HITEC UNIVERSITY

Taxila Cantt

SELF ASSESSMENT REPORT

Department of Mathematics

BS Mathematics

Faculty of Sciences

Heavy Industries Taxila Education City (HITEC) University

2022-2023

Prepared by:	**Department of Mathematics**
Supervised by:	**Quality Enhancement Cell**
Reviewed by:	**QEC, Chairman, Dean, Vice-Chancellor**
Endorsed by:	**Chairman, Dean, Vice-Chancellor**

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Executive Summary

This self-assessment report is being prepared for BS Mathematics from the Department of Mathematics and Faculty of Sciences as prescribed by Higher Education Commission. Quality Enhancement Cell was formed in HITEC University in 2011. Program Team and Assessment Team of mathematics department were formulated by University to collaborate with QEC to accomplish the following report in line with HEC guidelines with the support of Vice Chancellorand Department Heads.

This self-assessment report provides an analysis and evaluation of the academic standards followed and implemented by BS Mathematics Program. HEC prescribed Self-Assessment Manual is used as a reference and the program is being evaluated based on 8 criteria and 31 standards of quality improvement. First Program teams of Mathematics Department made the report and then further assessed by the assessment team. The report finds the prospects of maintaining and continually enhancing academic standards and student's learning.

This report also investigates the strong and weak areas and other improvements needed by the department. Feedback is then provided in the form of corrective actions and implementation plan for quality assurance and improvement of academic programs in the future.

Objectives

- To document the entire program into one report for the purpose of accountability, quality enhancement and accreditation.
- To make aware all the stake-holders their rights and duties as per the Self-Assessment Manual.
- To be eligible for HEC funding proportionate to our ranking.
- To be a preference for HEC scholarships for students and faculty.
- To be eligible for evaluation by external evaluators

Execution

The hierarchy of the execution tree was fundamental to the efficient working of all the stake-holders. Formulation of PT and AT was the very first step towards the goal.

Self-Assessment Manual was distributed to all the faculty members for awareness and especially to the Program and Assessment Teams for SAR. Lectures and workshops were arranged for senior faculty members along with the Registrar, Treasurer, Controller of Examination, Deans and Vice-Chancellor where qualified professionals of their fields taught the role of Quality and Accountability in education and especially in Higher Education.

The senior faculty members then became mentors for the junior faculty members and the knowledge of the subject spread to each faculty member along with supporting individuals/groups, until all were on the same page.

Following the lecturing and mentoring, a task distribution seminar was arranged by the chair of the Program Team. In this seminar, 8 criteria with 31 standards in total were distributed as tasks to various faculty members. An internal deadline of one month was given to all the task holders.

All task holders were instructed on the procedure of procurement of information for the completion of tasks. The information from various concerned departments of the university was to be obtained in written form along with initials of the information provider.

Once the criteria were ready, the task holder sent the soft copy for review and proof reading to the chair of the Program Team. The chair reviewed and proof read in company with the Quality Representative of the respective Department. Once all the corrections and revisions were done in line with the Self-Assessment Manual, the task holders sent a signed hard copy and a soft copy to the chair of the Program Team who then incorporated the finished criteria into a single report and the report was given a draft shape.

This draft was then sent as a soft copy and as a hard copy to the Quality Enhancement Cell, Chairman Mathematics Department, Dean and Vice- Chancellor who gave their valuable inputs.

Once the draft was finalized, QEC arranged for the Self-Assessment Report of the BS Mathematics Program to be assessed by the Assessment Team in the third week of May 2023.

The findings of the Assessment Team (AT) are given in annexure-G. It outlines the improvements required in the infrastructure, syllabi and training of the faculty and support staff. The implementation plan (annexure H) was prepared after discussion with all the stakeholders, and it indicates the resources required to improve the Quality. Responsible bodies, timelines and goals were set for the execution of the implementation plan.

Self-Assessment Report

Introduction

Heavy Industries Taxila Education City (HITEC) University is a private sector university. It was established in 2007 and chartered in 2009 by the Government of Punjab. The University is sponsored by Heavy Industries Taxila Education Welfare Trust (HITEWT). The university was established with a vision to produce skilled, moral, ethical and patriotic professionals who can serve society and who will be guardians of national, social and religious values.

University Mission Statement

HITEC University will be a center of excellence in teaching, learning and research. We shall instill and inspire intellectual curiosity, lifelong quest of knowledge and akeen urge for social and moral responsibility. The University will establish strong linkages with industry ensuring innovative research leading to economic prosperityof Pakistan.

Department of Mathematics

Department of Mathematics is currently running following four intakes of the BS Mathematics Program.

a. BS Mathematics 2019
b. BS Mathematics 2020
c. BS Mathematics 2021
d. BS Mathematics 2022

Program Selected

HITEC University has selected the **BS Mathematics Program** as first model program for Self-Assessment Report (SAR) under the directives of Higher Education Commission (HEC).

Program Evaluation

The program is being evaluated based on 8 criteria and 31 standards as given inthe Self-Assessment Manual provided by Higher Education Commission (HEC).

Criterion 1: Program Mission, Objectives and Outcomes

Standard 1-1 The program must have documented measurable objectives that support institution mission statements.

Program Mission Statement

The mission of the BS-Mathematics program at Hitec University is to prepare its students, through high quality education, for mathematically related careers, as well as for higher studies in mathematics and other related fields.

Program Objectives

The objectives of BS-Mathematics program are as follows:

1. Prepare graduates to apply their logical reasoning and problem-solving skills to real life problems throughout their careers.
2. Prepare graduates who are committed to the quality and improvement of teaching math at all school levels.
3. Prepare graduates to pursue advanced studies in mathematics or other related fields by providing them with the appropriate background in theoretical and applied areas.

Program Outcomes

Students who successfully complete the mathematics major will be able to:

1. Construct and analyze mathematical models describing real world phenomena.
2. Use appropriate mathematical tools for symbolic and numeric computations.
3. Apply mathematical methods to solve problems from various related disciplines.

4. Explain mathematical arguments effectively both orally and in writing.
5. Formulate and reproduce mathematical proofs.
6. Demonstrate mastery of the core concepts in algebra and analysis.
7. Interrelate different branches of mathematics.

Curriculum Design

Curriculum of BS Mathematics is carefully designed for a four-year degree program requires a course work of 131 credit hours in which project is included.BS Mathematics comprises of 43 courses and project to choose from, fully adhering to the Higher Education Commission's guidelines and requirements. Project topics for BS students pertain to numerical analysis, analytical and numerical techniquesfor ordinary and partial differential equations, and finite element analysis. Research opportunities are also available in numerical linear algebra, mechanics of fluids (Newtonian and Non-Newtonian), computational fluid dynamics, and computational rheology etc.

Program Objectives Assessment

Objective	How Measured	When Measured	Improvement Identified	Improvement Made
1	Student Exit Survey	At the end of the BS Program	Some new topics have been added	Yes
2	Alumni Survey Employer Survey	Every two years	Survey questions have been improved	Yes
3	Alumni Survey Employer Survey	Every two years	Survey questions have been improved	Yes
4	Alumni Survey	Every semester	Mathematics course has been introduced	Yes

Table 1: Program Objectives Assessment

Standard 1-2 The program must have documented outcomes for graduating students. It must be demonstrated that the outcome support the program objectives

and that graduating students are capable of performing these outcomes.

Program Outcomes

1. Students shall possess the required pre-requisites for admission to higher degrees in reputable universities.
2. Students shall have required applied and practical knowledge and skills to pursue professional jobs in industries, laboratories, consultancy firms and government sectors.
3. Students shall be well-rounded not only in the discipline of Mathematics but also in related inter-disciplinary fields of science and technology.
4. Students shall possess sufficient knowledge to pursue an academia job.
5. Students shall be well-versed in modern day technologies in the field of Mathematics and in related disciplines. They shall be able to apply probabilistic/statistical tools to not only solve technical problems but also todesign new solutions and be innovative.
6. Students shall be able to become entrepreneurs in their fields of interest. They shall possess leadership, decision making and risk-taking qualities necessary to compete, lead and succeed in a hugely competitive market. They shall possess problem solving skills and innovative ideas to be unique.
7. Students shall treat fairly all persons regardless of race, religion, gender, disability, age, or regional origin. Students shall avoid conflicts at workplaces.

Program Objectives	Program Outcomes						
	1	2	3	4	5	6	7
1	×	×	×				
2			×	×	×	×	
3				×	×	×	×
4	×						

Table 2 : Outcomes versus Objectives

Standard 1-3 The results of the Program's assessment and the extent to which they are used to improve the program must be documented.

The program assessment has been done by students evaluating the courses and the respective teachers as per the HEC Performa.

Course Evaluation

Courses evaluation is shown in the following table:

Sr#	Code	Subject	Evaluation
1	MTH-104	Element of Set Theory & Math: Logic	4.79
3	MTH-207	Discrete Mathematics	4.61

Table 3: Course Evaluation Table

See Annexure C (Course Evaluation Survey) for course evaluation Performa and the standards against which the students have evaluated the courses. An updated form is also attached as some changes are being made to the form. The total graded marks are 5.

Teachers Evaluation

MATHEMATICS DEPARTMENT

Dr. Dania Saleem / Elements of Set theory & Math. Logic

Variables	Evaluation
Satisfied with Online Teaching by the Teacher	4.75
The teachers use of technology is adequate	4.75
The teacher uploaded online lectures and relevant material (audio, video,PPT/PDF) on weekly basis.	4.83
The teacher was available for online consultation during the week atspecific timings	4.83
The teacher takes online assignments and quizzes regularly	4.83
The teacher returned all marked quizzes, assignments, and sessionalexam on time.	4.83
The teacher provide timely and constructive feedback on yourperformance regularly	4.83
The teacher maintained liaison/link with you to address your queriesrelated to the teaching material	4.75

How much you properly understand the lectures given/taught by theteacher online	4.75
How much are you satisfied with the quality of online lectures andcourse/lab materials shared/taught by the teacher/lab engineer?	4.75
How much are you satisfied with the grading and evaluation systemfollowed by the teacher?	4.75
You want to be taught by this teacher in the next semester	**4.33**
Evaluation	**4.79**

Figure 2: Teachers Evaluation Table

Sr#	Instructor	Subject	Evaluation
1	Dr. Dania	Element of Set Theory & Math: Logic	4.79
2	Dr. Dania	Discrete Mathematics	4.61

Table 4: Teacher's Evaluation Table

See Annexure D (Teachers Evaluation Survey) for teacher's evaluation Performa and the standards against which the students have evaluated them. Updated form is also attached as some changes are being made to the form. The total graded marks are 5.

HITEC University and especially the Mathematics department have a strong tradition of quality enhancement through students' feedback. The teachers' and courses' evaluation is given the due respect, analysis and direction. Teachers with strong feedback are appreciated and teachers with poor feedback are counseled, heard and encouraged. The course feedback is a major source of inspiration for curriculum and syllabi revision.

Program strengths

- Capable nine PhD faculty members.
- Amongst them, they cover all essential domains of applied mathematics.
- The department has a blooming research culture.

Standard 1-4 The department must assess its overall performance periodically using quantifiable measures.

Graduates/Undergraduates enrolled in last three years

Enrolled Students			
Program	**2020**	**2021**	**2022**
BS Mathematics	48	75	87

Graduated Students			
Program	**2020**	**2021**	**2022**
BS Mathematics	Nil	NIL	NIL

Student Faculty Ratio:

BS Mathematics has 7-1 ratio

Average GPA per semester:

Average GPA per semester for the batch enrolled in year 2022 is as under:

Average GPA: 3.10

Average CGPA: 3.5

Average Completion time

The average completion time for Bachelor Program is 4 years and the maximum permitted time is 6 years.

Employer Satisfaction

No Employer survey of BS program has been conducted yet. Employer survey will be conducted in Fall 2023.

Students Course Evaluation Rate

Average student evaluation for all courses is 4.67 which is very good by any measure.

Students Faculty Evaluation

Students Evaluated faculty. The feedback was taken by QEC staff in the absence of faculty members. 100% teachers are above average grades which mean none of the teacher is below average. All the teachers are above 4.0 which is the topmost tier of the grading hierarchy.

Research

The program faculty published research papers in different journals. List attached in Annexure A.

Community Service

HITEC university's students and faculty actively partakes in social welfare and community services. Be it floods or earthquakes or be it blood donation, HITEC University is always at the fore-front of giving back to the community.

Criterion 2: Curriculum Design and Organization

Title of Degree Program

BS Mathematics

Definition of credit hour:

One credit hour is 3 hours of theory lecture in a week.

Degree plan

Following is the list of courses taught in the selected program. Section 4.5 shows the details about these courses including pre-requisites.

Sr. #	Course Name	Code
1	Islamic Studies	IS-211
2	English	HS-101
3	Introduction to Information and Communication Technologies	CS-101
4	Introduction to Mechanics	PHY-101
5	Elements of Set Theory and Mathematical Logic	MTH-104
6	Calculus-I	MTH-105
7	Pakistan Studies	HS-102
8	Communication Skills	HS-103
9	Electricity and Magnetism	PHY-102
10	Programming Fundamental	CS-102
11	Calculus-II	MTH-106
12	Linear Algebra	MTH-107
13	Technical Report Writing	HS-201
14	Economics	HS-402
15	Mathematical Computation with Software Packages	MTH-205
16	Calculus-III	MTH-206

17	Discrete Mathematics	MTH-207
18	Mathematical Statistics-I	MTH-208
19	Arabic Language	ARB-102
20	Financial Management	ACC- 201
21	Group Theory	MTH-209
22	Elementary Number Theory	MTH-210
23	Ordinary Differential Equations-I	MTH-211
24	Mathematical Statistics-II	MTH-212
25	Real Analysis –I	MTH-301
26	Complex Analysis	MTH-304
27	Metric and Topological Spaces	MTH-305
28	Ordinary Differential Equations-II	MTH-306
29	Differential Geometry and Tensor Analysis	MTH-308
30	Partial Differential Equations	MTH-307
31	Analytical Mechanics	MTH-309
32	Functional Analysis	MTH-310
33	Real Analysis –II	MTH-311
34	Rings and Field	MTH-312
35	Calculus of Variations	MTH-401
36	Numerical Techniques	MTH-402
37	Fluid Mechanics	MTH-403
38	E-1	MTH-xxx
39	E-2	MTH-xxx
40	Integral Equations	MTH-404
41	Mathematical Modeling with Applications	MTH-405
42	Project/E-3	MTH-xxx
43	E-4	MTH-xxx
44	E-5	MTH-xxx

Table 5: Courses and their Respective Course Codes

Sr. No.	Course Code	Course Title
1	MTH-451	Fuzzy Logics
2	MTH-452	Advanced Group Theory
3	MTH-453	Theory of Modules
4	MTH-454	Analytical Dynamics
5	MTH-455	Quantum Mechanics
6	MTH-456	Algebraic Geometry
7	MTH-457	Theory of Manifolds

8.	MTH-458	Functional Analysis-II
9.	MTH-459	Operations Research
10.	MTH-460	Optimization Theory
11.	MTH-461	Mathematical Modeling and Simulation
12.	MTH-462	Theory of Elasticity
13.	MTH-463	Electromagnetism
14.	MTH-464	Special Theory of Relativity

Table 6: List of Elective Courses and their respective course codes

Courses Information

MTH-104: Elements of Set Theory and Mathematical Logic

Set theory: Sets, subsets, operations with sets union, intersection, difference, symmetric difference, Cartesian product and disjoint union. Functions: graph of a function. Composition, injections, surjections, bijections, inverse function. Computing cardinals: Cardinality of Cartesian product, union. Cardinality of all functions from a set to another set. Cardinality of all injective, surjective and bijective functions from a set to another set. Infinite sets, finite sets. Countable sets, properties, examples (Z, Q). R is not countable. R, RxR, RxRxR have the same cardinal. Operations with cardinal numbers. Cantor-Bernstein theorem. Relations: equivalence relations, partitions, quotient set, examples of parallelism, similarity of triangles. Order relations, min, max, inf, sup, linear order. Examples of: N, Z, R, P(A). Well-ordered sets and induction. Inductively ordered sets and Zorn's lemma. Mathematical logic: Propositional Calculus. Truth tables. Predicate Calculus.

Text Book:

A Concise Introduction to Pure Mathematics by M. Lie beck, CRC Press, 2011.

Reference Books:

1. Discrete Mathematics (Chapters 1,3,4,5) by R. Garnier, J. Taylor, CRC Press, 2010.
2. Discrete Mathematics by N. L. Biggs, Oxford University Press, 2002.
3. A Transition to Advanced Mathematics by D. Smith, M. Eggen, R.St. Andre,Brooks/Cole, 2001.

MTH-105: Calculus-I

Real numbers system, intervals inequalities, absolute values, coordinates and graphs. Functions, logarithmic, exponential, hyperbolic and inverse hyperbolic functions. Real valued functions their operations and graphs. Limits, continuity, differentiation, techniques of differentiation, implicit differentiation. Applications of derivatives, mean value Theorems, maxima and minima, concavity, singular points, higher order derivatives and Leibniz Rule. Integration, antiderivatives and techniques of Integration. Fundamental Theorem of integral Calculus. Definite integral and applications of definite integral.

Text Book:
Thomas Calculus by G. B. Thomas & R. L. Finney, published by Addison Wesley 2014.
Reference Books:
1. Calculus (Early Transcendental) by Howard Anton; Irl C. Bivens; Stephen Davis, published by Wiley & Sons 2016.
2. Calculus by James Stewart, fifth edition, published by Brooks/Cole, 2002.

MTH-106: Calculus-II
Infinite series: Infinite sequences and series, convergence and divergence of infinite sequences and series, comparison tests, Ratio and Root tests, integral test, alternating series, absolute and conditional convergence of series, power series and its applications. Taylor and Maclaurin series. Introduction to Conic section: Ellipse, Parabola, Hyperbola and Cycloid. Tangents and normal to the conics in rectangular, cylindrical and spherical coordinates, Quadratic equation and rotations. Equations of lines and planes. Parameterization of plane curves. Quadric surfaces. Vectors and analytic geometry in space: Coordinate system. The dot product, the cross product. Vector-valued functions. Derivatives and integrals of vector valued functions. Arc length. Curvature, normal and binormal vectors.

Text Book:
Thomas Calculus by G. B. Thomas & R. L. Finney, published by Addison Wesley 2014.
Reference Books:
1. Calculus (Early Transcendental) by Howard Anton; Irl C. Bivens; Stephen Davis, published by Wiley & Sons 2016.
2. Calculus by James Stewart, fifth edition, published by Brooks/Cole, 2002.

MTH-107: Linear Algebra
System of Linear Equations: Representation in matrix form. Matrices. Operations on matrices. Echelon and reduced echelon form. Inverse of a matrix. Solution of linear system. Gauss-Jordan method. Gaussian elimination. Determinants, Vector Spaces, Subspaces. Linear combination and Spanning. Linearly Independence and dependence. Finitely generated vector spaces. Bases and dimension of a vector space. Operations on subspaces, Intersections, sums and direct sums of subspaces. Quotient Spaces. Linear mappings, Kernel and image of a linear mapping. Rank and nullity. Reflections, projections. Change of basis. Eigen values and eigenvectors. Theorem of Hamilton-Cayley. Inner product Spaces. Properties, Orthogonal Projections, Cauchy Schwarz inequality. Orthogonal and orthonormal basis. Gram Schmidt Process. Diagonalization. Quadratic Forms.

Text Book:
Elementary Linear Algebra (Applications version) by H. Anton|C. Rorres, WILEY 2013.
Reference Books:
1. Linear Algebra and its Applications by David C. Lay, second edition, published by Addison –Wesley, 2000
2. Linear Algebra with Applications by Gareth Williams, published by Jones and Bartlett Publications 2017.

3. Introductory Linear Algebra with Applications by Bernard Kobman and David R. Hill 2005.

MTH-205: Mathematical Computation with Software Packages

MATLAB**:** Introduction to MATLAB syntax, variables, strings Vectors, Matrices, Basic program writing in MATLAB, Loops (do, for, while, if), Symbolic toolbox. Array operations, solving systems of linear equations, Two and three dimensional plots in MATLAB. Animations in MATLAB. MATHEMATICA: Introduction to the basic environment of MATHMATICA and its syntax, Running MATHEMATICA and Numerical/Algebraic Calculations, Symbolic Mathematics in MATHEMATICA, Functions and Programs, Graphics. MAPLE: Introductory Demonstration of Maple, Vectors and Matrices formations, Toolbars and Palettes, Operators, Constant, ElementaryFunctions, Plots of 2D and 3D functions, Packages within MAPLE.

Text Book:
Stephen J. Chapman, MATLAB Programming for Engineers, 2008
Reference Books:
1. The MATHEMATICA Book by Stephen Wolfram, Wolfram Media Inc. 2003.
2. Understanding Maple by Ian Thompson, University of Liverpool, CambridgeUniversity Press 2016.

MTH-206: Calculus-III
Multivariable functions and partial derivatives: Functions of several variables. Limits and Continuity. Partial derivatives, Composition and chain rule. Directional derivatives and the gradient vector. Implicit function theorem for several variables. Maximum and minimum values. Optimization problems. Lagrange Multipliers. Multiple integrals: Double integrals over rectangular domains and iterated integrals. Non-rectangular domains. Double integrals in polar coordinates. Triple integrals in rectangular, cylindrical and spherical coordinates. Applications of double and triple integrals. Change of variables in multiple integrals. Vector calculus: Vector fields. Line integrals. Green's theorem. Curl and divergence. Surface integrals over scalar and vector fields. Divergence theorem. Stokes' theorem.
Text Book:
Thomas Calculus by G. B. Thomas & R. L. Finney, published by Addison Wesley 2014.
Reference Books:
1. Calculus (Early Transcendental) by Howard Anton; Irl C. Bivens; Stephen Davis, published by Wiley & Sons 2016.
2. Calculus by James Stewart, fifth edition, published by Brooks/Cole, 2002.

