<td>02 + 1</td>
</tr>
<tr>
<td></td>
<td>MATH-123</td>
<td>Discrete Structures</td>
<td>03+0</td>
</tr>
<tr>
<td></td>
<td>CSE-111</td>
<td>Introduction to ICT/Computer</td>
<td>02+1</td>
</tr>
<tr>
<td></td>
<td>HUM-114</td>
<td>Pakistan Studies</td>
<td>02+0</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td></td>
<td>17</td>
</tr>
</tbody>
</table>

*Learning Outcomes:* After completing first year, the student should be able to utilize basic tools for computations in order to solve problems of mathematics
## Second Year

### Semester 3

<table>
<thead>
<tr>
<th>Course Code</th>
<th>TITLE</th>
<th>CREDIT HOURS</th>
</tr>
</thead>
<tbody>
<tr>
<td>HUM-211</td>
<td>Communication Skills /Presentation Skills</td>
<td>2 +1</td>
</tr>
<tr>
<td>CSE-211</td>
<td>Introduction to Language /Computer Appl. For Math.</td>
<td>3 + 1</td>
</tr>
<tr>
<td>MATH-211</td>
<td>Calculus III</td>
<td>3 + 0</td>
</tr>
<tr>
<td>ECO-102</td>
<td>General -A III/ Introduction to Macro Economic</td>
<td>3 + 0</td>
</tr>
<tr>
<td>SSC-201</td>
<td>General -B III/ Word History/Math History</td>
<td>2 + 1</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>16</td>
</tr>
</tbody>
</table>

### Semester 4

<table>
<thead>
<tr>
<th>Course Code</th>
<th>TITLE</th>
<th>CREDIT HOURS</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH-221</td>
<td>Algebra I</td>
<td>3 + 0</td>
</tr>
<tr>
<td>HUM-121</td>
<td>English Structure II/ Technical Writing</td>
<td>3 + 0</td>
</tr>
<tr>
<td>MATH-222</td>
<td>Computing Tools for Mathematics</td>
<td>2+1</td>
</tr>
<tr>
<td>MATH-223</td>
<td>Mathematical Statistics</td>
<td>3 + 0</td>
</tr>
<tr>
<td>HUM-221</td>
<td>General -A IV/ Introduction to Psychology</td>
<td>2 + 1</td>
</tr>
<tr>
<td>HUM-222</td>
<td>General -A IV Introduction to Sociology</td>
<td>2 + 1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>18</td>
</tr>
</tbody>
</table>

*Learning Outcomes*: After completing second year, the student should be able to understand proof and to write a formal proof for theoretical applications.
### Third Year

#### Semester 5

<table>
<thead>
<tr>
<th>Course Code</th>
<th>TITLE</th>
<th>CREDIT HOURS</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH-311</td>
<td>Algebra II</td>
<td>3 + 0</td>
</tr>
<tr>
<td>MATH-312</td>
<td>Vector &amp; Tensor Analysis</td>
<td>3+0</td>
</tr>
<tr>
<td>MATH-313</td>
<td>Operation Research</td>
<td>3 + 0</td>
</tr>
<tr>
<td></td>
<td>Guest/Students’ Seminar I</td>
<td>1 + 0</td>
</tr>
<tr>
<td>MATH-314</td>
<td>Numerical Analysis</td>
<td>3 + 0</td>
</tr>
<tr>
<td>MATH-315</td>
<td>Ordinary Differential Equations</td>
<td>3 + 0</td>
</tr>
<tr>
<td>MATH-316</td>
<td>Real Analysis I</td>
<td>2 + 0</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>18 + 0</td>
</tr>
</tbody>
</table>

#### Semester 6

<table>
<thead>
<tr>
<th>Course Code</th>
<th>TITLE</th>
<th>CREDIT HOURS</th>
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</thead>
<tbody>
<tr>
<td>MATH-321</td>
<td>Algebra III</td>
<td>3 + 0</td>
</tr>
<tr>
<td>MATH-322</td>
<td>Classical Mechanics</td>
<td>3 + 0</td>
</tr>
<tr>
<td>MATH-323</td>
<td>Real Analysis II</td>
<td>3 + 0</td>
</tr>
<tr>
<td>MATH-324</td>
<td>Introduction to Topology</td>
<td>3 + 0</td>
</tr>
<tr>
<td></td>
<td>Guest/Students’ Seminar II</td>
<td>1 + 0</td>
</tr>
<tr>
<td>MATH-325</td>
<td>Partial Differential Equations</td>
<td>3 + 0</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>16 + 0</td>
</tr>
</tbody>
</table>

*Learning Outcomes:* After completing third year, the student should know the main branches of mathematics, *i.e.*, analysis, topology, differential equations, mechanics, numerical analysis, probability and statistics and to apply these theories in practical problems.
### Fourth Year

<table>
<thead>
<tr>
<th>Semester 7</th>
<th>Course Code</th>
<th>TITLE</th>
<th>CREDIT HOURS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MATH-411</td>
<td>Elective – A I/ Mathematical Modeling and Simulation</td>
<td>3 + 0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Elective – A II</td>
<td>3 + 0</td>
</tr>
<tr>
<td></td>
<td>MATH-412</td>
<td>Graph theory</td>
<td>3+0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Guest/Students’ Seminar III</td>
<td>1 + 0</td>
</tr>
<tr>
<td></td>
<td>MATH-413</td>
<td>Final year Project I</td>
<td>3 + 0</td>
</tr>
<tr>
<td></td>
<td>MATH-414</td>
<td>Complex Analysis</td>
<td>3+0</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td></td>
<td>16 + 0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Semester 8</th>
<th>Course Code</th>
<th>TITLE</th>
<th>CREDIT HOURS</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>MATH-421</td>
<td>Elective – B OR Final year Project II</td>
<td>3 + 0</td>
</tr>
<tr>
<td></td>
<td>MATH-422</td>
<td>Mathematical Physic</td>
<td>2 +1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Guest/Students’ Seminar IV</td>
<td>1 + 0</td>
</tr>
<tr>
<td></td>
<td>MATH-423</td>
<td>Optimization Theory</td>
<td>3 + 0</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td></td>
<td>12 + 1</td>
</tr>
</tbody>
</table>

**Learning Outcomes:** After completing fourth year, the student should choose the field of specialization and write research paper.
**BS-Course Description**

### ALGEBRA I
- **Prerequisite(s):** Mathematics at intermediate level
- **Credit Hours:** 3 + 0

**Specific Objectives of the Course:**
This is the first course in groups, matrices and linear algebra, which provides basic background needed for all mathematics majors, a prerequisite for many courses. Many concepts presented in the course are based on the familiar setting of plane and real three-space, and are developed with an awareness of how linear algebra is applied.

**Course Outline:**
*Group Theory:* Basic axioms of a group with examples, abelian groups, center of a group, derived subgroup of a group, subgroups generated by subset of a group, system of generators, cyclic groups, cosets and quotient sets, Lagrange’s theorem, introduction to permutations, even and odd permutations, cycles, lengths of cycles, transpositions, symmetric group, alternating groups, rings, finite and infinite fields (definition and examples), vector spaces, subspaces, linear span of a subset of a vector space, bases and dimensions of a vector space

*Algebra of Matrices:* Determinants, matrix of a linear transformation, row and column operations, rank, inverse of matrices, group of matrices and subgroups, orthogonal transformation, Eigen value problem with physical significance

**Recommended Books:**
Englewood Cliffs, NJ, USA

### ALGEBRA II
- **Prerequisite(s):** Algebra I
- **Credit Hours:** 3 + 0

**Specific Objectives of the Course:**
This is a course in advanced abstract algebra, which builds on the concepts learnt in Algebra I.

**Course Outline:**
*Group Theory:* Normalizers and centralizers of a subset of a group, congruency classes of a group, normal subgroup, quotient groups, conjugacy relation between elements and subgroups, homomorphism and isomorphism between groups, Homomorphism and
isomorphism theorems, group of automorphisms, finite p-groups, internal and external direct products, group action on sets, isotropy subgroups, orbits, 1st, 2nd and 3rd Sylow theorems. 

