KHUSHAL KHAN KHATTAK UNIVERSITY, KARAK

SELF ASSESSMENT REPORT

DEPARTMENT OF MATHEMATICS

June, 2022-23

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Introduction

Khushal Khan Khattak University Karak was established in 2012. The University has been a dream of the populace, realized in the form of this University, named after the legendary Khushal Khan Khattak. The University provisionally started functioning in the old building, previously occupied by the revenue academy. The main campus of the University is under construction near Jail Chowk Karak which will hopefully be completed by 2024. At present thirteen departments have been started in the campus namely, Department of Education & Research, Management Sciences, Computer Sciences & Bioinformatics, Media & Communication Studies, Library & Information Sciences, English, Geology, Psychology, Chemistry, Botany, Zoology, Mathematics and Physics.

University Vision Statement

Competitive and conducive environment for research, discovery and learning.

University Mission Statement

To make university a place emanating knowledge, exhibiting liberty of thought and coveted seat of learning, to infuse spirit of excellence, creativity, innovation and scholarship into the life of the university. To offer competitive and nationally recognized, opportunities for research, discovery, learning and engagement to a diverse population of students in a conducive environment.

Department of Mathematics

Department of Mathematics, Khushal Khan Khattak University Karak was established in September, 2019, under the chairmanship of Dr. Saeed Ullah Jan. Currently the department offers:
Bachelor of Studies in Mathematics (BS Mathematics 4-Year Program)

Program Selected

The Department of Mathematics has selected the program of BS Mathematics for Self-Assessment Report (SAR) for the year 2021-22 under the directives of Higher Education Commission (HEC).

Program Evaluation

The program is being evaluated based on eight (8) criteria and thirty-one (31) standards as given in the Self-Assessment Manual provided by HEC.

EXECUTIVE SUMMARY

The Department of Mathematics, Khushal Khan Khattak University, Karak was established in September, 2019, under the chairmanship of Dr. Saeed Ullah Jan. The Department of Mathematics conducts research on each and every aspect of mathematics, like pure mathematics, applied mathematics, decision support systems, artificial intelligence, computational mathematics. The department offers only BS program in Mathematic with fresh admissions advertised every September (Fall). Currently enrolled students count is 14, 8, 10 and 14 in 2nd, 4th, 6th and 8th Semesters respectively.

It should be a matter of satisfaction to all the concerned that the Department has been successful in the pursuit of the aims and objectives for which it was established. The curriculum is designed by the faculty members of the department. The curriculum and course contents of the degree were then shared with Mathematics experts working in different universities and colleges. A few suggestions were put by experts, and the curriculum was designed accordingly. Departmental Board of Studies comprises of Head of the Department as convener and two senior faculty members from other departments. The Department of Mathematics is in the phase of development. The faculty members are perusing some research topics related to their academic growth.

Curriculum design updating is based upon approved criteria. The university Examinations and academic are annually scheduled in the form of academic calendar. The basic facilities are not available for students and faculty such as classrooms and faculty office. Student's affair Incharge has taken very active actions related to extra curriculum activities like sports, speech competition etc. There are some minor short comings and limitation which are hopefully in line for upcoming projects.

The mathematics department of the university can be advanced if the following suggestions are fulfilled.

- The Department of Mathematics needs permanent Faculty as there is no permanent teacher in the department.
- The latest mathematical software such as MATLAB, MATHEMATICA, LATEX, MAPPLE, SWP should be acquired with academic license in order to get students trained for the future prospects in academic activities and other private firms.

Criterion-1

Program Mission, Objectives and Outcomes

Standard 1.1
> ***The program must have documented measurable objectives that support Faculty / College and institution mission statements:***

Department Vision
To act as a leader in the advancement of Mathematics and promotion of science and technology in Khyber Pakhtunkhwa in particular and in the country in general.

Department Mission
The Department of Mathematics' mission is to provide an environment where students can learn and become competent users of Mathematics. Moreover, the Department will contribute to the development of students as Mathematical thinkers, enabling them to become lifelong learners, to continue, to grow in their chosen professions and to function as productive citizens.

Department Objective
- To engage in goal-oriented higher-level teaching and research.
- To promote cooperation and inter-disciplinary relationships with other teaching and research organizations of the country and abroad.
- To arrange conferences, seminars and refresher courses for the promotion of Mathematics, education and research. To provide a platform to the student so that to exploit their academic potentials and teaching skills.

Strategic Plan for Achieving Program Objectives:

1. Curriculum design and strengthening of faculty.
2. Use of ICTs and other modern techniques in delivering the lectures and knowledge.
3. Online lectures and literature review facilities.
4. Organizing seminars, workshops and other activities.
5. Study tours and visits of prominent Mathematics institutes.

Program Objectives:

1. Foundation:

To provide students with concrete foundation in Mathematics knowledge with respect to their needs upon entering the profession.
A number of elements and goals are set up to achieve the above objective:

Goal-1: To Identify elements and strategies for graduate program of the Department

Elements:

    a.   Current HEC and Statutory bodies approved curriculum of Mathematics for Graduate program with national standards.

    b.   Linkage between theory and practice.

    c.   Orientation of manual and computerized practical assignments.

    d.   Motivation of teachers and students.

    e.   Seeking inputs from employers.

Strategy: Analytical and critical review of graduate program in terms of academic and research activities with new strategy for continuous improvement in Mathematics education.

Goal-2: To provide quality education and scholarly research

Elements:

    a.   Promotion of individual and cooperative research activities.

    b.   Efforts of research towards national and international standards and challenges.

Strategy: Close liaison with all the stake holders for critical and analytical review of the program.

Goal-3: To establish cooperative measures and partnership with sister institutes and information settings.

Elements:

    a.   To adjust our students for internship in university.

    b.   Enhance relations with renowned departments and institutions settings for trainings, and workshops.

    c.   Seek internship for the students.

Strategy: Develop viable mechanism for continuous improvement of the program.

2.   Skills and Tools:

To provide students with the skills to work in Mathematics. Actually, these competencies are the further specific objectives of the program:

    a)   To create awareness of information and communication technologies used in students. (How Mathematics could aware you, either through lectures or through online activities)

    b)   To develop skills among students for the acquisition, organization, and dissemination of information and knowledge.

    c)   To develop an understanding among students about the properties of literature in the fields of Humanities, Social Sciences, Pure Sciences, Applied Science, Pakistan and Islam etc.

    d)   To inculcate skills among students about the methods of research and to promote problem-oriented research in the field of Mathematics or related topics.

e) To develop an understanding among students to use information technology efficiently in information storage, data processing and retrieval services of Mathematics center.

f) To develop competence among students for the automated management centers of Mathematics in Pakistan.

g) To develop skills for the production of media and material in the field of Mathematics.

h) To prepare students for planning and designing the software products, codes for their own mathematical model and to serve the users' national benefits.

i) To develop competence among students for the marketing mathematics technologies in Pakistan.

j) To make the students aware of the future needs of centers of Mathematics.

Professional Practices and Ethics:

To provide students with the knowledge relevant to mathematical practices including its ethical, professional, social and global impact on society.

Alignment of Objectives with Program:

"All the above objectives are aligned with vision and mission statements of the program in terms of competencies, needs of society as well as ethical and professional practices to work with the spirit of providing quality education".

Table-1: Program objectives assessment

S. #	Objectives	How measured	When measured	Improvement identified	Improvement made
A	B	C	D	E	F
1	Foundation	a) Survey of Graduating students. b) Faculty survey.	*The program was measured in previous semester and implemented some measures.* Feb-2022. (Current Surveys)	• *The department needs the following:* • Collection development in departmental library. • Provision of high speed internet connectivity, library visits. • Computer lab. • Arrangement of seminars, conferences and symposiums. • Student internship activities throughout the year in university central & departmental libraries	1. Implemented new curriculum of HEC. 2. Provided the facility of Internet connectivity. 4. Access to HEC National Digital Library Program 5. Partially acquired few reading material. 6.Workshop was arranged.
2	Skills and tools:	a. Alumni Survey. b. Employer Survey. Note: As the department is newly established, therefore no alumni exist. The same is for employer survey as we have no product in the market so far.	**N/A**	N/A	N/A
3	Professional Practices and Ethics:	a. Alumni Survey. b. Employer Survey. Note: As per para above	**N/A**	N/A	N/A

Note*: The survey reports of Faculty and Teachers Evaluation are attached in the Annexure II and III respectively*

Standard 1.2

The program must have documented outcomes for graduating students. It must be demonstrated that the outcomes support the program objectives and that graduating students are capable of performing these outcomes:

Program Outcomes

Following are the program outcomes that will enable the graduates of Mathematics to:

1. Demonstrate the ability to apply knowledge of Mathematics in the field with respect to print and non-print formats of information resources.
2. Assess collection development policy and bibliographical control.
3. Apply Mathematics classification system for organizing information.
4. Apply mathematical techniques in order to solve real work problems.
5. Locate, retrieve, evaluate and disseminate information and information sources and reference services.
6. Apply principles of Mathematics and demonstrate leadership abilities.
7. Apply relevant research method to problem solving.
8. Analyze tools and practices of Information Technology, Artificial Intelligence.
9. Apply MATLAB and other software for the analysis and graphical representation of the problem.
10. Demonstrate and develop mathematical tools and Networking.
11. Understand information sources and information cycle of disciplines of Natural Sciences.
12. Analyze the characteristics of Mathematics and their application to real life problems.
13. Communicate effective communication and interpersonal skills.

The program outcomes are the byproduct of the program objectives. In this connection, the following table shows interrelationship between program's objectives and outcomes:

Table-2: Relationship between program objectives and program outcomes

Program Objectives	Program outcomes												
	1	2	3	4	5	6	7	8	9	10	11	12	13
1	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	□
2a	⊙	●	⊙	⊙	⊙	⊙	⊙	□	□	⊙	□	□	□
2b	●	⊙	□	●	⊙	⊙	⊙	⊙	⊙	⊙	□	□	⊙
2c	●	⊙	□	●	⊙	□	□	⊙	⊙	⊙	⊙	□	●
2d	⊙	⊙	□	□	⊙	⊙	□	⊙	⊙	□	□	□	⊙
2e	⊙	⊙	⊙	⊙	⊙	⊙	□	⊙	⊙	⊙	●	□	□
2f	●	□	□	□	●	⊙	⊙	⊙	□	□	●	●	⊙
2g	⊙	□	⊙	⊙	□	□	□	●	●	□	□	□	●
2h	⊙	●	□	□	⊙	●	●	●	●	●	□	□	□
2i	⊙	●	●	●	●	⊙	⊙	⊙	□	□	□	●	●
2j	⊙	⊙	□	□	□	●	□	⊙	□	⊙	⊙	□	□
3	⊙	□	□	□	□	□	⊙	□	□	⊙	□	□	□

Legend:

□ Denotes substantial contribution to the objectives.

⊙ Denotes moderate contribution to the objectives.

● Denotes no contribution to the objectives.

The above table need to be easier not understandable

Standard 1.3

The results of program's assessment and the extent to which they are used to improve the program must be documented:

The program's assessment was carried out in Feb 2019 by using the 2 questionnaires/forms such as Student Course Evaluation and Students Feedback on Teaching. Some possible measures were taken in connection to findings of the assessment to improve the program:

a) Actions Taken:
   i) Started 4 years BS Mathematics Program (BS Mathematics).
   ii) Implemented the new and revised curriculum of HEC.
   iii) Some text books both in hard and soft form were acquired.
   iv) A number of faculty meetings were held for discussion and peer review relating to improving the program.

b) Future Program improvements plans:
   i) Readdressing the Curricula of Mathematics by incorporating emerging techniques of Mathematics management studies.
   ii) Extension of Computer Lab.
   iii) Improving Quality Education.
   iv) Improving Team work efforts.
   v) Achieving the objectives of quality education in terms of needed competencies.

     vi)   Providing and availing the facilities of Continuing Education.

     vii)   Capacity building of faculty through faculty development program.

     viii)   Internship is must for students

c)   Weaknesses of the Program:

     i)   Separate Lab for subject Practical.

     ii)   Limited Information resources

     iii)   Scarcity of reading materials and latest practical tools.

     iv)   IT training and sustainable development.

     v)   Limited access to HEC Digital Library.

d)   Future Development Plans:

     i)   Seeking collaboration with domestic and foreign agencies and organization for receiving help through exchanging the views, trainings, donations and boasting the research activities.

     ii)   Seeking collaboration of different organization for internship of the students.

     iii)   M.Phil and Ph.D Programs will be start soon.

     iv)   Establishing Practical Lab for convenient conduct of subject practical.

     v)   Understanding and Implementation of MATLAB software.

     vi)   Acquiring the latest editions of reading materials and practical tool.

     vii)   Planning and developing collaborative measures with sister departments for strengthening the department.

Standard 1.4

The department must assess its overall performance periodically using quantifiable measure:

a) Students Enrollment: See the table below:

Table 3: Students enrollment for the last two years

S. No.	Year	Bs Mathematics	Total
1	2019	15	15
2	2020	10	25
3	2021	11	36
4	2022	14	50

b) Faculty/ Student ratio   1:12

c) Time for completing BS Mathematics degree: 4 Years

d) Average grade point (or) 2nd Division

e) Employer's satisfaction: See Table 4 below:

Note*: Employer satisfaction level can be judged from the outcomes of the Department. As at this stage, the Department has not given any product to the market. That is there is no need of employer survey at this stage.*

Table 4*: Frequency and percentage distribution of the respondents (Faculty) regarding their satisfaction level and the effectiveness of programs to help them progress and excel in their profession.*

Q. #	Question Items	Very Satisfied		Satisfied		Neutral		Dissatisfied		Very Dissatisfied	
		f	%	f	%	f	%	f	%	f	%
1	Your mix of research, teaching and community service	0	0	5	100	0	0	0	0	0	0
2	The intellectual stimulation of your work	2	40	3	60	0	0	0	0	0	0
3	Type of teaching/ research you currently do	2	40	3	60	0	0	0	0	0	0
4	Your interaction with students	5	100	0	0	0	0	0	0	0	0
5	Cooperation you receive from colleagues	1	20	4	80	0	0	0	0	0	0
6	The mentoring available to you	0	0	3	60	2	40	0	0	0	0
7	Administrative support from the department	0	0	5	100	0	0	0	0	0	0
8	Providing clarity about the faculty promotion process	0	0	0	0	5	100	0	0	0	0
9	Your prospects for advancement and progress through ranks	0	0	0	0	5	100	0	0	0	0
10	Salary and compensation package	0	0	5	100	0	0	0	0	0	0
11	Job security and stability at the department	3	60	2	40	0	0	0	0	0	0
12	Amount of time you have for yourself and family	0	0	0	0	1	20	4	80	0	0
13	The overall climate the department	5	100	0	0	0	0	0	0	0	0
14	Whether the Department is utilizing your experience and knowledge	5	100	0	0	0	0	0	0	0	0
14	What are the best programs /factors currently available in your department that enhance your motivation and job satisfaction	New curricula, availability of computer lab facility along with internet connectivity and existing salary package are the factors of enhancing motivation and job satisfaction of the faculty.									
15	Suggest programs/factors that could improve your motivation and job satisfaction	Updating computer lab facilities, acquiring latest editions of reading material, providing IT training, conducting workshop / Seminars and availing the opportunity of pursuing further study are factors of improving motivation and job satisfaction of the faculty.									
16	Information about faculty member	Majority of faculty members are holding the post of Lecturers with 2-07 years experience.									

The above table reveals that faculty members seem satisfied with relation to program effectiveness in order to progress and excel in the profession except the availability of mentoring for them. But they seem unsatisfied with the time they get for their family and themselves.