MTH-207: Discrete Mathematics
Introduction to logic, quantifiers and conditional statements, proofs, valid and invalid arguments, predicates and quantified statements, arguments with quantified statements, direct proofs, counterexamples, quotient-remainder theorem, floor and ceiling functions, irrationality of some square roots, mathematical induction, strong induction, set theory, set properties, partitions, power sets, recursively defined sequences, solving recurrences by iteration, Big Oh notation, efficiency of algorithms, exponential and logarithmic functions, Relations,

equivalence relations, finite state automata, partial order relations, trees, graphs and graphtheory.

Text Book:
Discrete Mathematics and Its Applications by Kenneth H. Rosen, published by McGraw-Hill2012.

Reference Books:
1. Discrete Mathematics with Applications by S. Susanna, published by CengageLearning 2010.
2. Discrete Mathematical structures by Bernard Kolman; 4th ed.

MTH-208: Mathematical Statistics-I
Introduction: Introduction of the course and Counting Techniques. Axioms of Probability: Sample Space and Events, Axioms of Probability, Some Simple Propositions, Sample Spaces having Equally Likely Outcomes, Probability as a Continuous Set Function, Probability as a Measure of Belief Conditional Probability and Independence: Conditional Probability, Bayes's Formula, Independent Events. Discrete Random Variables: Random Variables, Discrete Random Variables, Expected Value, Expectation of a Function of a Random Variable, Variance, The Bernoulli and Binomial Random Variables, Properties of Binomial Random Variables, Computing the Binomial Distribution Function, The Poisson Random Variable, Computing the Poisson Distribution Function, Other Discrete Probability Distributions: The Geometric Random Variable, The Negative Binomial Random Variable, The Hypergeometric Random Variable, Expected Value of Sums of Random Variables, Properties of the Cumulative Distribution Function. Continuous Random Variables: Expectation and Variance of Continuous Random Variables, The Uniform Random Variable, Normal Random Variable, The Normal Approximation to the Binomial Distribution, Exponential Random Variable, Other Continuous Distributions, The Gamma Distribution.

Text Book:
Probability and Statistics for Engineers and Scientists by R. E. Walpole, R. H. Myers, S. L. Myers and Keying Ye, Prentice Hall, 2011.

Reference Books:
1. Probability, Random Variables, and Stochastic Processes by A. Papoulis, Addison-Wesley, 2002.
2. Basic Probability Theory by Robert B. Ash, Dover Publications 2008.
3. Probability and Statistics by M. H. DeGroot & M. J. Schervish Pearson Education, 2012.

MTH-209: Group Theory
Groups, Subgroup, Cyclic groups, Co-sets and Lagrange's theorem. Normalizer, Centralizer, Center of a group, Equivalence relation in a group, Conjugacy classes, Normal subgroups, Quotient group, Homomorphisms, Isomorphism and Automorphism. Kernel and image of homomorphism. Isomorphism theorems, Permutations, Cyclic Permutations. Cayley's theorem, Direct product of two groups.

Text Book:
A First Course in Abstract Algebra by J. B. Fraleigh, Addison-Wesley Publishing Company, 2003.

Reference Books:
1. Abstract Algebra, 3rd Edition, by D. S. Dummit & R.M. Foote, Addison-WesleyPublishing Company, 2004.
2. A Course on Group Theory by J. Rose, Cambridge University Press, 1978.
3. Basic Abstract Algebra by P. B. Bhattacharya, S. K. Jain and S. R. Nagpaul,Cambridge University Press, 1986.
4. Algebra by Vivek Sahai and Vikas Bist, Narosa Publishing House, 1999.

MTH-210: Elementary Number Theory
Divisibility and Factorization: Divisibility, Prime numbers, Greatest common divisors, Euclidean algorithm, Fundamental theorem of arithmetic. Congruences, Chinese remainder theorem, Wilson's Theorem, Fermat's theorem, Euler's theorem, Arithmetic Functions, multiplicative functions, Euler's Phi-function, Perfect numbers, Moebius function, Moebius inversion formula, Quadratic residues and non-residues, Legendre symbol, Law of quadratic reciprocity, Primitive Roots, Order of an integer, Primitive roots for primes, Primitive root theorem, Linear Diophantine equations, Pythagorean triples, Representation of integers as sum of squares.

Text Book:
Elementary Number Theory and its applications by Kenneth H. Rosen, fifth edition,published by Edison Wesley, 2005.

Reference Books:
1. A Friendly Introduction to Number Theory by Joseph H. Silverman, third edition,Published by Prentice Hall 2006.
2. An introduction to the theory of numbers by G.H. Hardy, E. M. Wright, Revised by D. R. Heath-Brown and J. H. Silverman. Oxford University Press, Oxford, 2008.
3. A Course in Combinatorics by J. H. Van Lint, R.M. Wilson, Cambridge UniversityPress, Cambridge, 1992.

MTH-211: Ordinary Differential Equations-I
First order ordinary differential equations: Basic concepts, formation and solution of differential equations, Separable variables, Exact Equation, Homogeneous Equations, Linear equations, integrating factors, nonlinear first order equation. Second and higher order linear differential equations: Initial value and boundary value problems, Homogeneous and non-homogeneous equations, Superposition principle, homogeneous equations with constant coefficients, Linear independence and Wronskian, UC method, Variation of parameters, Cauchy-Euler equation, Applications of second order differential equations. Undetermined Coefficients, Fourier series with periodic extensions. Fourier cosine and sine series, Gibbs phenomenon, half-range expansions, Fourier Integrals.

Text Book:
Differential equations with boundary value problems by Dennis G. Zill, Michael R. Cullen, Brooks/Cole Cengage Learning 2009.

Reference Books:

1. Elementary Differential Equations and Boundary Value Problems by William E.Boyce, Richard C. DiPrima, Douglas B. Meade, WILEY, 2017
2. Advanced Engineering Mathematics by Erwin Kreyszig, John Wiley & Sons, Inc2011.
3. Ordinary Differential Equations by V. I. Arnold, Springer, 1991.

MTH-212: Mathematical Statistics-II

Introduction to Descriptive Statistics: Collection and Presentation of Sample Data, Some Important Features of Sample Data. Distributions of Sampling Statistics: Sample Mean, Central Limit Theorem, Distribution of the Sample Variance of a Normal Population. Themethod of Maximum Likelihood: Point Estimator of a Population Mean, Estimating a Population Variance. Estimation: Interval Estimators of the Mean of a Normal Population with Known Population Variance, Lower and Upper Confidence Bounds, Interval Estimators of the Mean of a Normal Population with Unknown Population Variance, Lower and Upper Confidence Bounds. Testing Statistical Hypotheses: Hypothesis Tests and Significance Levels, Tests Concerning the Mean of a Normal Population: Case of Known Variance, One-Sided Tests, The t Test for the Mean of a Normal Population: Case of Unknown Variance. Hypothesis Tests Concerning Two Populations: Testing Equality of Means of Two Normal Populations: Case of Known Variances, Testing Equality of Means, Unknown Variances and Large Sample Sizes, Testing Equality of Means, Small- Sample Tests when the Unknown Population Variances are Equal.

Text Book:

Probability and Statistics for Engineers and Scientists (9th Edition) by R. E. Walpole, R. H. Myers, S. L. Myers and Keying Ye, Prentice Hall, 2011.

Reference Books:

1. Probability, Random Variables, and Stochastic Processes by A. Papoulis, Addison-Wesley, 2002.
2. Probability and Statistics by M. H. DeGroot & M. J. Schervish Pearson Education,2012.

MTH-301: Real Analysis-I

The Real Number System: Axioms for a Field, Natural Numbers and Sequences, Inequalities, Mathematical Induction, Continuity and Limits, One-Sided Limits, Limits at Infinity, Infinite Limits, Limits of Sequences. Basic Properties of Functions on R^1: The Intermediate-Value Theorem, Least Upper Bound, Greatest Lower Bound, The Bolzano– Weierstrass Theorem, The Boundedness and Extreme-Value Theorems, Uniform Continuity, The Cauchy Criterion, The Heine–Borel Theorem. Elementary Theory of Differentiation: The Derivative in R^1, Inverse Functions in R^1 Elementary Theory of Integration: The Darboux Integral for Functions on R^1

Text Book:

Introduction to Real Analysis (4th Edition) by Bartle, R.G. and Sherbert, D.R, John Wiley& Sons 2011.

Reference Books:

1. Introduction to Real Analysis by William F. Trench, Pearson Education 2013.
2. Advanced Calculus by D. V. Widder, Prentice-Hall, 1982.
3. Principles of Real Analysis by W. Rudin, McGraw-Hill, 1995.

MTH-304: Complex Analysis

Complex Numbers, basic properties, De- Moivre's theorem, roots of complex numbers, regions in the complex plane, functions of a complex variable, limits, continuity, derivatives, Cauchy- Riemann equations, analytic functions, harmonic functions, exponential, trigonometric, hyperbolic and logarithmic functions, contour integrals, Cauchy-Goursat theorem, Cauchy- integral formula, derivatives of analytic functions, Liouville's theorem, maximum modulus principle, sequences and series, Taylor and Laurent series, residues and poles, Cauchy's residue theorem, application to evaluation of real definite integrals, argument principle and Rouche's theorem, mapping by elementaryfunctions, linear fractional transformations.

Text Book:

Complex Variables and Applications by James W. Brown and Ruel V. Churchill, Mc-GrawHill, 2013.

Reference Books:

1. Complex Variables by Mark J. Ablowitz and A.S. Fokas, Cambridge UniversityPress 2003.

MTH-305: Metric and Topological Spaces

Sets, bounded subsets of real line, set operations, sequences and subsequences, Topology of n-dimensional Euclidean space, Functions. Introduction to metric Spaces: Metrics, pseudo-metrics and convergence of sequences, Norms and normed spaces, Open and closed balls, Continuous functions, Open sets. Introduction to Topological Spaces: Topologies and Topological spaces, Interior, Closure and related concepts, equivalent definitions of metric spaces, Continuous functions, homeomorphism and isometries, equivalence of metrics, Bases and sub-bases. Subspaces, Quotients and Products: The subspace topology, the quotient topology, the product topology. Compactness: Sequentialcompactness for metric spaces, Compactness for topological spaces, compactness in terms of closed sets, equivalence of compactness and sequential compactness for metric spaces. Connectedness: connected and disconnected topological spaces and subsets, connected setsand continuous functions, classification of connected subsets.

Text Book:

Elementary Topology by Michael C. Gemignani, second edition, published by Addison-Wesley, 1972

Reference Books:

1. Topology by James R. Munkres, second edition, Pearson Education India, 2015.

2. Introduction to Topology Modern Analysis, by J.F. Simmons, lealest editionMcGram Hill, N.Y.
3. An Introduction to General Topology by Paul E. Long, published by Charles E.Merill Publishing Company, 1971.

MTH-306: Ordinary Differential Equations-II

Introduction to eigen value problem, adjoint and self adjoint operators, self adjoint differential equations, eigen values and eigen functions, Sturm-Liouville (S-L) boundary value problems, regular and singular S-L problems, properties of regular S-L problems Series Solutions: Power series, ordinary and singular points, Existence of power series solutions, power series solutions, types of singular points. Series solution of differential equation. Frobenius theorem, Existence of Frobenius series solutions, solutions about singular points, The Bessel, Modified Bessel, Legendre, Hermite, Hypergeometric equations and their solutions. Greens function for ordinary differential equations.

Text Book:

Differential equations with boundary value problems by Dennis G. Zill, Michael R. Cullen, Brooks/Cole Cengage Learning 2009.

Reference Books:

1. Elementary Differential Equations and Boundary Value Problems, 11th Edition byWilliam E. Boyce, Richard C. DiPrima, Douglas B. Meade, WILEY, 2017
2. Advanced Engineering Mathematics by Erwin Kreyszig, John Wiley & Sons, Inc2011.
3. Ordinary Differential Equations by V. I. Arnold, Springer, 1991.

MTH-308: Differential Geometry and Tensor Analysis

Theory of Space Curves: Introduction, index notation and summation convention. Space curves, arc length, tangent, normal and binormal. Osculating, normal and rectifying planes.Curvature and torsion. The Frenet-Serret theorem. Natural equation of a curve. Involutes and evolutes, helices. Fundamental existence theorem of space curves**.** Theory of Surfaces: Coordinate transformation. Tangent plane and surface normal. The first fundamental form and the metric tensor. The second fundamental form. Principal, Gaussian, mean, geodesic and normal curvatures. Gauss and Weingarten equations. Gauss and Codazzi equations. Tensor Analysis: Einstein summation convention. Tensors of different ranks. Contravariant, covariant and mixed tensors. Addition, subtraction, inner and outer productsof tensors. Contraction theorem, quotient law. The line element and metric tensor. Christoffel symbols.

Text Book:

Elements of Differential Geometry by R. S. Millman and G. D. Parker, published byPrentice Hall, 1977.

Reference Books:

1. Differential Geometry of Curves and Surfaces by M. P. Do Carmo, Dover publications, 2016.
2. Elementary Differential Geometry by B. O. Neil, published by Academic Press,1966

3. Introduction to Differential Geometry by A. Goetz, published by Addison Wesley, 1970
4. Vector and Tensor Methods by F. Charlton, published by Ellis Horwood, 1976

MTH-307: Partial Differential Equations

Partial differential equations of the first order, The Cauchy's problem for quasilinear first order PDEs, First order nonlinear equations. Classification of second order partial differential equations: Basic concepts and definitions, The classical equations, The vibrating string, The vibrating membrane, Conduction of heat in solids, Canonical forms and general solution. The Cauchy problem and wave equations: Homogenous wave equations, Initial-Boundary value problems, Equations with non-homogenous boundary conditions, Vibration of finite string with fixed ends, Non-homogenous wave equation, Spherical and cylindrical wave equation. Methods of separation of variables: Solutions of elliptic, parabolic and hyperbolic. Dirichlet problem for a circle and circular annulus, Neumann problem for a circle, Nonhomogenous boundary value problems. Integral transform methods: Laplace Transform, Solution of PDEs by Laplace transforms. Fourier Transforms: Fourier transform, Convolution theorem of the Fourier transform. Solutions of heat, wave and Laplace equations by Fourier transform. Finite Fourier transform and its applications. Hankle transform for solutions of PDEs.

Text Book:

Elements of Partial Differential Equations by I. N. Sneddon, Dover Publications 2006.

Reference Books:

1. Introduction to Partial Differential Equations and Boundary Value Problems by R. Dennemyer, published by McGraw Hill.
2. Boundary Value Problems and Partial Differential Equations by M. Humi and W. B. Miller, published by PWS-Kent publishing company, 1992
3. Elementary Applied Partial Differential Equations by R. Haberman, published by Prentice Hall 1997.

MTH-309: Analytical Mechanics

Kinematics of particle and rigid body in three dimension; Euler's theorem. Work , Power, Energy, Conservative field of force, Motion in a resisting medium, Variable mess problem, Moving coordinate system, Rate of change of a vector, Motion relative to the rotating Earth, The motion of a system of particles, Conservation laws, Generalized coordinates, Lagrange's equations, Hamiltonian's equation, Simple applications, Motion of a rigid body, Momental ellipsoid; Equimomental systems, Gyroscopic motion, Euler's dynamical equations, Properties of a rigid body motion under no forces.

Text Book:

Classical Mechanics (Theory and Mathematical Modeling) by E. DiBenedetto, Birkhäuser Boston, 2011.

Reference Books:

1. Classical Mechanics by John R. Taylor, University of Colorado, 2005.
2. Theoretical Mechanics by M. R. Spiegel, Addison-Wesley Publishing Company, 2004.

3. Analytical Mechanics by G. R. Fowles and G. L. Cassiday, ThomsonBrooks/Cole, USA, 2005.

MTH-310: Functional Analysis

Review of Metric Spaces: Metric spaces, Examples of metric spaces, Open sets, Closed sets, Neighborhood, Completeness of metric spaces. Normed Spaces and Banach Spaces:Vector Space, Normed Space, Banach Space, Properties of Normed Spaces, Finite Dimensional normed spaces and subspaces, Compactness and finite dimension. Linear Operators Bounded and Continuous linear operators, Linear Functional, Linear Operatorsand Functional on finite dimensional spaces. Normed spaces of Operators, Dual Spaces. Inner Product Spaces and Hilbert Spaces: Inner product space, Hilbert space, Properties of inner product spaces, Orthogonal complements and direct sums, Orthonormal sets andsequences, Series Related to Orthonormal sequences and sets, Total Orthonormal Sets and Sequences, Self-Adjoint, Unitary and Normal Operators.

Text Book:

Introductory Functional Analysis and Applications, by E. Kreyszig, published by JohnWiley and Sons 1989.

Reference Books:

1. Elements of Functional Analysis by L. Maddox, published by CambridgeUniversity Press 1989.
2. Introduction to Topology and Modern Analysis by G. F. Simmons, published byMcGraw Hill 2003.

MTH-311: Real Analysis-II

Differentiation and Integration in R^n: Partial Derivatives and the Chain Rule, Extended mean-value theorem, Fundamental lemma of Differentiation, Partial Derivatives and Chain rule, Taylor's Theorem, Maxima and Minima, Multi-index, Binomial Theorem, Multinomial Theorem, The directional Derivative, Taylor Theorem with Reminder, The Derivative in R^n , The Darboux Integral in R^n, The Riemann Integral in R^n, Infinite Series: Tests for Convergence and Divergence, Geometric Series, Comparison test, integral test, Series of Positive and Negative Terms, Absolute convergence and conditional convergence, Alternating series theorem, Ratio, Root, Comparison and integral tests, Uniform Convergence of Series, Improper Integrals, The Derivative of a Function Defined by an Integral. The Leibniz Rule, Convergence and Divergence of Improper Integrals the Riemann–Stieltjes Integral, Functions of Bounded Variation, The Riemann–Stieltjes Integral.

Text Book:

Introduction to Real Analysis by R. G. Bartle and D. R. Sherbert, John Wiley & Sons 2011.

Reference Books:

1. Introduction to Real Analysis by William F. Trench, Pearson Education 2013.
2. Principles of Mathematical Analysis by Walter Rudin, McGraw-Hill 1976.

MTH-312: Rings and Field:Rings, Quadratic integer rings, Non-commutative rings, TheHamilton quaternions. Polynomial rings. Matrix rings. Units, zero-divisors, nilpotent,

idempotents. Subrings, Ideals. Maximal and prime Ideals. Left, right and two-sided ideals, Operations with ideals. The ideal generated by a set. Quotient rings. Ring homomorphism. The isomorphism theorems, applications. Finitely generated ideals. Rings of fractions. Integral Domain. Divisibility in integral domains, greatest common divisor, least common multiple. Euclidean domains. The Euclidean algorithm. Principalideal domains. Prime and irreducible elements in an integral domain. Gauss lemma, Criteria for polynomials, Unique factorization domains. Finite fields. Polynomials in several variables. Symmetric polynomials. The fundamental theorem of symmetric polynomials.

Text Book:
A First Course in Abstract Algebra by J. B. Fraleigh, Addison-Wesley Publishing Company, 2003.
Reference Books:
1. Basic Abstract Algebra by P. B. Bhattacharya, S. K. Jain and S. R. Nagpaul,Cambridge University Press, 2012.
2. Algebra by P. M. Cohn, John Wiley and Sons, London, 1982.

MTH-401: Calculus of Variation
The First Variation: The Finite-Dimensional Case, The Euler-Lagrange Equation, Some Special Cases: No Explicit y Dependence, No Explicit x Dependence, Degenerate Case, Invariance of the Euler-Lagrange. Some Generalizations: Functional Containing Higher- order, Several Dependent, Two Independent Variables, The Inverse Problem. Isoperimetric Problems: The Finite-Dimensional Case and Lagrange Multipliers, Single Constraint, Multiple Constraints Abnormal Problems, the Isoperimetric Problem, Some Generalizations on the Isoperimetric. Holonomic and Nonholonomic Constraints. Problems with Variable Endpoints: Natural Boundary Conditions, the General Case, Transversality Conditions. The Hamiltonian Formulation: The Legendre Transformation, Equations, Symplectic Maps, The Hamilton-Jacobi Equation, The General Problem, Conservative Systems, Separation of Variables, The Method of Additive, Separation, Conditions for Separable Solutions.

Text Book:
The Calculus of Variations by Bruce van Brunt, Springer-verlag New York, 2004.
Reference Books:
1. Mathematical Methods for Engineers and Scientists Vol 3 by K.T. Tang, Springer-Verlag Berlin Heidelberg 2007 .
2. Applied Calculus of Variations for Engineers by Louis Komzsik, CRC Press, 2009.
3. Introduction to the calculus of variations by Bernard Dacorogna, World ScientificPublishing, 1992.

MTH-402: Numerical Techniques
Number systems and errors: Loss of significance and error propagation, condition and instability, error estimation, floating point arithmetic. Interpolation by polynomials: existence and uniqueness of the interpolating polynomial, Lagrangian interpolation, the divided difference table, error of the interpolating polynomial, interpolation with equally

spaced data, Newton's forward and backward difference formulas, Bessel's interpolation formula, Hermite interpolation. Solution of non-linear equations: Bisection method, iterative methods, secant method, fixed point iteration, Newton -Raphson method, order of convergence of Newton-Raphson and secant methods. System of linear equations: Gauss elimination method, triangular factorization, Crout method. Iterative methods: Jacobi method, Gauss-Seidel method, SOR method, convergence of iterative methods. Numerical Differentiation: Numerical differentiation formulae based on interpolation polynomials, error estimates. Numerical Integration: Newton-Cotes formulae, trapezoidal rule, Simpson's formulas, composite rules, Romberg improvement, Richardson extrapolation, error estimates of integration formulas, Gaussian quadrature.