Ring Theory: Types of rings, matrix rings, rings of endomorphisms, polynomial rings, integral domain, characteristic of a ring, ideal, types of ideals, quotient rings, homomorphism of rings, fundamental theorem of homomorphism of rings.

Recommended Books:
Allenby RBJT, Rings, Fields and Groups: An Introduction to Abstract Algebra, 1983, Edward Arnold
Farleigh JB, A First Course in Abstract Algebra (7th edition), Addison- Wesley, Reading, Ma., USA
Macdonald ID, The Theory of Groups, 1975, Oxford Clarendon Press, Ma., USA

ALGEBRA III
Prerequisite(s): Algebra II
Credit Hours: 3 + 0

Specific Objectives of the Course:
This is a course in abstract linear algebra. The majority of follow up courses in both pure and applied mathematics assume the material covered in this course.

Course Outline:
Vector spaces; sums and direct sums of subspaces of a finite dimensional vector space, Dimension theorem, linear transformation, null space, image space of linear transformation, rank and nullity of a linear transformation, relation between rank, nullity and dimension of the domain of a linear transformation, matrix of linear transformation, change of basis, inner product spaces, projection of a vector along another vector, norm of a vector, Cauchy Schwartz inequality, Orthogonal and orthonormal basis, similar matrices and diagonalization of a matrix, Home (V,W), dimension and basis of Home (V,W), dual space and dual basis, annihilators.


CALCULUS I
Prerequisite(s): Mathematics at intermediate level
Credit Hours: 3 + 0

Specific Objectives of the Course:
This is the first course of the basic sequence, Calculus I-III, serving as the foundation of advanced subjects in all areas of mathematics. The sequence, equally, emphasizes basic concepts and skills needed for mathematical manipulation. Calculus I & II focus on the study of functions of a single variable.

Course Outline:
Limits and continuity; derivative of a function and its applications; optimization problems; mean value theorem (Taylor’s theorem and the infinite Taylor series with applications) and curve
sketching; anti-derivative and integral; definite integral and applications; the fundamental theorem of calculus; inverse functions (Chapters 1-6 of the text)

**Recommended Books:**

<table>
<thead>
<tr>
<th>CALCULUS II</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Prerequisite(s):</strong></td>
</tr>
<tr>
<td><strong>Credit Hours:</strong></td>
</tr>
</tbody>
</table>

**Specific Objectives of the Course:**
This is the second course of the basic sequence Calculus I-III serving as the foundation of advanced subjects in all areas of mathematics. The sequence, equally, emphasizes basic concepts and skills needed for mathematical manipulation. As continuation of Calculus I, it focuses on the study of functions of a single variable.

**Course Outline:**
Continuation of Calculus I: Techniques of integration; further applications of integration; parametric equations and polar coordinates; sequences and series; power series representation of functions (Chapters 7-10 of the text)

**Recommended Books:**

<table>
<thead>
<tr>
<th>CALCULUS III</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Prerequisite(s):</strong></td>
</tr>
<tr>
<td><strong>Credit Hours:</strong></td>
</tr>
</tbody>
</table>

**Specific Objectives of the Course:**
This is the third course of the basic sequence Calculus I-III serving as the foundation of advanced subjects in all areas of mathematics.

**Course Outline:**
This course covers vectors and analytic geometry of 2 and 3 dimensional spaces; vector-valued functions and space curves; functions of several variables; limits and continuity; partial derivatives; the chain rule; double and triple integrals with applications; line integrals; the Green theorem; surface area and surface integrals; the Green, the divergence and the Stokes theorems with applications (Chapters 11-14 of the text).
Recommended Books:

**CLASSICAL MECHANICS**

<table>
<thead>
<tr>
<th>Prerequisite(s):</th>
<th>Vector and Tensor Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Credit Hours:</td>
<td>3 + 0</td>
</tr>
</tbody>
</table>

**Specific Objectives of the Course:**

This course builds grounding in principles of classical mechanics, which are to be used while studying quantum mechanics, statistical mechanics, electromagnetism, fluid dynamics, space-flight dynamics, astrodynamics and continuum mechanics.

**Course Outline:** Particle kinematics, radial and transverse components of velocity and acceleration, circular motion, motion with a uniform acceleration, the Newton laws of motion (the inertial law, the force law and the reaction law), newtonian mechanics, the newtonian model of gravitation, simple-harmonic motion, damped oscillations, conservative and dissipative systems, driven oscillations, nonlinear oscillations, calculus of variations, Hamilton’s principle, lagrangian and hamiltonian dynamics, symmetry and conservation laws, Noether’s theorem, central-force motion, two-body problem, orbit theory, Kepler’s laws of motion (the law of ellipses, the law of equal areas, the harmonic law), satellite motion, geostationary and polar satellites, kinematics of two-particle collisions, motion in non-inertial reference frame, rigid-body dynamics (3-D-rigid bodies and mechanical equivalence, motion of a rigid body, inverted pendulum and stability, gyroscope)

**Recommended Books:**
Bedford A, Fowler W, Dynamics: *Engineering Mechanics*, Addision- Wesley, Reading, Ma, USA
Goldstein H, *Classical Mechanics* (2nd edition), 1980, Addison-Wesley, Reading, Ma, USA

**COMPLEX ANALYSIS**

<table>
<thead>
<tr>
<th>Prerequisite(s):</th>
<th>Real Analysis I</th>
</tr>
</thead>
<tbody>
<tr>
<td>Credit Hours:</td>
<td>3 + 0</td>
</tr>
</tbody>
</table>

**Specific Objectives of the Course:**

This is an introductory course in complex analysis, giving the basics of the theory along with applications, with an emphasis on applications of complex analysis and especially conformal mappings. Students should have a background in real analysis (as in the course Real Analysis I), including the ability to write a simple proof in an analysis context.
Course Outline:
The algebra and the geometry of complex numbers, Cauchy-Riemann equations, harmonic functions, elementary functions, branches of the logarithm, complex exponents. Contours and contour integrals, the Cauchy-Goursat Theorem, Cauchy integral formulas, the Morera Theorem, maximum modulus principle, the Liouville theorem, fundamental theorem of algebra. Convergence of sequences and series, the Taylor series, the Laurent series, uniqueness of representation, zeros of analytic functions. Residues and poles and the residue theorem, evaluation of improper integrals involving trigonometric functions, integrals around a branch point., the argument principle, the Roche theorem.

Recommended Text:

<table>
<thead>
<tr>
<th>COMPUTING TOOLS FOR MATHEMATICIANS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prerequisite(s): Programming Languages for Mathematicians</td>
</tr>
<tr>
<td>Credit Hours: 2 + 1</td>
</tr>
</tbody>
</table>

Specific Objectives of the Course:
The purpose of this course is to teach students the use of mathematical software like MATLAB, MAPLE, MATHEMATICA for solving computationally-difficult problems in mathematics. The student shall become well versed in using at least one mathematical software and shall learn a number of techniques that are useful in calculus as well as in other areas of mathematics.

Course Outline:
The contents of the course are not fixed, however the following points should be kept in mind while teaching the course. The course should be taught in a computer lab setting. Besides learning to use the software, the students must be able to utilize the software to solve computationally difficult problems in calculus and other areas of mathematics. At the end of the course, the students should have a good command on at least two of the three programs mentioned above.

Recommended Books:

<table>
<thead>
<tr>
<th>DISCRETE STRUCTURES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prerequisite(s): Mathematics at intermediate level</td>
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<tr>
<td>Credit Hours: 3 + 0</td>
</tr>
</tbody>
</table>

Specific Objectives of the Course:
This course shall assume background in number theory. It lays a strong emphasis on understanding and utilizing various strategies for composing mathematical proofs.
Course Outline:

*Set and Relations:* Basic notions, set operations, Venn diagrams, extended-set operations, indexed family of sets, countable and uncountable sets, relations, cardinality, equivalence relations, congruence, partitions, partial order, representation of relations, mathematical induction.

*Elementary Logic:* Logics of order zero and one, Propositions and connectives, truth tables, conditionals and bi-conditionals, quantifiers, methods of proof, proofs involving quantifiers.