Criterion-2

Curriculum Design and Organization

CRITERION-2: CURRICULUM DESIGN AND ORGANIZATION

Standard 2.1
> ***The Curriculum must be consistent and supports the programs documented objectives***

The curriculum designed for BS Mathematics is based on certain objectives and learning outcomes. The curriculum is a blend of theory and practical covering the needs of all types of subjects. The curriculum of the program is attached in the **Annexure V.**

The department of Mathematics is running its academic program through semester system of examination.

a)   **Title of Degree Program**:   BS Mathematics
-   Total numbers of credit hours   134
-   Duration   4 years (8 Semesters)
-   Semester duration   16-18 weeks
-   Semesters   8
-   Course load per semester   15-18 Credit hours
-   Number of courses per semester   4-6

Eligibility Criteria

F. A, F. Sc. with at least 2nd division

Definition of credit hour:

1 credit hour is 1 hour of theory lecture or 3 hours of laboratory work in a week

Table: 5

Sr.	Categories	No. of courses	Credit Hours
1.	Compulsory requirement (No Choice)	9	25
2.	General courses to be chosen from other disciplines	7	21
3.	Discipline specific foundation courses	12	37
4.	Major courses including research project / internship	12 + Project	39
5.	Electives within the major	4	12
	Total	**44**	**134**

PROGRAM LAYOUT

Details are Given in the Following Table

Compulsory Requirements		General Courses		Discipline Specific Foundation Courses		Major Courses including Research Project +		Elective courses within the major	
9 courses		7-8 courses		9-12 courses		11-13 courses		4-courses	
25 Credit hours		21-24 Cr. Hours		30-33 Credit Hours		36-42 Credit Hours		12 Credit Hours	
Title	**Cr. Hr.**	**Title**	**Cr. Hr.**	**Title**	**Cr. Hr.**	**Title**	**Cr. Hr.**	**Tite**	**Cr. Hr.**
English-I (Functional English)	3	Probability and Statistics	3	Group Theory	3	Number Theory	3	E-1	3
English -II (Communication Skills)	3	Computer Programming	3	Rings and fields	3	Real Analysis-I	3	E-2	3
English-III (Technical Writing and Presentation skills)	3	G-1	3	Integral Equations	3	Real Analysis-II	3	E-3	3
		G-2	3	Calculus I	4	Mathematical Methods	3	E-4	3
English-IV	3	G-3	3	Vector Analysis	3	Partial Differential Equations	3		
Islamic Studies/Ethics	2	G-4	3	Calculus II	3	Topology	3		
Pakistan Studies	2	G-5	3	Calculus-III	3	Differential Geometry and tensor	3		
Discrete Mathematics	3			Complex Analysis-I	3	Functional Analysis-I	3		
Elements of Set theory and Mathematical Logic	3			Ordinary differential equations	3	Functional Analysis-II	3		
Introduction to Computer	3			Linear algebra	3	Numerical Analysis-I	3		
				Affine and Euclidean Geometry	3	Numerical Analysis-II	3		
				Complex Analysis-II	3	Mathematical statistics	3		
						Project	3		
Total	25		21		**37**		39		12

General Courses for BS Mathematics

The courses G-1, G-2, G-3, G-4 and G-5 may be chosen from following titles. This list may be extended with consent of Board of Studies keeping in view the availability of expertise in the University.

G-1: Introduction to mechanics
G-2: Electricity & magnetism
G-3: Modern physics
G-4: Accounting
G-5: Classical Mechanics

Electives for BS (Mathematics)

- Measure Theory
- Advanced Group Theory
- Graph Theory
- Riemannian Geometry
- Fluid Mechanics
- General Relativity
- Simulation
- Dynamical Systems
- History of Mathematics
- Pointless Topology
- Optimization Theory
- Mathematical Physics
- Statistical Inferences
- Convex Analysis
- Optimization Theory
- Mathematical Biology
- Numerical solution for ODE's
- Numerical solution for PDE's

SCHEME OF STUDIES

Semester-I

S. No	Course code	Course Title	Credit Hr.
1	MATH-101	Calculus-I	4
2	MATH-103	Elements of Set Theory and Mathematical Logic	3
3	ENG-101	English-I (Functional English)	3
4	RS-101	Islamic Studies	2
5	PHY-101	Introduction to Mechanics	3
6	CS-101	Introduction to Computer	3
Total			**18**

Semester-II

S. No.	Course code	Course Title	Credit Hr.
1	MATH-102	Calculus-II	3
2	MATH-222	Discrete Mathematics	3
3	STAT-101	Probability Theory	3
4	ENG-102	English-II (Communication Skills)	3
5	PS-101	Pakistan Studies	2
6	PHY-102	Electricity & Magnetism	3
Total			**17**

Semester-III

S. No.	Course code	Course Title	Credit Hr.
1	MATH-231	Group Theory	3
2	MATH-212	Calculus III	3
3	PHY-232	Modern Physics	3
4	ENG-211	English III (Technical Writing and Presentation Skills)	3
5	Acc-235	Accounting	3
6	CS-102	Computer programing	3
Total			**18**

Semester-IV

S. No	Course code	Course Title	Credit Hr.
1	MATH-214	Linear Algebra	3
2	MATH-242	Vector Analysis	3
3	MATH-243	Ordinary differential equation	3
4	PHY-353	Classical Mechanics	3
5	MATH-245	Rings and Fields	3
6	ENG-212	English IV	3
Total			**18**

Semester-V

S. No.	Course code	Course Title	Credit Hr.
1	MATH-351	Topology	3
2	MATH-352	Differential Geometry and tensor	3
3	MATH-353	Complex Analysis –I	3
4	MATH-354	Real Analysis- I	3
5	MATH-355	Number Theory	3
6	MATH-356	Affine and Euclidean Geometry	3
Total			**18**

Semester-VI

S. No.	Course code	Course Title	Credit Hr.
1	Math-361	Numerical Analysis-I	3
2	Math-362	Partial Differential Equations	3
3	Math-363	Complex Analysis- II	3
4	Math-364	Functional Analysis- I	3
5	Math-365	Real Analysis-II	3
Total			**15**

Semester-VII

S. No.	Course code	Course Title	Credit Hr.
1	Math-471	Numerical Analysis- II	3
2	Math-472	Functional Analysis –II	3
3	Math-473	Mathematical Methods	3
4	XXXX	E-1	3
5	XXXX	E-2	3
Total			**15**

Semester-VIII

S. No.	Course code	Course Title	Credit Hr.
1	Math-481	Mathematical statistics	3
2	Math-482	Integral Equations	3
3	XXXX	E-3	3
4	XXXX	E-4	3
5		*Project*	3
Total			**15**

Table-6: The following table shows, how the program courses meet the program objectives

Courses/Groups of Courses	Program Objectives											
	1	2a	2b	2c	2d	2e	2f	2g	2h	2i	2j	3
Compulsory Courses	√	√	√	√	√	√	√	√	√	√	√	√
Optional Courses	√	√	√	√	√	√	√	√	√	√	√	√
Practical		√	√	√	√	√	√	√	√	√		

Standard 2.2

Theoretical backgrounds, problems analysis and solution design must be stressed within the program's core material:

The following table reveals the elements with respect to "Theoretical background'" **"Problem analysis"' and "Solution design" as contained in compulsory and optional** papers.

Table: 7

Elements	Courses
Theoretical background	Almost all the compulsory and optional courses cover /stress the required elements to create the good understanding in the courses taught.
Problem analysis	The compulsory, Foundations and Major courses, deal with the required element to great extent on the basis of generalizability while the optional courses provide the analysis for a specific environment.
Solution design	A number of manual and computer-based practical are conducted to meet the required element.

Standard 2.3

The curriculum must satisfy the core requirements for the program, as specified by respective accreditation body:

The Department of Mathematics executes the functions on the basis of HEC requirements for its BS program.
The core requirements are mentioned at the end of curriculum designed by HEC. However, these requirements are not fully met by the department due to lack of some facilities in terms of equipment's and infancy stage of the department.

Standard 2.4

The curriculum must satisfy the major requirements for the program as specified by HEC, the respective accreditation body / councils

The department works under the major requirements laid down by the HEC. Such requirements are the part of the curriculum so far designed for the purpose.

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/council:

Table: 8

Program of Study	Math and Basic Science	Engineering topics	General Education	Other Disciplines
BS Mathematics	Yes	Nil	Yes	Yes

The Department offers four years BS Mathematics program comprising upon 9 compulsory, 7 general, 12 foundation, 12 major and 04 optional courses. The curriculum satisfies the requirements of many disciplines to be taught as minor subject.

Standard 2.6

Information technology component of the curriculum must be integrated throughout the program:

Almost all the courses/papers of Mathematics cover the different components of mathematic. Keeping in view some contemporary needs for mathematical tools, some more advanced techniques of Information Technology need to be incorporated in the curriculum. Hence, components of Information Literacy, Software and Database designing needs to be incorporated in the curricula by conducting a survey about the competencies needed in different courses settings.

Criterion-3

Laboratory And Computing Facilities

CRITERION-3: LABORATORY AND COMPUTING FACILITIES

All the courses of Mathematics program are practical-based for that purpose the University has provided the facility of computers and Information technology with in Departmental library. Therefore, the library acts as library as well as a computer lab. The computing facilities are available both for the teachers and students of the department.
The status of existing laboratory is as below:

- ❖ Laboratory Title: Library cum Laboratory (Lib./Lab.).
- ❖ Location Area: Department of Mathematics,
   Khushal Khan Khattak University, Karak
- ❖ Objectives: 1. To handle the computer-based practical
   2. To develop codes and models for the solution of numerical and real-life problems.
   3. To develop practical skills for designing database, webpage, mathematic tools, and building Mathematics networking.
- ➢ Adequacy for Instruction: The computer lab comprised of 15 laptops which are utilized for

   conducting practical of all the courses but the existing facility is adequate to some extent that needs to be extended.
- ➢ Courses taught: All the courses are taught in class rooms and sometimes in computer

   lab for the purpose of practical.
- ➢ Software Available: The free of cost software are in use.
- ➢ Major Apparatus   15 Laptops, 1 printer, one Multimedia, one Photocopier and one

   scanner is available.

Standard 3.1

Laboratory manuals / documentation / instructions experiments must be available and readily accessible to faculty and students:

All students and teachers have adequate access to manual/documentation and instructions while using the laboratory. The computer lab is not compatible in terms of proper number of computers, mathematics software availability and other practical tools for conducting the practical works in all the papers being taught. The following shortcomings are noted which are hurdles on the way to keep the best pace of working environment for achieving the targets rested with the academic uplifting:

Shortcomings:

a. 1 Scanner
b. 20 Pcs
c. 3 Printers
d. A. V. aids
e. Digital camera
f. Practical tools latest.
g. Specialized training of information technology and MATLAB, Latex, Scientific work place.
h. Faculty with certain specialization.
i. Furniture and fixture.
j. Space for class rooms for teaching specialized/optional papers.
k. Course books
l. Mathematics Automation Software's
m. 3 Multimedia Projectors

Justification of above listed items:

The scanner and digital cameras are required to teach the students about the scanning and preserving the archival records in the library.

The items listed above i.e., b, c, & d are necessary for extending and upgrading the computer lab and facilitating the teachers for improving the practical works.

Acquiring the practical tools will upgrade the departmental library for the purpose of accessing required information whereas, the training facilities will create the skills required for teaching the courses in more conducive environment

The faculty and space are also required to teach the specialized papers in future along with furniture and fixture.

Availability of course related books will help the students to get the relevant and latest information about the field.

The availability of MATLAB software will help to provide the necessary trainings to the students.

Standard 3.2
There must be adequate support personnel for instruction and maintaining the laboratories:

The personnel support in shape of lab supervisor is not available; hence the maintenance of computer lab sometimes becomes a problem. The supervisor for computer lab is needed with the extended facilities in computer lab. At the moment, a non-professional employee is deputed to look after the matters of computer lab. Almost all the papers are computer-based-practical and hence a full-time computer lab supervisor can maintain the computer lab in functional order at the time of practical work in computer lab.

Standard 3.3
   The University computing infrastructure and facilities must be adequate to support program's objectives:

   The Khushal Khan Khattak University Karak has adequate and smart computing facilities with all sorts of support through the Department of Computer Science as and when required specially at the time of troubleshooting of the computers. Each of the department (including Department of mathematics) of the university is equipped with Multimedia and a number of computers with internet connectivity. The internet connectivity is available in teacher's offices which facilitates the access to easy information at the time of urgency.

Criterion-4

Student Support and Advising

CRITERION-4: STUDENT SUPPORT AND ADVISING

A time of four years is fixed to complete the program on the basis of time management policy for all the curricula and co-curricular activities. The vocal students avail the time for interaction with their teachers relating to their present and future matters on the way. However, the passive students are motivated through other ways, the details of such motivation are ahead.

Standard 4.1
Courses must be offered with sufficient frequency and number for students to complete the program in a timely manner.

The required and elective courses are offered in a logical sequence that grooms the students to obtain the program's defined objectives and outcomes. The faculty members teach the courses according to time table, designed to run the classes smoothly.

Standard 4.2
Courses in the major area of study must be structured to ensure effective interaction between students, faculty and teaching assistants.

Students are encouraged to communicate with teachers and para-teaching staff for their academic and co-curricular activities. The faculty includes highly qualified staff on regular basis so as to achieve the departmental objectives effectively. Overall, the faculty members are responsible for major areas of study on the basis of their subject competence. Most of the papers are completely taught by the individual teachers.

Standard 4.3
Guidance on how to complete the program must be available to all students and access to academic advising must be available to make course decisions and career choices.

a. **Program requirements** as whole students are informed through the Khushal Khan Khattak University Karak prospectus about the program requirements. The department-wise program requirements are updated annually at the start of current academic session to keep the matter in line with university policy in order to avoid any inconvenience. Moreover, a faculty member (being the student advisor) is available at departmental level to cope with all the program requirements and matters concerning to students' problems and day to day needs of their academic achievements.

b. Advising and students counseling system

A faculty member is deputed as Coordinator of Guidance and Career Counseling. The advising system in the department is run by the coordinator, who arranges the orientation lectures for the student's guidance and career counseling. The guidance and counseling process is based on all such activities which the students and the department feel necessary for the required achievements for their (students) prosperous career development. The department arranges some activities in this regard:

- Displaying advertisements of vacant posts appearing in daily newspapers for the information of the students to get familiar with the avenues where the opportunities exist for their career.

- Students are free to meet with the coordinator for seeking the guidance and counseling relating to their problems/matters.

- Sometimes students avail the opportunity of exchanging their views with guest speakers invited by the department.

- The students have the opportunity of interacting with the mathematics professionals who visit the department for some professional inputs and outputs. The students have also the opportunity to join the Pakistan Mathematical Association (PMA) as a student member of this professional body of national repute.

c. Incharge Students Affairs

To take care of certain academic and nonacademic matters of the students, the services of Incharge of Students Affairs are available for this purpose. The office of the Incharge Students Affairs deals with all the activities of scholarship, fellowships, workshops, and conferences, admissions for different categories, interdepartmental migration, re-admission and financial assistance for the student community. The office of students' affairs also makes plan for co-curricular activities, book fairs, Sports Gala/competitions and holding the annual convocation.

More or less, the students get a better opportunity of the services rendered by Students Advisor, Coordinator Students Guidance and Counseling and Director Students Affairs. However, the co-curricular activities need to be extended at large scale to break the hesitant and non-confident behaviors of the students. The extended co-curricular programs will provide a wide range exposure to the students for facing, bearing and tackling the issues in a coherent way.

Criterion-5

Process Control

CRITERION-5:   PROCESS CONTROL

The overall process is controlled and governed by the Khushal Khan Khattak University Karak policy and this process is somewhat similar almost in all the departments with some variations on the basis of subject nomenclature.

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 it objectives.

The program has a well-defined admission criterion, which include evaluation of student's marks at different levels. The admission is done once a year, in fall semester. Students who have completed the 12 years of education are eligible for admission. Admission is granted strictly on the basis of academic record and interview. Students from accredited universities are eligible to transfer their credits to Khushal Khan Khattak University, Karak. Students have to submit complete course curriculum and internal evaluation certificate of each subject from his/her previous institution duly signed by head of department. Student's applications in this regard are dealt on case-to-case basis. Such applications are discussed in Board of Studies to evaluate them and make decision.

This admission criterion is evaluated every 2-years by the board of faculties and academic council in the light of instructions issued by HEC.

Standard 5.2

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

The student's name, after completion of the admission process, is forwarded to the Registrar office for registration in the specific program and the registration number is issued. Students are evaluated through assignments, sessional, mid-term tests and final examinations at the end of each semester. The laboratory work is done on regular basis as per schedule and contributes significantly towards the student's evaluation for relevant course. Only qualified students in each semester are allowed to join the next semester.