Text Book:

Elementary Numerical Analysis by S. D. Conte and C. Boor, SIAM-Society for Industrial and Applied Mathematics 2017.

Reference Books:

1. Elements of Numerical Analysis by F. Ahmad and M. A. Rana, published byNational Book Foundation, Islamabad, 1995
2. Numerical Analysis for Engineers and Physicists by R. Zurmuhl, published bySpringer Verlag.

MTH-403: Fluid Mechanics

Real fluids and ideal fluids, velocity of a fluid at a point, streamlines and pathlines, steadyand unsteady flows, velocity potential, vorticity vector, local and particle rates of change, equation of continuity, acceleration of a fluid, conditions at a rigid boundary, general analysis of fluid motion, Euler's equations of motion, Bernoulli's equation, Navier-Stokes'equations steady motion under conservative body forces, some potential theorems, impulsive motion, sources, sinks and doublets, images in rigid infinite plane and solid spheres, axi-symmetric flows, Stokes' stream function, complex potential for two dimensional irrotational, incompressible flow, complex velocity potential for uniform stream, line sources and line sinks, line doublets and line vortices, image systems, Miline–Thomson circle theorem, Blasius theorem, use of conformal transformation and Schwartz-Christoffel transformation in solving problems, vortex rows, Kelvin's minimum energy theorem, uniqueness theorem, fluid streaming past a circular cylinder, irrotational motion produced by a vortex filament, Helmholtz vorticity equation, Karman's vortex-street.

Text Book:

Textbook of Fluid Dynamics by F. Chorlton, CBS Publishers & Distributors 2004.

Reference Books:

1. Theoretical Hydrodynamics by M. Thomson, published by Palgrave 2014.
2. Continuum Mechanics by W. Jaunzemics, published by Elsevier, 2009.
3. An Introduction to Fluid Dynamics by G. K. Batchelor, published by CambridgeUniversity Press 2000.

MTH-404: Integral Equations

Classification of integral equations, Linear integral equations, Special types of kernel, Square integrable functions and kernels, Singular integral equations, Non-linear equations.

Connection with differential equations, Linear differential, Green's function, Integral equations of the convolution type, Integral transforms, Fredholm equation of the first and second kind, Volterra equation of first and second kind, Method of successive approximations, Neumann series, Iterates and the resolvent kernel. Integral equations with singular kernels, Generalization to higher dimensions, Green's functions in two and three dimensions, Dirichlet's problem, Poisson's formula for the unit disc, Bacher's example, Degenerate kernels, Approximation by degenerate kernel, Fredholm's theorems, Fredholm formulae for continuous kernels, Bounds on characteristic values, Positive kernels, Mercer's theorem, Variational principles, Rayleigh-Ritz variational method.

Text Book:

Linear Integral Equations by W. V. Lovitt, Dover Publications, 2005.

Reference Books:

1. A first Course in Integral Equations by M. Wazwaz, World Scientific Pub., 2015.
2. Ordinary Differential Equations and Integral Equations by C. T. H. Baker, ELSEVIER SCIENCE & TECHNOLOGY, 2001.
3. Integral Equations by F. Smithies, Cambridge University Press, 1989.

MTH-405: Mathematical Modeling with Applications

Differential Equation models: Introduction, radiometric dating, the age of Uranium in our solar system, the age of the universe, carbon dating, epidemic modeling, Stability and asymptotic stability, Calculus, Newton and Leibniz, Vector calculus, Modeling in physical sciences: Rewriting Kepler's law mathematically, Generalizations, Newton and Elliptic Orbit. Nonlinear Population models: Population models, Growth and Decay, Logistic equation, Qualitative analysis, Harvesting models, Economic considerations, Depensation growth models. The nonlinear system and its linearization, Fundamental Theorem of Stability. Models for Interacting species: Lotka-Volterra Predator-Prey model, linear analysis, nonlinear analysis, Harvesting of Predator and Prey, Indiscriminate spraying of insects, the case of missing large mammalian carnivores. Age of the earth. Lord Kelvin's model.

Text Book

Mathematical Modeling, Third Edition, Mark M. Meerschaert, Academic Press, 2007

Reference Books:

1. Topics in mathematical modeling by K. K. Tung, Princeton University Press, New Jersey, 2007.
2. An Introduction to Mathematical Biology by J. S. Allen, Pearson/Prentice Hall, 2007.
3. Mathematical Models in Population Biology and Epidemiology by Fred Brauer, Carlos Castillo-Chavez, Springer, 2011.

Course Outlines of Elective Courses BS Mathematics

MTH-451: Fuzzy Logics

Examples of fuzziness, Modeling of fuzziness, Operations on fuzzy Sets, Fuzziness as uncertainty, Boolean algebra and lattices, Equivalence relations and partitions, Composing mappings, Isomorphism and homomorphisms, Alpha cuts, Images of alpha level sets, Fuzzy quantities, Fuzzy numbers, Fuzzy intervals, t–norms, Generators of t-norms, Isomorphisms of t–norms, Negations, t–conorms, Strict De Morgan Systems, Nilpotent De Morgan Systems, Nonuniqueness of negations in strict De Morgan Systems, Fuzzy implications, Averaging operators and negations, Averaging operators and nilpotent t- norms, De Morgan systems with averaging operators, Power of t-norms, Sensitivity of connectives, Binary fuzzy relations, Operations on fuzzy relations.

Text Book:
A first course in Fuzzy Logic H.T. Nguyen and E. A. Walker, Chapman and Hall/CRC2005.

Reference Books:
1. An introduction to Fuzzy Set Theory and fuzzy logic by Chander Mohan 2009.
2. Fuzzy Set Theory and its Applications by H. J. Zimmermann, Springer, 1996

MTH-452: Advance Group Theory

Actions of Groups, Permutation representation, Equivalence of actions, Regular representation, Cosets spaces, Linear groups and vector spaces, Affine group and affine spaces, Transitivity and orbits, Partition of G-spaces into orbits, Orbits as conjugacy class Computation of orbits, The classification of transitive G-spaces Catalogue of all transitive G-spaces up to G-isomorphism, One-one correspondence between the right coset of Ga and the G-orbit, G-isomorphism between coset spaces and conjugation in G, Simplicity of A5, Frobenius-Burnside lemma, Examples of morphisms, G-invariance, Relationship between morphisms and congruences, Order preserving one-one correspondences between congruences on Ω and subrroups H of G that contain the stabilizer Gα, The alternating groups, Linear groups, Projective groups, Mobius groups, Orthogonal groups, unitary groups, Cauchy's theorem, P-groups, Sylow P-subgroups, Sylow theorems, Simplicity of An when n>5.

Textbook:
A Course on Group Theory by J.S. Rose, Dover Publications, 2012.

Reference Books:
1. Finite Permutation Groups by H. Wielandt, Academic Press, 1964.
2. A Course in Algebra by J.B. Fraleigh, Addison-Wesley 1982.

MTH-453: Theory of Modules

Motivations to modules. Submodules, quotient modules, finitely generated and cyclic modules, exact sequences and elementary notions of homological algebra, Noetherian andArtinian rings and modules, radicals, semisimple rings and modules.

Textbook:
Module theory by T. S. Blyth, Oxford University Press, 1990.
Reference Books:
1. Groups, Rings And Modules with Applications, M. R. Adhikari, A. Adhikari,Universities Press, 2003.
2. A first Course in Algebra by J.B. Fraleigh, Addison-Wesley 1982.
3. Ring, Modules and Linear Algebra by B. Hartley & T.O. Hawkes, Chapman andHall, 1980.

MTH-454: Analytical Dynamics

Constraints, generalized co-ordinates, generalized forces, general equation of dynamics, Lagrange's equations, conservation laws, ignorable co-ordinates, Explicit form of Lagrange's equation in terms of tensors. Hamilton' principle of least action. Hamilton's equations of motion, Hamilton-Jacobi Method. Poisson Brackets (P.B's), Poisson's theorem, Solution of mechanical problems by algebraic technique based on (P.B's) Smalloscillations and normal modes, vibrations of strings, transverse vibrations normal modes, forced vibrations and damping, reflection and transmission at a discontinuity, longitudinalvibrations, Rayleigh's principle.

Textbook:
Textbook of Dynamics by F. Chorlton, published by CBS 2004.
Reference Books:
1. Mechanics by W. Chester, published by Springer 2013.
2. Classical Mechanics by H. Goldstein, published by Cambridge University, 1980
3. Methods of Analytical Dynamics by G. Meirovitch, published by McGraw-Hill,1970.

MTH-455: Quantum Mechanics
Basic postulates of quantum mechanics. State vectors. Formal properties of quantum mechanical operators. Eigenvalues and eigenstates, simple harmonic oscillator. Schrodinger representation. Heisenberg equation of motion Schrodinger equation. Potential step, potential barrier, potential well. Orbital angular momentum. Motion in a centrally symmetric field. Hydrogen atom. Matrix representation of angular momentum and spin. Time independent perturbation theory, degeneracy. The Stark effect. Introductionto relativistic Quantum Mechanics.

Textbook:
Principles of Quantum Mechanics by P. M.A. Dirac , Snowball Publishing 2012.
Reference Books

1. Quantum Mechanics by Fayyazuddin and Riazuddin, World Scientific 1990.
2. Quantum Mechanics by E. Merzbacher, John Wiley 1997.
3. Introductory Quantum Mechanics by R.L. Liboff, Addision-Wesley 2002.

MTH-456: Algebraic Geometry

Algebraic varieties: Affine algebraic varieities, Hibert basis Theorem, Decomposition of variety into irreducible components, Hibert's Nulttstellensatz, The Sectrum of a Ring, Projective variety and the homogeneous Spectrum. Functions and Morphisms: Some properties of Zariski topology, Rings and modules of franctions and their properties, Coordinate ring and polynomial functions, Polynomial maps, Regular and rational functions, Morphisms, Rational maps. Dimension: The Krull dimension of Topological Spaces and Rings, Prime Ideal Chain and Integral Extensions, The Dimension of Affine Algebras and Affine Algebraic Varieties, The Dimension of Projective Varieties. Applications: The product of varieties, On dimension, Tangent space and smoothness, Completeness.

Textbook:

I.R. Shafarevich, Basic Algebraic Geometry, Springer Verlag, 2014.

Reference Books:

1. Introduction to Commutative Algebra by M.F. Atiyah and I. G. Macdonald, Addison Wesley Pub. Co., 1994.
2. Introduction to Commutative Algebra and Algebraic Geometry by E, Kunz,Birkhäuser; 2013.

MTH-457: Theory of Manifolds

Manifolds and smooth maps, Derivatives and Tangents, The inverse function theorem and Immersions, Submersions, Transversality, homotopy and stability, Embedding manifolds in Euclidean space, Manifolds with boundary, One manifolds and some consequences, Exterior algebra, Differential forms, Partition of unity, Integration on manifolds, Exterior derivative, Cohomology with forms, Stoke's theorem, Integration and mappings, The Gauss-Bonnet --theorem, Lie groups as examples of manifolds, Their Lie algebras, Examples of matrix Lie groups and their Lie algebras.

Textbook:

Representations of Compact Lie groups by T. Boecker & T. Dieck, Springer Verlag 2003.

Reference Books:

1. Differential Topology by V. Guillemin & A. Pollock, American MathematicalSociety 2010.
2. Bredon, G.E., Introduction to Compact Transformation Groups, Academic Press,1972.

MTH-458: Functional Analysis-II

The Hahn-Banach theorem, principle of uniform boundedness, open mapping theorem, closed graph theorem, Weak topologics and the Banach-Alouglu theorem, extreme points and the Krein-Milman theorem. The dual and bidual spaces, reflexive spaces, compact operators, Spectrum and eigenvalue, of an operator, elementary spectral theory.

Textbook:

Introductory Functional Analysis and Applications by E. Kreyszig, published by JohnWiley, 1989.

Reference Books:

1. Introduction to Functional Analysis by A. E. Taylor and D. C. Lay, published byJohn Wiley
2. Functional Analysis by H. G. Heuser, published by John Wiley, 1982

MTH-459: Operations Research

Linear Programming: Linear programming, formulations and graphical solution, Simplex method, M-Technique and two-phase technique, Special cases, Duality and Sensitivity Analysis, The dual problem, primal-dual relationships, Dual simplex method, Sensitivity and post optimal analysis, Transportation Models, North-West corner, Least-Cost and Vogel's approximations methods, The method of multipliers, The assignment model, Thetranshipment model, Network minimization.

Textbook:

Operations Research: An Introduction, 10th Edition, by Hamdy A. Taha, 2016.

Reference Books:

1. Operations Research-An Introduction by A. Taha Hamdy, Macmillan PublishingCompany Inc., 1987.
2. Introduction to Operations Research by B. E. Gillett, McGraw-Hill, 1984.

MTH-460: Optimization Theory

Introduction to optimization, relative and absolute extrema, concave and unimodal Functions, constraints, Mathematical programming problems, optimization of one, two andseveral variables functions and necessary and sufficient conditions of their optima, optimization by equality constraints, direct substitution method and Lagrange multiplier method, necessary and sufficient conditions for an equality constrained optimum with bounded independent variables, inequality constraints and Lagrange multipliers, Kuhn-Tucker Theorem, multidimensional optimization by gradient method, convex and concaveprogramming, Calculus of variation and Euler-Lagrange equations, functionals depending on several independent variables, variation problems in parametric form, generalized mathematical formulation of dynamics programming, non-linear continuous models, dynamics programming and variational calculus, Control theory.

Textbook:

Optimization Theory with Applications by Dover Publications, 1986.

Reference Books:

1. Introduction to Optimization Theory by B. S. Gotfried and J. Weisman, PrenticeInc.,1973.
2. Differential Equations and the Calculus of Variations by L. Elsgolts, MirPublishers Moscow, 1970.
3. Introduction to Nonlinear Optimization by D. A. Wismer and R. Chattergy, NorthHolland New York, 1978.

MTH-461: Mathematical Modelling and Simulation

Basic concepts of computer modeling in science and engineering using discrete particle systems and continuum fields. Techniques and software for statistical sampling, simulation, data analysis and visualization. Use of statistical, quantum chemical, molecular dynamics, Monte Carlo, mesoscale and continuum methods to study fundamental physical phenomena encountered in the fields of computational physics, chemistry, mechanics, materials science, biology, and applied mathematics. Applications drawn from a range of disciplines to build a broad-based understanding of complex structures and interactions in problems where simulation is on equal-footing with theory and experiment.

Textbook:

Mathematical Modeling and Simulation: Introduction for Scientists and Engineers by KaiVelten, Wiley-VCH, 2009.

Reference Books:

1. Graphs, Models and Finite Mathematics by Malkevitich, Prentice Hall, 1973.
2. Analytical and Computational Methods of Advanced Engineering by G. B.Gustafson, SV, 1998.

MTH-462: Theory of Elasticity

Cartesian tensors, analysis of stress and strain, generalized Hooke's law, crystalline structure, point groups of crystals, reduction in the number of elastic moduli due to crystal symmetry, equations of equilibrium, boundary conditions, compatibility equations, plane stress and plane strain problems, two dimensional problems in rectangular and polar co- ordinates, torsion of rods and beams.

Textbook:

Theory of Elasticity 3rd Edition by Stephen Timoshenko, McGraw-Hill College,1970.

Reference Books:

1. Elastic Waves in Solids by E. Dieulesaint, John Wiley and Sons, 1980.
2. Foundations of Solid Mechanics by Y. C. Funk, Prentice-Hall, Englewood Cliffs,1965.

MTH-463: Electromagnetism

Electrostatics and the solution of electrostatic problems in vacuum and in media, Electrostatic energy, Electric currents, The magnetic field of steady currents, Magnetic properties of matter. Magnetic energy, Electromagnetic Induction, Maxwell's equations, Boundary Value Potential Problems in two dimensions, Electromagnetic Waves, Radiation, Motion of electric charges.

Textbook:
Classical Electromagnetism: Second Edition by Jerrold Franklin, Dover Publications,2017.

Reference Books:
1. Classical Electricity and Magnetism by K. H Panofsky and M. Philips, Addision-Wesley, 1962.
2. Introduction to Electromagnetic fields and waves by D. Corson. and P. Lerrain,Freeman, 1962.

MTH-464: Special Theory of Relativity
Historical background and fundamental concepts of special theory of relativity, Lorentz transformations (one dimensional), length contraction, time dilation and simultaneity, velocity addition formulae, 3- dimensional Lorentz transformations, introduction to 4-vector formalism, Lorentz transformations in the 4-vector formalism, the Lorentz and Poincare groups, introduction to classical mechanics, Minkowski space time and null cone, 4-velocity, 4-momentum and 4-force, application of special relativity to Doppler shift and Compton effect, particle scattering, binding energy, particle production and decay, electromagnetism in relativity, electric current, Maxwell's equations and electromagnetic waves, the 4-vector formulation of Maxwell's equations, special relativity with small acceleration.

Textbook:
Relativity: The Special and General Theory by Albert Einstein, Create Space IndependentPublishing Platform, 2017.

Reference Books
1. Relativity: An Introduction to the Special Theory by Asghar Qadir, World Scientific, 1989.
2. Introducing Einstein's Relativity by R. D. Inverno, Oxford University Press, 1992.
3. Classical Mechanics by H. Goldstein, Addison Wesley, 1962.
4. Classical Electrodynamics by J. D. Jackson, John Wiley 1962.

Course Outlines of Compulsory/ General Courses

IS-211: Islamic Studies

Basic teaching of the Holy Quran: Basic principle of the Arabic language (fundamentals of Arabic grammar, definite & indefinite articles, parts of speech, haroof e jara, subject & object pronouns, demonstrative pronouns, namaz (full text & translation) prayers, imperative sentences, singular, dual & plural, masculine & feminine, tajweed o qirat, surah al Hujrat (verdict & explanation) surah al Furqan (last chapter, traits of a momin) (verdict & explanation); the importance of Hadith in Islam; Jawahir ul Hadith (20 selected Ahadith); philosophy of Islamic beliefs (Tawheed, angels, holy scripture, prophets, day of judgment, predestination and decree, philosophy of Islamic prayers (shahadah, salat, zakat, saum & haj); duties in Islam (Jihad, Dawah, amr bil maroof wa nahi anil munkir); life of Muhammad (PBUH) as trader, teacher, preacher, army commander, guardian, husband & loving father; makki & madni life; sources of Islamic law and jurisprudence (Quran, Hadith, Ijma and Qayas); Islamic culture & civilization; death, shrouding and burial.

ARB-102: Arabic Language

Definition of nahw, sarf, ism, fa'il and harf, jumla ismiya, fi'lya, fi'l and its kinds, marifa and nakira, murakab and its kind, mowsuf and siffat, kana and its sisters, inna and its sisters, huroof-e-nwasib, huroof-e-jazima, dmeer and its kinds.

HS-101: English

Vocabulary (frequently confused / misused words, phrases, synonyms, antonyms, idioms & general vocabulary), practical use of business grammar (nouns, pronouns, verbs, adjectives, adverbs, prepositions, conjunctions, articles, interjections & tenses), sentences (types of sentences, parts of sentences, direct and indirect speech, active & passive voice & conditional sentences), reading and comprehension (extensive reading, intensive reading, skimming & scanning) and composition & summarization (descriptive, argumentative and persuasive skills in composition & comprehension and précis writing).

HS-102: Pakistan Studies

Ideology of Pakistan and Two Nation Theory, Nation state and nationalism, Sir Syed Ahmad Khan (Aligarh Movement), Allama Iqbal and Quaid-e-Azam on Two Nation Theory, Role of minorities in Pakistan Movement, Role of Women in Pakistan Movement, Overview of Muslim politics in United India from 1906 to 1947, Pakistan Constitution of 1956 , 1962 and 1973 (with amendments), Political History of Pakistan (1970-2013), Major issues of conflict between Pakistan and India, Pakistan's foreign policy, Pakistan's relation with international ommunity, OIC, ASEAN, SAARC, SCO and ECO, Physiographic Features of Pakistan, Geo-strategic importance of Pakistan, Various political, social, economic and cultural issues like National integration/ sovereignty violation, quagmire of front line state, menace of corruption, energy crisis, Importance of Gawadar Port and CPEC.

HS-103: Communication Skills

Principles of effective communication, concepts, benefits and characteristics of effective organizational communication, verbal & non verbal communication, components of communication, problems of communication, intercultural communication in the global context. Oracy skills (listening & speaking), literacy skills (reading & writing), presentation skills, seven C's of effective communication, reading skills, extensive, intensive, skimming and scanning. Communication and the technology context, formal letters, memorandum, Curriculum Vitae (Résumé), business E-mails and fax messages.

HS-201: Technical Report Writing

Introduction to technical writing basics, top down method, use of headings, use of chunks, visual aids, consistent visual logic, plain and objective language, use of honest language and format, codes of ethical conduct, pre-writing, writing and post-writing stages, structural parallelism, editing, plagiarism, choppy sentences, wordiness and verbosity, what is meant by tone and the use of correct tone, interviewing, echo techniques, synonyms, extended definitions, comparing and contrasting, explaining cause and effect, description of a human system, elements of memos, external proposals, letters, technical writing applications, memorandums, project reports, proposals, user manuals and letters.

HS- 402: Economics

Principles of engineering economy, scarcity, alternatives, opportunity cost of each choice, normative and positive economic analysis, consumer and producer goods, types of markets, demand law, supply law, price equilibrium, circular flow diagram, stakeholders, theory of firms behavior, cost terminologies, cost curves, breakeven analysis, time value of money, methods of calculating interest, methods of depreciation, project cost control, numerical & graphical representation of break even, internal rate of return, payback period, discrete and continuous compounding, types of ownership, project feasibility analysis, macroeconomics, inflation, unemployment, economic forces.