**Recommended Text:**


**FUNCTIONAL ANALYSIS**

<table>
<thead>
<tr>
<th>Prerequisite(s):</th>
<th>Complex Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Credit Hours:</td>
<td>3 + 0</td>
</tr>
</tbody>
</table>

**Specific Objectives of the Course:**

This course extends methods of linear algebra and analysis to spaces of functions, in which the interaction between algebra and analysis allows powerful methods to be developed. The course will be mathematically sophisticated and will use ideas both from linear algebra and analysis.

**Course Outline:**


**Recommended Books:**


**MATHEMATICAL SPACES**

<table>
<thead>
<tr>
<th>Prerequisite(s):</th>
<th>Discrete Structures, Real Analysis I</th>
</tr>
</thead>
<tbody>
<tr>
<td>Credit Hours:</td>
<td>3 + 0</td>
</tr>
</tbody>
</table>

**Specific Objectives of the Course:**

This course is designed primarily to develop pure mathematical skills of students. Students will
need some background in writing proofs. They will lean notions of spaces, metric, measure and topology

Course Outline:

Notion of Spaces: Example of set, group, field, ring, affine space, Banach space, normed space, Hilbert space (Simmon)
a) Notion of Topology: Calculus on manifolds, continuity of functions on spaces, neighborhoods, topological spaces, finer and weaker topologies, homomorphism, homomorphic spaces, compactness, connectedness, normal spaces, Urysohn’s lemma (Munkres)
b) Notion of Metric: Metric space, complete metric space, Baire category theorem, metrization of spaces (Friedmann)
c) Notion of Measure: Spaces with measure, measurable function, idea of σ-fields (Holmos)

Recommended Books:
Friedmann A, Foundations of Modern Analysis, 1982, Dover
Holmos PR, Measure Theory, van Nostrand, New York

MATHEMATICAL STATISTICS
Prerequisite(s): Probability Theory
Credit Hours: 3 + 0

Specific Objectives of the Course:
In the course “Probability Theory” the students learnt how to set up mathematical models of processes and systems that are affected by chance. In the present course the students would learn how to check these models against reality, to determine whether they are reliable/accurate enough for practical purposes or otherwise. This helps in making predictions and decisions

Course Outline:
Sampling theory: sampling distributions; sampling procedures; estimation of parameters: estimation of mean, variance; confidence intervals; decision theory: hypothesis testing and decision making; types of errors in tests; quality control; control charts for mean, standard deviation, variance, range; goodness of fit, chi-square test. Regression analysis; method of least squares; correlation analysis.

Recommended Books:
Sincich T, Statistics by Examples, 1990, Dellen Publication Company
MODELING AND SIMULATION
Prerequisite(s): Partial-Differential Equations
Credit Hours: 2 + 1

Specific Objectives of the Course:
Mathematics is used in many areas such as engineering, ecological systems, biological systems, financial systems, economics, etc. In all such applications one approximates the actual situation by an idealized model. This is an introductory course of modeling, consisting of three parts: modeling with ordinary differential equations and their systems; partial differential equations; and integral equations. The course will not be concerned with the techniques for solving the equations but with setting up the equations in specific applications. Whereas the first two types of equations have already been dealt with, the third type has not. Consequently, solutions of the former will be discussed but of the latter will barely be touched upon.

Course Outline:
Concepts of model, modeling and simulation, functions, linear equations, linear-differential equations, nonlinear-differential equations and integral equations as models, introduction to simulation techniques
Ordinary-Differential Equations: Modeling with first order differential equations: Newton’s law of cooling; radioactive decay; motion in a gravitational field; population growth; mixing problem; Newtonian mechanics. Modeling with second order differential equations: vibrations; application to biological systems; modeling with periodic or impulse forcing functions. Modeling with systems of first order differential equations; competitive hunter model; predator-prey model.

Partial-Differential Equations: Methodology of mathematical modeling; objective, background, approximation and idealization, model validation, compounding. Modeling wave phenomena (wave equation); shallow water waves, uniform transmission line, traffic flow, RC circuits. Modeling the heat equation and some application to heat conduction problems in rods, lamina, cylinders etc. Modeling the potential equation (Laplace equation), applications in fluid mechanics, gravitational problems. Equation of continuity.
Simulation: Techniques of simulation (students are required to simulate at least one system)

Recommended Books:
Giordano FR, Weir MD, Differential Equations: A Modeling Approach, 1994, Addison-Wesley, Reading, Ma, USA (suggested text)
Myint UT, Debnath L, Partial Differential Equations for Scientists and Engineers (3rd edition), 1987, North Holland, Amsterdam

GRAPH THEORY
Prerequisite(s): Calculus I, Discrete Structures
Credit Hours: 3 + 0

Specific Objectives of the Course:
This course gives knowledge of graph theoretical concepts, important classes of problems in graph theory to use graph as a tool to model real-life problems.

Course Outline:

Fundamental Concepts, Trees and distance, bipartite graphs, Matchings and Factors, Connectivity and Paths, k-connected graphs and Menger’s theorems, colorings of graphs, Planarity graph, Edges and Cycles, Hamilton cycles, elementary Ramsey theory, some applications of graphs in natural science, timetabling and computer science.

Recommended Books:

J.A.Bondy and U.S.R.Murty, Graph Theory with Applications, North-Holland, 1976

### NUMBER THEORY

**Prerequisite(s):** Calculus I, Discrete Structures  
**Credit Hours:** 3 + 0

Specific Objectives of the Course:

This course shall assume no experience or background in number theory or theoretical mathematics. The course introduces various strategies for composing mathematical proofs.

Course Outline:

Divisibility, Euclidean algorithm, GCD and LCM of 2 integers, properties of prime numbers, fundamental theorem of arithmetic (UFT), congruence relation, residue system, Euler’s phi-function, solution of system of linear congruence’s, congruence’s of higher degree, Chinese remainder theorem, Fermat’s little theorem, Wilson’s theorem and applications, primitive roots and indices; integers belonging to a given exponent (mod p), primitive roots of prime and composite moduli, indices, solutions of congruence’s using indices., quadratic residues, composite moduli, quadratic residues of primes, the Legendre symbol, the Quadratic reciprocity law, the Jacobi symbol, Diophantine equations

**Recommended Books:**

Grosswald E, *Topics from the Theory of Numbers*, The Macmillan Company  
LeVeque WJ, *Topics in Number Theory*, Vol.1, Addison-Wesley, Reading, Ma, USA  
Niven I, Zuckerman HS, *An Introduction to The Theory of Numbers*, Wiley Eastern  

### NUMERICAL ANALYSIS

**Prerequisite(s):** Computing Tools for Mathematicians  
**Credit Hours:** 3 + 0
Specific Objectives of the Course:
This course is designed to teach the students about numerical methods and their theoretical bases. The students are expected to know computer programming to be able to write program for each numerical method. Knowledge of calculus and linear algebra would help in learning these methods.

Course Outline:

Recommended Books:

OPTIMIZATION THEORY
Prerequisite(s): Algebra I, Real Analysis I
Credit Hours: 3 + 0

Specific Objectives of the Course:
The main objective is to teach the basic notions and results of mathematical programming and optimization. The focus will be to understand the concept of optimality conditions and the construction of solutions. Students should have a good background in analysis, linear algebra and differential equations.

Course Outline:
Linear programming: simplex method, duality theory, dual and primal- dual simplex methods. Unconstrained optimization: optimality conditions, one dimensional problem, multi-dimensional problems and the method of steepest descent, Constrained optimization with equality constraints: optimality conditions, Lagrange multipliers, Hessians and bordered Hessians, Inequality constraints and the Kuhn-Tucker Theorem. The calculus of variations, the Euler-Lagrange equations, functional depending on several variables, variational problems in parametric form, transportation models and networks

Recommended Books:
ORDINARY-DIFFERENTIAL EQUATIONS
Prerequisite(s): Calculus III,
Credit Hours: 3 + 0

Specific Objectives of the Course:
This course provides the foundation of all advanced subjects in Mathematics. Strong foundation and applications of Ordinary Differential Equations is the goal of the course.