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.*

The higher authorities in consultation with the department advertise and create the new posts time to time in order to recruit new faculty and retain the qualified faculty on the basis of eligibility criteria. The opportunities are available to recruit the highly qualified faculty on the basis of criteria given by HEC without any discrimination in terms of color, creed, race and so on.

Process and Procedure of Recruitment:

All the appointments of teaching cadre are made in the university on the basis of HEC criteria. The criteria are as follow:

a. Lecturer

Eligibility Criteria:

The candidates must have M.Phil or equivalent degree or equivalent awarded after 18 years of education in the relevant field from HEC recognized University/Institution. The candidates must not have third division in his/her academic career.

Note: However, the specific eligibility criteria (including the general criteria) for specific other academic disciplines are based on certain conditions.

b. Assistant Professor

Minimum Qualification

Ph.D from an HEC recognized Institution in the relevant field. No experience required.

<div align="center">

OR

</div>

Master's degree (foreign) or M.Phil (Pakistan) or equivalent degrees awarded after 18 years of education as determined by the HEC in the relevant field from an HEC recognized University/Institution.

Experience:

4 years teaching/research experience in a recognized University or a Post-graduation Institution or professional experience in the relevant field in a National or International Organization.

c. Assistant Professor

Minimum Qualification

Ph.D from an HEC recognized Institution in the relevant field.

Experience:

10-year teaching/research in HEC recognized University or a Post-graduate Institution or professional experience in the relevant field in a National or International Organization.

OR

5-Year post Ph. D. teaching/research experience in a recognized University or a post-graduate Institution or professional experience in the relevant field in a National or International Organization.

Minimum No. of Publications

10 research publications (with at least 4 publications in the last 5 years) in HEC recognized journals.

Note: *However, the specific eligibility criteria (including the general criteria) for specific other academic disciplines are based on certain conditions.*

d. Professor

Minimum Qualification

Ph.D from an HEC recognized Institution in the relevant field.

Experience

15-years teaching /research in HEC recognized University or a Post-graduate Institution or professional experience in the relevant field in a National or International Organization.

OR

10-years post-Ph.D. teaching/research experience in recognized University or a post-graduate Institution or professional experience in the relevant field in a National or International Organization.

Minimum No of Publications:

15 research publications (with at least 5 publications in last 5 years) in HEC recognized journals.

Note: *However, the specific eligibility criteria (including the general criteria) for specific other academic disciplines are based on certain conditions.*

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Standard 5.4
> ***The process and procedures used to ensure that teaching and delivery of course material to the students emphasizes active learning and the course learning outcomes are met. The process must be periodically evaluated to ensure that it is meeting its objectives.***

The faculty of Mathematics plan the teaching and delivery of course material by observing the class time table in its real sense in order to avoid any inconvenience of missing the classes. Each of the faculty members prepares course plan on the basis of syllabi which followed thought-out the year. This helps the faculty for time-bound completion of the course. Every faculty member provides the detailed course outline to the students as a break up of topics to be taught. Teaching and course evaluation is carried out through Director Quality Assurance proformas at the end of academic session and the same is reported to the Director Quality Enhancement Cell for reference and record. The department also learns a lesson through this evaluation and tries to improve the situation on the basis of available resources.

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.***

The prospectus of the university enlists all the requirements which the students have to meet such as 75% attendance, code of conduct and other requirements. The students are penalized by individual departments if they do not fulfill the requirements under the University rules.

Criterion-6

Faculty

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.

The curriculum of HEC "comprised of 134 credit hours having 44 courses for BS Mathematics Program. The existing faculty is committed to run the program in a team work effort by letter and spirit. At the moment, two of faculty members hold Ph.D in the discipline whereas the rest are M.Phil degree holders.

The faculty should seek the opportunities of achieving the best level of competence by utilizing the time for conducting the researches and enhancing the qualification up to the level of Post Ph. D. The university should also motivate and facilitate the faculty to achieve the excellence in their subjects through certain opportunities of learning and upgrading the existing knowledge/competence.

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, the effective programs for faculty development must be in place.

- The faculty members attend the seminars, workshops and conferences to keep them current in the discipline and browse the internet time to time for emerging trends in the discipline. Moreover, the faculty members exchange their professional views with their peers in order to avoid any misconception.
- All the courses in mathematics are practical-based and most of the faculty members teach three different papers, hence they rarely find time for writing their research papers. However, efforts are in pipeline to inculcate this trend.
- The facilities for participating in seminars and conferences are available for the faculty within the university and outside the university and the individual teacher avails this opportunity time to time.

Standartd-6.3
   All faculty members should be motivated and have job satisfaction to excel in their profession.

   The faculty of the department is motivated as they can win the facility of scholarship, availing of tenure track status on the basis of their intellect and ability. The opportunity of promotion is also available in the department provided they fulfill the criteria in this connection. The university also provides financial assistance to the faculty for writing and attending the research papers for the journals and conferences. All such opportunities and facilities are effective for the motivation and job satisfaction for the faculty in any way.

Criterion-7

Institutional Facilities

CRITERION-7: INSTITUTIONAL FACILITIES

Standard 7.1
>*The institution must have the infrastructure to support new trends in learning such as e-learning.*

Infrastructure: The existing infrastructure of the department is established by the Khushal Khan Khattak University, Karak in terms of space and other facilities. The existing facilities needs to be upgraded specially in the field of E-learning because of speedily shifting of Mathematics discipline from conventional to E-learning approaches. To cope with the situation, the above listed shortcomings should be removed by acquiring the requisite equipment and resources.

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.*

The collection of reading material in the departmental library is not worthwhile that may fully support the academic activities in the department. The collection development in the departmental library is somewhat slow which hinders some learning options both for the teachers and the students. The departmental library houses about 1000 documents in the forms of books and theses (both soft and hard form), whereas the central library houses a very small collection of books on Mathematics. Both the central and departmental libraries do not subscribe any journal relating to mathematics except those which are available on line through digital library of HEC. The departmental library is manual-ridden system managed by the non-professional staff. The hiring of professional staff is likely to be made shortly. The departmental library needs to be computerized being a model library. The central library of the university should acquire the demanded books through its acquisition process.

Standard 7.3
>*Class-rooms must be adequately equipped and offices must be adequate to enable faculty to carry out their responsibilities.*

Class-rooms and faculty offices: The class rooms and the faculty offices are adequate to some extent to carry out the academic, administrative and other sorts of related activities. All the faculty members don't have their separate offices except a few. The class room facilities are up to the mark in terms of proper furniture and multimedia. The multimedia facility is available also in the class rooms for the purpose of some specialized lectures. The faculty members feel a dire need of modern and smart computers in their offices which should be provided to boast the academic and research activities.

Criterion-8

Institutional Support

CRITERION-8: INSTITUTIONAL SUPPORT

The institution's support and the financial resources for the program must be sufficient to provide an environment in which the program could achieve its objectives and retain the strength required.

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 teacher and scholars.***

The financial resources of the Department of Mathematics are allocated in the annual budget of the Khushal Khan Khattak University, Karak. The department has qualified faculty mostly with PhD degrees and each of them striving their best to maintain the competence by exchanging their professional views in professional gathering and attending seminars and workshops. The meager financial resources for the department are not compatible for the overall development of the department in terms of Lab expansion and the departmental library. The available secretarial support and office equipment are adequate to some extent to execute the daily functions of department.

Standard 8.2
> ***There must be an adequate number of high quality graduate students, research assistants and Ph.D students***

As the Department is at embryonic stage and has been established in 2019. That is why; the strength of the students is also minimal. The department currently offers BS Mathematics programs in fall semester 2019.

Table-9

Program of Studies	*2019*	*2020*	*2021*	*2022*
BS Mathematics	15	15+10=25	25+11=36	36+14=50
Research Assistants	*Nil*	*Nil*	*Nil*	*Nil*
Teacher/ Students Ratio	1:8	1:5	1:7	1:12

Standard 8.3
Financial resources must be provided to acquire and maintain Library holdings, laboratories and computing facilities

The meager resources for the Departmental Mathematics and the special mathematics lab become the hurdle in accessing some specific information for academic achievements of the students and faculty, however reading material is acquired in the departmental library through acquisition of the central library of Khushal Khan Khattak University on a very small scale. Similarly the department lacks the resources and facilities in terms of establishing the laboratory for individual subject practical. The computing facilities in the department are available to run the functions of the department but that needs to be extended.

ANNEXURES

Annexure-I

Faculty Resumes

Resume No. 3

Name	Dr. Saeed Ullah Jan
Personal	**Khushal Khan Khattak University Karak , Khyber Pakhunkhwa Pakistan** Phone#: 0927211895 Cell#: 03339274808 E-mail: saadullahjan2011@gmail.com saadullahjan2002@yahoo.com
Experience	1- Worked as HoD at Sarhd University Peshawar from May 02, 2012 to December 03,2015 (Evening program). 2- Worked as librarian at Higher education department, Government of Khyber Pakhtunkhwa, Peshawar from 25-09-1998 to 30-04-2012. 3- Teaching the subject of Library Science at College level for the above mentioned period. 4. Worked as Librarian at Central Library of Forest, Govt: of N-W.F.P (now Khyber Pakhtunkhwa) from 30-11-1995 to 24-09-2008.
Professional Affiliations	• Higher Education Commission Islamabad, National Committee for Curriculum Revision of Library and Information Science , Member • Sarhad University Peshawar, Board of Studies for Library and Information Science, Member • Bacha Khan University Charsadda. Board of Studies for Library and Information Science, Member • University of Peshawar, Board of Studies for Library and Information Science, Member • National Testing Services Pakistan, Subject committee in LIS, Developer.
Publications	**Research Paper Published Or In The Process Of Publication** 1- Jan, S. U., & Sheikh, R. A. (2011). Automation Of University Libraries: A Comparative Analysis Of Islamabad And Khyber Pukhtoon Khwa, Pakistan. Library Philosophy And Practice, (1), 21. 2- Jan, Saeed Ullah, Rafia A Sheikh & Sajjad Ullah Jan (2013). Technological Library Practices In Pakistan: Case Study Of Public Sector University Libraries. *Internal Journal Of Digital Library Services,3(1)* 3- Khan, I., Jan, S. U., & Khan, M. (2015). Determinant Of Capital Structure: An Empirical Study Of Cement Sector Of Pakistan. Asian Journal Of Management Sciences & Education Vol, 4(3).

	4- Ibrahim, M., & Jan, S. U. (2015). Bibliometric Analysis Of The Journal Of Pakistan Medical Association Form 2009 To 2013. JPMA. The Journal Of The Pakistan Medical Association, 65(9), 978-983. 5- Khattak, H., Mughal, A. W., SU Jan & Marwat, M. K. (2015). Perception Of The Students Of Sarhad University Regarding The Impact Of Different Systems Of Examination Upon Their Academic Performance. Asian Journal Of Management Sciences & Education, 4(2), 43-51. 6- Rehman,H, Saeed Ullah Jan And Mukhtiar Ali (2015). Awareness & Utilization Of Electronic Information Resources Among Medical Students. 23(4), 238-241 7- Jan, Saeed Ullah (2015). Use Of Internet By The Teaching Faculty Of Bacha Khan University,Charsadda Khyber Pakhtunkhwa.3(8),7-11 8- Zakria, Jan, Saeed Ullah And Zeshan (2015). Arts And Letters Ka Bibiliomteric Tajzia. 14(1), 336-341. 9- Jalal-Ud-Din, A. R., Ahmad, S. M., & Jan, S.(2015). Students' Perceptions Regarding Library Services In The Institute Of Education & Research (Ier), University Of Peshawar. 10- Jan, Saeed Ullah & Rafia A Sheikh (2014). Impact Of Emerging Technologies On University Libraries Of Pakistan.4(3), 56-69 11- Jan, Saeed Ullah & Rafia A.S (2013) Status Of Library Automation And Digitization In The Public Sector Universities Of Balochistan: A Case Study, *Pakistan Library Associatiojn Journal*,49-70 12- Jan, Saeed Ullah & Rafia A.S (2013). Modern Trends In University Libraries Of Pakistan *Sarhad University Of Science & Information Technology Peshawa*r, 1(1),478-485 13- Jan, Saeed Ullah & Rafia A.S and Sajjad Ullah Jan(2013). Technological Library Practices In Pakistan: A Case Study Of Public Sector University Libraries. *International Journal Of Digital Library Services,3(1), 22-33*
Theses & Books Published	1- Jan, Saeed Ullah (2012). *Modernization of University Libraries of Pakistan: case studies*. LAP LAMBERT Academic Publishing, Germany. 2- Jan, Saeed Ullah (2012). Digital Technology and its impact on Library and Information services and resources in the Public sector universities of Pakistan. Doctoral Research Thesis. 3- Jan, Saeed ullah (2002). *Role of library in teaching of science education at secondary school level. A thesis submitted for the partial fulfillment of the Master degree in education.* Submitted to Allam Iqbal Open University, Islamabad for partial fulfillment for Master of Education.

	4- Jan, Saeed Ullah & Zia khan (2004). Data base design. A thesis submitted to Gomal University D.I.Khan for partial fulfillment for the award of MIT degree.
Conferences Seminars Workshops	1- Organized a workshop titled " New Horizon of LIS profession" in collaboration with HEC Islamabad at the DLIS, Khushal Khan Khattak University Karak from November 22-23,2016 2- Presented a paper in the international conference " 8th Qualitative and Quantitative Methods in Libraries," at University of London, UK, 27-30 May, 2016. 3- Presented Paper Titled "Impact Of Digital Technology On Library Services And Resources" In A Training Workshop Organized By Pakistan Academy For Rural Development (Pard), Peshawar, February 18-22, 2013. 4- Presented A Paper Titled "Modern Trends In University Libraries Of Pakistan" In 2nd International Multidisciplinary Conference: Towards Better Pakistan Organized By Sarhad University Of Science &It And Higher Education Commission Of Pakistan,24-25th September, 2012. 5- Presented A Paper Titled "Open Source Library Softwares In Pakistan" In One Day Seminar: Open Source Movement And Libraries, Organized By Sarhad University, Peshawar & University Of Azad Jammu & Kashmir, 17th October,2012. 6- Presented A Paper Titled "Technological Library Practices In Pakistan" In 5-Day Seminar On Library Management In Virtual Environment, Organized By Peshawar Universities Campus Librarians Associations, Bara Gali Summer Capmus, Abbotabad,2nd -6th June,2012. 7- Presented A Paper In The International Conference "1st Asian Conference On Literature And Librarianship" Organized By International Academic Forum, Osaka, Japan, 27-30 May, 2011. 8- Presented A Paper At "6th Pakistan Library Science Conference" University Of Peshawar , Baragali, Jun28-July2,2009. 9- Paper Accepted For Presentation In International Conference" Qualitative And Quantitative Research Methods In Libraries 2012" Limerick, Ireland,22-25, May,2012. 10- Participated In Workshop On "Library Automation Systems-Introduction And Practical Implementation Of Automation Software", Organized By Pakistan Academy For Rural Development (Pard) Peshawar, September 15-19, 2008 11- Participated in workshop on ""Library Automation and digitization software", organized by the Department of Library and Information Science, University of Peshawar, February 2-4, 2009

Resume No. 2

Name	Dr. Muhammad Sajjad Ali Khan

Personal	**Khushal Khan Khattak University Karak, Khyber Pakhtunkhwa Pakistan**
	Cell#: **03369107510**
	E-mail: sajjadalimath@yahoo.com
	Other Information:
	  Father's Name Gul Raib Khan
	  Date of Birth 28/02/1987
	  Religion Islam
	  Domicile Bannu, KPK
	  CNIC No. 11101-5181538-1
	  Nationality Pakistani
	  Marital Status Married
	  Permanent Add: Kakki, Tehsil Kakki, District Bannu
	  Postal Address: Mir Khani Street Kakki, P/O Kakki
	  Language Known Pashto, English, Urdu