ACC – 201: Financial Management

Meaning & scope of financial management, financial manager & financial environment, time value of money, corporate financial statement analysis / ratios, financial forecasting & financial planning, analysis of cash flows, bond, securities & their valuation, budgeting& evaluation, the basis of capital, introduction to working capital management & managing current assets, working capital financing / financing current assets, strategic financial\ decisions- basics, risk & return, analysis of inventories, cash flow estimation and other topics in capital budgeting.

CS-101: Introduction to Information and Communication Technologies

Basic definitions and concepts, hardware: computer systems and components. Storage devices, number systems, software: operating systems, programming and application software, introduction to programming, databases and information systems, networks,

data communication, the Internet, browsers and search engines, email, collaborative computingand social networking, e-commerce, IT security and other issues.

CS-102 Programming Fundamentals
This course covers principles of structured and modular programming, overview of structured programming languages, algorithms and problem solving, program development: analyzing problem, designing algorithms, testing designed solutions, translating algorithms into programs, fundamental programming constructs, data types, basics of input and output, selection and decision (if, if-else, nested if-else, switch statement and condition operator), repetition (while and for loop, do-while loops), break statement, continue statement, control structures, functions, arrays, pointers, records, Files(input-output), testing & debugging.

PHY-101: Introduction to Mechanics
Units of physical quantities (SI Units), Motion of objects in one, two and three dimensions, Newton's laws of motion, Gravitation, Kepler's laws, Work done by Constant and Variable Forces (conservative and non-conservative), Power, Work and Potential Energy, Isolated Systems and Conservation of Mechanical Energy, Work done by External Forces and Conservation of Energy, Motion of a System of Particles and Extended Rigid Bodies, Center of Mass and Newton's Laws for a System of Particles, Linear Momentum, Impulse, Momentum & Kinetic Energy in One and Two Dimensional, Elastic and Inelastic Collisions, Rigid bodies, conservation laws, Rotation about a Fixed Axis, Angular motion(Displacement, Velocity and acceleration, work, power), Rotational Inertia, Parallel-axis Theorem, Torque and Newton's Law for Rotation, Rolling Motion, Angular Momentum for a single Particle and a System of Particles and its conservation, Static Equilibrium involving Forces and Torques, Rotational inertia of various shapes i.e. for disc, bar and solid sphere, Elasticity, Stress, Strain and Properties of Materials, Angular Velocity, Conservation of angular momentum, effects of Torque and its relation with angular momentum, Amplitude, Phase, Angular Frequency, Velocity and Acceleration in SHM, Linear and Angular Simple Harmonic Oscillators, Energy in SHM, Simple Pendulum, Physical Pendulum, SHM and Uniform Circular Motion. Static Fluids and Pressure, Archimedes' Principle, Fluid Dynamics, Equation of Continuity and Bernoulli's Principle

Textbook:
Fundamentals of Physics by D. Halliday, R. Resnick and J. Walker, John Wile & Sons2010.
Reference Books:

1. Physics for Scientists and Engineers by R. A. Serway and J. W. Jewett, Cengage Learning 2013.

PHY-102: Electricity and Magnetism
Electrostatics**:** Electric Charge, Conductors and Insulators, Coulomb's Law, Electric Fields due to a Point Charge and an Electric Dipole, Electric Field due to a Charge Distribution, Electric Dipole in an Electric Field, Electric Flux, Gauss' Law and its Applications in Planar, Spherical and Cylindrical Symmetry. Electric Potential**:** Equipotential Surfaces, Potential due to a Point Charge and a Group of Point Charges,

Potential due to an Electric Dipole, Potential due to a Charge Distribution, Relation between Electric Field and,

Electric Potential Energy. Capacitors and Capacitance**:** Parallel Plate, Cylindrical and Spherical capacitors, Capacitors in Series and Parallel, Energy Stored in an Electric Field, Dielectrics and Gauss' Law. DC Circuits: Electric Current and Current Density, Resistance and Resistivity, Ohm's Law, Power in Electric Circuits, Semiconductors and Superconductors, Work, Energy, and EMF, Resistances in Series and Parallel, Single and Multiloop Circuits, Kirchhoff's Rules, RC Circuits, Charging and Discharging of a Capacitor. Magnetic Field and Magnetic Force: Crossed Electric and Magnetic Fields and their Applications, Hall Effect, Magnetic Force on a Current Carrying Wire, Torque on a Current Loop, Magnetic Dipole Moment, Magnetic Field Due to a Current, Force between two Parallel Currents, Ampere's Law, Biot-Savart Law: Magnetic Field due to a Current, Long Straight Wire carrying Current, Solenoids and Toroids, A current-carrying Coil as a Magnetic Dipole, Inductance, Faraday's Law of Induction, Lenr's Law, Induction and Energy Transfers, Induced Electric Fields, Inductors and Inductances, Self-Inductance.

Textbook:

Fundamentals of Physics by D. Halliday, R. Resnick and J. Walker, John Wiley & Sons2010.

Reference Books:

1. Physics for Scientists and Engineers by R. A. Serway and J. W. Jewett, CengageLearning 2013.
2. R. A. Freedman, H. D. Young, and A. L. Ford (Sears and Zeemansky), Addison-Wesley-Longman, 1 3Ih international ed. 2010.

Physics: Principles with Applications by D. C. Giancoli, Pearson 2013

Standard 2-1The curriculum must be consistent and supports the program's documented objectives.

Sr. #	Course Name	Code
1	Islamic Studies	IS-211
2	English	HS-101
3	Introduction to Information and Communication Technologies	CS-101
4	Introduction to Mechanics	PHY-101
5	Elements of Set Theory and Mathematical Logic	MTH-104
6	Calculus-I	MTH-105
7	Pakistan Studies	HS-102
8	Communication Skills	HS-103
9	Electricity and Magnetism	PHY-102
10	Programming Fundamental	CS-102
11	Calculus-II	MTH-106
12	Linear Algebra	MTH-107
13	Technical Report Writing	HS-201
14	Economics	HS-402

15	Mathematical Computation with Software Packages	MTH-205
16	Calculus-III	MTH-206
17	Discrete Mathematics	MTH-207
18	Mathematical Statistics-I	MTH-208
19	Arabic Language	ARB-102
20	Financial Management	ACC- 201
21	Group Theory	MTH-209
22	Elementary Number Theory	MTH-210
23	Ordinary Differential Equations-I	MTH-211
24	Mathematical Statistics-II	MTH-212
25	Real Analysis –I	MTH-301
26	Complex Analysis	MTH-304
27	Metric and Topological Spaces	MTH-305
28	Ordinary Differential Equations-II	MTH-306
29	Differential Geometry and TensorAnalysis	MTH-308
30	Partial Differential Equations	MTH-307
31	Analytical Mechanics	MTH-309
32	Functional Analysis	MTH-310
33	Real Analysis –II	MTH-311
34	Rings and Field	MTH-312
35	Calculus of Variations	MTH-401
36	Numerical Techniques	MTH-402
37	Fluid Mechanics	MTH-403
38	E-1	MTH-xxx
39	E-2	MTH-xxx
40	Integral Equations	MTH-404
41	Mathematical Modeling with Applications	MTH-405
42	Project/E-3	MTH-xxx
43	E-4	MTH-xxx
44	E-5	MTH-xxx

Table 7: Courses and their respective Course Codes

Standard 2-2 Theoretical backgrounds, problem analysis and solution design must be stressed within the program's core material.

Elements	Courses
Theoretical Bakground	MTH-104 Elements of Set Theory and Mathematical Logic MTH-209 Group Theory MTH-210 Elementary Number Theory

	MTH-310	Functional Analysis
	MTH-305	Metric and Topological Spaces
	MTH-308	Differential Geometry and Tensor Analysis
	MTH-312	Rings and Fieldes
Problem Analysis	MTH-105	Calculus I
	MTH-106	Calculus II
	MTH-206	Calculus III
	MTH-107	Linear Algebra
	MTH-207	Discrete Mathematics
	MTH-208	Mathematical Statistics-I
	MTH-212	Mathematical Statistics-II
	MTH-301	Real Analysis-I
	MTH-311	Real Analysis-II
	MTH-304	Complex Analysis
	MTH-211	Ordinary Differential Equations-I
Solution Design	MTH-306	Ordinary Differential Equations-II
	MTH-307	Partial Differential Equations
	MTH-309	Analytical Mechanics
	MTH-401	Calculus of Variations
	MTH-402	Numerical Techniques
	MTH-403	Fluid Mechanics
	MTH-404	Integral Equations
	MTH-405	Mathematical Modeling with Applications
	MTH-	Project

Table 8: Standard 2-2 Requirement (table 4.5)

Standard 2-3 The Curriculum must satisfy the core requirements for the program as specified by therespective accreditation body.

BS Mathematics program is recognized by Higher Education Commission (HEC).

Minimum Requirements for each program (Program Semester Credit Hours):

Program	Theory Courses	Research Thesis
BS Mathematics	128	3

Table 9: Program Credit Hours

Standard 2-4 The curriculum must satisfy the major requirements for the program as specified by the respective accreditation body.

Same as Standard 2-3.

Standard 2-5 The curriculum must satisfy general education, arts and professional and other discipline requirements for the program as specified by the respective accreditation body.

Same as standard 2-3 and Standard 2-1 (table 4.4) as defined above.

Standard 2-6 Information technology component of the curriculum must be integrated throughout the program

Not applicable.

Standard 2-7 Oral and written communication skills of the student must be developed and applied in the program.

Students go through course presentations and research methodology, which develop the oral and written communication skills of the students. Students have to write a thesis and present their work in thesis defense in 4th semester.

Criterion 3: Laboratories and Computing Facilities

Standard3-1	Laboratory manuals/documentation/instructions for experiments must be available and easily accessible to faculty and students.

Not applicable.

Standard 3-2	There must be support personal for instruction and maintaining the laboratories.

Not applicable.

Standard 3-3	The University computing infrastructure and facilities must be adequate to support program's objectives.

Not applicable.

Criterion 4: Student Support and Advising

Since the launch of HITEC University in year 2007, all its programs have started and finished on schedule. The beauty of the HITEC culture is that teachers and students have facility of frequent interaction, even after classes, for any professional and academic advice. This aspect is even highlighted and indicated by the students in the feedback on HEC Performa number 10, taken by the QualityEnhancement Cell (QEC) in the university.

Standard 4-1 Courses must be offered with sufficient frequency and number for students to complete the program in a timely manner.

The department circulates a list of postgraduate courses to be offered by the PhD qualified faculty. A student registers in a semester can take 2 courses as additionalone. The minimum number of the students needed for offering a course is 6. The practice is followed in all the teaching semesters. Over the years, our experience shows that this scheme gives ample opportunities to complete the BS coursework in three semesters quite comfortably. The eighth semester is meant for research and writing a thesis. Thus, an average student cannot complete all requirements for the BS degree in four years time frame.

Standard 4-2 Courses in the major area of study must be structured to ensure effective interaction between students, faculty and teaching assistants.

The department ensures that postgraduate courses are offered in well-considered chronological sequences, leading towards the assigned research projects of the students.

Standard 4-3 Guidance on how to complete the program must be available to all students and access to qualified advising must be available to make course decisions and career choices.

The department has dedicated a senior faculty member as the advisor for each semester of the batch. He advises the students to select courses and in doing so, he consults the HOD as well as the PhD faculty. This ensures a smooth process of course selection. During the project phase, each student has a dedicated supervisor as well. He keeps guiding the students regularly till the end of the research defense.

Criterion 5: Process Control

Standard 5-1 The process by which students are admitted to the program must be based on quantitative and qualitative criteria and clearly documented. This process must be periodically evaluated to ensure that it is meeting its objectives.

Our university has a clearly defined and well documented admission process. The candidate seeking admission in BS (Mathematics) Program, must meet the following eligibility criterion.

- Intermediate with Mathematics, securing at least 50% marks in aggregate.

Or

- Any other examination of a Foreign University / Institution / Examining Body, equivalent to Intermediate with Mathematics. Equivalence and percentage of marks will be determined by IBCC.

Or

- Diploma of Associate Engineering Examination, securing at least 60% marks in aggregate.
- BS (Mathematics) is a 131 credit hours program of studies spreadover Eight (8) semesters.

Domains	Number of Course	Number of Credit Hours	HEC Required Credit Hours
Compulsory Courses	9	25	25
General Courses	7	21	21
Discipline Specific FoundationCourses + Major Courses + Project/Thesis	13+10+Project	73	70
Elective Courses	4	12	12
Total	**43+Project**	**131**	**128**

Standard 5-2 The process by which students are registered in the program and monitoring of students' progress to ensure timely completion of the program must be documented. This process must be periodically evaluated to ensure that it is meeting its objectives.

As mentioned earlier, the postgraduate program supervisor keeps track of the performance of each student and HOD also, individually, keeps a check on the progress as well. The controller of examinations department keeps in custody all

the results and raises an alarm whenever a student is likely to get into difficulties situation

Standard 5-3	**The process of recruiting and retaining highly qualified faculty members must be in place and clearly documented. Also processes and procedures for faculty evaluation, promotion must be consistent with institution mission statement. These processes must be periodically evaluated to ensure that it is meeting with its objectives.**

Vacant and newly created positions are advertised on the university website and also in the national newspapers, applications are received by the Registrar office, scrutinized by the respective Deans, and call letters are issued to the short-listed candidates on the basis of experience, qualification, publications and other qualities/activities as determined by the University in the light of HEC guidelines.

The candidates are interviewed by the University Selection Board. Selection of candidates is approved by the BOG. Induction of new candidates depends upon the number of approved vacancies.

Faculty members are retained by giving them good remuneration, favorable teaching environment, research facilities and management support.

On semester basis faculty performance is evaluated basing on HEC Performa number 10 by the students, HOD recommendations and with the counter signature of Dean and Vice Chancellor. The additional annual increment is based on the recommendations of the HOD, Dean and the Vice Chancellor.

Standard 5-4	**The process and procedures used to ensure that teaching and delivery of course material to the students emphasizes active learning and that course learning outcomes are met. The process must be periodically evaluated to ensure that it is meeting its objectives.**

Students are the recipient of the delivery of course material, through their teachers. The program is actively evaluated by HOD, Dean, In Charge program and QEC. The feedback of the taught course is best instrument to measure that the course learning outcomes are met. The students give feedback on Performa number 1 regarding course contents and how it was delivered. Through Performa number 10, students evaluate and comment on teacher's efforts, put in to deliver the course contents, his general conduct in the class, the environment, he/she, maintains and extra efforts, he/she makes to satisfy students, thirst for knowledge.

Faculty feedback is also taken on HEC Performa number 2 (Faculty Course Review Report – Annexure C) and Performa number 5 (Faculty Survey – Annexure
- E) which is a very useful activity to evaluate the course contents, learning and teaching environments and overall teachers' satisfaction level. Course evaluation by teachers also indicates what percentage of desired outcome has been achieved by the course contents and what needs to be improved or changed.

This exercise is done twice a year. The feedback is discussed with HOD, Dean and In-charge program, who focus on making improvements in the weak areas, identified by the students. Teacher's evaluation Performa's are fed to the computerand bar charts are made. Each teacher is graded out of 5 marks. The comparativebar charts indicate level of performance of teachers, as visualized by the students. QEC formally submits these bar charts to HOD, Dean and Vice Chancellor for their information and taking of necessary corrective actions.

Standard 5-5 The process that ensures that graduates have completed the requirements of the program must be based on standards, effective and clearly documented procedures. This process must be periodically evaluated to ensure that it is meeting its objectives.

HEC criteria for enduring the fulfillment of all the requirements are strictly followedin the University for the Award of MS degree. It consists of passing 131 credit hours with the defined courses provided in the curriculum of our BS Mathematics program and also with the project. Also, our requirement is that a student must achieve a minimum

CGPA of 2.0 out of 4.00. The minimum duration for Bachelor Program is 4 years and the maximum permitted time is 6 years. The complete process is well documented and well publicized. The appropriateness of this process is reviewed through faculty and student feedback forms by the QEC Directorate.

Criterion 6: Faculty

Standard 6-1 There must be enough full time faculties who are committed to the program to provide adequate coverage of the program areas/courses with continuity and stability. The interests and qualifications of all faculty members must be sufficient to teach all courses, plan, modify and update courses and curricula. All faculty members must have a level of competence that would normally be obtained through graduate work in the discipline. The majority of the faculty must hold a Ph.D. in the discipline.

There are nine PhD faculty members, specialist in the fields of numerical analysis, analytical and numerical techniques for ordinary and partial differential equations, and finite element analysis, fluid dynamics and computational fluid dynamics, fixed point theory and cryptography. Including these following ranks are available in the mathematics department:

- Associate Professor – 2 (1 Head of Department)
- Assistant Professor – 3
- Lecturer-6

Program Area of Specialization	**Elective Courses**		
Mathematics	Sr. No.	Course Code	Course title
	1.	MTH-451	Fuzzy Logics
	2.	MTH-452	Advanced Group Theory
	3.	MTH-453	Theory of Modules
	4.	MTH-454	Analytical Dynamics
	5.	MTH-455	Quantum Mechanics
	6.	MTH-456	Algebraic Geometry
	7.	MTH-457	Theory of Manifolds
	8.	MTH-458	Functional Analysis-II
	9.	MTH-459	Operations Research
	10.	MTH-460	Optimization Theory

	11.	MTH-461	Mathematical Modeling and Simulation
	12.	MTH-462	Theory of Elasticity
	13.	MTH-463	Electromagnetism
	14.	MTH-464	Special Theory of Relativity

Table 10: Courses Taught vs. Availability of Faculty

The ratio of faculty courses being taught is satisfactory. The present faculty is in position to take up all courses of post graduate students. Each faculty member is assigned subjects along with approved syllabus at the beginning of the semester. The faculty member prepares lecture plans and delivers to his / her students. Remaining restricted to the approved syllabus, the faculty member can update the already taught subject material according to the current developments in the field. Thus students are kept updated to the latest developments. Each faculty member is assigned access to the internet. Time table is scheduled in such a way so as to provide enough time to each teacher for research work. The courses being taught and commitment of the faculty is shown in the Table 10 for prescribed regular courses.

Standard 6-2 All faculty members must remain current in the discipline and sufficient time must be provided for scholarly activities and professional development. Also, effective programs for faculty development must be in place. Effective Programs for Faculty Development

University has an efficient and committed faculty. Each faculty member is assigned to teach subjects according to the syllabus prescribed in the light of HEC and PEC directives. Every faculty member is provided an opportunity at the end of semester through faculty satisfaction report to evaluate his/her performance and comment on the suitability of the contents of curriculum being taught by him according to the latest trends / developments. If deemed necessary, suitable changes to the curricula are made by a board in the light of the suggestions of the concerned faculty member.

University encourages the researchers by providing them a nominal amount after publication of research paper. Enough time is provided to the faculty members for

devoting their time to research in their fields. The faculty members are assisted by university through provision of internet facility and library.

Standard 6-3 All faculty members should be motivated and have job satisfaction to excel in their profession.

Students' feedbacks about their teachers are received after termination of each semester. Basing on these feedbacks, faculty members graded best by their students are awarded with appreciation letters. Letter of caution is served to the faculty member with whom students are not satisfied.

The faculty survey as per Performa prescribed by HEC is evaluated and basing on the inputs of the Performa, the system is further improved to provide beneficial teaching / learning environment. Faculty Surveys results are attached as per Annexure G.

Criterion 7: Institutional Facilities

Standard 7-1 The institution must have the infrastructure to support new trends in learning such as e-learning.

The university has provided e-learning facilities to faculty members and students. Students have been provided a number of computer systems in the library to access e-learning section. Every student has been provided with user ID to access the e-learning resources from within the university library. Our library hosts over 12,000 e-books on all relevant subjects.

The support staff to look after the e-learning resources is sufficient in number, trained and responsive. The university has provided enough funding to support thee-learning.

Standard 7-2 The library must possess an up-to-date technical collection relevant to the program and must be adequately staffed with professional personnel.

Our library holds more than 21,000 titles on all relevant engineering, sciences, mathematics, and humanities subjects. We add nearly 2,000 titles every year. Ourlibrary staff members are all duly qualified in library science subjects and also helpthe students

for searching the required material. The library also provides 22 dedicated computers which students use for web browsing.

Standard 7-3 Class-rooms must be adequately equipped and offices must be adequate to enable faculty to carry out their responsibilities.

The department has ample classrooms. These are very well furnished and also contain electric heaters and air conditioners. At most every classroom has installed multimedia projector. Similarly, faculty offices are well-equipped and well- furnished.

Criterion 8: Institutional Support

Standard 8-1 There must be sufficient support and financial resources to attract and retain high quality faculty and provide the means for them to maintain competence as teachers and scholars.

University allocates enough financial resources each year to hire competent faculty as required.

As already listed in standard 5-3, Faculty members are retained by giving them favorable teaching environment and management support. Most important point is that our pay scales for faculty are highly competitive and better than most of our competing institutions, including NUST.

As listed in standard 6-2, Faculty members are provided with adequate resources for research and academic activities to maintain their competence. Faculty members have access to the internet and library materials for academic and research activities. Professional training is also provided to faculty if required to enhance their capabilities. The university has schemes in place to reward faculty for each published research paper, chapter of a book, or the complete book. Similarly, travel grants up to 1,000/- rupees are available for attending a conference.

Standard 8-2 There must be an adequate number of high quality graduate students, research assistants and Ph.D. students.

The university follows the guidelines of HEC for admission in MS programs. The department has very vibrant postgraduate and doctoral programs. The university provokes its students to enhance their academic qualification. Also, all T/As and R/As are selected from our under study postgraduate students.

Standard 8-3 Financial resources must be provided to acquire and maintain Library holdings, laboratories and computing facilities.

The library holds more than 21,000/- titles and 12,000/- e-books. Sufficient numbers of computers are available for students. A computerized online search facility is also available.