Course Outline:
Introduction; formation, solution and applications of first-order-differential equations; formation and solution of higher-order-linear-differential equations; differential equations with variable coefficients; Sturm- Liouville (S-L) system and boundary-value problems; series solution and its limitations; the Frobenius method, solution of the Bessel, the hyper geometric, the Legendre and the Hermite equations, properties of the Bessel function

Recommended Text:

PARTIAL-DIFFERENTIAL EQUATIONS
Prerequisite(s): Real Analysis I, Ordinary-Differential Equations
Credit Hours: 3 + 0

Specific Objectives of the Course:
The course provides a foundation to solve Partial Differential Equations with special emphasis on wave, heat and Laplace equations. Formulation and some theory of these equations are also intended.

Course Outline:
First-order-partial-differential equations; classification of second-order PDE; canonical form for second-order equations; wave, heat and the Laplace equation in Cartesian, cylindrical and spherical-polar coordinates; solution of partial differential equation by the methods of: separation of variables; the Fourier, the Laplace and the Hankel transforms, non-homogeneous-partial-differential equations

Recommended Text:
Myint UT, Partial Differential Equations for Scientists and Engineers (3rd edition), 1987, North Holland, Amsterdam

PROBABILITY THEORY
Prerequisite(s): Calculus III
Credit Hours: 3 + 0
Specific Objectives of the Course:
This course is designed to teach the students how to handle data numerically and graphically. If data are influenced by chance effect, the concepts and rules of probability theory may be employed, being the theoretical counterpart of the observable reality, whenever chance is at work.

Course Outline:
Introduction to probability theory; random variables; probability distributions; mean, standard deviation, variance and expectation. Binomial, negative binomial, Poisson, geometric, hyper geometric and normal distributions; normal approximation to binomial distribution; distributions of 2 random variables.

Recommended Books:
Sincich T, Statistics by Examples, 1990, Dellen Publishing Company

PROGRAMMING LANGUAGES FOR MATHEMATICIANS
Prerequisite(s): Calculus II
Credit Hours: 3 + 1

Specific Objectives of the Course:
The purpose of this course is to introduce students to operating systems and environments

Course Outline:
Introduction to operating systems, one Language (FORTRAN or C/C++), building blocks, variables, input/output, loops (FOR, WHILE, DO), decisions (IF, IF ELSE, ELSE IF) construct switch statement, conditional statement, function that returns a value using argument to pass data to another function, external variable, arrays and strings, pointers, structure, files and introduction to object-oriented programming

Recommended Books:

REAL ANALYSIS I
Prerequisite(s): Calculus III
Credit Hours: 2 + 0

Specific Objectives of the Course:
This is the first rigorous course in analysis and has a theoretical emphasis. It rigorously develops the fundamental ideas of calculus and is aimed to develop the students’ ability to deal
with abstract mathematics and mathematical proofs.

**Course Outline:** Ordered sets, supremum and infimum, completeness properties of the real numbers, limits of numerical sequences; limits and continuity, properties of continuous functions on closed bounded intervals; derivatives in one variable; the mean value theorem; Sequences of functions, power series, point-wise and uniform convergence. Functions of several variables: open and closed sets and convergence of sequences in $\mathbb{R}^n$; limits and continuity in several variables, properties of continuous functions on compact sets; differentiation in $n$-space; the Taylor series in $\mathbb{R}^n$ with applications; the inverse and implicit function theorems.

**Recommended Books:**

---

**REAL ANALYSIS II**
**Prerequisite(s):** Real Analysis I
**Credit Hours:** 3 + 0

**Specific Objectives of the Course:**
A continuation of Real Analysis I, this course rigorously develops integration theory. Like Real Analysis I, Real Analysis II emphasizes proofs.

**Course Outline:**
Series of numbers and their convergence, Series of functions and their convergence, Dabroux upper and lower sums and integrals, Dabroux integrability, Riemann sums and the Riemann integral, Riemann integration in $\mathbb{R}^2$, change of order of variables of integration. Riemann integration in $\mathbb{R}^3$, and $\mathbb{R}^n$, Riemann-Steiltjes integration, Functions of bounded variation, The length of a curve in $\mathbb{R}^n$

**Recommended Books:**

---

**VECTOR AND TENSOR ANALYSIS**
**Prerequisite(s):** Calculus II
**Credit Hours:** 3 + 0
Specific Objectives of the Course:
This course shall assume background in calculus. It covers basic principles of vector analysis, which are used in mechanics

Course Outline:
3-D vectors, summation convention, kronecker delta, Levi-Civita symbol, vectors as quantities transforming under rotations with $\varepsilon_{ijk}$, scalar and vector triple products, scalar- and vector-point functions, differentiation and integration of vectors, line integrals, path independence, surface integrals, volume integrals, gradient, divergence and curl with physical significance and applications, vector identities, Green’s theorem in a plane, divergence theorem, Stokes’ theorem, coordinate systems and their bases, the spherical-polar- and the cylindrical-coördinate meshes, tensors of first, second and higher orders, algebra of tensors, contraction of tensor, quotient theorem, symmetric and skew-symmetric tensors, invariance property, application of tensors in modeling anisotropic systems, study of physical tensors (moment of inertia, index of refraction, etc.), diagonalization of inertia tensor as aligning coordinate frame with natural symmetries of the system

Recommended Books:
Graduate Program

- **MS-Applied Mathematics**
  Mathematics, as the language of science and engineering, is essential to our study of both nature and technology. The clear logical thought processes that arise from mathematical studies are extremely valuable in many professions.

**Program objectives**

Master the core mathematical content both at operational and conceptual level

i) Be able to use technology to solve practical computational problems.

ii) Be able to communicate clearly with experts in other disciplines

iii) Be able to continue studies in Applied Mathematics doctoral programs abroad.

iv) To develop confidence in attacking indigenous problems and creating new solutions

v) After completing this program our students will be able:

- To apply acquired knowledge in financial corporations.
- Exhibit ethical and team work commitment.
- To analyses and exhibit mathematical models in governmental institutions or in academia

**Eligibility Criteria (**)**

- Applicants who have completed their 16 Years of Education in any one of the fields mentioned below with at least 1st Division or 2.2 CGPA from any HEC recognized University / Institution are eligible for admission.

  i. BS Mathematics
  ii. BS Engineering
  iii. M.Sc/BS in Mathematics/ Economics/ Statistics/Finance
  iv. Physics
  v. Actuarial Mathematics

- Applicant should have passed the NTS (GAT-General test) with a minimum of 50% cumulative score.
• A test equivalent to GRE (General and Subjective) is to be taken by the applicant for admission into MS degree. The test will be organized by the Sukkur-IBA. Those applicants who qualify test will appear for the Interview.

Registration and Enrollment:

➢ Pass Certificate/ marks sheet of (BS / MSc) plus attested copies
➢ HSC/A-Level (OR equivalent) Certificate with marks Sheet.
➢ Migration certificate of the University /University’s Board.
➢ Six Copies of recent passport-size photographs

<table>
<thead>
<tr>
<th>Grades</th>
<th>GP</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>4.0</td>
<td>93 and above</td>
</tr>
<tr>
<td>A-</td>
<td>3.67</td>
<td>87-92</td>
</tr>
<tr>
<td>B+</td>
<td>3.33</td>
<td>82-86</td>
</tr>
<tr>
<td>B</td>
<td>3.00</td>
<td>77-81</td>
</tr>
<tr>
<td>B-</td>
<td>2.67</td>
<td>72-76</td>
</tr>
<tr>
<td>C+</td>
<td>2.3</td>
<td>68-71</td>
</tr>
<tr>
<td>C</td>
<td>2.00</td>
<td>64-67</td>
</tr>
<tr>
<td>C-</td>
<td>1.67</td>
<td>60-63</td>
</tr>
<tr>
<td>F</td>
<td>0.00</td>
<td>0-59</td>
</tr>
</tbody>
</table>

Evaluation of Student
The performance of students is evaluated through a system of continuous testing spread over the entire period of studies. In addition to the final examination given at the end of each semester, students are tested through monthly examinations, a series of short quizzes, class discussions, written assignments, research reports, etc., all of which contribute to the final grade.

Midterm examinations are administered every month. A student sits through two such examinations for each course every semester. A number of quizzes are taken during the semester to monitor the performance of the students. To rate students’ academic performance & (CGPA) is computed at the end of Semester.