Honors and Awards	PHD in Mathematics
Service Activity	Teaching
Experience	• Lecture in Mathematics, GPGC Bannu form sept 2015 to Feb 2018 • Work as a Lecturer in Mathematics, INS, Kohat University of Science and Technology, Kohat, from 12 Feb 2020 to 31 May 2021. • Work as an Assistant Professor (IPFP) in Department of Mathematics, Khushal Khan Khattak University, Karak, from May 31 to date.
Brief Statement of Research Interest	I have completed my PhD degree in Mathematics from Hazara University Mansehra. During my PhD, I have published 50 papers in different national and international well reported journals. Studies focused on Pure Mathematics and Applied Mathematics; in particular, my PhD study is focusing on Pythagorean hesitant fuzzy sets and their applications, beside this I have also done research work in the field of Fuzzy semigroup Theory and Logical Algebras. I have one and half year teaching experience at Kohat University of Science and technology. Recently I joint Department of Mathematics Khushal Khan Khattak University, Karak based on IPFP.
Publications	**(1)** **M. Sajjad Ali Khan**, A. S. Khan, I. A. Khan, F. Hussain and W. K. Mashwani, Linguistic Interval-valued Q-rung Orthopair fuzzy TOPSIS method for decision making problem with incomplete weight. Journal of Intelligent & Fuzzy Systems, DOI: 10.3233/JIFS-200845. **(IF: 1.851)** **(2)** **M. Sajjad Ali Khan**, S. Abdullah and K. Hilla, On the generalization an interval valued -fuzzy generalized bi-ideals in ordered semigroup, Applications and Applied mathematics: An international journal Vol. 16, Issue 1 (June 2021), pp. 237 – 267. **(ISI)** **(3)** **M. Sajjad Ali Khan**, S. Abdullah and K. Hilla, A more general form of interval valued fuzzy filters in ordered semigroups, Afrika Mathematics June, 2021. **(ISI)** **(4)** Tehreem, A. Hussain, J. R. Lee, **M. Sajjad Ali Khan** and D. Y. Shin, Analysis of

social networks by using Pythagorean Cubic Pythagorean fuzzy Einstein weighted geometric aggregation operators, Journal of Mathematics, (2021). **(IF: 0.971)**

(5) **M. Sajjad Ali Khan**, Faisal Khan, Joseph Lemley, Saleem Abdullah, Fawad Hussain, *Extended Topsis Method Based on Pythagorean Cubic Fuzzy Multiple Criteria Decision-Making with Incomplete Weight Information,* Journal of Intelligent & Fuzzy Systems, vol. 38, no. 2, pp. 2285-2296, 2020. DOI:10.3233/JIFS-191089 **(IF: 1.851)**

(6) I. A. Khan, A. S. Khan, S. Q. Jan, S. Islam, **M. Sajjad Ali Khan,** A. Ullah, *Explication of the conserved quantities corresponding to the spacetimes carrying 10 Noether symmetries*, International Journal of Geometric Methods in Modern Physics, (2020) DOI:10.1142/S0219887821500535. **(IF: 1.287)**

(7) S. K. Mittal, M. Mittal and **M. Sajjad Ali Khan**, Ground-Level Water Predication Using Time Series Statistical Model, (2021) In book: Advances in Information Communication Technology and Computing.

(8) **M. Sajjad Ali Khan**, On More Generalized Fuzzy Interior Ideals in Semigroup (2020), In book: Handbook of Research on Emerging Applications of Fuzzy Algebraic Structures.

(9) **M. Sajjad Ali Khan**, S. Abdullah, Asad Ali, *Multi-attribute group decision making based on Pythagorean fuzzy Einstein prioritized aggregation operators*, Int J Intell Syst. 2019 (34)1001-1033. **(IF: 7.229)**

(10) **M. Sajjad Ali Khan**, S. Abdullah, A. Ali, F. Amin and F. Hussain, *Pythagorean Hesitant fuzzy Choquet Integral aggregation operators and their application to group decision making,* Soft Computing 2019 (23):251–267. https://doi.org/10.1007/s00500-018-3592-0**. (IF: 2.784)**

(11) Aurangzeb, **M. Sajjad Ali Khan**, M. Ibrar, *Approaches to multi-attribute decision making with risk preference under extended Pythagorean fuzzy environment*. Journal of Intelligent & Fuzzy Systems, 2019 (36):325–335. DOI:10.3233/JIFS-181385. **(IF: 1.637)**

(12) F. Khan , **M. Sajjad Ali Khan**, M. Shahzad, S. Abdullah, *Pythagorean cubic fuzzy aggregation operators and their application to multi criteria decision making problems,* Journal of Intelligent & Fuzzy Systems, 2019 (36):595–607. DOI: 10.3233/JIFS-18943 **(IF: 1.637)**

(13) S. Z. Abbas, **M. Sajjad Ali Khan** ,S. Abdullah, H. Sun and F. Hussain, *Cubic Pythagorean fuzzy sets and their application to multi-attribute decision making with unknown weight information*, Journal of Intelligent & Fuzzy Systems 37(1): 1529-1544, 2019, DOI:10.3233/JIFS-18382. **(IF: 1.637)**

(14) **M. Sajjad Ali Khan,** *The Pythagorean fuzzy Einstein Choquet integral operators and their application in group decision making*, Computational and Applied Mathematics (2019) 38: 128. **(IF: 1.260)**

(15) **M. Sajjad Ali Khan**, S. Abdullah, A. Ali, K. Rahman, F. Amin, F. Hussain, *On Hyper BCH-algebras,* Italian Journal of Pure and Applied Mathematics, 2019 (41)**:** 85-96. **(ISI)**

(16) **M. Sajjad Ali Khan**, A. Ali, S. Abdullah, F. Hussain, F. Amin and K. Rahman, *On the generalization of (∈, ∈Vq)-intuitionistic fuzzy bi-ideals of semigroups*, Italian Journal of Pure and Applied Mathematics. 2019 (41) **:** 116-142. **(ISI)**

(17) F. Hussain, W. Khan, **M. Sajjad Ali Khan** and S. Abdullah, *Quasi and Bi-Ideals in Left Almost Rings*, Honam Mathematical J.41(2019), No. 3, pp. 449–461. **(ISI)**

(18) **M. Sajjad Ali Khan,** *On generalized (∈,∈Vq_k)-fuzzy interior ideals in semigroups*. (Book Chapter, Accepted Global IGI)

(19) **M. Sajjad Ali Khan**, S. Abdullah, *Interval-valued Pythagorean fuzzy GRA method for multiple attribute decision making with incomplete weight information,* International Journal of Intelligent Systems, 2018, 33(8):1689-1716 DOI:10.1002/int.21992. **(IF: 3.363)**

(20) A. Fahmi, S. Abdullah, F. Amin and **M. Sajjad Ali Khan**, *Trapezoidal cubic fuzzy Einstein hybrid weighted averaging operator and its application to decision making*, soft computing **23**:5753–5783(2019)https://doi.org/10.1007/s00500-018-3242-6. **(IF: 2.367)**

(21) **M. Sajjad Ali Khan**, M. Yousaf Ali, S. Abdullah, I. Hussain and M. Farooq, *Extension of TOPSIS method base on Choquet integral under interval-valued*

Pythagorean fuzzy environment, Journal of Intelligent & Fuzzy Systems, vol. 34, no. 1, pp. 267-282, 2018. **(IF: 1.426)**

(22) M. Sajjad Ali Khan, S. Abdullah, A. Ali and F. Amin, F. Hussain, *New extension of TOPSIS method based on Pythagorean hesitant fuzzy sets with incomplete weight information*. Journal of Intelligent & Fuzzy Systems 35 (2018) 5435–5448 DOI:10.3233/JIFS-171190. **(IF: 1.426)**

(23) M. Sajjad Ali Khan, K. Rahman, Aliya Fahmi and M. Shakeel., *Generalized ($\in$, $\in \lor q_k$) –fuzzy quasi-ideals in semigroups*, Punjab University Journal of Mathematics, Vol. 50(1) (2018) pp. 35-53 (HEC Approved X Category)

(24) M. Shakeel, S. Abdullah , M. Sajjad Ali Khan, K. Rahman ,*Averaging Aggregation Operators with Interval Pythagorean Trapezoidal Fuzzy Numbers and Their Application to Group Decision Making*, Punjab University Journal of Mathematics Vol. 50(2)(2018) pp. 147-170. (HEC Approved X Category)

(25) K. Rahman, A. Ali, M. Sajjad Ali Khan, *Some Interval-Valued Pythagorean Fuzzy Weighted Averaging Aggregation Operators and Their Application to Multiple Attribute Decision Making,* Punjab University Journal of Mathematics Vol. 50(2)(2018) pp. 113-129. (HEC Approved X Category)

(26) M. Sajjad Ali Khan, S. Abdullah, A. Ali and K. Rahman., *Pythagorean Hesitant Fuzzy Information Aggregation and Their Application to Multi-Attribute Group Decision-Making Problems* J. Intell. Syst. 2018; 1-18, https://doi.org/10.1515/jisys-2017-0231. **(ISI)**

(27) K. Rahman, S. Abdullah, M. Sajjad Ali Khan, *Some Interval-Valued Pythagorean Fuzzy Einstein Weighted Averaging Aggregation Operators and Their Application to Group Decision Making.* J. Intell. Syst. 2018, https://doi.org/10.1515/jisys-2017-0212. **(ISI)**

(28) M. Sajjad Ali Khan, S. Abdullah, P. De Li, *Grey method for multi-attribute decision making with incomplete weight information under Pythagorean fuzzy setting*. Journal of Intelligent Systems, 2018 https://doi.org/10.1515/jisys-2018-0099. **(ISI)**

(29) K. Rahman, , Fawad Hussain M. Sajjad Ali Khan, *Pythagorean fuzzy hybrid averaging aggregation operator and its application to multiple attribute decision making,* Italian Journal of Pure and Applied Mathematics 40(2018)180-187. **(ISI)**

(30) M. Sajjad Ali Khan, S. Abdullah, Asad Ali and Fazli Amin, *An Extension of VIKOR method for multi-attribute decision making under Pythagorean hesitant fuzzy sets environment,* Granular Computing https://doi.org/10.1007/s41066-018-0102-9 (2018)

(31) M. Sajjad Ali Khan, S. Abdullah, Asad Ali and Fazli Amin, *Pythagorean fuzzy prioritized aggregation operators and their application to multi-attribute group decision making.* Granular Computing (2019) 4:421–434. https://doi.org/10.1007/s4106 6-018-0093-6.

(32) M. Sajjad Ali Khan, S. Abdullah, A. Ali, F. Amin and K. Rahman, *Hybrid aggregation operators based on Pythagorean hesitant fuzzy sets and their application to group decision making*, Granular Computing (2018) https://doi.org/10.1007/s41066-018-0107-4.

(33) M. Sajjad Ali Khan, S. Abdullah, Asad Ali, Fazli Amin and Nasir Siddique, *Pythagorean hesitant fuzzy sets and their application to group decision making with incomplete weight information*, Journal of Intelligent & Fuzzy Systems 33 (2017) 3971–3985. DOI:10.3233/JIFS-17811. **(IF: 1.246)**

(34) M. Shakeel, K. Rahman, M. Sajjad Ali Khan and Murad Ullah., *Induced Averaging Aggregation Operators with Interval Pythagorean Trapezoidal Fuzzy Numbers and their Application to Group Decision Making.,* The Nucleus **54**, No. 2 (2017) 140-153. (HEC Approved Y Category)

(35) K. Rahman, A. Ali, M. Shakeel, M. Sajjad Ali Khan, Murad Ullah, *Pythagorean Fuzzy Weighted Averaging Aggregation Operator and its Application to Decision Making Theory, The Nucleus 54, No. 3 (2017) 190-196.* (HEC Approved Y Category)

(36) K. Rahman, M. Sajjad Ali Khan, Murad Ullah, A. Fahmi., *Multiple Attribute Group Decision Making for Plant Location Selection with Pythagorean Fuzzy Weighted Geometric Aggregation Operator., The Nucleus 52, No. 1 (2017) 7-10.*

(HEC Approved Y Category)

(37) K. Rahman, S. Abdullah, F. Hussain, **M. Sajjad Ali Khan** and M. Shakeel., *Pythagorean Fuzzy Ordered Weighted Geometric Aggregation Operator and Their Application to Multiple Attribute Group Decision Making*, *J. Appl. Environ. Biol. Sci.*, 7(4)67-83, 2017. **(ISI)**

(38) K. Rahman, S. Abdullah, **M. Sajjad Ali Khan**, M. Ibrar and F. Hussain., *Some Basic Operations on Pythagorean Fuzzy sets*, *J. Appl. Environ. Biol. Sci.*, 7(1)111-119, 2017. **(ISI)**

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(40) K. Rahman, S. Abdullah, M. Shakeel, **M. Sajjad Ali Khan** and Murad Ullah., *Interval-valued Pythagorean fuzzy geometric aggregation operators and their application to group decision making problem.*, *Cogent Mathematics* (2017), 4: 1338638 https://doi.org/10.1080/23311835.2017.1338638. **(ISI)**

(41) **M. Sajjad Ali Khan,** S. Abdullah, Y. B. Jun and K. Rahman., *More Generalized Fuzzy Subsemigroups/Ideals In Semigroups*, Honam Mathematical J. 39 (2017), No. 4, pp. 527-559 https://doi.org/10.5831/HMJ.2017.39.4.527. **(ISI)**

(42) **M. Sajjad Ali Khan**, S. Abdullah, K. Rahman and S. Z. Abbass., *"Characterization of regular semigroups by $(\in, \in \lor (k^{*}, q_k))$ –fuzzy ideals"*, Annals of Fuzzy Mathematics and Informatics Volume 13, No. 3, (March 2017), pp. 403-419.

(43) K. Rahman, **M. Sajjad Ali Khan** , Murad Ullah., *New Approaches to Pythagorean Fuzzy Averaging Aggregation Operators.*, Mathematics Letters 2017; 3(2): 29-36.

(44) **M. Sajjad Ali Khan**, S. Abdullah, A. Ali, F. Amin and K. Rahman, *On generalized $(\in, \in \lor q_k)$-fuzzy quasi ideals in ordered semigroups.* Turkish Journal of Fuzzy Systems, Vol.8, No.1, pp. 033-051, (2017).

(45) **M. Sajjad Ali Khan**, S. Abdullah, M. Shakeel and K. Rahman**., "Generalized Intuitionistic fuzzy interior ideals of semigroups"**, International Journal of computer science and information security. *Vol. 6(2016), 829-836*. **(ISI)**

(46) K. Rahman, S. Abdullah, **M. Sajjad Ali Khan** and M. Shakeel, *"Pythagorean fuzzy hybrid geometric operator and their application to multiple attribute decision making"*, International Journal of computer science and information security. *Vol. 6(2016), 837-854*. **(ISI)**

(47) K. Rahman, S. Abdullah, F. Husain, **M. Sajjad Ali Khan**., *Approaches to Pythagorean Fuzzy Geometric Aggregation Operators*, International Journal of computer science and information security. *Vol. 14(2016),* 174-200. **(ISI)**

(48) K. Rahman, F. Husain, S. Abdullah, **M. Sajjad Ali Khan**, *On Left Almost Semiring*, International Journal of computer science and information security. *Vol. 14(2016),* 201-216. **(ISI)**

(49) F. Hussain, **M. Sajjad Ali Khan**, K. Rahman, M. Khan**.,** *"Congruences and External Direct Sum of LA-modules"*, Indian Journal of Science and Technology, *Vol 8(28), 54-60, October 2015.*

Resume No.3

Name	**Shabbir Rehman**

Personal	**Khushal Khan Khattak University Karak, Khyber Pakhtunkhwa Pakistan**
	Cell#: **0333-9717862**
	E-mail: shabbirrehman2@yahoo.com
	Other Information:
	  Father's Name Ayaz Khan
	  Date of Birth 12/02/1984
	  Religion Islam
	  Domicile Karak
	  CNIC No. 14203-2572691-1
	  Nationality Pakistani
	  Marital Status Married (2 Dependents)
	  Permanent Add: Village Ahmad Abad Tehsil Tahti Nasrati &
	                       Distt: Karak
	  Postal Address: Village Ahmad Abad Tehsil Tahti Nasrati &
	                       Distt: Karak
	  Language Known Pashto, English, Urdu

Experience	• Lecturer in Department of Mathematics, Khushal Khan Khattak University, Karak: Teaching Bachelors since February 2015 till date.
Service Activity	1.Teaching 2.Department coordinator 3. Focal Person of Mathematics
Brief Statement of Research Interest	I have received M.Phil degree from University of UET Peshawar. My topic of research was General relativity: A case study of Khyber Pakhtunkhwa.
Publications	1. Proper homothetic vector fields of static space time in the general relativity.