Our laboratories are very well-equipped with the latest equipment and facilities. The university takes pride in the fact that our laboratories have been replicated bya number of other universities.

Conclusion

The self-assessment report of the Faculty of Mathematics, HITEC University, Taxila is an important document, which gives strengths and weaknesses of the program. The management is striving hard to improve infrastructure for establishment of conducive environment for studies. The faculty is focused on imparting quality education, introduction of new and innovative techniques and conduct of quality research to produce competent engineers. The report has been prepared after evaluating the program in the light of 8 criterion and 31 standards given in HEC's Self-Assessment Manual. The program mission objectives and outcomes are assessed and strategic plans are presented to achieve the goal, which are again measurable through definite standards. Teachers' evaluation revealed satisfactory standards, the score of all teachers of the program ranged from 4.55 and 4.84. Students' course evaluation score ranged between 4.43 to
4.85 with a mean of 4.67 points in 0-5 scale. Alumni surveys revealed variable results with regards to knowledge, interpersonal skills, management and leadership skill. Weaknesses are identified which are related to space, laboratories and equipment. Improvements in curriculum design and infrastructure are suggested which are based upon set, well defined and approved criteria. Pre- requisites are fully observed, examinations are held on schedules, academic schemes are prepared well in advance, transparent admission, registration and recruiting policy are some of the strong areas of this program. The number of courses along with titles and credit hours for each semester, course contents for degree program, is thoroughly planned. Their efficacy was measured through different standards and it was found to be satisfactory.

Proper steps are taken to guide the students for program requirements, research work, meetings, and students-teacher interaction etc. Some improvements have been suggested. As regards the process control covering admission, registration, recruiting policy, courses and delivery of material, academic requirements, performance and grading, university, PEC as well as Higher Education Commission has set forth proper rules, which are properly followed. At present

there are nine faculty members who are highly qualified in their fields. However, faculty members need motivation for advanced knowledge, research and externaltraining.

Institutional facilities were measured through Criterion 3; infrastructure, library, class room and faculty offices and in each case, short comings and limitation are highlighted. Institutional facilities need to be strengthened. Accordingly, institutional support will greatly promote and strengthen academic, research, management and leadership capabilities.

In conclusion, BS Mathematics program is designed to educate students to meet the challenges of the modern world and present market needs. During the execution of the program several observations were made that can be categorized as strong and weak points of the program. These points are listed below:

Strong Areas

- Capable nine PhD faculty members.
- Amongst them, they cover all essential domains of applied mathematics.
- The department has a blooming research culture.

Weak Areas

- There is a need to create research topics in collaboration with other engineering departments.
- The department should induct faster PCs and having more memory.

Annexure – A: Research Papers List

FACULTY PUBLICATIONS

Dr. Rashid Mehmood

Journal Papers

1. Non-orthogonal stagnation point flow of a nano non-Newtonian fluid towards a stretching surface with heat transfer International Journal of Heat and MassTransfer 57 (2), 679–689(Impact factor 2.50) (2013).

2. Non-orthogonal stagnation point flow of a micro polar second grade fluid towards a stretching surface with heat transfer Journal of the Taiwan Institute of Chemical Engineers 44, 586-595 (Impact factor 2.60) (2013).

3. Nanoparticle Analysis for Non-Orthogonal Stagnation Point Flow of a Third Order Fluid Towards a Stretching Surface Journal of Computational and Theoretical Nanoscience 10 (11), 2737-2747(Impact factor 1.03)(2013).

4. Optimized analytical solution for oblique flow of a Casson-nano fluid with convective boundary conditions International Journal of Thermal Sciences 78, 90-100(Impact factor 2.56) (2014).

5. Thermo-diffusion effects on MHD oblique stagnation-point flow of a viscoelastic fluid over a convective surfaceEur. Phys. J. Plus 129 (182), 1-18(Impact factor 1.50) (2014).

6. Partial slip effects on a rotating flow of two phase Nano fluid over a stretching surface Current Nano science 10 (6)(Impact factor 1.50)(2014).

7. Oblique stagnation point flow of a casson Nano fluid over a stretching surface with heat transfer Journal of Computational and Theoretical Nano science 12, 1-8 (Impact factor 1.03) (2014).

8. Boundary Layer Flow of Rotating Two Phase Nanofluid Over a Stretching SurfaceHeat Transfer Asian Research, 1-14(Impact factor 0.0)(2014).

9. Combined effects of magnetic field and partial slip on obliquely striking rheological fluid over a stretching surfaceJournal of Magnetism and Magnetic Materials 378, 457–462(Impact factor 2.0) (2015).

10. Oblique stagnation point flow of CNT based fluid over a convective surfaceJournal of Computational and Theoretical Nano science 12, 1-8(Impact factor 1.03) (2015).

11. Oblique stagnation flow of Jeffery fluid over a stretching convective surface: Optimal SolutionInternational journal of numerical method for heat and fluid flow (Impact factor 1.0)(2015).

12. Partial slip effect on non-aligned stagnation point nanofluid over a stretching convective surfaceChinese Physics B 24 (1)(Impact factor 1.50)(2015).

13. Numerical investigation on MHD oblique flow of Walter's B type nano fluid over a convective surface International Journal of Thermal Sciences (Impact factor 2.50)(2015).

14. Optimal and numerical solution for an MHD micro polar Nano fluid between rotating horizontal parallel plates PLOS ONE(Impact factor 3.50)(2015).

15. A comparative study on flow and heat transfer analysis for a non-aligned Jeffery nano-fluid over a stretching surface", (Under Review) Neural Computing and Applications(Impact factor 1.86)(2015).

16. Chebyshev Spectral Quasi-linearization method for an obliquely striking Maxwell fluid over a convective surface" (Under Review)Applied Numerical Mathematics(Impact factor 1.22)(2015)

(Research work at HITEC University Taxila Cantt Since 13-02-2015)

17. Nonaligned ethylene glycol 30 % based stagnation point fluid over a stretching surface with hematite Nano particles (Accepted) Journal of Applied fluid Mechanics(Impact factor 0.75)(2015).

18. Effects of transverse magnetic field on a Rotating Micropolar fluid between parallel plates with heat transfer (Under Review) Journal of Magnetism and magnetic materials(Impact factor 2.00)(2015).

19. Effects of single and multi-walled carbon nanotubes on water and engine oil based rotating fluids with internal heating (Under Review) International Journal of heat and Mass transfer(Impact factor 2.50)(2015)

Dr. Naveed Ahmed

Journal Papers

1. M. Rani, N. Ahmed, S. S. Dragomir, S. T. Mohyud-Din, New travelling wave solutions to (2+1)-Heisenberg ferromagnetic spin chain equation using Atangana's conformable derivative, Physica Scripta, https://doi.org/10.1088/1402-4896/ac07b9, 2021 Impact Factor=1.902.

2. M. Rani, N. Ahmed, S. S. Dragomir, S. T. Mohyud-Din, I. Khan, K. S. Nisar "Some newly explored exact solitary wave solutions to nonlinear inhomogeneous Murnaghan's rod equation of fractional order" Journal of Taibah University for Science, 15 (1),97-110, https://doi.org/10.1080/16583655.2020.1841472, 2021.

Impact Factor=1.863

3. N. Ahmed, Adnan, Umar Khan, S. T. Mohyud-Din, I. Khan, R. Murtaza, I. Hussain and E. S. M. Sherif. "A Novel Investigation and Hidden Effects of MHD and Thermal Radiations in Viscous Dissipative Nanofluid Flow Models" Frontiers in Physics,

Section Mathematical Physics, https://doi.org/10.3389/fphy.2020.00075 2020. Impact Factor=1.895

4. Umar Khan, Adnan, N. Ahmed, S. T. Mohyud-Din, D. Baleanu, I. Khan, K. S. Nisar, "A Novel Hybrid Model for Cu-Al2O3/H2O Nanofluid Flow and Heat Transfer in Convergent/Divergent Channels" Energies, 13(7),https://doi.org:10.3390/en13071686 , 2020. Impact Factor=2.707

5. N. Ahmed, Adnan, Umar Khan, S. T. Mohyud-Din, Y. M. Chu, I. Khan, K. S. Nisar, "Radiative Colloidal Investigation for Thermal Transport by Incorporating the Impacts of Nanomaterial and Molecular Diameters (dNanoparticles, dFluid): Applications in Multiple Engineering Systems" Molecules, 25(8),https://doi.org:10.3390/molecules25081896 ,2020. Impact Factor=3.060

6. Umar Khan, Adnan, N. Ahmed, S. T. Mohyud-Din, Y. M. Chu, I. Khan, K. S. Nisar, " γ -Nanofluid Thermal Transport Between Parallel Plates Suspended by Micro-Cantilever Sensor by Incorporating the Effective Prandtl Model: Applications to Biological and Medical Sciences" Molecules, 25(8), https://doi.org/10.3390/molecules25081777 , 2020. Impact Factor=3.060

7. Adnan, S. Z. A. Zaidi, Umar Khan, N. Ahmed, S. T. Mohyud-Din, Y. M. Chu, I. Khan, and K. S. Nisar, "Impacts of Freezing Temperature based Thermal Conductivity on the Heat Transfer Gradient in the Nanofluid: Applications for Curved Riga Surface" Molecules, 25(9), https://doi.org/10.3390/molecules25092152 ,2020. Impact Factor=3.060

8. S. T. Mohyud-Din, Adnan, Umar Khan, T. Abdeljawad, N. Ahmed and I. Khan, "Thermal Transport in Nonlinear Unsteady Colloidal Model by Considering the Carbon Nanomaterials Length and Radius" Energies, 13(10),https://doi.org/10.3390/en13102448 , 2020. Impact Factor=2.707

9. N. Ahmed, Adnan, Umar Khan, S. T. Mohyud-Din, I. Khan and K. S. Nisar, "Heat and Mass Transfer in Magneto-Newtonian Fluid Past a Paraboloid of Revolution with Internal Heat Source" Journal of Magnetics, Vol. 25, no. 2, pp. 254-261, 2020. ImpactFactor=0.873

10. S. T. Mohyud-Din, Adnan, Umar Khan, N. Ahmed, I. Khan, T. Abdeljawad, and K. S. Nisar, "Thermal Transport Investigation in Magneto-Radiative GO-

MoS2/H2O- C2H6O2 Hybrid Nanofluid Subject to Cattaneo-Christov Model" Molecules, 25(11), https://doi.org/10.3390/molecules25112592 , 2020. Impact Factor=3.060

11. Adnan, S. Z. A. Zaidi, Umar Khan, T. Abdeljawad, N. Ahmed, S. T. Mohyud-Din, I. Khan, and K. S. Nisar, "Investigation of Thermal Transport in Multi Shapes Cu Nanomaterial based Nanofluids" Materials 13(12),https://doi.org/10.3390/ma13122737 ,2020. Impact Factor=2.972

12. Adnan, S. Z. A. Zaidi, Umar Khan, N. Ahmed, S. T. Mohyud-Din and I. Khan, "Heat Transfer Enhancement in H2O Suspended by Aluminum Alloy Nanoparticles Over a Convective Stretching Surface". Advances in Mechanical Engineering Accepted 24- June-2020. Impact Factor=1.161

13. A. M. Alqahtani1, Adnan, Umar Khan, N. Ahmed, S. T. Mohyud-Din, I. Khan, "Numerical Investigation of Heat and Mass Transport in the Flow over a Magnetized Wedge by Incorporating the Effects of Cross-Diffusion Gradients: Applications in Multiple Engineering Systems". Mathematical Problems in Engineering Accepted 30-June-2020. Impact Factor=1.009

14. Umar Khan, Adnan, N. Ahmed and S. T. Mohyud-Din, "Surface Thermal Investigation in Water Functionalized Al2O3 and γAl2O3 Nanomaterials based Nanofluid over a Sensor Surface" Applied Nanoscience, Accepted 23 July 2020. Impact Factor=2.88

15. Adnan, Umar Khan, N. Ahmed, S. T. Mohyud-Din, I. Khan and E. S. M. Sherif, "Novel Analytical Thermal Performance Rate Analysis in ZnO-SAE50 Nanolubricant: Nonlinear Mathematical Model" CMC-Computers Materials and Continua, Accepted 2 Aug. 2020. Impact Factor=4.89

16. N. Ahmed, F. Saba, Umar Khan, ST Mohyud-Din, ESM Sherif, I Khan Nonlinear Thermal Radiation and Chemical Reaction Effects on a Cu-CuO/NaAlg Hybrid Nanofluid Flow Past a Stretching Curved Surface, Processes, 7 (12) 2019, 962. ImpactFactor=1.963.

17. F. Saba, S. Noor, N. Ahmed, Umar Khan, S. T. Mohyud-Din, Z. Bano, Elsayed M. Sherif, I. Khan Heat Transfer Enhancement by Coupling of Carbon Nanotubes and SiO2 Nanofluids: A Numerical Approach, Processes, 7 (12) 2019, 937. Impact Factor=1.963.

18. A. Waheed, A. Nazir, S. Ahmed, M. Zeb, N. Ahmed, Umar Khan, S. T. Mohyud-Din, On conformable mathematical model of immune system coupled with intestinal microbiome, Thermal Science 2019, Pages: 409-409. Impact Factor=1.431.

19. N. Ahmed, Adnan, Umar Khan, S.T. Mohyud-Din, Modified Heat Transfer Flow Model for SWCNTs-H2O and MWCNTsH2O Over a Curved Stretchable Semi Infinite Region

with Thermal Jump and Velocity Slip: A Numerical Simulation, Physica A: Statistical Mechanics and its Applications. Accepted, 2019, Impact Factor=2.50.

20. A. Nazir, N. Ahmed, Umar Khan, S.T. Mohyud-Din, On stability of improved conformable model for studying the dynamics of a malnutrition community, Physica A: Statistical Mechanics and its Applications, 537 (1) (2020) 122664. Impact Factor=2.50.

21. A. Nazir, N. Ahmed, Umar Khan, S.T. Mohyud-Din, A conformable mathematical model for alcohol consumption in Spain, International Journal of Biomathematics, Accepted (2019). Impact Factor=0.846.

22. S. Bibi, N. Ahmed, I. Faisal, S. T. Mohyud-Din, M. Rafiq, Umar Khan, Some new solutions of the Caudrey–Dodd–Gibbon (CDG) equation using the conformable derivative, Advances in Difference Equations, December 2019, 2019:89. Impact Factor=1.066.

23. Umar Khan, Adnan, N. Ahmed, S.T. Mohyud-Din, I. Khan, Stimulations of Thermophysical Characteristics of Nano-Diamond and Silver Nanoparticles for Nonlinear Radiative Curved Surface Flow, IEEE Access, Accepted (2019), Impact Factor=3.557.

24. N. Ahmed, F. Saba, Umar Khan, S.T. Mohyud-Din, A novel coupling of CNT-Fe_3O_4/H_2O hybrid nanofluid for improvements in heat transfer for flow in an asymmetric channel with dilating/squeezing walls, International Journal of Heat and Mass Transfer, 136 (2019) 186-195. Impact Factor=3.891.

25. N. Ahmed, Adnan, Umar Khan, S.Z. A. Zaidi, I. Faisal, S.T. Mohyud-Din, Heat Transfer Intensification in Hydromagnetic and Radiative 3D Unsteady Flow Regimes: A Comparative Theoretical Investigation for Aluminum and γ-Aluminum Oxides Nanoparticles, Journal of Central South University, Accepted (2019), Impact Factor=0.761.

26. F. Saba, N. Ahmed, Umar Khan, S. T.Mohyud-Din, Impact of an effective Prandtl number model and across mass transport phenomenon on the γ-Al_2O_3 nanofluid flow inside a channel, Physica A: Statistical Mechanics and Its Applications, 526 (2019) 121083. Impact Factor=2.5.

27. S. Bibi, N. Ahmed, Umar Khan, S. T. Mohyud-Din, Auxiliary equation method for ill- posed Boussinesq equation, Physica Scripta, Accepted (2019). Impact Factor=1.902.

28. Umar Khan, Adnan, N. Ahmed, S. Noor, I. Khan, S. T. Mohyud-Din, W. A. Khan, Modified MHD Radiative Mixed Convective Nanofluid Flow Model by Considering the

Impact of Freezing Temperature and Molecular Diameter, Symmetry, Accepted (2019), Impact Factor=1.256.

29. N. Ahmed, A Tassadiq, R. Alabdan, Adnan, U, Khan, S. Noor, S. T. Mohyud-Din, I. Khan, Applications of Nanofluids for the Thermal Enhancement in Radiative and Dissipative Flow over a Wedge, Applied Sciences, Accepted (2019). Impact Factor=1.689.

30. N. Ahmed, F. Saba, Umar Khan, I. Khan, T. A. Alkanhal, I. Faisal, S. T. Mohyud-Din, Spherical Shaped (A g-F e3O4/H2O) Hybrid Nanofluid Flow Squeezed between Two Riga Plates with Nonlinear Thermal Radiation and Chemical Reaction Effects, Energies 12 (1) (2019) 76. Impact Factor=2.676.

31. N. Ahmed, Adnan, Umar Khan, S. T. Mohyud-Din, Corrigendum to “Influence of an Effective Prandtl number Model on Squeezed Flow of γAl2O3-H2O and γAl2 O3-C2H6O2 Nanofluids, Journal of Molecular Liquids 238(2017), 447-454”, Journal of Molecular Liquids, 277 (2019) 36-39, Impact Factor=4.51.

32. W. Sikander, N. Ahmed, Umar Khan, S.T. Mohyud-Din, Coupling of optimal variation of parameters method with Adomian’s polynomials for nonlinear equations representing fluid flow in different geometries, Neural Computing and Applications, (Springer), 30 (11) (2018) 3431-3444. Impact Factor=4.213.

33. N. Ahmed, Adnan, Umar Khan, S. T. Mohyud-Din, Thermal radiation effects on flow of Jeffery fluid in convergent/divergent stretchable channels, Neural Computing and Applications, (Springer), 30 (8) (2018) 2371-2379. Impact Factor=4.213.

34. F. Saba, N. Ahmed, Umar Khan, A. Waheed, M. Rafiq, S. T. Mohyud-Din, Thermophysical Analysis of Water Based (Cu–Al2O3) Hybrid Nanofluid in an Asymmetric Channel with Dilating/Squeezing Walls Considering Different Shapes of Nanoparticles, Applied Sciences, 8(9) (2018) 1549. Impact Factor=1.689.

35. N. Ahmed, Adnan, Umar Khan, S. T. Mohyud-Din, Influence of shape factor on flow of magneto-nanofluid squeezed between parallel disks, Alexandria Engineering Journal,(Elsevier), 57 (3) (2018) 1893-1903. Impact Factor=6.026.

36. S.Z. A. Zaidi, S.T. Mohyud-Din, Umar Khan, N. Ahmed, Powell Eyring fluid flow through wall jet in the presence of viscous dissipation, The European Physical JournalPlus, 133 (2018) 340. Impact Factor=2.24.

37. N. Ahmed, Adnan, F. Saba, Umar Khan, S. T. Mohyud-Din, Flow of Ferro-Magnetic nanoparticles in a Rotating System: A Numerical Investigation of Particle Shapes, Indian Journal of Physics, 91 (8) (2018) 969–977. Impact Factor=0.967.

38. N. Ahmed, Adnan, F. Saba, Umar Khan, S. T. Mohyud-Din, Analytical and Numerical treatment of a Nano-Bioconvection Flow model in the presence of Nanoparticles and Gyrotactic Microorganisms, Journal of Nanofluids, 7 (4), (2018) 755-765. Impact Factor=0.00.

39. N. Ahmed, Adnan, Umar Khan, S. T. Mohyud-Din, A Theoretical Investigation of Unsteady Thermally Stratified Flow of γAl2O3-H2O and γAl2O3-C2H6O2 Nanofluids through a Thin Slit, Journal of Physics and Chemistry of Solids, (Elsevier), 119 (2018) 296-308. Impact Factor=2.207.

40. S. Bibi, N. Ahmed, Umar Khan, S. T. Mohyud-Din, Some New Exact Solitary Wave Solutions of the Van der Waals Model Arising in Nature, Results in Physics 9 (2018) 648-655 (Elsevier). Impact Factor=2.147.

41. A. Nazir, N. Ahmed, Umar Khan, S. T. Mohyud-Din, Analytical approach to study a mathematical model of CD4+Tcells, International Journal of Biomathematics 11 (04) (2018) 1850056. Impact Factor=0.846.

42. Umar Khan, Naveed Ahmed, Syed Tauseef Mohyud-Din, Analysis of Magnetohydrodynamic Flow and Heat Transfer of Cu-Water Nanofluid between Parallel Plates for Different Shapes of Nanoparticles, Neural Computing and Applications, (Springer), 29 (10) (2018) 695-703. Impact Factor=4.213.

43. S. T. Mohyud-Din, S. Bibi, N. Ahmed, Umar Khan, Some Exact Solutions of the Nonlinear Space –Time Fractional Differential Equations, Waves in Random and Complex Media, https://doi.org/10.1080/17455030.2018.1462541, Taylors and Francis (Accepted), (2018). Impact Factor=1.447.

44. Umar Khan, Adnan, N. Ahmed, S. T. Mohyud-Din, Response to “Comment on the paper " Heat transfer enhancement in hydromagnetic dissipative flow past a moving wedge suspended by H2O-aluminum alloy nanoparticles in the presence of thermal radiation, Umar Khan, Adnan, Naveed Ahmed, Syed Tauseef Mohyud-Din,International Journal of Hydrogen Energy 42 (2017) 24634-24644", International Journal of Hydrogen Energy 43 (12) (2018) 6478-6479, (Elsevier). ImpactFactor=4.299.