<table>
<thead>
<tr>
<th>Category</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final Exam</td>
<td>40</td>
</tr>
<tr>
<td>Mid Term 1</td>
<td>20</td>
</tr>
</tbody>
</table>
Fees Structure for Graduate Program

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Admission Fees</td>
<td>15000</td>
</tr>
<tr>
<td>Course Registration</td>
<td>15,000</td>
</tr>
<tr>
<td>Thesis/Semester</td>
<td>30,000</td>
</tr>
<tr>
<td>Hostel Fees (For Single Occupancy Room)</td>
<td>18000</td>
</tr>
<tr>
<td>Hostel Fees (For Double Occupancy Room)</td>
<td>15000</td>
</tr>
<tr>
<td>Hostel Fees (For Tri Occupancy Room)</td>
<td></td>
</tr>
</tbody>
</table>

Program Road Map

Duration: Minimum 2 Years & Maximum 4 Years
Semesters: 04
Credit Hours: 30

Sukkur IBA offers MS in Applied Mathematics. The MS program in Applied Mathematics prepares students for careers in research, applications and academia. The courses and research areas are designed so that students excel in following fields.

- **Numerical Optimization** (It covers optimization methods with applications in biology, chemical engineering, economic and finance including asset and liability management, asset pricing, optimization models arising in model calibration, prediction and estimation, risk analysis and financial data analysis.
- **Computational Finance** (It includes applications of finite difference methods, Monte-Carlo methods, finite element method and simulation methods for option pricing)
• **Actuarial Mathematics** (It includes topics in industrial and operational engineering, economics, statistics and accounting)

• **Applied Mathematics** (It includes numerical and analytical techniques for applications in various phenomena, mathematical modeling of complex models from biotechnology, geology, engineering, nanotechnology, etc.)

Students are required to successfully qualify eight courses (4 compulsory and 4 electives) each of 3 credit hours duration. On successful completion of MS course work students will be allowed to work on a 06 credit hour thesis on a subject of interest and on the availability of the faculty. The minimum duration of completion of MS Program is 2 years (Four Semesters) and maximum duration is 4 Years and students must pass GAT (General) before applying for the admission or within six months after the admission.

**Note:**

Following specialization tracks will be offered under the MS Applied Mathematics program in Mathematics Department and courses will be offered in accordance to the availability of faculty members. Following pre-program non-credit courses will be offered in zero semester of MS Applied Mathematics Program whose basic back ground is not Mathematics:

• Basic Finance
• Mathematics Foundation
• Probability and Statistics
• Introduction to Programming
• Report writing skills

There will be no exam. The qualifying criteria will be pass/No passing subject to satisfactory completion of assignments. Only those students will be allowed to continue the MS program who successfully pass (60% marks) in the zero semester.
Flow chart for minimum criteria for MS in Applied Mathematics

Eligibility Criteria See (**)  

IBA admission Test (70) Math & 30% Eng = 100%) + GRE Type Test  

Pre-Program Courses  

GPA >=3.00  

Allowed to improve GPA as per university policy  

Success  

Research Proposal  

Successful Dissertation Evaluation (By two subject Experts)  

Successful Dissertation Defense  

Submission of Dissertation copies to IBA (06 credit hours)

Pre-Program Courses (only for non Mathematicians)  

- Introduction to Programming  
- Mathematics Foundations  
- Probability and Statistics  
- Basic Finance  
- Introduction to Economics

NOTE: These are minimum requirements.
Teaching Assistantships/Scholarship for MS Students

- Selected students will be provided Teaching Assistantships for teaching in THP and foundation programs for six months.
- Prime Minister Fee reimbursement

Course Description of Pre-Program non-credit Courses

- The students from Economics/Finance/Physics and BS Engineering have weak mathematical background. Hence a non-credit foundation course is offered that equips students with the mathematical background necessary to understand the courses in MS Applied Mathematics.
- The course is recommended for those with an undergraduate degree and/or those with advanced degrees who need a refresher course in mathematics. The main challenge of the course will not be the math, but the mental framework needed to think effectively in advanced areas. See ANNEXURE-B

Total Credit Hours: (24+6=30)

Distribution of Total Credit Hours (MS with Thesis)

<table>
<thead>
<tr>
<th>Category of Area</th>
<th>Courses</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core Courses</td>
<td>04</td>
<td>12</td>
</tr>
<tr>
<td>Elective Courses</td>
<td>04</td>
<td>12</td>
</tr>
<tr>
<td>Thesis</td>
<td>02</td>
<td>06</td>
</tr>
<tr>
<td><strong>Total Credit Hours</strong></td>
<td></td>
<td><strong>30</strong></td>
</tr>
</tbody>
</table>

Semester I: Core Courses (Credit Hrs. _06)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>MTS-601</td>
<td>Core 1 Advanced Numerical Analysis-I</td>
<td>03</td>
</tr>
<tr>
<td>MTS-602</td>
<td>Core 2 Stochastic Calculus</td>
<td>03</td>
</tr>
<tr>
<td>ENG-601</td>
<td>Non Credit Report Writing</td>
<td>00</td>
</tr>
<tr>
<td><strong>Total Credit Hours</strong></td>
<td></td>
<td><strong>06</strong></td>
</tr>
</tbody>
</table>
### Semester II: Core Courses (Credit Hrs. 9)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Core/Elective</th>
<th>Course Title</th>
<th>Credits Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>MTS-603</td>
<td>Core 3</td>
<td>Optimization and Complexity</td>
<td>03</td>
</tr>
<tr>
<td>MTS-604</td>
<td>Core 4</td>
<td>Special Topics in Real Analysis</td>
<td>03</td>
</tr>
<tr>
<td>MTS-</td>
<td>Elective 1</td>
<td><strong>Elective 1:</strong> To be selected from list of approved courses</td>
<td>03</td>
</tr>
</tbody>
</table>

**Total Credit Hours**: 09

### Semester III: Core Courses (Credit Hrs. 9)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>MTS-</td>
<td><strong>Elective 2:</strong> To be selected from list of approved courses</td>
<td>03</td>
</tr>
<tr>
<td>MTS-</td>
<td><strong>Elective 3:</strong> To be selected from list of approved courses</td>
<td>03</td>
</tr>
<tr>
<td>MTS-</td>
<td><strong>Elective 4:</strong> To be selected from list of approved courses</td>
<td>03</td>
</tr>
<tr>
<td>Thesis</td>
<td><strong>Research Proposal Defense</strong> (Discussion with Supervisor and Literature review )</td>
<td>00</td>
</tr>
</tbody>
</table>

**Total Credit Hours**: 09

### Semester IV (Credit Hrs. 06)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thesis</td>
<td>Submission of Thesis + Final defense</td>
<td>06</td>
</tr>
</tbody>
</table>

**Total Credit Hours**: 06

---

**Note**: These Elective Courses will be offered on the availability of course instructors and the number of students registered for the course.

- Maximum duration for submission of the thesis proposal and getting approved by the Doctoral Committee is three months from the date of registration.
- Minimum duration for thesis completion is 6 months and maximum duration is 12 months. In case of exceed, the candidate will have to get approval from the Doctoral Committee and he/she will have to pay fees also.
• Thesis is a compulsory requirement for MS degree.
• Supervisor has to give candidate’s performance report to HEC after every 6 months.
• The reports of the referees shall be scrutinized by the Academic Committee of the SIBA. If the reports declare the thesis to be satisfactory and recommend for the award of MS degree, the Director & Dean, SIBA shall appoint a Board of Examiners for the viva-voce Examination of the candidate to defend his/her thesis.
• The board for the viva-voce examination shall comprise of the Director & Dean, SIBA, one Internal examiner, one External examiner and the supervisor(s) of the candidate.
• On the satisfactory performance of the candidate in the viva-voce examination the Board of Examiners shall recommend to the Academic Committee of SIBA for the award of the degree to the candidate.
• The accepted thesis, its formulation/ invention of commercial interest shall become the property of the SIBA.

Elective Courses of Applied Mathematics

Note: These Elective Courses will be offered on the availability of course instructors and the number of students registered for the course.