Resume No. 4

Name	**Mr. Zaheer Anjum**
Personal	**Khushal Khan Khattak University Karak, Khyber Pakhtunkhwa Pakistan** **Phone#:** **Cell#:** **03119718903** **E-mail:** **Other Information:** Father's Name Dost Ali Khan Date of Birth 04/01/1992 Religion Islam Domicile Karak CNIC No. 14203-9362320-3 Nationality Pakistani Marital Status Single Permanent Add: Village and P\O Ahmad Abad District Karak Postal Address: As above Language Known Pashto, English, Urdu
	•
Service Activity	1.Teaching
Brief Statement of Research Interest	M.PHIL Mathematics
Publications	NIL
Research Grants and Contracts	NIL

Resume No. 5

Name	**Mr. Naeem Abass**
Personal	**Khushal Khan Khattak University Karak, Khyber Pakhtunkhwa Pakistan** **Phone#:** **Cell#:** **03171909689** **E-mail:** **Other Information:** Father's Name Muhammad Abbas khan Date of Birth 19/11/1993 Religion Islam Domicile Karak CNIC No. 14203-6792303-7 Nationality Pakistani Marital Status Single Permanent Add: Village and P\O Ahmad Abad District Karak Postal Address: As above Language Known Pashto, English, Urdu
	•
Service Activity	1.Teaching
Brief Statement of Research Interest	M.PHIL Mathematic
Publications	NIL
Research Grants and Contracts	NIL

ANNEXURE-II

FACULTY SURVEY

Table 10
Faculty Survey

Groups	Count	Mean	Variance
1. Your mix of research, teaching and community service.	85	4.29	0.50
2. The intellectual stimulation of your work.	85	4.16	0.85
3. Type of teaching / research you currently do.	85	4.33	0.55
4. Your interaction with students.	85	4.51	0.46
5. Cooperation you receive from colleagues.	85	4.37	0.47
6. The mentoring available to you.	85	4.10	0.92
7. Administrative support from the department.	85	4.20	1.06
8. Providing clarity about the faculty promotion process.	85	3.41	1.95
9. Your prospects for advancement and progress through ranks.	85	3.58	1.76
10. Salary and compensation package.	85	3.56	1.93
11. Job security and stability at the department.	85	3.87	1.59
12. Amount of time you have for yourself and family.	85	4	0.83
13. The overall climate at the department.	85	4.15	0.94
14. Whether the department is utilizing your experience and knowledge	85	4.16	1.04

*Figure*

Faculty Survey Responses Display
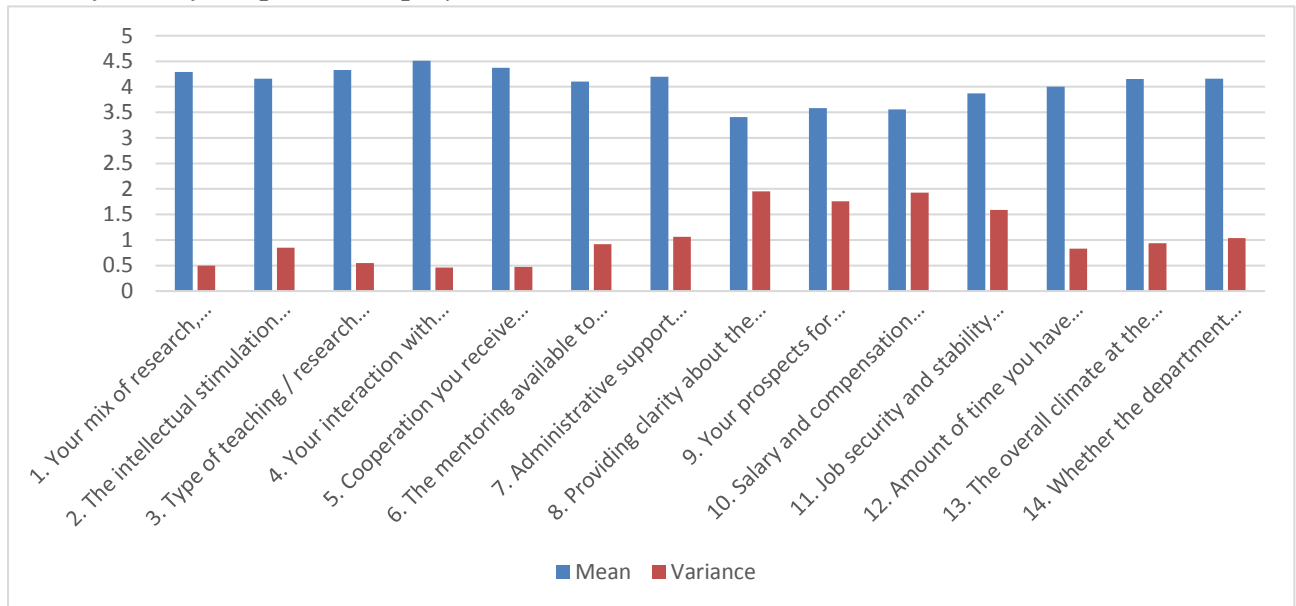
Annexure-III

Teacher and Employer Evaluation Statistics

Table 11
Teachers Evaluation Survey

Teacher	Average
Mr. Shabbir Rehman	4.84
Ms. Anum Khalil	4.6
Dr. Muhammad Sajjad Ali Khan	5
Mr. Tariq Usman	4.9
Mr. Naqeeb Ullah	5
Mr. Junaid Khan	4.82
Dr. Muhammad Sajjad Ali Khan	4.82
Dr. Muhammad Sajjad Ali Khan	4.83
Mr. Shabbir Rehman	4.81
Mr. Waheed Ullah	4.67
Mr. Waheed Ullah	4.65
Ms. Ayesha Kalsoom	4.85

Figure

Teachers Evaluation Survey Display
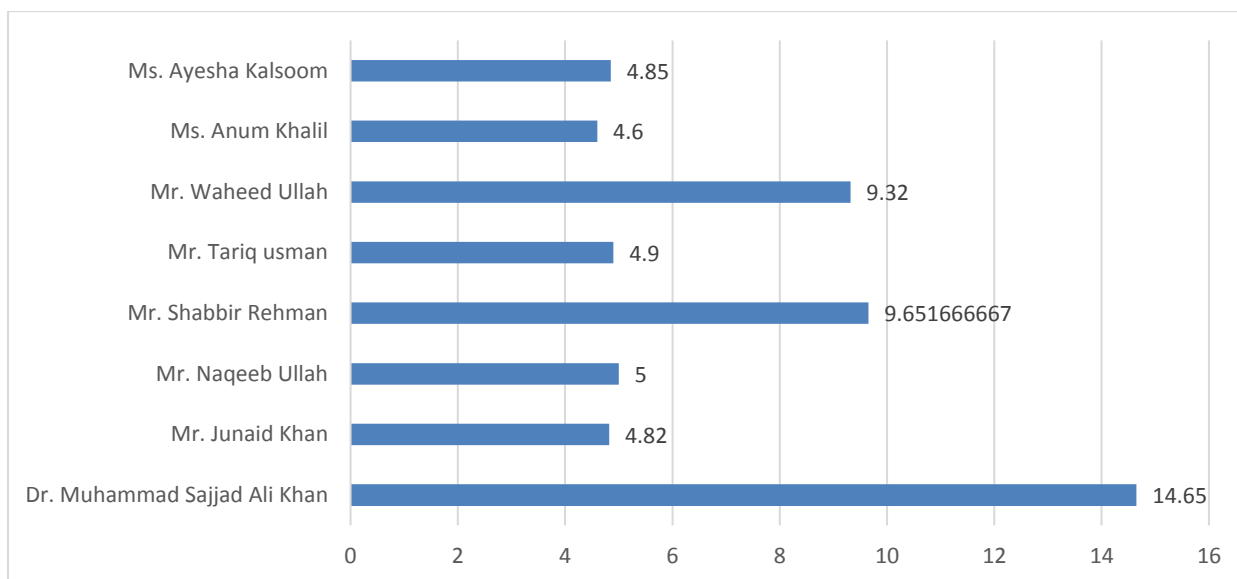
Table 12
Employer Survey Summary

Groups	N	Mean	Variance
Knowledge. Math, Science, Humanities and professional discipline, (if applicable)	9	4.2	0.64
Knowledge. Problem formulation and solving skills	9	4.1	0.36
Knowledge. Collecting and analyzing appropriate data	9	4.1	1.61
Knowledge Ability to link theory to Practice	9	4	1.75
Knowledge. Ability to design a system component or process	9	3.88	1.11
I. Knowledge. Computer knowledge.	9	3.66	1
Communication Skills. Oral communication	9	4.55	0.52
Communication Skills Report writing	9	3.66	1.75
Communication Skills. Presentation skills]	9	4.44	1.02
Interpersonal Skills Ability to work in teams]	9	4.44	1.77
Interpersonal Skills. Leadership]	9	4.44	0.52
Interpersonal Skills. Independent thinking]	9	4.33	1
Interpersonal Skills. Motivation]	9	4.22	0.69
Interpersonal Skills. Reliability]	9	4.33	0.5
Interpersonal Skills. Appreciation of ethical values]	9	4.55	0.52
Work skills. Time management skills]	9	4.11	1.11
Work skills. Judgment]	9	4.11	1.11
Work **skills.** Discipline]	9	4.33	1.25

Figure
Employer Survey Display
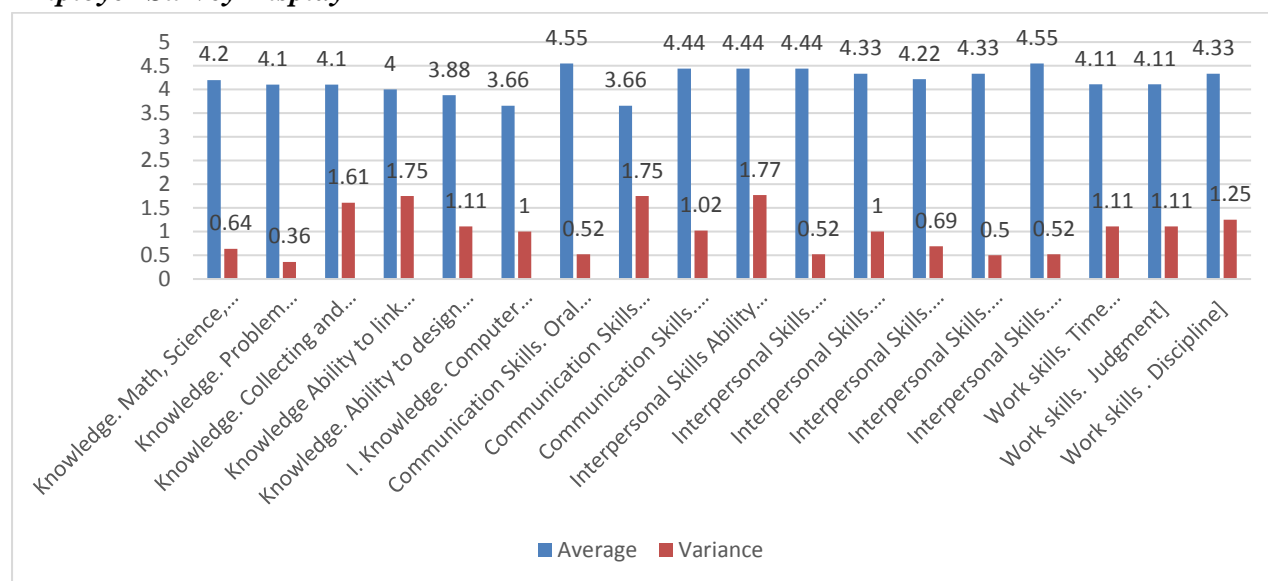
Appendix-IV

Student Courses Evaluation Questionnaire

Table 13
Student Courses Evaluation

Subject	Course Code	Average
Calculus III	Math-232	4.86
Technical writing and Skills	Eng-234	4.6
Group Theory	Math-231	5
Computer Programming	Comp-236	4.9
Accounting	Acc-235	5
Moden Physics	Phy-233	4.82
Differential Geometry	Math-352	4.82
Real Analysis-I	Math-354	4.83
Number Theory	Math-355	4.81
Topology	Math-351	4.67
Auffine and Euclidean Geometry	Math-356	4.65
Complex Analysis I	Math-353	4.85

Figure
Student Courses Evaluation Display
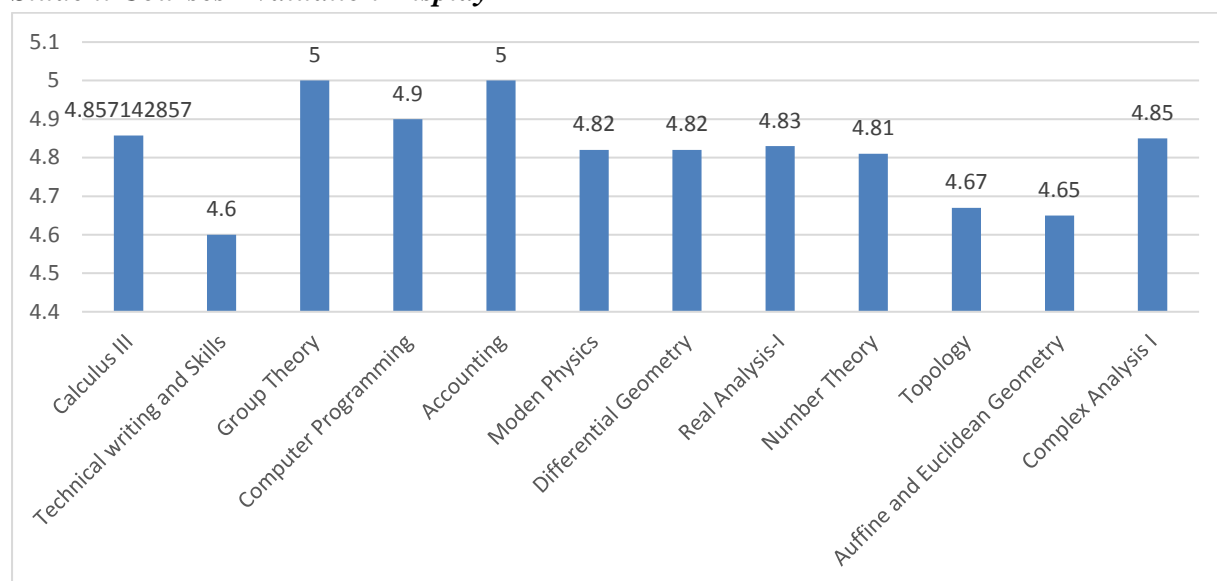
Curriculum of the Program
<u>Course Contents for BS (Mathematics)</u>

MATH-101   **Calculus-I**   **Cr.Hrs: 04**

Specific Objectives of course: Calculus serves as the foundation of advanced subjects in all areas of mathematics. This is the first course of Calculus. The objective of this course is to introduce students to the fundamental concepts of limit, continuity, differential and integral calculus of functions of one variable.

Course Outline:
Equations and inequalities: Solving linear and quadratic equations, linear inequalities. Division of polynomials, synthetic division. Roots of a polynomial, rational roots; Viète Relations. Descartes rule of signs. Solutions of equations with absolute value sign. Solution of linear and non-linear inequalities with absolute value sign.

Functions and graphs: Domain and range of a function. Examples: polynomial, rational, piecewise defined functions, absolute value functions, and evaluation of such functions. Operations with functions: sum, product, quotient and composition. Graphs of functions: linear, quadratic, piecewise defined functions.

Lines and systems of equations: Equation of a straight line, slope and intercept of a line, parallel and perpendicular lines. Systems of linear equations, solution of system of linear equations. Nonlinear systems: at least one quadratic equation.

Limits and continuity: Functions, limit of a function. Graphical approach. Properties of limits. Theorems of limits. Limits of polynomials, rational and transcendental functions. Limits at infinity, infinite limits, one-sided limits. Continuity.