45. Umar Khan, A. Irshad, N. Ahmed, S. T. Mohyud-Din, Improved tan((𝜙(𝜉))/2)-expansion method for (2+1)-Dimensional KP-BBM Wave Equation, Optical and Quantum Electronics, (Springer), 50 (3) (2018) 135. Impact Factor=1.168.

46. S.T. Mohyud-Din, Umar Khan, N. Ahmed, M.M. Rashidi, A Study of Heat and Mass Transfer of MHD flow of Nanoparticles, Propulsion and Power Research (Elsevier), 7(1) (2018) 72-77. Impact Factor=4.56.

47. N. Ahmed, S. Bibi, Umar Khan, S. T. Mohyud-Din, A New Modification in Exponential Rational Function Method for Nonlinear Fractional Differential Equations, The European Physical Journal Plus, (Springer), 133 (2018) 45. Impact Factor=2.24.

48. S.T. Mohyud-Din, S.U. Jan, Umar Khan, N. Ahmed, MHD Flow of Radiative Micropolar Nanofluid in a Porous Channel: Optimal and Numerical Solutions, Neural Computing and Applications, (Springer), 29 (3) (2016) 793-801. Impact Factor=4.213.

49. S. I. U. Khan, Umar Khan, N. Ahmed, S. U. Jan, Y. Xiao-Jun, S. T. Mohyud-Din, Squeezing Flow of MHD Fluid between Parallel Disks, International Journal for Computational Methods in Engineering Science & Mechanics, (Taylor & Francis), 19 (1) (2018) 42-47. Impact Factor=0.00.

50. Umar Khan, Adnan, N. Ahmed, S.T. Mohyud-Din, Corrigendum to '3D squeezed flow of γAl2O3–H2O and γAl2O3–C2H6O2 nanofluids: A numerical study', International Journal of Hydrogen Energy, 43 (46) (2018) 21629-21631. Impact Factor=4.299.

51. N. Ahmed, Umar Khan, S. T. Mohyud-Din, B. B. Mohsin, A Finite element investigation of flow of Newtonian fluid in dilating and squeezing porous channel under influence ofnonlinear thermal radiation, Neural Computing and Applications, (Springer), 29 (2) (2018) 501–508. Impact Factor=4.213.

52. N. Ahmed, A. Irshad, S.T. Mohyud-Din, Umar Khan, Exact Solutions of Perturbed Nonlinear Schrödinger's Equation with kerr law nonlinearity by improved tan((ϕ(ξ))/2)- expansion method, Optical and Quantum Electronics, (Springer), 50 (2018) 45. ImpactFactor=1.168.

53. Umar Khan, N. Ahmed, S. T. Mohyud-Din, W. Sikander, Flow of Carbon Nanotubes Suspended Nanofluid in Stretchable Non-Parallel Walls, Neural Computing and Applications, (Springer), 30 (9) (2018) 2859–2871. Impact Factor=4.213.

54. W. Sikandar, Umar Khan, N. Ahmed, S.T. Mohyud-Din, Variation of Parameters Method with an Auxiliary Parameter for Initial Value Problems, Ain Shams EngineeringJournal, Elsevier, 9 (4) (2018) 1959-1963. Impact Factor=3.18

55. N. Ahmed, Adnan Abbasi, Umar Khan, S. T. Mohyud-Din, Blasius and Sakiadis problems over an inclined plane suspended by nanofluids, Nonlinear Science LettersA, Physical Sciences, Accepted 2018.

56. N. Ahmed, Umar Khan, S. T. Mohyud-Din, B. B. Mohsin, MHD flow of a viscous Fluid between Dilating and Squeezing Porous Walls, Iranian Journal of Science and Technology (Science), 41 (4) (2017) 951–956. Impact Factor=0.34.

57. S.T. Mohyud-Din, Umar Khan, N. Ahmed, Bandar Bin-Mohsin, Heat and mass transfer analysis for MHD flow of nanofluid in convergent/divergent channels with stretchable walls using Buongiorno's model, Neural Computing and Applications, (Springer), 28 (12) (2017) 4079-4092. (DOI 10.1007/s00521-016-2289-5) Impact Factor=2.505.

58. Umar Khan, Adnan, N. Ahmed, S. T. Mohyud-Din, Particle Shape, Thermal Radiations, Viscous Dissipation and Joule Heating Effects on Flow of Magneto-nanofluid in a Rotating System, Engineering Computations, (Emerald), 34 (8) (2017) 2479-2498. Impact Factor=1.010.

59. N. Ahmed, Umar Khan, S. U. Jan, S. T. Mohyud-Din, Non-linear Radiative Squeezed flow in a Rotating Frame, Engineering Computations, (Emerald), 34 (8) (2017) 2450- 2462. Impact Factor=1.010.

60. Umar Khan, Adnan, N. Ahmed, S. T. Mohyud-Din, Flow of Magneto-nanofluid over a thermally stratified bi-directional Stretching Sheet in the presence of Ohmic Heating: A numerical study of particle shapes, Engineering Computations, (Emerald), 34 (8) (2017) 2499-2513. Impact Factor=1.010.

61. N. Ahmed, Adnan, Umar Khan, S.T. Mohyud-Din, Unsteady Radiative Flow of Chemically reacting Fluid over a Convectively Heated Stretchable Surface with Cross-Diffusion Gradients, International Journal of Thermal Sciences (Elsevier), 121 (2017) 182-191. Impact Factor=3.615.

62. S. T. Mohyud-Din, W. Sikandar, Umar Khan, Naveed Ahmed, Optimal Variational Iteration Method for nonlinear Problems, Journal of the Association of Arab Universities for Basic and Applied Sciences, 24 (1) (2017) 191-197. Impact Factor=0.00.

63. Umar Khan, Adnan, N. Ahmed, S.T. Mohyud-Din, Heat Transfer Enhancement in Hydromagnetic Dissipative Flow Past a Moving Wedge suspended by $\boldsymbol{H2O}$-Aluminum Alloy Nanoparticles in the Presence of Thermal Radiation, International Journal of Hydrogen Energy, (Elsevier), 4 2 (2017) 24634-24644. Impact Factor=3.582.

64. Umar Khan, Adnan, N. Ahmed, S. T. Mohyud-Din, 3D Squeezed Flow of γAl2 O3-H2O and γAl2O3-C2H6O2 Nanofluids: A Numerical Study, International Journal of Hydrogen Energy, (Elsevier), 42 (39) 2017, 24620-24633. Impact Factor=3.582.

65. S.T. Mohyud-Din, N. Ahmed, Umar Khan, Flow of a radioactive Casson fluid through a deformable asymmetric porous channel, International Journal of Numerical Methods for Heat and Fluid Flow, (Emerald), 27 (9) (2017) 2115-2130. Impact Factor=1.713.

66. Umar Khan, N. Ahmed, S.T. Mohyud-Din, B. B. Mohsin, Nonlinear radiation effects on MHD flow of nanofluid over a nonlinearly stretching/shrinking wedge, Neural Computing and Applications, (Springer), 28 (1) (2017), 2041-2050, (DOI 10.1007/s00521-016-2187-x) Impact Factor=2.505.

67. N. Ahmed, Adnan, Umar Khan, S. T. Mohyud-Din, A. Waheed, Shape effects of nanoparticles on Squeezed flow between two Riga Plates in the presence of thermal radiation, The European Physical Journal Plus, July 2017, 132:321. (Springer), Impact Factor=1.753.

68. N. Ahmed, Adnan, Umar Khan, S.T. Mohyud-Din, Influence of an Effective Prandtl number Model on Squeezed Flow of γAl2O3-H2O and γAl2O3-C2H6O2 Nanofluids, Journal of Molecular Liquids, (Elsevier), Volume 238, July 2017, Pages 447–454. Impact Factor=3.648.

69. S.T. Mohyud-Din, Umar Khan, N. Ahmed, M.M. Rashidi, Stokes First Problem for MHD Flow of Casson nanofluid, Multidiscipline Modelling in Materials and Structures (Emerald), 13 (1) (2016) 2-10. Impact Factor=0.00.

70. N. Ahmed, Adnan, Umar Khan, S.T. Mohyud-Din, Influence of Thermal Radiation and Viscous dissipation on Squeezed flow of Water between Riga Plates saturated with Carbon nanotubes, Colloids and Surfaces A: Physicochemical and Engineering Aspects, (Elsevier), 522 (2017) 389-398. Impact Factor=2.76.

71. N. Ahmed, Adnan, Umar Khan, S. T. Mohyud-Din, Thermo diffusion and diffusion Thermo effects on Flow of viscous Incompressible fluid between Convergent/divergent Channels with Stretching/shrinking Walls, Journal of Nanofluids, 6 (3), (2017) 574-
586. Impact Factor=1.951.

72. N. Ahmed, S. U. Jan, Umar Khan, S. T. Mohyud-Din, Heat Transfer Analysis of Third- grade Fluid Flow between Parallel Plates: Analytical Solutions, International Journal of Applied and Computational Mathematics, Springer, 3 (2) (2017) 579–589. Impact Factor=0.00.

73. N. Ahmed, Umar Khan, S.T. Mohyud-Din, Variation of Parameters Solution for Two Dimensional Flow of a Viscous Fluid Between Dilating and Squeezing Channel with Permeable Walls, International Journal of Applied and Computational Mathematics, Springer, 3(2) (2016) 635–643. Impact Factor=0.00.

74. N. Ahmed, Umar Khan, S. T. Mohyud-Din, MHD Nanofluid Flow through a Deformable Asymmetric Porous Channel, Engineering Computations (Emerald), 34 (3) (2017), 852-868. Impact Factor=1.010.

75. S.T. Mohyud-Din, W. Sikander, Umar Khan, N. Ahmed, Optimal Variational Iteration Method for Physical Problems on Finite and Semi-Infinite Intervals, The European Physical Journal Plus, (Springer), (2017), 132 (5): 236. Impact Factor=1.753.

76. N. Ahmed, Adnan, Umar Khan, S. T. Mohyud-Din, R. Manzoor, Influence of Viscous dissipation on Copper Oxide Nanofluid in an Oblique Channel: Implementation of KKL Model, The European Physical Journal Plus, (Springer), (2017), 132 (5): 237. Impact Factor=1.753.

77. S. T. Mohyud-Din, N. Ahmed, Umar Khan, M. M. Rashidi, Thermo-diffusion, Diffusion-thermo and chemical reaction effects on flow of micropolar fluid of asymmetric channel with dilating and contracting permeable walls, Engineering Computations, (Emerald),34 (2) (2017), 587-602. Impact Factor=1.010.

78. B.B. Mohsin, N. Ahmed, Adnan, Umar Khan, S. T. Mohyud-Din, A Bioconvection Model for a squeezing flow of nanofluid Between parallel plates in the presence of gyrotactic microorganisms, The European Physical Journal Plus, (Springer), (2017), 132 (4): 187. Impact Factor=1.753.

79. Umar Khan, Adnan, N. Ahmed, S.T. Mohyud-Din, Influence of the Shape Factor on the Flow and Heat Transfer of a Water based Nanofluid in a Rotating System, The European Physical Journal Plus, 132:166 (2017) (Springer). Impact Factor=1.753.

80. Umar Khan, Adnan, M, Asadullah, N. Ahmed, S. T. Mohyud-Din, Influence of Joule heating and viscous dissipation on MHD Flow and Heat Transfer of Viscous Fluid in Converging/Diverging Stretchable Channels, Journal of Nanofluids, 6 (2017) 254-263. Impact Factor=0.00.

81. S.I.U. Khan, Umar Khan, N. Ahmed, S.T. Mohyud-Din, Variation of Parameters Method for Heat Diffusion and Heat Convection Equations, International Journal of Applied and Computational Mathematics (Springer), Volume 3 (1) (2017) 185–193. Impact Factor=0.00.

82. Umar Khan, N. Ahmed, S. T. Mohyud-Din, Numerical Investigation for three dimensional squeezing flow of nanofluid in a rotating channel with lower stretching wall

suspended by carbon nanotubes, Applied Thermal Engineering, (Elsevier), 113 (2017) 1107-1117, Impact Factor=3.356.

83. Umar Khan, N. Ahmed, S.T. Mohyud-Din, B.B. Mohsin, Nonlinear Radiation Effects on Flow of Nanofluid over a Porous Wedge in the Presence of Magnetic Field, International Journal of Numerical Methods for Heat and Fluid Flow, (Emerald), 27 (1) (2017), 48-63. Impact Factor=1.713.

84. S. Bibi, S. T. Mohyud-Din, Rahmat Ullah, N. Ahmed, Umar Khan, Exact solutions for STO and (3+1)-dimensional KdV-ZK Equations Using (G^'/G^2)-Expansion Method, Results in Physics, (Elsevier), 7 (2017) 4434-4439. Impact Factor=0.946.

85. S. Bibi, S. T. Mohyud-Din, Umar Khan, N. Ahmed, Khater method for Nonlinear Sharma Tasso-Olever (STO) Equation of Fractional Order, Results in Physics, (Elsevier), 7 (2017) 4440-4450. Impact Factor=0.946.

86. A. Irshad, S. T. Mohyud-Din, N. Ahmed, Umar Khan, A New Modification in Simple Equation Method and its Applications on Nonlinear Equations of Physical Nature, Results in Physics, (Elsevier), 7 (2017) 4232-4240. Impact Factor=0.946.

87. S. T. Mohyud-Din, A. Irshad, N. Ahmed, Umar Khan, Exact Solutions of (3+1)-dimensional generalized KP Equation Arising in Physics, Results in Physics, (Elsevier), 7 (2017) 3901-3909. Impact Factor=0.946.

88. N. Ahmed, Adnan, Umar Khan, S.T. Mohyud-Din, V.S. Erturk, Influence of Thermal and Concentration Gradients on Unsteady Flow over a Stretchable Surface, Results in Physics, 7, (2017), 3153-3162 (Elsevier). Impact Factor=0.946.

89. Umar Khan, Adnan, N. Ahmed, S. T. Mohyud-Din, Soret and Dufour effects on Jeffery- Hamel Flow of Second-Grade Fluid between Convergent/Divergent channel with Stretchable walls, Results in Physics, (Elsevier), 7 (2017) 361-372. Impact Factor=0.946.

90. N. Ahmed, Umar Khan, S.I.U. Khan, S. Bano, S. T. Mohyud-Din, Effects of Magnetic Field in Squeezing Flow of Casson Fluid Between Parallel Plates, Journal of King Saud University- Science, (Elsevier), 29 (1) (2017) 119-125. Impact Factor=0.00.

91. W. Sikandar, Umar Khan, N. Ahmed, S.T. Mohyud-Din, Optimal Solutions for a Bio Mathematical Model for the Evolution of Smoking Habit, Results in Physics, (Elsevier),7 (2017) 892-901. Impact Factor=0.964.

92. Umar Khan, N. Ahmed, S. T. Mohyud-Din, Heat transfer effects on carbon nanotubes suspended nanofluid flow in a channel with non-parallel walls under the

effect of velocity slip boundary condition: A numerical study, Neural Computing and Applications, (Springer), 28 (2017) 37-46. Impact Factor=2.505.

93. W. Sikander, Umar Khan, N. Ahmed, S.T. Mohyud-Din, Optimal Solutions for Homogeneous and non-Homogeneous Equations Arising in Physics, Results in Physics, (Elsevier), 7 (2017) 216-224., Impact Factor=0.946.

94. N. Ahmed, Umar Khan, S.T. Mohyud-Din, Influence of Nonlinear Thermal Radiation on the viscous flow through a Deformable Asymmetric Porous Channel: A numerical study, Journal of Molecular Liquids, (Elsevier), 225 (2017) 1167-1173. Impact Factor=3.648.

95. Umar Khan, N. Ahmed, S.T. Mohyud-Din, B. B. Mohsin, A bio-convection model for MHD flow and heat transfer over a porous wedge containing both nanoparticles and gyrotactic microorganisms, Journal of Biological Systems, (World Scientific), 23 (4) (2016) 409. Impact Factor=0.479.

96. Umar Khan, N. Ahmed, S.T. Mohyud-Din, Influence of viscous dissipation and Joule heating on MHD bio-convection flow over a porous wedge in the presence of nanoparticles and gyrotactic microorganisms, SpringerPlus, 5 (2016) 2043. Impact Factor=0.982.

97. Adnan, M. Asadullah, Umar Khan, N. Ahmed, S. T. Mohyud-Din, Analytical and Numerical Investigation of Thermal Radiation effects on Flow of viscous Incompressible fluid with Stretchable Convergent/divergent Channels, Journal of Molecular Liquids, (Elsevier), 224, Part A, (2016) 768–775. Impact Factor=2.74.

98. Adnan, Umar Khan, N. Ahmed, S. T. Mohyud-Din, Thermo-diffusion and Diffusion- Thermo effects on Flow of Second Grade fluid between two Inclined plane Walls, Journal of Molecular Liquids, (Elsevier), 224 (2016) 1074–1082, Impact Factor=2.74

99. Umar Khan, W. Sikander, N, Ahmed, S.T. Mohyud-Din, Effects of Velocity Slip on MHD Flow of a non-Newtonian Fluid in Converging and Diverging Channels, International Journal of Applied and Computational Mathematics, Springer, 2 (4) (2016) 469–483. Impact Factor=0.00.

100. S.T. Mohyud-Din, Umar Khan, N. Ahmed, W. Sikander, Jeffery Hamel Flow of a non-Newtonian Fluid, Journal of Applied and Computational Mechanics, 2 (1) (2016) 21-28. Impact Factor=0.00.

101. Umar Khan, N. Ahmed, S. T. Mohyud-Din, Stoke's first problem for carbon nanotubes suspended nanofluid flow under the effect of slip boundary condition, Journal of Nanofluids, 5 (2016) 239-244. Impact Factor=0.00.

102. Umar Khan, S. I.U. Khan, N. Ahmed, S. Bano, S. T. Mohyud-Din, Heat Transfer Analysis for Squeezing Flow of a Casson Fluid between Parallel Plates, Ain Shams Engineering Journal, (Elsevier), 7 (1) (2016) 497-504. Impact Factor=3.18.

103. Umar Khan, N. Ahmed, S.T. Mohyud-Din, Thermo-diffusion, diffusion-thermo and chemical reaction effects on MHD flow of viscous fluid in divergent and convergent channels, Chemical Engineering Science, (Elsevier), 141 (2016) 17-27, Impact Factor=2.337.

104. Umar Khan, N. Ahmed, S.T. Mohyud-Din, Soret and Dufour effects on Flow in Converging and Diverging Channels with Chemical Reaction, Aerospace Science and Technology, (Elsevier), 49 (2016) 135-143. Impact Factor=1.75.

105. S.T. Mohyud-Din, N. Ahmed, Umar Khan, Flow of a Viscous Fluid between Dilating and Squeezing Channel: A model for Biological Transport, Electronic journal of Biology, 12 (2016) 4. Impact Factor=0.00.

106. N. Ahmed, Umar Khan, S. T. Mohyud-Din, Two-dimensional flow of a Jeffery fluid in a dilating and squeezing porous channel, World Journal of Modeling and Simulation, 12 (1) (2016) 59-69. Impact Factor=0.00.

107. S.T. Mohyud-Din, N. Ahmed, Umar Khan, A. Waheed, S. Hussain, M. Darus, On Combined Effects of Heat Transfer and Chemical Reaction for the Flow through Asymmetric Channel with Orthogonally Deformable Porous Walls, Mathematical Problems in Engineering, Volume 2016, Article ID 2568785, 10 pages, http://dx.doi.org/10.1155/2016/2568785., (Hindawi), Impact Factor=0.762.

108. S.I.U. Khan, Umar Khan, N. Ahmed, S. T. Mohyud-Din, Thermal Radiation Effects on Squeezing Flow of Casson Fluid Between Parallel Disks, Communications in Numerical Analysis, 2016 (2) (2016) 92-107. Impact Factor=0.00.

109. Umar Khan, N. Ahmed, W. Sikander, S. T. Mohyud-Din, A study of Velocity and temperature slip effects on flow of water based nanofluids in converging and diverging channels, International Journal of Applied and Computational Mathematics, Springer, 1 (4) (2015) 569-587. Impact Factor=0.00.

110. S. T. Mohyud-Din, Z. A. Zaidi, Umar Khan, N. Ahmed, On heat and mass transfer analysis for the flow of a nanofluid between rotating parallel plates, Aerospace Science and Technology, (Elsevier), 46 (2015), 514-522. Impact Factor=0.94

111. S. I. U. Khan, N. Ahmed, Umar Khan, S. U. Jan, S. T. Mohyud-Din, Heat Transfer Analysis for Squeezing Flow between Parallel Disks, Journal of the Egyptian Mathematical Society, Elsevier, 23 (2) (2015) 445-450. Impact Factor=0.00.

112. S. I. U. Khan, Umar Khan, N. Ahmed, S. U. Jan, A. Waheed, S. T. Mohyud-Din, Effects of viscous dissipation and convective boundary conditions on Blasius and Sakiadis problems for Casson Fluid, National Academy Science Letters, (Springer), 38 (3) (2015) 247-250. Impact Factor=0.292.

113. Umar Khan, N. Ahmed, M. Asadullah, S. T. Mohyud-Din, Effects of Viscous Dissipation and Slip Velocity on Two-dimensional and Axisymmetric Squeezing Flow of Cu-Water and Cu-Kerosene Nanofluids, Propulsion and Power Research, Elsevier,4(1) (2015) 40-49. . Impact Factor=4.56.

114. S. T. Mohyud-Din, N. Ahmed, A. Waheed, M.A. Akbar, Umar Khan, Solution of diffusion equations of fractional order using variation of parameters method, ThermalScience, 19 (1) (2015) S69-S75. (Impact Factor=1.22).

115. S.T. Mohyud-Din, Umar Khan, N. Ahmed, S. M. Hassan, Magnetohydrodynamic flow and heat transfer of nanofluids in stretchable convergent/divergent channels, Applied Sciences, (MDPI), 5 (2015), 1639-1664. Impact Factor=1.484.