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Course Code</th>
<th>Course Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>MTS-605</td>
<td>Advanced Numerical Analysis II</td>
<td>03</td>
</tr>
<tr>
<td>2</td>
<td>MTS-606</td>
<td>Numerical Techniques for solving Differential Equations</td>
<td>03</td>
</tr>
<tr>
<td>3</td>
<td>MTS-607</td>
<td>Financial Mathematics</td>
<td>03</td>
</tr>
<tr>
<td>4</td>
<td>MTS-608</td>
<td>Financial Engineering</td>
<td>03</td>
</tr>
<tr>
<td>5</td>
<td>MTS-609</td>
<td>Numerical Techniques for Variational Inequalities</td>
<td>03</td>
</tr>
<tr>
<td>6</td>
<td>MTS-610</td>
<td>Stochastic differential equation</td>
<td>03</td>
</tr>
<tr>
<td>7</td>
<td>MTS-608</td>
<td>Advanced Mathematics Physics</td>
<td>03</td>
</tr>
<tr>
<td>8</td>
<td>MTS-611</td>
<td>Geometric Methods in Mechanics and Physics</td>
<td>03</td>
</tr>
<tr>
<td>S. No.</td>
<td>Course Code</td>
<td>Course Title</td>
<td>Credit Hours</td>
</tr>
<tr>
<td>-------</td>
<td>-------------</td>
<td>------------------------------------------------------------------------------</td>
<td>--------------</td>
</tr>
<tr>
<td>9</td>
<td>MTS-612</td>
<td>Advanced Modern Algebra with Applications</td>
<td>03</td>
</tr>
<tr>
<td>10</td>
<td>MTS-613</td>
<td>Advanced Hilbert Space</td>
<td>03</td>
</tr>
<tr>
<td>11</td>
<td>MTS-614</td>
<td>Calculus of Variation</td>
<td>03</td>
</tr>
<tr>
<td>12</td>
<td>MTS-615</td>
<td>Advanced Analytical Mechanics</td>
<td>03</td>
</tr>
<tr>
<td>13</td>
<td>MTS-616</td>
<td>Advanced nonlinear Dynamics</td>
<td>03</td>
</tr>
<tr>
<td>14</td>
<td>MTS-617</td>
<td>Advanced Numerical methods for Stochastic differential equation</td>
<td>03</td>
</tr>
<tr>
<td>15</td>
<td>MTS-618</td>
<td>Numerical Methods 1: Finite difference Methods</td>
<td>03</td>
</tr>
<tr>
<td>16</td>
<td>MTS-619</td>
<td>Numerical Methods 2: Monte-Carlo Methods</td>
<td>03</td>
</tr>
<tr>
<td>17</td>
<td>MTS-620</td>
<td>Introduction to Mathematical Methods and Modeling</td>
<td>03</td>
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<td>18</td>
<td>MTS-621</td>
<td>Optimization Models and Methods for Financial Engineering</td>
<td>03</td>
</tr>
<tr>
<td>19</td>
<td>MTS-622</td>
<td>Stochastic Models for Financial Engineering</td>
<td>03</td>
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<tr>
<td>20</td>
<td>MTS-623</td>
<td>Applications programming for Financial Engineering</td>
<td>03</td>
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<tr>
<td>21</td>
<td>MTS-624</td>
<td>Advanced Convex Analysis</td>
<td>03</td>
</tr>
<tr>
<td>22</td>
<td>MTS-625</td>
<td>Advanced Optimization Techniques</td>
<td>03</td>
</tr>
</tbody>
</table>

**Elective Courses for Financial Engineering/ Actuarial Mathematics**

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Course Code</th>
<th>Course Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>STS-601:</td>
<td>Computational Statistics</td>
<td>03</td>
</tr>
<tr>
<td>2</td>
<td>FIN-</td>
<td>Portfolio Optimization and Asset Management</td>
<td>03</td>
</tr>
<tr>
<td>3</td>
<td>FIN-</td>
<td>Investment Science I</td>
<td>03</td>
</tr>
<tr>
<td>4</td>
<td>MTS-</td>
<td>Options and Derivatives</td>
<td>03</td>
</tr>
<tr>
<td>No.</td>
<td>Course Code</td>
<td>Course Title</td>
<td>Credit Hours</td>
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</tr>
<tr>
<td>5</td>
<td>FIN-</td>
<td>Investment Science II</td>
<td>03</td>
</tr>
<tr>
<td>6</td>
<td>FIN-</td>
<td>Financial Risk Management II</td>
<td>03</td>
</tr>
<tr>
<td>7</td>
<td>FIN-</td>
<td>Financial Data Modeling and Analysis in R</td>
<td>03</td>
</tr>
<tr>
<td>8</td>
<td>FIN-</td>
<td>Fixed Income Analytics and Portfolio Management</td>
<td>03</td>
</tr>
<tr>
<td>9</td>
<td>MTS-</td>
<td>Actuarial Mathematics I</td>
<td>03</td>
</tr>
<tr>
<td>10</td>
<td>MTS-</td>
<td>Actuarial Mathematics I</td>
<td>03</td>
</tr>
<tr>
<td>11</td>
<td>FIN-</td>
<td>Models in life Contingencies</td>
<td>03</td>
</tr>
<tr>
<td>12</td>
<td>FIN-</td>
<td>Stochastic Analysis of Insurance Portfolios</td>
<td>03</td>
</tr>
</tbody>
</table>

**MS-Course Description**

**MTS-601: Advanced Numerical Analysis-I** (by using software Maple and Mathematica etc)

Prerequisite(s):

Credit Hours: 3 + 0

**Specific Objectives of the Course:**

This course is designed to teach the students about numerical methods apply on nonlinear equation and system of nonlinear equations and their theoretical bases. The students are expected to know computer programming to be able to write program for each numerical method. Knowledge of calculus and linear algebra would help in learning these methods.

**Course Outline:**

- approximations and errors; methods for the solution of nonlinear equations and their convergence: bisection method, regula falsi method, fixed point iteration method, Newton-Raphson method, secant method; error analysis for iterative methods.

**Recommended Books:**

RECOMMENDED BOOKS:


iii) Peter E. Kloeden and Eckhard Platen, *Numerical Solution of Stochastic Differential Equations*
Recommended Books:

iii) Statistical and Computational Inverse Problems by Jari Kaipio and Erkki Somersalo Springer 2005

MTS-607: Financial Mathematics
Prerequisite(s): Credit Hours: 3 + 0

Specific Objectives of the Course:
This course is designed to provide a mature understanding of financial mathematics and appropriate computational techniques. The focus of the course is on computational techniques for finance, on mathematical modeling and mathematical economic theories of finance. The quantitative finance area is widely recognized as a rapidly expanding market for mathematical and scientific skills. The main areas in which financial mathematics is applied are modeling and forecasting financial markets, derivative instruments and securities, hedging and financial risk management, asset allocation and investment management, quantitative trading and arbitrage, asset/liability management, quantitative issues in corporate and public financial policy, in financial service industry. This is an introductory course in financial mathematics throughout this course you will be able to learn about types of interest rate (simple and compound), mathematics related to time value of money, Bonds, Stocks, Portfolio and derivative securities.


Recommended Books:

i) John C. Hull, Options, Futures and others Derivatives, (Sixth edition), Pearson.
iv) Srdjan Stojanovic, Computational Financial Mathematics using MATHEMATICA, Springer Science
MTS-606: Numerical Techniques for solving Differential Equations  
Prerequisite(s):  
Credit Hours: 3 + 0


RECOMMENDED BOOKS:

i) Abdul-Majid Wazwaz, PDEs and Solitary Waves theory,
ii) Abdul-Majid Wazwaz, Linear and Nonlinear Integral equations
iii) Xin-She Yang, Introduction to Computational Mathematics

MTS-608: Financial Engineering  
Prerequisite(s): MTS-607  
Credit Hours: 3 + 0

Specific Objectives of the Course:

This course capitalize upon the intuitive understanding of different concepts in the first course and introduces more abstract aspects of the subject. The concept of pricing, following a Risk Neutral Market approach, is developed in details within the framework of a Binomial Model. In this case a valuation formula for European options is obtained. Important concepts of complete and viable markets, self financing and admissible portfolios are introduced Option Pricing under Continuous time Models: Classical Black Scholes model and its famous pricing formula are studied. The later is obtained for European options, under risk neutral and arbitrage arguments. Extensions to a variety of situations, are considered Sensitivities to parameters in the contract (Greeks) are analyzed.