Derivatives: Definition, techniques of differentiation. Derivatives of polynomials and rational, exponential, logarithmic and trigonometric functions. The chain rule. Implicit differentiation. Rates of change in natural and social sciences. Related rates. Linear approximations and differentials. Higher derivatives, Leibnitz's theorem.
Applications of derivatives: Increasing and decreasing functions. Relative extrema and optimization. First derivative test for relative extrema. Convexity and point of inflection. The second derivative test for extrema. Curve sketching. Mean value theorems. Indeterminate forms and L'Hopitals rule. Inverse functions and their derivatives.
Integration: Anti derivatives and integrals. Riemann sums and the definite integral. Properties of Integral. The fundamental theorem of calculus. The substitution rule.

Recommended Books:
Thomas, *Calculus*, 11th Edition. Addison Wesley Publishing Company, 2005
H. Anton, I. Bevens, S. Davis, *Calculus*, 8th Edition, John Wiley & Sons, Inc. 2005
Hughes-Hallett, Gleason, McCallum, et al, *Calculus Single and Multivariable*, 3rdEdition.
John Wiley & Sons, Inc. 2002. 4 Frank A. Jr, Elliott Mendelson, *Calculus*, Schaum's outlines series, 4th Edition, 1999

C.H. Edward and E.D Penney, *Calculus and Analytics Geometry*, Prentice Hall, Inc. 1988

E. W. Swokowski, *Calculus with Analytic Geometry*, PWS Publishers, Boston, Massachusetts, 1983.

M. Liebeck, *A Concise introduction to pure Mathematics*, CRC Press, 2011.

A. Kaseberg, *Intermediate Algebra*, Thomson Brooks/cole, 2004

MATH-103: Element of Theory and Mathematical Logic   Cr.Hrs: 03

Specific Objectives of course: Everything mathematicians do can be reduced to statements about sets, equality and membership which are basics of set theory. This course introduces these basic concepts. The course aims at familiarizing the students with cardinals, relations and fundamentals of propositional and predicate logics.

Course Outline:

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: Equivale

snce relations, partitions, quotient set; examples, parallelism, similarity of triangles. Order relations, min, max, inf, sup; linear order. Examples: 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.

Recommended Books:

- M. Liebeck, *A Concise Introduction to Pure Mathematics*, CRC Press, 2011.
- N. L. Biggs, *Discrete Mathematics*, Oxford University Press, 2002.
- R. Garnier, J. Taylor, *Discrete Mathematics*, Chapters 1,3,4,5, CRC Press, 2010.
- A.A. Fraenkal, *Abstract Set Theory*, North-Holland Publishing Company, 1966.
- P. Suppes, *Axiomatic Set Theory*, Dover Publication, 1972.
- P.R. Halmos, *Naive Set Theory*, New York, Van Nostrand, 1950.
- B. Rotman, G.T. Kneebone, *The Theory of sets and Transfinite Numbers*, Oldbourne London, 1968.
- D. Smith, M. Eggen, R.St. Andre, *A Transition to Advanced Mathematics*, Brooks/Cole, 2001.

ENG-101:   English-I (Functional English)   **Cr.Hrs: 03**

Learning Objectives

Enhance language skills and develop critical thinking.

Learning Outcomes

After completion of this course, the students will be able to learn grammar and enhance English language writing and reading skills.

Course Contents

Basics of Grammar**,** Parts of speech and use of articles**,** Sentence structure, active and passive voice**,** Practice in unified sentence**,** clause and sentence structure, Transitive and intransitive verbs, Punctuation and spelling**. Discussion** (General topics and every-day conversation (topics for discussion to be at the discretion of the teacher keeping in view the level of students) **Listening** (To be improved by showing documentaries/films carefully selected by subject teachers) **Translation skills** (Urdu to English) **Paragraph writing** (Topics to be chosen at the discretion of the teacher).

Books Recommended:

a)   **Grammar**

• Practical English Grammar by A.J. Thomson and A.V. Martinet. Exercises 1. Third edition. Oxford University Press. 1997. ISBN 0194313492

• Practical English Grammar by A.J. Thomson and A.V. Martinet. Exercises 2. Third edition. Oxford University Press. 1997. ISBN 0194313506

b)   **Writing**

• Writing. Intermediate by Marie-Christine Boutin, Suzanne Brinand and Francoise Grellet. Oxford Supplementary Skills. Fourth Impression 1993. ISBN 0 19 435405 7 Pages 20-27 and 35-41.

c)   **Reading/Comprehension**

• Reading. Upper Intermediate. Brain Tomlinson and Rod Ellis. Oxford Supplementary Skills. Third Impression 1992. ISBN 0 19 453402.

MUM-101:   Islamic Studies   Cr. Hrs: 02

Course Objectives

Provide Basic information about Islamic Studies, enhance understanding of students regarding Islamic Civilization, and improve Students skill to perform prayers and other worships, enhance the skill of the students for understanding of issues related to faith and religious life.

Courses Contents

Introduction to Quranic Studies

Verses of Surah Al-Baqra Related to Faith (Verse No-284-286)
Verses of Surah Al-Hujrat Related to Adab Al-Nabi

(Verse No-1-18)
Verses of Surah Al-Mumanoon Related to Characteristics of faithful (Verse No-1-11)
Verses of Surah al-Furqan Related to Social Ethics (Verse No.63-77)
Verses of Surah Al-Inam Related to Ihkam(Verse No-152-154)
Study of Selected Text of Holly Quran

Verses of Surah Al-Ihzab Related to Adab al-Nabi (Verse No.6, 21, 40, 56, 57, 58.)Verses of Surah Al-Hashar (18,19,20) Related to thinking, Day of Judgment
Verses of Surah Al-Saf Related to Tafakar,Tadabar (Verse No-1,14)
Seerat of Holy Prophet (S.A.W) I

Life of Muhammad Bin Abdullah (Before Prophet Hood)Life of Holy Prophet (S.A.W) in Makkah
Important Lessons Derived from the life of Holy Prophet in Makkah
Seerat of Holy Prophet (S.A.W) II

Life of Holy Prophet (S.A.W) in Madina
Important Events of Life Holy Prophet in Madina
Important Lessons Derived from the life of Holy Prophet in Madina
Introduction to Sunnah

Basic Concepts of Hadith
History of Hadith
sKinds of Hadith
Uloom –ul-Hadith

Reference Books:

Hameed Ullah Muhammad, "Emergence of Islam", IRI, Islamabad Hameed Ullah Muhammad, "Muslim Conduct of State".
Hameed Ullah Muhammad, 'Introduction to Islam.
Hussain Hamid Hassan, "An Introduction to the Study of Islamic Law" leaf Publication Islamabad, Pakistan.

PHY-101: Introduction to Mechanics Cr. Hrs: 03

Course Objectives:
To understand the fundamental unit system, vectors and rectilinear motion on a macroscopic scale and to develop simple mathematical formalisms to analyze such motions. This is a calculus-based introductory course with maximum emphasis on applying the acquired knowledge to solving problems.

Course outlines

Basic Concepts: Units and Dimensions, SI Units, precision and accuracy, significant figures, Scalars and Vectors, Vectors addition (Graphical as well as Component Method), Rectangular components, Vectors multiplication (Dot and Cross Products),

Motion in One, Two and Three Dimensions: Position & Displacement, Velocity and Acceleration, Motion under Constant Acceleration, Projectile Motion, Uniform Circular Motion, Relative Velocity and Acceleration in One and Two Dimensions, Inertial and Non-Inertial Reference Frames.

Newton's Laws: Newton's Laws of Motion and their Applications involving some particular forces including Weight, Normal Force, Tension, Friction, and Centripetal Force, Newton's Law of Gravitation, Mass of earth, Gravitational Potential Energy, Escape Velocity, Satellite Orbits & Energy

Work and Kinetic Energy: Work done by Constant and Variable Forces:

Gravitational and Spring Forces, Power, Conservative and Non-conservative Forces, Kinetic Energy and Work Energy Principle, Work and Potential Energy, Isolated Systems and Conservation of Mechanical Energy, Work Done by External Forces including Friction and Conservation of Energy.

System of Particles: 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.

Equilibrium and Elasticity: Equilibrium, The Requirements of Equilibrium, The Center of Gravity, Some Examples of Static Equilibrium, Stress and Strain, Elasticity and Plasticity, Elastic Modulus, Elastic Force, Hooks Law, Young and Bulk Modules.

Recommended Books:

1. D. Halliday, R. Resnick and J. Walker, "Fundamentals of Physics", John Wiley & Sons, 9th ed.
   2010.
2. R. A. Serway and J. W. Jewett, "Physics for Scientists and Engineers", Golden Sunburst Series,
   8th ed. 2010.
3. R. A. Freedman, H. D. Young, and A. L. Ford (Sears and Zeemansky), "University Physics with
   Modern Physics", Addison-Wesley-Longman, 13th International ed. 2010.
4. F. J Keller, W. E., Gettys and M. J. Skove, "Physics: Classical and Modern, McGraw Hill. 2nd

COMP-101:   Introduction to Computer   Cr. Hrs: 03

Course Objectives:

Computer is one of the most advanced and fast growing Technology of the day. Each and every day a lot of improvement is emerging in both Software and Hardware of computer. In response to this trend, the course has been designed for Business Administration Students that include Introduction to computer, History and Practical use of MS-Office Concept required in organization. It also provides Students the Concepts of Networking and Database along with role of Information System in Business Organization.

Course Contents:

Computer (Definition)   Characteristic of Computer, Function of Computer
Computer Generations   Hardware and Software, Types of Software

Operating System   Programming Languages, Machine Language, Assemble Language

Practical / Lab Practices
Recommended Books:
Introduction to Computer by Peter Norton, 3rd Edition
Mastering Microsoft Office 2000 by Gini Courter, Anneth Marquis Professiona Computer Fundamentals Concepts, Systems & Applications, by P.K. Sinha

MATH-102:   Calculus II   Cr .Hrs: 03

Specific Objectives of course: This is second course of Calculus and builds up on the concepts learned in first courses. The students would be introduced to the vector calculus, the calculus of multivariable functions and double and triple integrals along with their applications.
Course Outline:

Vectors and analytic geometry in space: Coordinate system. Rectangular, cylindrical and spherical coordinates. The dot product, the cross product. Equations of lines and planes. Quadric surfaces.
Vector-valued functions: Vector-valued functions and space curves. Derivatives and integrals of vector valued functions. Arc length. Curvature, normal and binormal vectors.

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.

Recommended Books:

Thomas, *Calculus*, 11th Edition. Addison Wesley Publishing Company, 2005
H. Anton, I. Bevens, S. Davis, *Calculus*, 8th Edition, John Wiley & Sons, Inc. 2005
Hughes-Hallett, Gleason, McCallum, et al, *Calculus Single and Multivariable*, 3rd Edition. John Wiley & Sons, Inc. 2002.
Frank A. Jr, Elliott Mendelson, *Calculus*, Schaum's outlines series, 4th Edition, 1999
C.H. Edward and E.D Penney, *Calculus and Analytics Geometry*,   Prentice Hall, Inc. 1988
E. W. Swokowski, *Calculus with Analytic Geometry*, PWS Publishers, Boston, Massachusetts, 1983.

MATH-222:   Discrete Mathematics   Cr .Hrs: 03

Specific Objectives of course: Discrete Mathematics is study of distinct, un-related topics of mathematics; it embraces topics from early stages of mathematical development and recent additions to the discipline as well. The present course restricts only to counting methods, relations and graphs. The objective of the course is to inculcate in the students the skills that are necessary for decision making in non-continuous situations.

Course Outline:

Counting methods: Basic methods: product, inclusion-exclusion formulae. Permutations and combinations. Recurrence relations and their solutions. Generating functions. Double counting. Applications. Pigeonhole principle, applications.

Relations: Binary relations, n-ary Relations. Closures of relations. Composition of relations, inverse relation.

Graphs: Graph terminology. Representation of graphs. Graphs isomorphism. Algebraic methods: the incidence matrix. Connectivity, Eulerian and Hamiltonian paths. Shortest path problem. Trees and spanning trees. Complete graphs and bivalent graphs.

Recommended Books:
- B. Bollobas, *Graph Theory*, Springer Verlag, New York, 1979.
- K.R. Parthasarathy, *Basic Graph Theory*, McGraw-Hill, 1994
- K.H. Rosen, *Discrete Mathematics and its Application*, McGraw-Hill, 6th edition, 2007.
- B. Kolman, R.C. Busby, S.C. Ross, *Discrete Mathematical Structures*, Prentice-Hall of India, New Delhi, 5th edition, 2008.
- A. Tucker, *Applied Combinatorics*, John Wiley and Sons, Inc New York, 2002.
- R. Diestel, *Graph Theory*, 4th edition, Springer- Verlag, New York, 2010.
- N.L. Brigs, *Discrete Mathematics*, Oxford University Press, 2003

MATH-101: Probability Theory Cr .Hrs: 03

DATA CONDENSATION AND PRESENTATION

Data

Classification and Tabulation

Frequency Distribution

s

DATA CONDENSATION AND PRESENTATION

Graphical Representation

Pie Chart

Frequency Bar Chart

Frequency Histogram

Frequency Polygon

Ogive

MEASURES OF CENTRAL TENDENCY FOR GROUPED AND UNGROUPED DATA

Means: (Arithmetic, Geometric, Harmonic)

The Median

The Mode

MEASURES OF DISPERSION FOR GROUPED AND UNGROUPED DATA

Range

Mean absolute deviation

Variance

Standard Deviation

Relative Dispersion

PROBABILITY AND LAWS OF PROBABILITY

PROBABILITY AND LAWS OF PROBABILITY

Basic concepts

Definitions of probability

Random experiment

Sample space

Events

Probability of an event

Addition rules of probability for mutually exclusive and non-mutually exclusive events

Sample regression and correlation

Simple regression
Deterministic and Probabilistic Model
Scatter diagram
Least square estimation in simple linear regression model
Simple correlation

Recommended Books:

David, S Moore et.al, Introduction to the Practice of Statistics, 6th Edition WH.
   Freeman.
Levin I. Richard., Statistics for Management, 4th ed; McGraw Hill.
Michael J. Evans & Jeffrey S. Rosenthal, Probability and Statistics, WH Freeman
Starr K. Martian & Sobal Gross Marion, Statistics for Business and Economics, 1st
   Ed; New York, McGraw Hill, International, 1983.
Walpole, R, Introduction to Statistics, Edition 3
Chaudhry, S. M and Kamal, S, Introduction to Statistical Theory, part-1. Ilmi Kitab
   Khana, Urdu Bazar Lahore.

ENG-102:Functional English-II (Communication Skills) Cr. Hrs:03
Learning Objectives
 Enable the students to meet their real-life communication needs.
Course Contents
Paragraph writing
Practice in writing a good, unified and coherent paragraph
Essay writing
Introduction
CV and job application
Translation skills
Urdu to English
Study skills
Skimming and scanning, intensive and extensive, and speed reading, summary and précis
writing and comprehension
Academic skills
Letter/memo writing, minutes of meetings, use of library and internet
Presentation skills
Personality development (emphasis on content, style and pronunciation)
Note: documentaries to be shown for discussion and review
Books Recommended:

a)   **Grammar**
• Practical English Grammar by A.J. Thomson and A.V. Martinet. Exercises 2. Third edition.
   Oxford University Press 1986. ISBN 0 19 431350 6.

b)   **Writing**

- Writing. Intermediate by Marie-Chrisitine Boutin, Suzanne Brinand and Francoise Grellet. Oxford Supplementary Skills. Fourth Impression 1993. ISBN 019 435405 7 Pages 45-53 (note taking).
- Writing. Upper-Intermediate by Rob Nolasco. Oxford Supplementary Skills. Fourth Impression 1992. ISBN 0 19 435406 5 (particularly good for writing memos, introduction to presentations, descriptive and argumentative writing).

   c) **Reading**

- Reading. Advanced. Brian Tomlinson and Rod Ellis. Oxford Supplementary Skills. Third Impression 1991. ISBN 0 19 453403 0.

- Reading and Study Skills by John Langan

Study Skills by Riachard Yorky.