116. Umar Khan, N. Ahmed, S.I.U. Khan, S.T. Mohyud-din, Thermo-diffusion effects on MHD stagnation point flow towards a stretching sheet in a nanofluid, Propulsion and Power Research, Elsevier, (3) (2014) 151-158. Impact Factor=4.56.

117. Umar Khan, N. Ahmed, S. I. U. Khan, Z. A. Zaidi, X. J. Yang, S. T. Mohyud-Din, On unsteady two-dimensional and axisymmetric squeezing flow between parallel plates, Alexandria Engineering Journal, (Elsevier), 53 (2014) 463-468. Impact Factor=6.026.

118. Umar Khan, N. Ahmed, Z. A. Zaidi, M. Asadullah, S. T. Mohyud-Din, MHD Squeezing Flow between Two Infinite Plates, Ain Shams Engineering Journal, (Elsevier), 5 (2014) 187-192. Impact Factor=3.18.

119. Umar Khan, N. Ahmed, S. I. U. Khan, S. Bano, S. T. Mohyud-Din, Unsteady Squeezing flow of Casson fluid between parallel plates, World Journal of Modeling andSimulation, 10 (4) (2014) 308-319. Impact Factor=0.00.

120. N. Ahmed, Umar Khan, Z. A. Zaidi, S. U. Jan, A. Waheed, S. T. Mohyud-din, MHDflow of an Incompressible Fluid through porous medium between Dilating and Squeezing Permeable walls, Journal of Porous Media, (Begell house), 17 (10) (2014) 861-867. Impact Factor=0.81.

121. N. Ahmed, Umar Khan, S. I. U. Khan, Y. X. Jun, Z. A. Zaidi, S. T. Mohyud-Din, Magneto hydrodynamic (MHD) Squeezing Flow of a Casson Fluid between Parallel

Disks, International Journal of Physical Sciences, 8 (2013) 1788-1799. Impact Factor=1.20.

122. N. Ahmed, Umar Khan, S. Ali, M. Asadullah, Y. X. Jun, S.T. Mohyud-Din, Non- Newtonian Fluid Flow with Natural Heat Convection through Vertical Flat Plates, International Journal of Modern Mathematical Sciences, Modern Publishing, Florida USA, 8 (3) (2013), 166-176. Impact Factor=0.00.

123. Z.A. Zaidi, S.U. Jan, N. Ahmed, Umar Khan, S.T. Mohyud-Din, Variation of parameters method for thin film flow of a third-grade fluid down an inclined plane, Italian Journal of Pure and Applied Mathematics, 31 (2013) 161-168. Impact Factor=0.00.

124. Umar Khan, N. Ahmed, Z. A. Zaidi, S. U. Jan, S. T. Mohyud-Din, On Jeffery-Hamel Flows, International Journal of Modern Mathematical Sciences, Modern Publishing, Florida USA, 7 (2013) 236-247. Impact Factor=0.00.

125. M. Asadullah, Umar Khan, R. Manzoor, N. Ahmed, S. T. Mohyud-din, MHD Flow of a Jeffery Fluid in Converging and Diverging Channels, International Journal of Modern Mathematical Sciences, Modern Publishing, Florida USA, 6 (2) (2013) 92-106.Impact Factor=0.00.

126. Z. A. Zaidi, N. Ahmed, Umar Khan, S. T. Mohyud-Din, A novel approach in Homotopy Perturbation Method for the expansion of non-linear terms, Italian Journal of Pure and Applied Mathematics, 31 (2013) 169-176. Impact Factor=0.00.

127. S. T. Mohyud-Din, Umar Khan, N. Ahmed, Z. A. Zaidi, S. I. U. Khan, X. J. Yang, Heat transfer analysis in diverging and converging channels Nonlinear Science Letters A: Mathematics, Physics and Mechanics, 3(2-4) (2012) 61-71. Impact Factor=0.00.

Dr. Farman Ullah Khan

Journal Papers

1. Analytical solutions and moment analysis of chromatographic models for rectangular pulse injections, Journal of Chromatograph-A (Impact Factor-4.759), 1315,92-106, 2013.

2. Irreversible and Reversible Reactions in a Liquid Chromatographic Column: Analytical Solutions and Moment Analysis, Industrial & Engineering Chemistry Research (Impact Factor-4.326), 53, 2461–2472, 2014.

3. Analytical solution of a two-dimensional model of liquid chromatography including moment analysis, Chemical Engineering Science, (Impact Factor-4.889), 116, 576– 589, 2014.
4. Analysis of linear two-dimensional general rate model for chromatographic columns of cylindrical geometry, Journal of Chromatograph-A (Impact Factor-4.4.759), 1496,92-104, 2017.
5. Two-dimensional model for reactive-sorption columns of cylindrical geometry: Analytical solutions and moment analysis, Journal of Chromatographic Science (Impact Factor-1.618), 55, 536–549, 2017.
6. Optical solitons of the paraxial wave dynamical model in kerr media and its applications in nonlinear optics, International Journal of Modern Physics B (Impact Factor-1.30)https://doi.org/10.1142/S0217979220500782, Vol. 34, No. 09, 2050078, 2020.
7. Transmission Dynamics of Stochastic Hepatitis C Model by Spectral Collocation Method, Computer Method in Biomechanics and Biomedical Engineering, (Impact Factor-1.669), 25, 578-592, 2022.

8. Dynamics of Stochastic Zika Virus with Treatment Class in Human Population Via Spectral Method, Symmetry (Impact Factor-2.94), 14(10), p.2137, 2022
9. **On dynamics of stochastic avian influenza model with asymptomatic carrier using spectral method,** Mathematical Methods in the Applied Sciences (Impact Factor-3.007), 45, 8230–8246, 2022.

Dr. Arif Ullah

Journal Papers

1. Nadeem, S., Khan, A. U., & Saleem, S. (2016). A comparative analysis on different nanofluidmodels for the oscillatory stagnation point flow. The European Physical Journal Plus, 131(8),261.
2. Khan, A. U., Nadeem, S., & Hussain, S. T. (2016). Phase flow study of MHD nanofluid with slip effects on oscillatory oblique stagnation point flow in view of inclined magnetic field.Journal of Molecular Liquids, 224, 1210-1219.
3. S. Nadeem, A.U. Khan, S.T. Hussain, Model based study of SWCNT and MWCNT thermal conductivities effect on the heat transfer due to the oscillating wall conditions, In International Journal of Hydrogen Energy, Volume 42, Issue 48, 2017, Pages 28945-28957, ISSN 0360-3199, https://doi.org/10.1016/j.ijhydene.2017.09.114.
4. Nadeem, S., Ullah, N., Khan, A. U., & Akbar, T. (2017). Effect of homogeneous- heterogeneous reactions on ferrofluid in the presence of magnetic dipole along a stretchingcylinder. *Results in physics*, *7*, 3574-3582.
5. Nadeem, S., Abbas, N., & Khan, A. U. (2018). Characteristics of three dimensional stagnation point flow of Hybrid nanofluid past a circular cylinder. *Results in physics*, *8*, 829-835.

6. Abbas, N., Saleem, S., Nadeem, S., Alderremy, A. A., & Khan, A. U. (2018). On stagnation point flow of a micro polar nanofluid past a circular cylinder with velocity and thermal slip. *Results in Physics*, *9*, 1224-1232. .

7. Hayat, T., Nadeem, S., & Khan, A. U. (2018). Rotating flow of Ag-CuO/H 2 O hybrid nanofluid with radiation and partial slip boundary effects. *The European Physical Journal E*, *41*(6), 75.

8. Saleem, S., Firdous, H., Nadeem, S., & Khan, A. U. (2019). Convective heat and mass transfer in magneto Walter's B nanofluid flow induced by a rotating cone. *Arabian Journal for Science and Engineering*, *44*(2), 1515-1523.

9. Hayat, T., Nadeem, S., & Khan, A. U. (2018). Numerical analysis of Ag–CuO/water rotating hybrid nanofluid with heat generation and absorption. *Canadian Journal of Physics*, *97*(6),644-650.

10. Sadiq, M. A., Khan, A. U., Saleem, S., & Nadeem, S. (2019). Numerical simulation of oscillatory oblique stagnation point flow of a magneto micropolar nanofluid. *RSC Advances*,*9*(9), 4751-4764.

11. Nadeem, S., Hayat, T., & Khan, A. U. (2019). Numerical study of 3D rotating hybrid SWCNT–MWCNT flow over a convectively heated stretching surface with heat generation/absorption. *Physica Scripta*, *94*(7), 075202.

12. Nadeem, S., & Khan, A. U. Stability analysis of− nanofluid over a curved stretching/shrinking sheet: Existence of dual solutions. *Canadian Journal of Physics*, (ja).

13. Khan, A. U., Hussain, S. T., & Nadeem, S. (2019). Existence and stability of heat and fluid flow in the presence of nanoparticles along a curved surface by mean of dual nature solution. *Applied Mathematics and Computation*, *353*, 66-81.

14. Nadeem, S., & Khan, A. U. (2019). MHD oblique stagnation point flow of nanofluid over an oscillatory stretching/shrinking sheet: existence of dual solutions. *Physica Scripta*, *94*(7), 075204.

15. Nadeem, S., Ullah, N., & Khan, A. U. (2019). Impact of an oblique stagnation point on MHD micropolar nanomaterial in porous medium over an oscillatory surface with partial slip.*Physica Scripta*, *94*(6), 065209.

16. Hayat, T., Nadeem, S., & Khan, A. U. (2019). Aspects of 3D rotating hybrid CNT flow for a convective exponentially stretched surface. *Applied Nanoscience*, 1-10.

17. Saleem, S., Nguyen-Thoi, T., Shafee, A., Li, Z., Bonyah, E., Khan, A. U., & Shehzadi, I. (2019). Steady laminar natural convection of nanofluid under the impact of magnetic field on two-dimensional cavity with radiation. *AIP Advances*, *9*(6), 065008.

18. Nadeem, S., Khan, M. R., & Khan, A. U. (2019). MHD stagnation point flow of viscous nanofluid over a curved surface. *Physica Scripta*.

19. Li, X.; Khan, A.U.; Khan, M.R.; Nadeem, S.; Khan, S.U. Oblique Stagnation Point Flow of Nanofluids over Stretching/Shrinking Sheet with Cattaneo–Christov Heat Flux Model: Existence of Dual Solution. *Symmetry* **2019**, *11*, 1070.

20. Ullah, N., Nadeem, S., Khan, A. U., Haq, R. U., & Tlili, I. (2020). Influence of metallic nanoparticles in water driven along a wavy circular cylinder. Chinese Journal of Physics, 63,168-185

21. Khan, A. U., Saleem, S., Nadeem, S., & Alderremy, A. A. (2019). Analysis of unsteady non- axisymmetric Homann stagnation point flow of nanofluid and possible existence of multiple solutions. Physica A: Statistical Mechanics and its Applications, 123920

22. Khan, M. R., Pan, K., Khan, A. U., & Nadeem, S. (2020). Dual solutions for mixed convection flow of SiO2− Al2O3⁄water, hybrid nanofluid near the stagnation point flow over a curved surface. Physica A: Statistical Mechanics and its Applications, 123959

23. Ullah, N., Nadeem, S., & Khan, A. U. (2020). Finite element simulations for natural convective flow of nanofluid in a rectangular cavity having corrugated heated rods. Journalof Thermal Analysis and Calorimetry, 1-13.
24. Khan, M. R., Pan, K., Khan, A. U., & Ullah, N. (2020). Comparative study on heat transfer in CNTs-water nanofluid over a curved surface. International Communications in Heat and

Mass Transfer, 116, 104707.
25. Ahmed, Z., Saleem, S., Nadeem, S., & Khan, A. U. (2020). Squeezing Flow of Carbon Nanotubes-Based Nanofluid in Channel Considering Temperature-Dependent Viscosity: A Numerical Approach. *Arabian Journal for Science and Engineering*, 1-7.
26. Nayak, M. K., Mehmood, R., Muhammad, T., Khan, A. U., & Waqas, H. (2021). Entropy minimization in mixed convective Falkner-Skan flow of ZnO-SAE50 nanolubricant over stationary/moving Riga plate. *Case Studies in Thermal Engineering*, 101176.
27. Khan, A. U., Al-Zubaidi, A., Munir, S., Saleem, S., & Duraihem, F. Z. (2021). Closed form solutions of cross flows of Casson fluid over a stretching surface. *Chaos, Solitons & Fractals*, *149*, 111067.
28. Khan, A. U., Ullah, N., Al-Zubaidi, A., & Nadeem, S. (2021). Finite element analysis for CuO/water nanofluid in a partially adiabatic enclosure: Inclined Lorentz forces and porous medium resistance. Alexandria Engineering Journal.
29. Rehman, K. U., Khan, A. U., Rehman, F., & Shatanawi, W. (2022). Thermal case study on linearly twisting cylinder: A radial stagnation point flow of nanofluid. *Case Studies in Thermal Engineering*, 101861.
30. Mehmood, R., Tufail, Y., Rana, S., Khan, A. U., & Ijaz, S. (2022). Non-Fourier pseudoplastic nanofluidic transport under the impact of momentum slip and thermal radiation. *International Journal of Modern Physics B*, 2350135.
31. Rehman, K. U., Khan, A. U., Abbas, S., & Shatanawi, W. (2023). Thermal analysis of micropolar nanofluid in partially heated rectangular enclosure rooted with wavy heated rods. *Case Studies in Thermal Engineering*, 102701.
32. Rehman, K. U., Shatanawi, W., Bahaidarah, H. S., Abbas, S., & Khan, A. U. (2023). Thermal case study of nanofluid flow in partially heated rectangular enclosure rooted with sinusoidal heated rods and inclined magnetic field. *Case Studies in Thermal Engineering*, 102982.
33. Duraihem, F. Z., Ullah Khan, A., & Saleem, S. (2023). Mathematical Analysis of Transverse Wall-Shearing Motion via Cross Flow of Nanofluid. *Lubricants*, *11*(3), 138.

Dr Muhammad Irfan

Journal Papers

1. Magnetohydrodynamic free stream and heat transfer of nanofluid flow Over an exponentially radiating stretching sheet with variable fluid properties, Frontier in Physics, 7,186, 3.56 (2019).

2. Thermophoretic MHD free stream flow with variable internal heat generation/absorption and variable liquid characteristics in a permeable medium over a radiative exponentially stretching sheet, Journal of Materials Research and Technology, 9(3), pp. 4855-4866, 6.27, 2020.

3. A new computational technique design for EMHD nanofluid flow over a variable thicked surface with variable liquid characteristics, Frontier in Physics, 8,66, 3.56 Frontier in Physics, 8,66,(2020).

4. A simplified finite difference method (SFDM) for EMHD Powell-Eyring nanofluid flow featuring variable thickness surface and variable fluid characteristics, Mathematical Problems in Engineering, 1.3, (2020)

5. Unsteady MHD bio-nanofluid flow in a porous medium with thermal radiation near a stretching/shrinking sheet, Mathematical Problems in Engineering, 1.3, (2020).

6. Magnetohydrodynamic Time-DependentBio-Nanofluid Flow in a Porous Medium with Variable Thermophysical Properties, Mathematical Problems in Engineering, 1.3, (2021).

7. Insight into the dynamics of electro-magneto-hydrodynamic fluid flow past a sheet using the Galerkin finite element method: Effects of variable magnetic and electric fields, Frontier in Physics, 7,186, 3.56 (2022).

Dr. Yasir Mahsud

Journal Papers

1. Effect of generalized thermal transport on MHD free convection flows of nanofluids: A generalized Atangana-Baleanu derivative model, Authors: NA Shah, KK Asogwa, **Y Mahsud**, S Lee, S Kang, JD Chung, M Ishtiaq, Journal: Case Studies in Thermal Engineering 40, 102480, (6.268) (2022).
2. Effects of fractional derivative and heat source/sink on MHD free convection flow of nanofluids in a vertical cylinder: A generalized Fourier's law model, Authors: NA Shah, A Wakif, R Shah, SJ Yook, B Salah, **Y Mahsud**, K Hussain,Journal: Case Studies in Thermal Engineering 28, 101518, (6.268) (2021).
3. Heat transfer analysis in convective flows of fractional second grade fluids with Caputo–Fabrizio and Atangana–Baleanu derivative subject to Newtonion heating, Authors: I Siddique, I Tlili, SM Bukhari, **Y Mahsud**, Journal: Mechanics of Time-Dependent Materials 25, 291-311, (2.739) (2021).
4. Slip effect on the unsteady electroosmotic and pressure-driven flows of two-layer fluids in a rectangular microchannel, Authors: A Rauf, **Y Mahsud,** Journal: Journal of Computational Applied Mechanics 52 (1), 12-26, (2021).
5. Multi-layer flows of immiscible fractional Maxwell fluids in a cylindrical domain, Authors: A Rauf, **Y Mahsud**, I Siddique, Journal: Chinese Journal of Physics 67, 265-282, (2.544) (2020).
6. Numerical simulations of unsteady flows in a rotating channel using a novel eigenfunction expansion method, Authors: Q Rubbab, **Y Mahsud**, S Irshad, MAImran, A Ahmadian, S Salahshour, Journal: AIP Advances 10 (6), 065035, (1.624) (2020).
7. Analytical solutions for unsteady electrohydrodynamics flows of Maxwell fluids in microchannels with circular cross section, Authors: NA Shah, **Y Mahsud**, MAziz, I Tlili, Journal: Physics of Fluids 32 (1), 013107, (2.627) (2020).
8. Multi-layer flows of immiscible fractional Maxwell fluids with generalized thermal flux, Authors: A Rauf, **Y Mahsud**, IA Mirza, Q Rubbab, Journal: Chinese Journal of Physics 62, 313-334, (2.544) (2019).
9. Electro-magneto-hydrodynamics Flows of Burgers' Fluids in Cylindrical Domains with Time Exponential Memory, Authors: A Rauf, **Y Mahsud,** Journal: Journal of Applied and Computational Mechanics 5 (4), 577-591, (2019).

10. Effect of magnetic field on double convection flow of viscous fluid over a moving vertical plate with constant temperature and general concentration by using new trend of fractional derivative, Authors: NA Shah, A Hajizadeh, M Zeb, S Ahmad**, Y Mahsud**, IL Animasaun, Journal: Open Journal of Mathematical Sciences 2 (1), 253-265, (2018).
11. Natural convection flows and heat transfer with exponential memory of a Maxwell fluid with damped shear stress, Authors**: Y Mahsud**, NA Shah, D Vieru, Journal: Computers & Mathematics with Applications 76 (9), 2246-2261,(2.811) (2018).
12. Unsteady two-dimensional flows of a nanofluid over a vertical plate with time-exponential temperature, Autors: A Rauf, **Y Mahsud**, Journal: Arab Journal of Basic and Applied Sciences 25 (3), 150-157, 2018.
13. MHD mixed convection Poiseuille flow in a porous medium: New trends of Caputo time fractional derivatives in heat transfer problems, Authors: I Khan, NAli Shah, N Nigar, **Y Mahsud,** Journal: The European Physical Journal Plus 133, 1-14, (2.612) (2018).
14. Insight into the natural convection flow through a vertical cylinder using caputo time-fractional derivatives, Authors: NA Shah, T Elnaqeeb, IL Animasaun, **Y Mahsud,** Journal: International Journal of Applied and Computational Mathematics 4 (3), 80, 2018.
15. Unsteady free convection flow of viscous fluids with analytical results by employing time-fractional Caputo-Fabrizio derivative (without singular kernel), Authors: N Ali Shah, **Y Mahsud**, A Ali Zafar, Journal: The European Physical Journal Plus 132, 1-18, (2.612) (2017).
16. Influence of time-fractional derivatives on the boundary layer flow of Maxwell fluids, Authors: **Y Mahsud**, NA Shah, D Vieru, Journal: Chinese journal of physics 55 (4), 1340-1351, (2.544) (2017).
17. Heat transfer analysis in a Maxwell fluid over an oscillating vertical plate using fractional Caputo-Fabrizio derivatives, Authors: I Khan, N Ali Shah, **Y Mahsud**,D Vieru, Journal: The European Physical Journal Plus 132, 1-12, (2.612) (2017).

Dr. Feroz

Journal Papers

1. Approximation of Oscillatory Bessel Integral Transforms, Mathematics & Computers in Simulation (Impact Factor-3.601), 208, 727-744, 2023.
2. On the Evaluation of Poisson Equation with Dual Interpolation Boundary Face Method, European Journal of Mechanics/Asolids (Impact Factor-4.87) 88, 0997-7538, 2021.
3. Higher Order Pathwise Approximation for the Stochastic Burgers' Equation with Additive Noise, Applied Numerical Mathematics (Impact Factor-2.994), 162 67-80, 2021.
4. Pathwise Convergence of an Efficient Scheme for SPDEs with non-globally Lipschitz nonlinearity, Applied Mathematics & Computation (Impact Factor-4.39), 353 114-133,2019.

Dr. Dania Saleem

Journal Papers

1. Color Multiple image encryption scheme based on 3D chaotic maps, Mathematics and Computer in Simulation, Volume 178, page 646-666.

Rafay Mustafa

Journal Papers

1. G-Symplectic Integration of Many Body Problems, Bulletin of Iranian MathematicalSociety (2018)
2. Symplectic Effect for the Numerical Solution of Conservative Systems, InternationalJournal of Artificial Intelligence and Mathemtical Sciences(IJAIMS) Vol1 No 1 (2022).