Course Outline:

Recommended Books:


iii) John C. Hull, Options, Futures and others Derivatives, (Sixth edition), Pearson.

iv) Srdjan Stojanovic, Computational Financial Mathematics using MATHEMATICA, Springer Science

<table>
<thead>
<tr>
<th>MTS-609: Numerical Techniques for Variational Inequalities</th>
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<tbody>
<tr>
<td><strong>Prerequisite(s):</strong></td>
</tr>
<tr>
<td><strong>Credit Hours:</strong></td>
</tr>
<tr>
<td>3 + 0</td>
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</tbody>
</table>

**Introduction to Course:**

Variational inequalities theory, which was introduced in the sixties, has emerged as an interesting and fascinating branch of applicable mathematics with a wide range of applications in industry, finance, economics, optimization, social, regional, pure and applied sciences. This field is dynamic and is experiencing an explosive growth in both theory and applications; as a consequence, research techniques and problems are drawn from various fields. The ideas and techniques of variational inequalities are being applied in a variety of diverse areas of sciences and prove to be productive and innovative. It has been shown that this theory provides the most natural, direct, simple, unified and efficient framework for a general treatment of a wide class of unrelated linear and nonlinear problems.

**Learning Objectives (Outcomes):**

At the end of this course the students will be able to understand the basic concept of Variational Inequalities, convex function, minimum of convex functions, formulation of variational inequalities, Wiener-Hopf equations technique, approximation and projection theorems. Study the existence of unique solution of variational inequalities and related problems. Preparing students to be self independent and enhancing their mathematical ability by giving them home work and projects

**Recommended Books:**


MTS-610: **Stochastic differential equation**  
**Prerequisite(s):**  
**Credit Hours:** 3 + 0

The purpose of this course is to introduce the reader to the basic ideas and results of Stochastic Calculus up to the point that he can acquire a sufficient knowledge for the understanding of its role in applications. Stochastic differential equations, that is, to differential equations subject to additive “white noise” and related random disturbances are introduced. The course starts with a quick survey of measure theoretic probability theory, followed by an introduction to Brownian motion and the Itô stochastic calculus, and finally the theory of stochastic differential equations. The course also includes applications to partial differential equations, optimal stopping problems and options pricing.

**Recommended books:**

i) An Introduction to Stochastic Differential Equations Lawrence C. Evans  
ii) University of California, Berkeley, CA Published by American Mathematical Society 2013  
v) Karatzas, Ioannis; Shreve, Steven E.: Brownian motion and stochastic calculus 2nd ed.  
vi) Graduate Texts in Mathematics, Springer-Verlag.  
viii) Revuz, Daniel; Yor, Marc: Continuous martingales and Brownian a. Motion 3rd ed. Grundlehren der Mathematischen Wissenschaften 293. Berlin: Springer

MTS-621: **Optimization Models and Methods for Financial Engineering**  
**Prerequisite(s):**  
**Credit Hours:** 3 + 0

This course introduces the methodology of modeling financial decisions as constrained optimization problems and then selecting appropriate optimization methods to solve these problems. We will specifically discuss linear programming, quadratic and general nonlinear programming, dynamic and stochastic programming. We will also discuss some discrete optimization techniques. The main theoretical features of these optimization methods will be discussed. However, the emphasis will be on modeling financial decision problems and the choice of appropriate optimization methods.

**Recommended books:**

i) John C. Hull, Options, Futures and others Derivatives, (Sixth edition), Pearson.  
Stochastic processes are widely used in financial engineering as models for the evolution of various economic quantities - stock prices, interest rates, credit ratings, ... and form the building blocks of mathematical models used in finance. This course is an introduction to stochastic processes for students in the Masters Program in Financial Engineering (MFE), providing students the foundations in probability and stochastic processes for the other courses. Among topics covered are: discrete-time Markov chains, random walks, martingales, continuous-time Markov chains, Poisson processes, Brownian motion and geometric Brownian motion. The emphasis will be on techniques relevant for financial engineering: multivariate distributions, conditional expectation, characteristic functions, Laplace transforms, Kolmogorov equations, link between Brownian motion and the heat equation.

### Recommended books:

2. John C. Hull, *Options, Futures and others Derivatives*, (Sixth edition), Pearson

In this course we will take a hands-on approach to developing computer applications for Financial Engineering. Special focus will be placed on high-performance numerical applications that interact with a graphical interface. In the course of developing such applications we will learn how to use different programming tools. Examples of problems settings that we will consider include: simulation of stock price evolution, tracking, evaluation and optimization of a stock portfolio; optimal trade execution. In the course of developing these applications we will review topics of interest to OR/FE in a holistic fashion.

### Recommended books:

2. John C. Hull, *Options, Futures and others Derivatives*, (Sixth edition), Pearson

Survival distributions: age at death, life tables, fractional ages, mortality laws, select and ultimate life tables. Life insurance: actuarial present value function (apv), moments of apv, basic life
insurance contracts, portfolio. Life annuities: actuarial accumulation function, moments of apv, basic life annuities. Net annual premiums: actuarial equivalence principle, loss function, accumulation type benefits. Actuarial reserves: prospective loss function, basic contracts, recursive equations, fractional durations. Covers part of the syllabus for Exam M of the Society of Actuaries and Exam 3 of the Casualty Actuarial Society, and covers practical applications such as computational aspects of pricing and reserving, and risk measurement of insurance portfolios.

**Recommended books:**

i) *Actuarial Mathematics for Life Contingent Risks, 2nd ed.* by Dickson, Hardy & Waters.; Publisher: Cambridge University Press

ii) *Models for Quantifying Risk* by R. Cunningham, T. Herzog, R. London, Publisher: ACTEX

iii) *ACTEX Study Manual for Exam M of the SOA* by Matt Hassett, Donald G. Stewart, Amy Steeby, publisher: ACTEX.

iv) *Life Contingencies* by C.W. Jordan; publisher: SOA.


**Actuarial Mathematics II**

**Prerequisite(s):** Actuarial Mathematics I  
**Credit Hours:** 3 + 0


**Recommended books:**

i) *Actuarial Mathematics for Life Contingent Risks, 2nd ed.* by Dickson, Hardy & Waters.; Publisher: Cambridge University Press

ii) *Models for Quantifying Risk* by R. Cunningham, T. Herzog, R. London, Publisher: ACTEX

iii) *ACTEX Study Manual for Exam M of the SOA* by Matt Hassett, Donald G. Stewart, Amy Steeby, publisher: ACTEX.

iv) *Life Contingencies* by C.W. Jordan; publisher: SOA.


**FIN-6 Risk Theory**

**Prerequisites:** Stochastic Models for Financial Engineering  
**Credit Hours:** 3 + 0
This course introduces the theory of compound Poisson processes, with a particular emphasis on their application to insurance portfolios (though their applicability in other areas is also noted). Topics include: Modelling loss distributions; Skewed parametric distribution families; Method of moments, method of percentiles and maximum likelihood estimation; Pearson goodness-of-fit testing for distribution assessment; Truncated and censored data, including applications to reinsurance and policy excess schemes; Random sums, convolutions and compound distributions, particularly for modeling aggregate claim distributions; Normal and gamma approximations to compound distributions; Compound Poisson process theory, including applications to insurance portfolio surplus processes; Ultimate and finite-time ruin probabilities; Adjustment coefficients and optimal reinsurance contracts.

**Recommended books:**

*Actuarial Mathematics for Life Contingent Risks, 2nd ed.* by Dickson, Hardy & Waters.; Publisher: Cambridge University Press

<table>
<thead>
<tr>
<th><strong>Stochastic Analysis of Insurance Portfolios</strong></th>
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</thead>
<tbody>
<tr>
<td><strong>Prerequisite(s):</strong> Actuarial Mathematics I</td>
</tr>
<tr>
<td><strong>Credit Hours:</strong> 3 + 0</td>
</tr>
</tbody>
</table>


**Recommended books:**

*Life Contingencies* by C.W. Jordan; publisher: SOA.