PS-101: Pakistan Studies Cr. Hrs: 02

Learning Objectives

Develop vision of historical perspective, government, politics, contemporary Pakistan, ideological background of Pakistan. Study the process of governance, national development, issues arising in the modern age and posing challenges to Pakistan.

Learning Outcomes

After completion of this course, the students will be able to learn historical and ideological background of Pakistan, government policies and politics and current affairs.

Course contents

Historical Perspective

Ideological rationale with special reference to Sir Syed Ahmed Khan, Allama Muhammad Iqbal and Quaid-i-Azam Muhammad Ali Jinnah.Factors leading to Muslim separatism, People and Land, Indus Civilization, Muslim advent, Location and geo-physical features.

Government and Politics in Pakistan

    Political and constitutional phases:
1947-58
1958-71
1971-77
1977-88
1988-99
1999 onward

Contemporary Pakistan

Economic institutions and issues

Society and social structure

Ethnicity

Foreign policy of Pakistan and challenges
Futuristic outlook of Pakistan

Recommended Books:

Ishtiaq Hussain Qureshi, The struggle for Pakistan, 1987, University of Karachi.

Khalid Bin Sayeed, Pakistan, The Formative Phase, 1857- 1948, Oxford University Press.

Safdar Mehmood, Pakistan Political Roots and Development, 1947- 1999, Oxford University Press, 2000.

Ikram Rabbani, The Constitutional and Political History.

Hamid Khan, Constitutional and Political History of Pakistan Second Edition, Oxford University Press.

PHY-102:   Electricity & magnetism   Cr.Hrs: 03

Course Objectives

The main objectives of this course are;
To understand and develop simple mathematical formalism to analyze the rotational motion of the objects on a macroscopic scale, moment of inertia of different bodies, angular momentum and their practical applications. This is a calculus-based introductory course with maximum emphasis on applying the acquired knowledge to solving problems.

Course outlines

Rotational Dynamics:
Rotational variables, Rotation with constant angular momentum, relating linear and angular variables, Torque, Newton's second law for rotation. Work and rotational Kinetic energy. Kinetic energy of rotation, moment of inertia, moment of inertia of bodies of various shapes parallel axis and perpendicular axis theorems, Rotational dynamics of rigid bodies, Equation of motion and effects of application of torques, Related problems

Rolling, Torque, and Angular Momentum:

Forces and Kinetic energy of rolling, Angular momentum, Newton's Second Law in Angular Form, The Angular Momentum of a System of Particles, Torque and Angular momentum, Conservation of angular momentum, Precessional motion of spinning top and gyroscope, Related problems.

Fluid Statics and Fluid Dynamics

What is fluid, Density and pressure, Fluids at rest, Measuring pressure, Pascal's principle, Archimedes principle, ideal fluids in motion, the Equation of continuity, Bernoulli's equation and its applications, Related problems.
Special Theory of Relativity

Special Theory of Relativity: Einstein's Postulates, Michelson-Morley experiments, Lorentz transformation, Relativity of simultaneity, relativistic kinematics, addition of velocities, relativistic momentum and energy, mathematical properties of the space-time, matrix representation of Lorentz transformations, length contraction, time dilation, intervals,

causality, four vectors and transformation properties, transformation of angles, the Doppler effect, Invariance of electric charge, covariance of electrodynamics, transformation of electromagnetic fields, dynamics of relativistic particles and electromagnetic fields.

Recommended Books:

Resinck, Krane (2002), Physics Vol I. I,5th Edition. John Wiley and Sons Inc. New York.

Halliday, Resinck & Walker (2010), Fundamental of Physics,8th Edition, John Wiley and Son Inc. New York.

Sear, Zemansky & Young (2000), University Physics 8th Edition: USA.

MATH-231: Group Theory Cr .Hrs: 03

Specific Objectives of course: This course introduces basic concepts of groups and their homomorphisms. The main objective of this course is to prepare students for courses which require a good back ground in group theory like Rings and Modules, Linear Algebra, Group Representation, Galois Theory etc.

Course Outline:
Groups: Definition of a group, subgroup, subgroup generated by a set. The cyclic groups, cosets and Lagrange's theorem. Normalizer centralizer. The center of a group. Equivalence relation in a group, conjugacy classes. Normal subgroups, quotient group. **Group homomorphism**s: Homomorphisms and isomorphism and Automorphism. Kernel and image of homomorphism. Isomorphism theorems. Permutation groups. The cyclic decomposition of a permutation group. Cayley's theorem. Direct product of two groups and examples.

Recommended Books:
J. Rose, *A Course on Group Theory*, Cambridge University Press, 1978.
I. N. Herstein, *Topics in Algebra*, Xerox Publishing Company, 1964.
P. M. Cohn, *Algebra*, John Wiley and Sons, London, 1974.
P. B. Bhattacharya, S. K. Jain and S. R. Nagpaul, *Basic Abstract Algebra*, Cambridge University Press, 1986.
J. B. Fraleigh, *A First Course in Abstract Algebra*, AddisonWesley Publishing Company, 2002.
Vivek Sahai and Vikas Bist, *Algebra*, Narosa Publishing House, 1999.
D. S. Dummit and R. M. Foote, *Abstract Algebra*, 3rd Edition, Addison-Wesley Publishing Company, 2004.

MATH-212:   Calculus III   Cr .Hrs: 03

Specific Objectives of course: This is second course of Calculus. As continuation of Calculus I, it focuses on techniques of integration and applications of integrals. The course also aims at introducing the students to infinite series, parametric curves and polar coordinates.

Course Outline:

Techniques of integration: Integrals of elementary, hyperbolic, trigonometric, logarithmic and exponential functions. Integration by parts, substitution and partial fractions. Approximate integration. Improper integrals. Gamma functions.

Applications of integrals: Area between curves, average value. Volumes. Arc length. Area of a surface of revolution. Applications to Economics, Physics, Engineering and Biology.

Infinite series: Sequences and series. Convergence and absolute convergence. Tests for convergence: divergence test, integral test, pseries test, comparison test, limit comparison test, alternating series test, ratio test, root test. Power series. Convergence of power series. Representation of functions as power series. Differentiation and integration of power series. Taylor and McLaurin series.
Approximations by Taylor polynomials.

Conic section, parameterized curves and polar coordinates: Curves defined by parametric equations. Calculus with parametric curves: tangents, areas, arc length. Polar coordinates. Polar curves, tangents to polar curves. Areas and arc length in polar coordinates.

Recommended Books:
Thomas, *Calculus*, 11th Edition. Addison Wesley Publishing Company, 2005
H. Anton, I. Bevens, S. Davis, *Calculus*, 8th Edition, John Wiley & Sons, Inc. 2005
Hughes-Hallett, Gleason, McCallum, et al, *Calculus Single and Multivariable*, 3rd Edition. John Wiley & Sons, Inc. 2002.
Frank A. Jr, Elliott Mendelson, *Calculus*, Schaum's outlines series, 4th Edition, 1999
C.H. Edward and E.D Penney, *Calculus and Analytics Geometry*, Prentice Hall, Inc. 1988
E. W. Swokowski, *Calculus with Analytic Geometry*, PWS Publishers, Boston, Massachusetts, 1983.
M. Liebeck, *A Concise introduction to pure Mathematics*, CRC Press, 2011.

PHY-232:   Modern Physics   Cr. Hrs: 03

Course Objectives:

 To give the concept of modern physics
 To know about the dual nature of light and its interaction with matter
 To learn Energy Levels and Spectrum of Hydrogen atom

Course Outlines:

Radiation and Particle Nature of light

Electromagnetic Waves: Coupled electric and magnetic oscillations, Blackbody Radiation, Photoelectric Effect, Compton Effect, Pair Production, Annihilation of matter, Photons and Gravity

Wave Nature of Light

Wave description and its general formula, De Broglie Hypothesis, Phase and Group Velocities, Particle Diffraction: The Davisson-Germer experiment, Correspondence Principle, Wave function, Time dependent and time independent Schrodinger wave equation, Particle in a Box: Energy quantization, Heisenberg's Uncertainty Principles and its applications

Atomic Physics

The atoms and electron orbits, The planetary model and its failure, Origin of atomic spectra and spectral series, The Bohr theory of atom, Energy levels and spectrum of Hydrogen atom, Angular momentum of electrons, Electron spin, X-Rays, Continuous and Characteristics X-Rays, X-Ray Diffraction, Atomic Excitation, The Laser

Recommended Books
"Concepts of Modern Physics" by Arthur Beiser (6th edition) McGraw-Hill, 2002.

"Fundamental of Physics" by Halliday, Resineck and Krane volume 2 (5th Edition).

"Modern Physics by Ronald gautreau" and William savin, Schaum's outline series.

ENG-211:   Functional English III   Cr. Hrs: 03
(Technical Writing & Presentation Skills)

Objectives: Enhance language skills and develop critical thinking

Course Contents
Presentation skills
Essay writing
Descriptive, narrative, discursive, argumentative
Academic writing
How to write a proposal for research paper/term paper
How to write a research paper/term paper (emphasis on style, content, language, form, clarity, consistency)
Technical Report writing
Progress report writing
Note: Extensive reading is required for vocabulary building
Recommended books:
Technical Writing and Presentation Skills
a) Essay Writing and Academic Writing

1. Writing. Advanced by Ron White. Oxford Supplementary Skills. Third Impression 1992. ISBN 0 19 435407 3 (particularly suitable for discursive, descriptive, argumentative and report writing).
2. College Writing Skills by John Langan. Mc=Graw-Hill Higher Education. 2004.
3. Patterns of College Writing (4th edition) by Laurie G. Kirszner and Stephen R. Mandell. St. Martin's Press.

b) Presentation Skills
c) Reading
The Mercury Reader. A Custom Publication. Compiled by norther Illinois University. General Editors: Janice Neulib; Kathleen Shine Cain; Stephen Ruffus and Maurice Scharton. (A reader which will give students exposure to the best of twentieth century literature, without taxing the taste of engineering students).

Mng-235:   Accounting   Cr .Hrs: 03

Course Objectives

This course provides an introduction to the field of accounting and the development and use of accounting information in the business world. It is intended for everyone, not just those students who may pursue careers in accounting. There is more diversity today in the contents of introductory accounting course than at any time in the recent past. This course of accounting is also structured to emphasis accounting techniques and procedures and the interpretation and use of accounting information.

Need and importance of Accounting
> Purpose and Nature of Accounting
> Accounting the language of Business
> Accounting Definition

Book keeping Versus Accounting
> Accounting versus Accountancy
> Branches of Accounting
> > Important Accounting Terms and Concepts

Forms of business Enterprises
> Sole proprietorship Business
> Partnership Business
> Corporations

Accounting Information: A means to an end
> Types of accounting information
> Accounting systems
> Basic Function of accounting System

Internal and external users of accounting information
        Characteristics of Externally Reported information
        Characteristics of internally Reported information
        Integrity of accounting information
        Objectives of accounting

Generally Accepted Accounting principles (GAAP)
        Accounting Convention
        The Accounting Equation
        Effect of Business Transaction on Accounting Equation

Accounting cycle and accounting process
        Basic Financial Statements
        Preparation of balance sheet
        Income statement
        Statement of cash Flow

        Relationship among Financial Statements
        Definitions, Uses and preparation of Journal

Ledger Account
        Use of ledger Account
        Debit and credit Entries.
        Record Transaction in ledger
        Preparation of Trail Balance
        Uses and limitation of Trail Balance

Measuring Business income
        Completion of Accounting Cycle
        Financial Statement
        Income Statement, statement of owner equity
        Realization principles and matching Principles
        Balance Sheet

Adjusting process
        Concept of Depreciation
        Preparation of Work sheet
        Closing Entries

Accounting for merchandising businesses
        Definition of merchandising Company
        Methods of recording merchandising businesses
        Perpetual inventory system
        Periodic inventory system
        Inventory valuation methods (LIFO, FIFO, and AVG Cost)

Corporation Accounting

        Organization, Classes of stock

        Issuing Capital, Stock holder equity statement

        Distribution of Dividend, Stock value, Stock dividend

Bills of Exchange

        Specimen of bills of exchange

        Advantages of bills of exchange

        Different kind of acceptance

        Different between bills of exchange, Cheque and Promissory Notes.

Bank Reconciliation Statement

        Difference between Banks & Accounting Record

        Steps in preparing Bank Reconciliation

Plant Assets & Deprecation

        Categories of Plant Assets

        Deprecation Methods

        Straight Line Methods

        Declining Balance Methods

Double Declining Balance Methods

        150% Declining Balance Methods

        MACRS Methods

        Amortization & Depletion Methods

Recommended Books:

- Robert F.Meigs and Walter B. Meigs: Accounting The Basis for business Decisions, 9e,10e, Mcgraw Hill, Inc.
- Eric G. Flamholtz, Diana Troik Flamholtz, Michael A. Diamond: Principle of Accounting, Macmillan Publishing Co. New York.
- Imdiake, Heirnkemp and Simith: Principles of Accounting, Johnwilley.
- Pile and Larsen: Principle of Accounting.
- Aftab Ahmed: Fundamentals of Accounting.

COMP-102: Computer Programming Cr. Hrs: 03

Objectives: the main objective of this course are to introduce the students with basic programming skills related to their own computing problems, processing of data and calculation of various parameters. This intern will enable students to save their time by using ad developing computer software instead of manual calculations.

Course Outlines:

Programming and problem analysis. Development of basic algorithms. Translation of algorithms into programs. Standard Data Types. Basic control structures. Functions. Structured data types; Arrays, Structures, Pointers and Files. Debugging and testing programs.

Recommended Books:

1. Robert Lafore, C Programming Using Turbo C++, Sams, 1997.
2. Deitel & Deitel, C How to Program, 3rd Edition, Prentice Hall, 2000.
3. Aho, AV, Ulman JD, Foundation of Computer Science, 1995, Computer Science Press, WH Freeman, New York
4. Hein JL, Theory of Computation: An Introduction (1st edition), Jones & Bartlett, Boston

MATH-214 Linear Algebra Cr .Hrs: 03

Specific Objectives of course: Linear algebra is the study of vector spaces and linear transformations. The main objective of this course is to help students learn in rigorous manner, the tools and methods essential for studying the solution spaces of problems in mathematics, engineering, the natural sciences, and social sciences and develop mathematical skills needed to apply these to the problems arising within their field of study; and to various real world problems.

Course Outline:

System of Linear Equations: Representation in matrix form. Matrices. Operations on matrices. Echelon and reduced echelon form. Inverse of a matrix (by elementary row operations). Solution of linear system. Gauss-Jordan method. Gaussian elimination.ss

Determinants: Permutations of order two and three and definitions of determinants of the same order. Computing of determinants. Definition of higher order determinants. Properties. Expansion of determinants. **Vector Spaces**: Definition and examples, subspaces. Linear combination and spanning set. Linearly Independent sets. 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: Definition and examples. Kernel and image of a linear mapping. Rank and nullity. Reflections, projections, and homotheties. Change of basis. Eigen-values and eigenvectors. Theorem of Hamilton-Cayley.

Inner product Spaces: Definition and examples. Properties, Projection. Cauchy inequality. Orthogonal and orthonormal basis. Gram Schmidt Process. Diagonalization.

Recommended Books:
- Ch. W. Curtis, *Linear Algebra*, Springer 2004.
- T. Apostol, *Multi Variable Calculus and Linear Algebra*, 2nd ed., John Wiley and sons, 1997.
- H. Anton, C. Rorres , *Elementary Linear Algebra: Applications Version*, 10th Edition, John Wiley and sons, 2010.
- S. Friedberg, A. Insel, Linear Algebra, 4th Edition, Pearson Education Canada, 2003.
- S. I. Grossman, *Elementary Linear Algebra*, 5th Edition, Cengage Learning, 2004.

MATH-242: Vector Analysis Cr .Hrs: 03

3-D vectors, summation convention, kronecker delta, Levi-Civita symbol, vectors as quantities transforming under rotations with ∈ijk notation, scalar and vector-triple products, scalar and vector-point functions, differentiation and integration of vectors, line integrals, path independence, surface integrals, volume integrals, gradient, divergence and curl with physical significance and applications, vector identities, Green's theorem in a plane, divergence theorem, Stokes' theorem, coordinate systems and their bases, the spherical-polar and the cylindrical-coordinate.