Annexure – B: Faculty Resume

S.No	Name	Designation	Qualification	Institution	Specialization	Experience (yrs.)	Utilization
						Teaching	Dedicated / Shared
1	Dr. Rashid Mehmood	Assoc. Prof	PhD	Quaid-i- Azam University, Islamabad	Fluid Mechanics, Rheology	8	D
2	Dr. Naveed Ahmd	Assoc. Prof	PhD	HITEC University,Taxla	Applied Mathmatics	7	D
3	Dr. Farman Ullah Khan	Asst. Prof	PhD	COMSATS University,Islamabad	Computational Fluid Dynamics & Process Engineering	8	D
4	Dr. Arif Ullah Khan	Asst. Prof	PhD	Quaid-i- Azam University, Islamabad	Fluid Mechanics	4	D
5	Dr. Feroz	Lecturer	PhD	CentralSoth University	Numerical Anlysis of SPDEs	3+	D
6	Dr. Misbah	Lecturer	PhD	Quaid-i- Azam Univesity,Islamabad	Fixed Point Theory	5	D

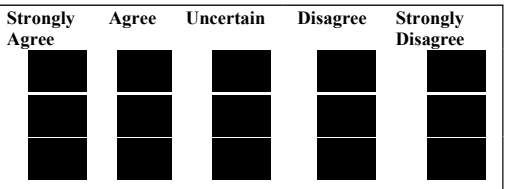
7	Dr. M. Irfan	Lecturer	PhD	NUST, Islamabad	Computational Fluid Dynamics	7	D
8	Dr. Dania Saleem Malik	Lecturer	PhD	Quaid-i-Azam University, Islamabad	Applied Cryptography	6	D
9	Dr. Yasir	Lecturer	PhD	Abdus Salam Scool	Fluid Mechaics	5	D
10	Ms. Rafay Mustafa	Lecturer	M.Phil	NUST, Islamabad	Computational Mathematics	8	D
11	Mr. Noman Alam	Lecturer	M.Phil	AIOU Islamabad	Fluid mechanics	4	D

Annexure – C: Student Course Evaluation

Previous Form

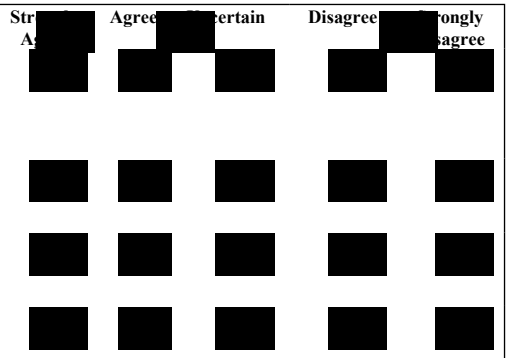
CORE QUESTIONS

Course Content and Organization



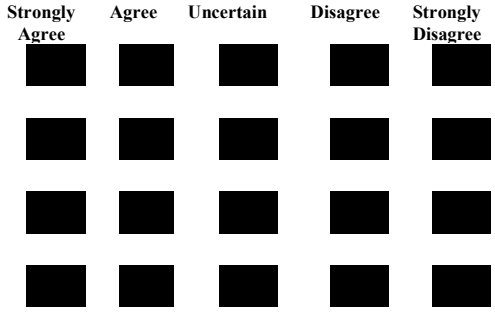
1. The course objectives were clear
2. The Course workload was manageable
3. The Course was well organized (e.g. timely access to materials, notification of changes, etc.)
4. Comments

Learning Environment and Teaching Methods



9. I think the Course was well structured to achieve the learning outcomes (there was a good balance of lectures, tutorials, practical etc.)
10. The learning and teaching methods encouraged participation.
11. The overall environment in the class was conducive to learning.
12. Classrooms were satisfactory
13. Comments

Learning Resources



14. Learning materials (Lesson Plans, Course Notesetc.) were relevant and useful.
15. Recommended reading Books etc. were relevantand appropriate
16. The provision of learning resources in the librarywas adequate and appropriate
17. The provision of learning resources on the Webwas adequate and appropriate (if relevant)

18 Comments

Quality of Delivery	Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree
19. The Course stimulated my interest and thought on the subject area					
20. The pace of the Course was appropriate					
21. Ideas and concepts were presented clearly					
22.Comments					

Assessment	Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree
23. The method of assessment were reasonable					
24. Feedback on assessment was timely					
25. Feedback on assessment was helpful					
26. Comments					

Additional Core Questions

Tutorial	Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree
30. The material in the tutorials was useful					
31. I was happy with the amount of work needed for tutorials					
32. The tutor dealt effectively with my problems					

Practical	Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree
33. The material in the practicals was useful					
34. The demonstrators dealt effectively with my problems.					

Overall Evaluation

35. The best features of the Course were:

36. The Course could have been improved by:

Equal Opportunities Monitoring (Optional)

37. The University does not tolerate discrimination on any irrelevant distinction (e.g. race, age, gender) and is committed to work with diversity in a wholly positive way. Please indicate below anything in relation to this Course which may run counter to this objective:

Demographic Information: (Optional)

38. Full/part time study: Full Time ☐ Part Time ☐
39. Do you consider yourself to be disabled: Yes ☐ No ☐
40. Domicile:
41. Gender: Male ☐ Female ☐
42. Age Group: less than 22 ☐ 22-29 ☐ over 29 ☐
43. Campus: Distance Learning/ Collaborative ☐

Updated Form (Effective from Spring 2016)

Statements	Score
1. The Class Room facilities and overall environment were conducive to learning.	
2. The recommended Textbook was student-friendly i.e. a student can easily follow it afterattending the class lecture.	
3. The library resources, i.e. other books, internet facility, magazines etc. were adequate insupporting the learning.	
4. The concepts were clearly explained.	
5. The course created interest in me to know more about it.	
6. Quizzes, Sessionals and Assignments etc. were helpful in learning this course.	
7. The lab experiments were synchronized with the theory classes.	
8. The lab experiments were helpful in learning the subject.	
9. The lab support was satisfactory.	
10. The course workload was manageable.	
11. I had the knowledge of pre-requisite subjects and mathematics for this course.	Yes/No

Additional Comments:

Annexure – D: Student's Teacher Evaluation

Previous Form

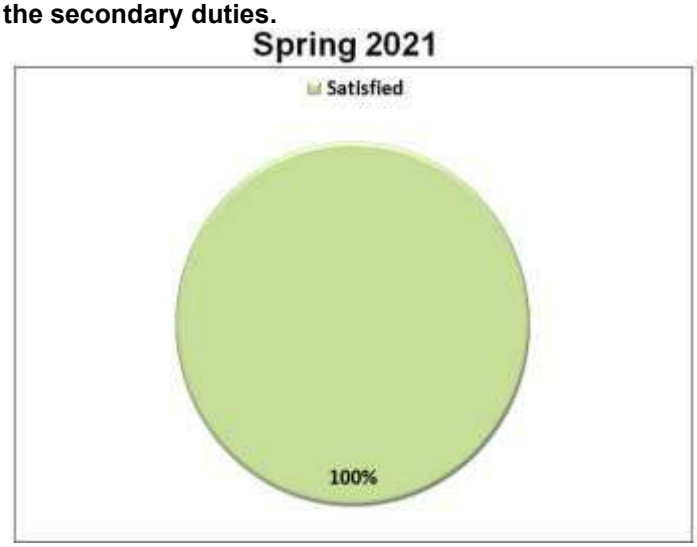
Points	**Instructor's Name** Course Name
1. The instructor is prepared for each class	
2. The instructor demonstrates knowledge of the subject	
3. The instructor provides additional material apart from the textbook	
4. The instructor communicates the subject matter effectively	
5. The instructor shows respect towards students and encourage class participation	
6. The instructor maintains an environment that is conducive to learning	
7. The instructor arrives on time	
8. The instructor leaves on time	
9. The instructor is fair in examination	
10. The instructor returns the grade scripts etc in a reasonable amount of time	
11. The instructor is available during the specified office hours and for class consultation	
12. The subject matter presented in the course has increased your knowledge of the subject	
13. The syllabus clearly states course objectives requirements, procedures and grading	
14. The course integrates theoretical course concepts with real world applications	
15. The assignment and exams covered the materials presented in the course	
16. The course material is modern and updated	
17. Do you want to be taught by this teacher in next semester?	

Updated Form (Effective from Spring 2016)

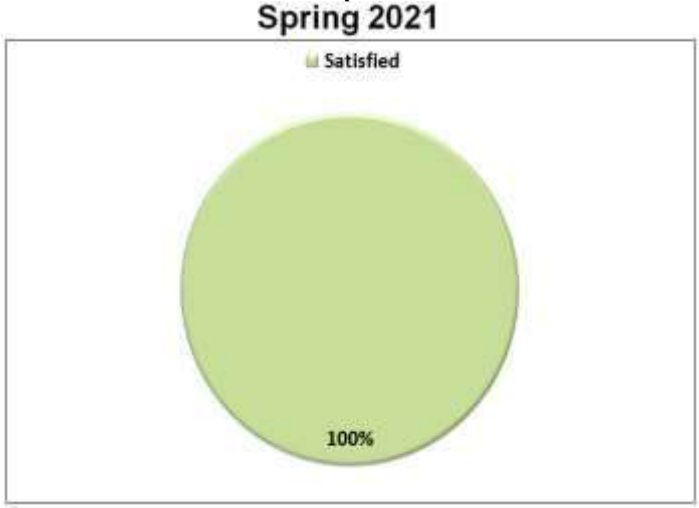
Statements	Score
1. The teacher distributed the course plan well in time for the current semester.	
2. The course plan contained objectives, topics, Course Learning Outcomes (CLOs),Grading policy etc.	
3. The teacher was punctual.	
4. The teacher communicated the subject matter clearly and effectively and solved sufficient examples.	
5. The teacher encouraged class participation.	
6. The teacher was fair in marking exam papers.	
7. The teacher returned all marked quizzes, assignments, sessionals etc. in reasonableamount of time.	
8. The teacher was available for consultation during the specified visiting hours.	
9. The teacher encouraged use of Library resources to supplement learning of course topics.	
10. The teacher covered all topics as given in the course plan.	
11. The teacher clearly indicated those questions which were meant for CLO evaluation.	
12. The teacher encouraged innovative thinking.	
13. You want to be taught by this teacher in the next semester	
Additional Comments:	

Annexure – E: Faculty Survey

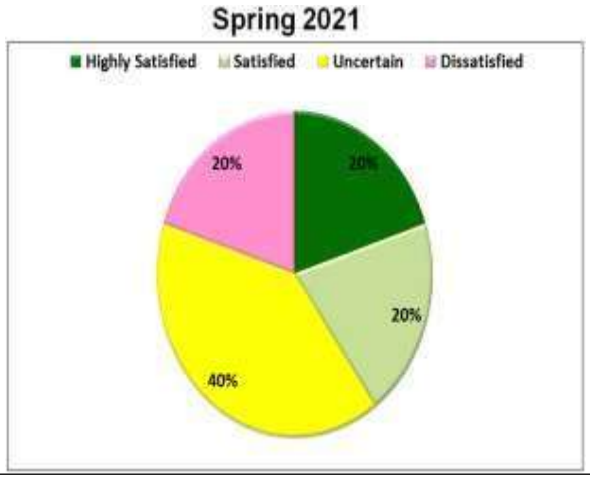
Q1. You are satisfied with your pursuits like teaching, research and the secondary duties.



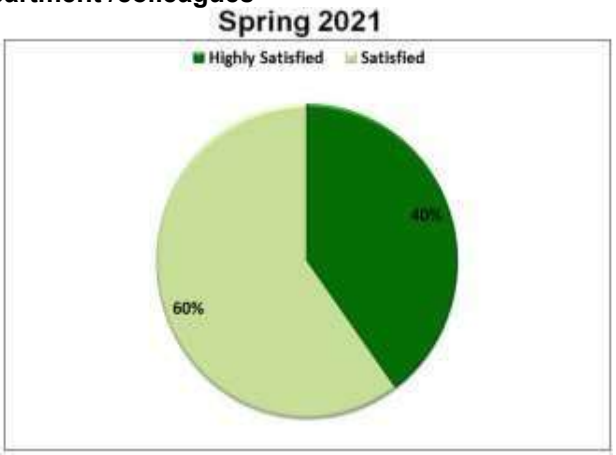
Q2. The overall environment in the department provide intellectual stimulation for improvement



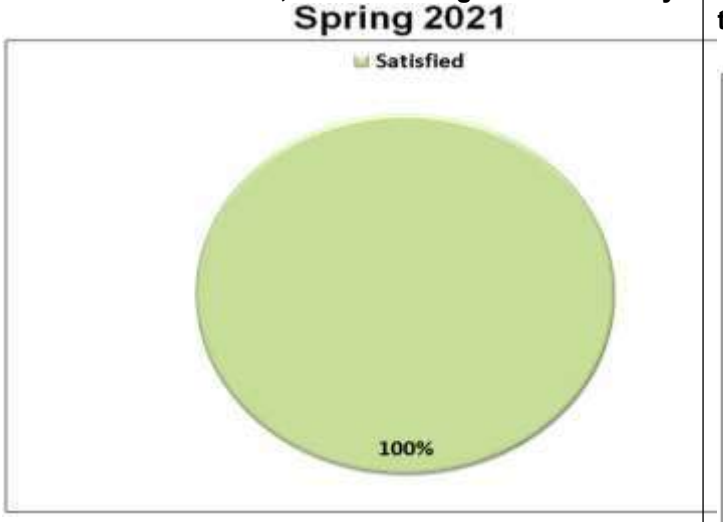
Q3. The overall workload is reasonable



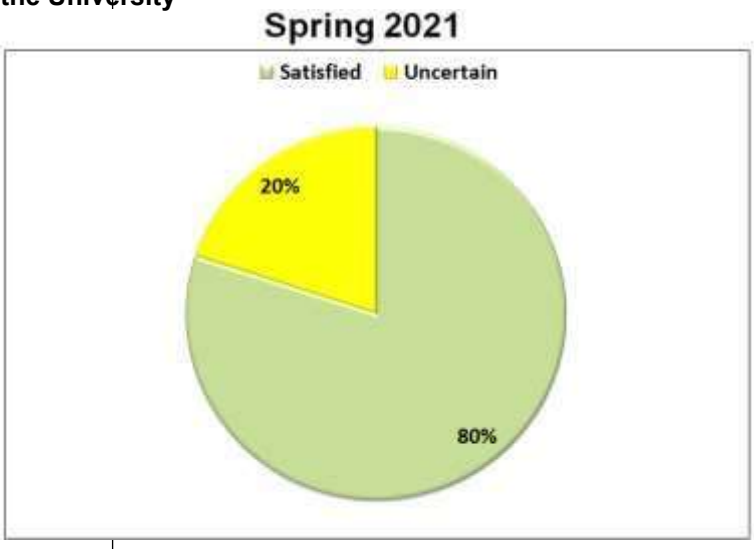
Q4. The cooperation you receive from your department /colleagues



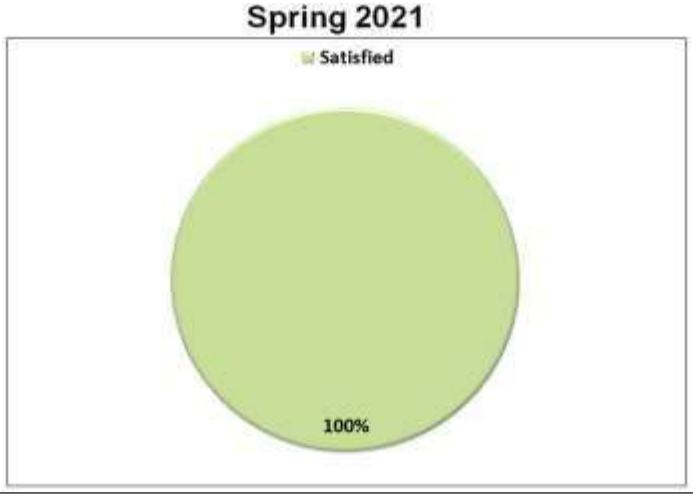
Q5. Whenever needed, the mentoring is available to you



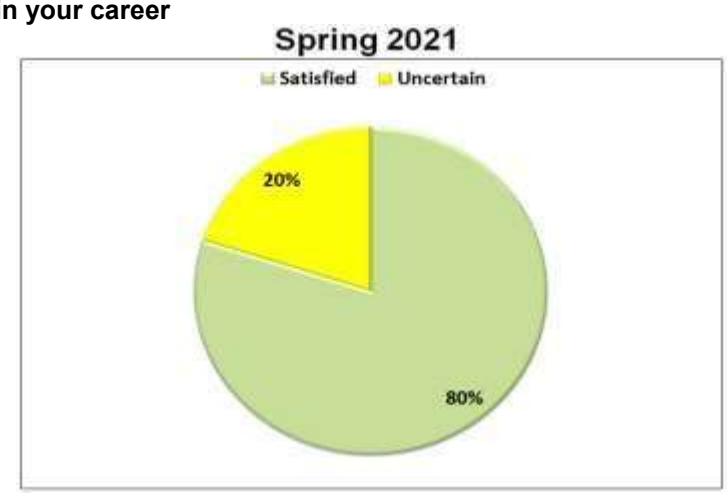
Q6. You are satisfied with the administrative support from the University



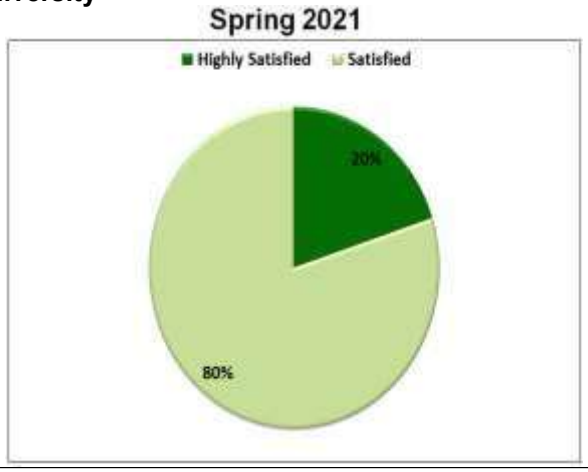
Q7. You are quite clear about the faculty promotion policies and processes



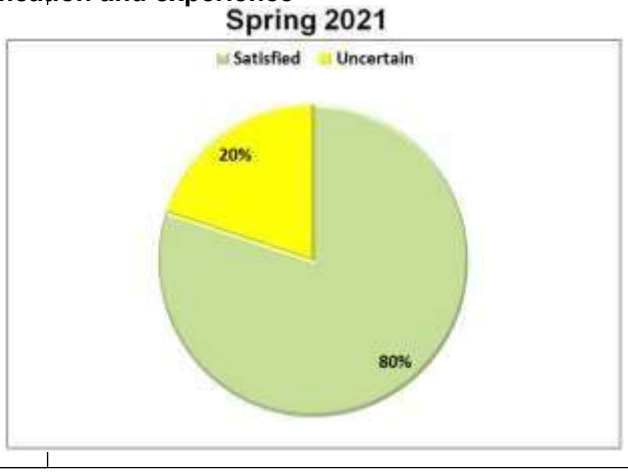
Q8. You are satisfied with the prospects for advancement in your career



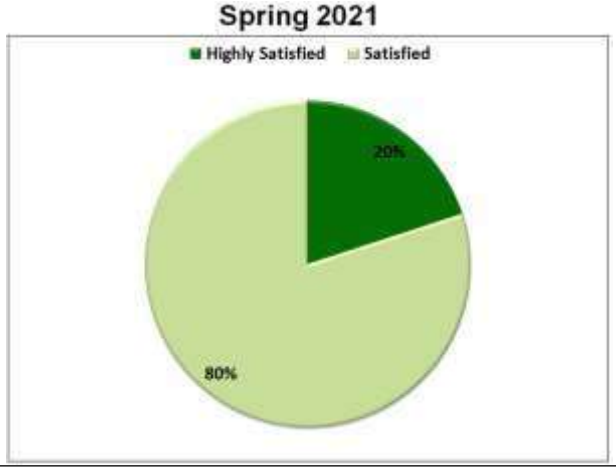
Q9. You are satisfied with the speed of redressal of complaints in the University



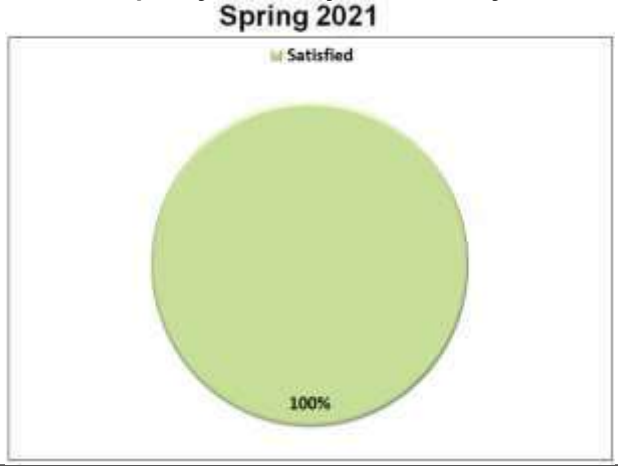
Q10. Your salary package is commensurate with your qualification and experience



Q11. Your perception about job-security in the present position



Q12. Your primary and secondary duties permit you to have sufficient quality-time for yourself and your family



Annexure – F: Faculty Course Review Report

Faculty of Mathematics is running 27 core courses for the BS Mathematicsprogram. All courses curriculum is reviewed periodically by the faculty to assess its effectiveness and contribution in achieving program objectives. Course review also contributes towards making any changes in the syllabi and enhancements required in areas identified as a result of Alumni Survey, Employer Survey and Graduating Students Feedback.

PT members launched HEC Performa 2 (Faculty of Course Review Report) to all the faculty members, to obtain their feedback about courses.

The summary of the overall feedback of all courses identified the following improvement points:

a. More Subjects related to Practical Implementation should be introduced.

b. Refinement in course outlines.

c. Students' interest should be addressed by giving options in Elective subjects.