*The Mathematics of Life Insurance* by Menge and Fisher; publisher: Ulrich's

<table>
<thead>
<tr>
<th><strong>MTS-617: Advanced Numerical Methods for Stochastic Differential Equation</strong></th>
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</thead>
<tbody>
<tr>
<td><strong>Prerequisite(s):</strong> MTS-607 Stochastic Differential Equation</td>
</tr>
<tr>
<td><strong>Credit Hours:</strong> 3 + 0</td>
</tr>
</tbody>
</table>

The aim of this lecture series is to present various modern numerical methods for stochastic differential equations, including jump diffusions. It develops further mathematical concepts, techniques and intuition necessary for modern modeling of dynamical phenomena such as derivative pricing and risk management in finance. This lecture series provides the foundations for a sufficiently rigorous understanding of advanced numerical methods. Emphasis will be laid on developing skills that allow students to deal with numerical questions related to models involving the simulation of solutions for stochastic differential equations. Questions of numerical stability and convergence will be discussed in detail.

**Models in life Contingencies**

**Prerequisite(s):** Probability and Statistics for Computational Finance or equivalent, Introduction to Computational Finance and Financial Econometrics or equivalent, Investment Science or
This course is an introduction to life contingencies, which are concerned with the valuation of future cash flows predicated upon death, survivorship or any random event. The first part of the course will focus on probability, survival models and actuarial present value, and the latter will apply these concepts to insurance and financial risks. Course work includes assignments in theory and computation and a final exam.

- Review of interest theory, probability, Markov chains and stochastic simulation
- Survival models and life tables
- Contingent models for annuities, benefits and premiums
- Extension of these concepts to multiple life and multiple decrement models
- Other topics include interest rate risk, pension mathematics, and aspects of universal life

Upon successful completion, students will have a firm understanding of contingent payment models and the application of those models to insurance and other financial risks.

**Recommended Books:**


Dr. Waseem Asghar Khan
Assistant Professor
HoD & MS/PhD Coordinator (Applied Mathematics)

Earned his PhD degree from COMSATS, Institute of Information Technology, Islamabad (2012) in the field of Numerical Analysis and Optimization (Applied Mathematics). He has more than 7 years of teaching and research experience at university level. He has a vast experience of international conferences in various countries including United State America (USA), Greece and Malaysia. He has more than seventeen research papers accepted in well reputed journals. He is a reviewer of many international journals. He is also member of many societies (Chawalla Mathematics Society as President “GC University Lahore Pakistan and Member of Center of Research for Public Health (CRPH). His Area of Interests: Analytical and numerical solutions of initial and boundary value problems related to the applied/engineering, Finance, Economics sources using Numerical techniques (variational iteration, Homotopy perturbation, variation of parameters, modified variation of parameters, variational iteration using He’s polynomials, variational iteration using Adomain’s polynomials, exp function, iterative, decomposition and finite difference schemes).
Dr Zarqa Bano  
Assistant Professor  
Dr. Zarqa Bano is working at Sukkur IBA since August 2014. She has done her PhD degree in the field Applied Mathematics from COMSATS Institute of Information Technology, Islamabad (2014). She has a teaching experience of more than four years. Her field of research includes Newtonian and non-Newtonian fluids, analytical solution of linear/non-linear differential equations arising in fluid dynamics and other fields of engineering. She has publications in reputed International Journals. She is a member of All Pakistan Mathematical Society.

Dr. Naveed Ahmed  
Assistant Professor  
PhD in Mathematics, Abdus Salam School of Mathematical Sciences GC University, Lahore, 2012  
Dissertation’s Title: Stability Estimates for multidimensional elliptic and parabolic obstacle problem.

MSc in Mathematics, Bahaud-din-Zakariya University Multan, 2005

BSc, Mathematics, Statistics, Islamia University Bahawalpur, 2002

His areas of interest are Partial Differential Equations and Financial Mathematics.
Dr. Sidrah Ahmed  
Assistant Professor  
Dr. Ahmed completed her M. SC (2004-2006) and MPhil (2007-2009) in Mathematics from Quaid e Azam University, Islamabad. Then she started PhD as HEC scholar in COMSATS Institute of Information Technology (2009-2012). Her area of research is computational fluid dynamics. She has published 7 articles in reputed journals. The impact factor of her publications is about 10.8.

She has three years of teaching experience. She has been awarded the Merit scholarship during MPHIL at QAU, COMSATS research productivity award during PhD, HEC indigenous scholarship and HEC Startup Research grant during her job at KIU.

Mr. Ubaidullah Yaskun  
Assistant Professor  
M.Phil, University of Sindh Jamshoro  
M.Sc., University of Karachi  
BSc, University of Karachi  
His area of expertise is Computational Fluid Dynamics and Applications of Mathematics in Economics
Mr Niaz Hussain Ghumro  
Assistant Professor (Study Leave)  
He has specialization in economics and finance

Mr. Adnan Rauf,  
Assistant Professor in Mathematics, holds MSc in Industrial and Business Mathematics from the University of Karachi 1999 and MS in Industrial Mathematics with specialization in “Mathematical Modeling and Scientific Computing” from TU Kaiserslautern, Germany in 2004. He has taught at Institute of Business Management, Korangi Creek Karachi, FAST Karachi and Hamdard University Karachi.
Mr. Zahid Hussain Shaikh
Assistant Professor (Study Leave)
Has completed his M.Phil Econometrics from Pakistan Institute of Development Economics (PIDE), Islamabad in 2014, and MSc in Mathematics from Shah Abdul Latif University Khairpur in 2004. He has secured distinguished position ‘Faculty Top’ in BSc(H) Mathematics from Shah Abdul Latif University Khairpur.
He is most senior faculty member of Mathematics department at Sukkur-IBA. He joined Sukkur-IBA as a lecturer in Mathematics in 2005. He has teaching experience of more than 9 years at undergraduate and graduate level.
His subjects of interest are Applied Econometrics, Statistics and Applied Calculus. Nowadays he is working in the field of Financial Econometrics in which his focus is consumer price index and its decomposition into traded price index and non traded price index.

Mr. Javed Hussain
Lecturer (Study Leave)
Areas of interest and research include, Theory of S-acts, Credit Risk and credit derivatives, Stochastic Geometric partial differential equation particularly stochastic partial differential equations taking values in Semi-Remanian Manifolds
Mr M. Asif Memon
Lecturer (Study Leave)
Group Theory, Homological Algebra, Stochastic Analysis with applications in Finance

Mr Amanullah Phulpoto
Lecturer

M.Phil, Quaid-i-Azam University Islamabad
M.Sc., Quaid-i-Azam University Islamabad
BSc, Shah Abdul Latif University Khairpur

Mr. Amanullah has diverse teaching and research experience, his research interest includes algebraic coding theory
Abid Ali Memon
Lecturer
1. BSc (Hon’s) from Shah Abdul Latif University with silver medal.
2. MSc (applied mathematics) from Shah Abdul Latif University Khairpur with Gold Medal.
3. MS (applied mathematics) passed all the courses with 3.93 CGPA and doing research on solving non-linear partial differential equation by FEM.
His areas of interest are Numerical computations and applied mathematics.

Mr. Irfan Ali
Lecturer
M.Phil, Sukkur IBA
M.Sc University of Sindh Jamshoro
BSc(Hon’s) University of Sindh Jamshoro

Mr. Irfan is working in Sukkur IBA as Lecturer in Mathematics. His area of interest includes analytical dynamics, differential equations; Mr. Irfan is currently working on dynamical systems.
Mr. Arfan Hyder
Lecturer
M.Phil. Sukkur IBA
BS(Hon’s) Shah Abdul Latif University Khairpur

Applied Mathematics and Computational Finance

Mr. M. Shoaib Khan
Lecturer
M.Phil, Sukkur IBA
M.Sc University of Sindh Jamshoro
BSc(Hon’s) University of Sindh Jamshoro

Mr Nazim Hussain

Lecturer

M.Phil ; Shah Abdul Latif University Khairpur

M.Sc : Shah Abdul Latif University Khairpur

Mr. Nazim Hussain is working as Lecturer Mathematics at Sukkur IBA. His area of interest is Graph Labeling on (a, d) - Vertex antimagic total labeling, Graph Theory, Discrete Structures and Financial Mathematics.
People say Sky is the limit;
But we in Sukkur IBA believe
“Sky is our first step”