Recommended Books:

1. Bourne DE, Kendall PC, Vector Analysis and Cartesian Tensors (2nd edition0, Thomas Nelson

2. Shah NA, Vector and Tensor Analysis, 2005 A-One Publishers, Lahore

3. Smith GD, Vector Analysis, Oxford University Press, Oxford

4. Spiegel MR, Vector Analysis, 1974, McGraw Hill, New York

5. M. Afzal Qazi, A First Course on Vectors West Pakistan Publishing Co. Lahore.

MATH-243: Ordinary Differential Equations Cr .Hrs: 03

Specific Objectives of course: To introduce students to the formulation, classification of differential equations and existence and uniqueness of solutions. To provide skill in solving initial value and boundary value problems. To develop understanding and skill in solving first and second order linear homogeneous and nonhomogeneous differential equations and solving differential equations using power series methods.

Course Outline:
Preliminaries: Introduction and formulation, classification of differential equations, existence and uniqueness of solutions, introduction of initial value and boundary value problems

First order ordinary differential equations: Basic concepts, formation and solution of differential equations. Separable variables, Exact Equations, Homogeneous Equations, Linear equations, integrating factors. Some nonlinear first order equations with known solution,

differential equations of Bernoulli and Ricaati type, Clairaut equation, modeling with first-order ODEs, Basic theory of systems of first order linear equations, Homogeneous linear system with constant coefficients, Non homogeneous linear system

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, Nonhomogeneous equations, undetermined coefficients method, variation of parameters, Cauchy-Euler equation, Modeling.

Sturm-Liouville problems: 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, Frobenius theorem, Existence of Frobenius series solutions, solutions about singular points, The Bessel, modified Bessel Legendre and Hermite equations and their solutions.

Recommended Books:
- Dennis G. Zill and Michael R., Differential equations withboundary-value problems by Cullin 5th Edition Brooks/Cole, 1997.
- William E. Boyce and Richard C. Diprima, Elementarydifferential equations and boundary value problems, Seventh Edition John Wiley & Sons, Inc
- V. I. Arnold, *Ordinary Differential Equations*, Springer, 1991.

MATH-353:   Classical Mechanics   Cr .Hrs:03

Specific Objectives of course: To provide solid understanding of classical mechanics and enable the students to use this understanding while studying courses on quantum mechanics, statistical mechanics, electromagnetism, fluid dynamics, space-flight dynamics, astrodynamics and continuum mechanics.

Course Outline:
Kinematics: Rectilinear motion of particles. Uniform rectilinear motion, uniformly accelerated rectilinear motion. Curvilinear motion of particle, rectangular components of velocity and acceleration. Tangential and normal components. Radial and transverse components. Projectile motion.
Kinetics: Work, power, kinetic energy, conservative force fields. Conservation of energy, impulse, torque. Conservation of linear and angular momentum. Non-conservative forces.
Simple Harmonic Motion: The simple harmonic oscillator, period, frequency. Resonance and energy. The damped harmonic oscillator, over damped, critically damped and under damped. Motion, forces and vibrations.
Central Forces and Planetary Motion: Central force fields, equations of motion, potential energy, orbits. Kepler's law of planetary motion. Apsides and apsidal angles for nearly circular orbits. Motion in an inverse square field.
Planer Motion of Rigid Bodies: Introduction to rigid and elastic bodies, degree of freedom, translations, rotations, instantaneous axis and center of rotation, motion of the center of mass. Euler's theorem and Chasles' theorem. Rotation of a rigid body about a fixed axis, moments and products of inertia. Parallel and perpendicular axis theorem.

Motion of Rigid Bodies in Three Dimensions: General motion of rigid bodies in space. The momental ellipsoid and equimomental systems. Angular momentum vector and rotational kinetic energy. Principal axes and principal moments of inertia. Determination of principal axes by diagonalizing the inertia matrix.

Euler Equations of Motion of a Rigid Body: Force free motion. Free rotation of a rigid body with an axis of symmetry. Free rotation of a rigid body with three different principal moments. The Eulerian angles, angular velocity and kinetic energy in terms of Euler angles. Motion of a spinning top and gyroscopes-steady precession, sleeping top.

Recommended Books:
- E. DiBenedetto, *Classical Mechanics. Theory and Mathematical Modeling*, ISBN: 978-0-8176-4526-7, Birkhauser Boston, 2011.
- John R. Taylor, *Classical Mechanics*, ISBN: 978-1-89138922-1, University of Colorado, 2005.
- H. Goldstein, *Classical Mechanics*, Addison-Wesley Publishing Co., 1980.
- C. F. Chorlton, *Text Book of Dynamics*, Ellis Horwood, 1983.
- M. R. Spiegel, *Theoretical Mechanics*, 3rd Edition, AddisonWesley Publishing Company, 2004.
- G. R. Fowles and G. L. Cassiday, *Analytical Mechanics,* 7th edition, Thomson Brooks/COLE, USA, 2005

MATH-245: Rings and Field Cr .Hrs: 03

Specific Objectives of course: This is a course in advanced abstract algebra, which builds on the concepts learnt in Algebra I. The objectives of the course are to introduce students to the basic ideas and methods of modern algebra and enable them to understand the idea of a ring and an integral domain, and be aware of examples of these structures in mathematics; appreciate and be able to prove the basic results of ring theory; appreciate the significance of unique factorization in rings and integral domains.

Course Outline:
Rings: Definition, examples. Quadratic integer rings. Examples of non-commutative rings. The Hamilton quaternions. Polynomial rings. Matrix rings. Units, zero-divisors, nilpotents, 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: The Chinese remainder theorem. Divisibility in integral domains, greatest common divisor, least common multiple. Euclidean domains. The Euclidean algorithm. Principal ideal domains. Prime and irreducible elements in an integral domain. Gauss lemma, irreducibility criteria for polynomials. Unique factorization domains. Finite fields. Polynomials in several variables. Symmetric polynomials. The fundamental theorem of symmetric polynomials.

Recommended Books:
- J. Rose, *A Course on Group Theory*, Cambridge University Press, 1978.
- I. N. Herstein, *Topics in Algebra*, Xerox Publishing Company, 1964.
- P. M. Cohn, *Algebra*, John Wiley and Sons, London, 1974.

- P. B. Bhattacharya, S. K. Jain and S. R. Nagpaul, *Basic Abstract Algebra*, Cambridge University Press, 1986.
- J. B. Fraleigh, *A First Course in Abstract Algebra*, AddisonWesley Publishing Company, 2002.
- Vivek Sahai and Vikas Bist, *Algebra*, Narosa Publishing House, 1999.
- D. S. Dummit and R. M. Foote, *Abstract Algebra*, 3rd Edition, Addison-Wesley Publishing Company, 2004.

ENG-212:   English-IV   Cr .Hrs: 03

Course Description The main purpose of this course is to guide students in their first year of learning and impart basic study skills. It is designed with the view to enable them to take immediate control of their learning. The course will enable students to devise and follow "study systems" and equip them with the ability to think critically and adopt effective learning strategies. With the help of various study techniques and styles and other available resources, the students will be able to improve their academic performance.

Course Objectives To help students learn basic self-management and study skills To enable them to use combination of skills to minimize risks of failure To make them become confident and successful in the new learning environment

Course Contents 1. Seeking Success in University Knowing your campus and its resources Form An Academic Support Group Know Where to Find Help Stay Informed Get Involved 2. Motivating Yourself to Learn Assess Academic Strengths and Weaknesses Discover and use your learning style Develop Critical Thinking & Study Skills Adapt learning style to teaching method 3. Using Critical Thinking Strategies, Examine Your Assumption, Make Predictions Read With A Purpose, Sharpen Your Interpretations Find Implications in What You Learn Read and Understand Graphics 19

 Evaluate what you learn 4. Setting Goals and Solving Problems Set goals for success in college, How to develop a positive attitude 5. Sharpening Your Classroom Skills , Prepare for Class , Become an Active Listener, Develop A Personal Note-Taking System, Guidelines for Note Taking, The Informal Outline/Keywords System, The Cornell Method, Matching Note-Taking Style and Learning Style, Learn To Make Effective Presentations 6. Making the Most of Your Time, How to GRAB Some Time, Scheduling Your Time, Time Management and Learning Style, Procrastination 7. Creating Your Study System, SQ3R: The Basic System, Devising Your Study System 8. Organizing Information for Study, Memorization, Concept or Information Maps, Comparison Charts, Timelines, Process Diagrams , Informal Outlines ,Branching Diagrams 9. Controlling Your Concentration, Concentrations, Eliminate Distractions, Use A Study System, Strategies to Improve Concentration 10. Preparing for Tests, How To Prepare for Tests: Three Steps, Develop a Test-taking Routine, Master Objective Tests, Know How to Answer Essay Questions 11. Becoming an Active Reader, Reading Actively, Find the Main Idea, Details, and Implications, Using a Textbook Marking System 12. How to use a dictionary 13. Building Career Skills, Working in the New Economy 20

Where the Jobs will be, Choosing Your Future, Your course of Study, Your Plan, What Employers Want Career Skills to Develop, Workplace Ethics, From University to Work, Your Resume and Cover Letter, The Interview

Recommended Book: Ken. (2012). what the best college students do. Kanar, Carol C. (2001). The Confident Student. Houghton Mifflin Co. Mcmillan, Kathleen. (2011). The Study skills book. Pearson. Pauk, Walter. How to Study in College. Wallace, M.J. (1980). Study Skills in English.

MATH-351:   Topology   Cr .Hrs: 03

Specific Objectives of course: The aim of this course is to introduce the students to metric spaces and topological spaces. After completion of this course, they would be familiar with separation axioms, compactness and completeness. They would be able to determine whether a function defined on a metric or topological space is continuous or not and what homeomorphisms are.

Course Outline:
Topological spaces: Examples; open and closed subsets, metric spaces, neighbourhoods. Examples. Limit points and accumulation points. Interior, closure, dense subsets. Constructing new topological spaces: Cartesian products, induced topology and quotient topology. Continuous maps, open and closed maps, homeomorphisms. Examples: R, RxR, S^1, S^2, torus, cylinder. Cauchy sequences, complete metric spaces. Separation axioms. Compact spaces. Properties. Power of Compactness. Image of a compact set through a continuous map. Compactness and completeness of metric spaces.
Connected spaces, connected components. Properties. Image of a connected set through a continuous map. Path-connectedness.

Recommended Books:
1. J. Kelly, *General Topology*, Springer, 2005.
2.K. Janich, *Topology*, Springer, 1994.
3.J. Hocking, G. Young, *Topology*, Dover Publications, 1961.
4.J. R. Munkres, *Topology - A First Course*, Prentice-Hall, 2003.
5.G. Simmons, *Topology and modern analysis*, McGraw-Hill, 1963.
6.S. Lipschutz, *General Topology*, McGraw-Hill, 2004.
7.J. Dugundji, *Topology*, Allyn and Bacon, 1966.

MATH-352:   Differential Geometry and Tensor   Cr .Hrs: 03

Specific Objectives of course: After having completed this course, the students would be expected to understand classical concepts in the local theory of curves and surfaces including normal, principal, mean, curvature, and geodesics. They will also learn about tensors of different ranks.

Course Outline:

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 products of tensors. Contraction theorem, quotient law. The line element and metric tensor. Christoffel symbols.

Recommended Books:
- R. S. Millman and G. D. Parker, *Elements of Differential Geometry*, Prentice-Hall, New Jersey, 1977.
- A. Goetz, *Introduction to Differential Geometry*, AddisonWesley, 1970.
- E. Kreyzig, Differential Geometry, Dover, 1991.
- M. M. Lipschutz, *Schaum's Outline of Differential Geometry*, McGraw Hill, 1969.
- D. Somasundaram, *Differential Geometry*, Narosa Publishing House, New Delhi. 2005.
- M. R. Spiegel, Vector Analysis, McGraw Hill Book Company, sSingapore, 1981.
- A. W. Joshi, *Matrices and Tensors in Physics*, Wiley Eastern Limited, 1991.
  8 F. Chorlton, *Vector and Tensor Methods*, Ellis Horwood Publisher, U.K., 1977

MATH-353:   Complex Analysis-I   Cr .Hrs: 03

Analytic Function: Function of a Complex Variable, Limits, Theorems on Limits. Continuity, Differentiation, Cauchy-Riemann conditions, Sufficient conditions, Analytic functions, Harmonic functions. L.Hospital's Rule. Singular points and their types. Elementary Functions: The Exponential function, Trigonometric functions, Logarithmic functions, Branches, Complex exponents. Inverse Trigonometric functions. Integrals: Definite Integrals, Contours, Line Integrals, Simply and Multiply connected regions, Cauchy Integral theorem, Cauchy-Goursat theorem for the case of triangle, closed polygon, simple closed curve and Multiply connected region, Indefinite Integrals, Cauchy Integral formula, Derivatives of analytic functions, Morera's theorem, Cauchy inequality, Liouville's theorem, fundamental theorem of Algebra, Maximum and Minimum modulus theorems, Rouche's theorem. Power

Series:Taylor's Series, Laurent's Series, Properties of Series, Uniform convergence, Integration and Differentiation of Power Series, Uniqueness of representations by Power Series. Multiplication and Division of Series. Zeros of analytic functions.

Recommended Books:

1. L.L.Pennisi, Elements of Complex Variables, Holt Rinehart & Winston NY, 1976.

2. Ruel V.Churchill, Complex Variable and Applications, McGraw-Hill, 1990 (5th Edition).

3. Walter Rudin, Real and Complex Analysis, McGraw-Hill International Edition (1986).

4. M. Iqbal, Fundamental of Complex Analysis, Ilmi Kitab Khana, Kabir Street, Urdu Bazar, Lahore.

MATH-354: Real Analysis-I Cr .Hrs: 03

Specific Objectives of course: This is the first course in analysis. It develops the fundamental ideas of analysis and is aimed at developing the students' ability in reading and writing mathematical proofs. Another objective is to provide sound understanding of the axiomatic foundations of the real number system, in particular the notions of completeness and compactness.

Course Outline:
Number Systems: Ordered fields. Rational, real and complex numbers. Archimedean property, supremum, infimum and completeness.
Topology of real numbers: Convergence, completeness, completion of real numbers. Open sets, closed sets, compact sets. Heine Borel Theorem. Connected sets.
Sequences and Series of Real Numbers: Limits of sequences, algebra of limits. Bolzano Weierstrass Theorem. Cauchy sequences, liminf, limsup. Limits of series, convergences tests, absolute and conditional convergence. Power series.
Continuity: Functions, continuity and compactness, existence of minimizers and maximizers, uniform continuity. Continuity and connectedness, Intermediate mean Value Theorem. Monotone functions and discontinuities.
Differentiation: Mean Value Theorem, L'Hopital's Rule, Taylor's Theorem.

Recommended Books:
- S. Lang, Analysis *I*, Addison-Wesley Publ. Co., Reading, Massachusetts, 1968.
- W. Rudin, *Principles of Mathematical Analysis*, 3rd ed., Mc.Graw-Hill, 1976.
- B. S. Thomson, J. B. Bruckner and A. M. Bruckner, *Elementary Real Analysis*, 2nd Ed. 2008.
- G. Boros, V. Moll, *Irresistible Integrals: Symbolics, Analysis an Experiments in the Evaluation of Integrals*, Cambridge University Press, 2004.
- J. Borwein, D. Bailey, R. Girgenson, *Experimentation in Mathematics: Computational Paths to discovery*, Wellesley, MA, A.K. Peters, 2004.

rd
G. Bartle , R. Sherbert , *Introduction to Real Analysis,* 3 edition, John Wiley, New York, 1999.

MATH-355: Number Theory Cr .Hrs: 03

Specific Objectives of course: The focus of the course is on study of the fundamental properties of integers and develops ability to prove basic theorems. The specific objectives include study of division algorithm, prime numbers and their distributions, Diophantine equations, and the theory of congruences.

Course Outline:
Preliminaries: Well-ordering principle. Principle of finite induction. **Divisibility theory:** The division algorithms. Basis representation theorem. Prime and composite numbers. Canonical decomposition. The greatest common divisor. The Euclidean algorithm. The fundamental theorem of arithmetic. Least common multiple.
Linear Diophantine equations: Congruences. Linear congruences. System of linear congruences. The Chinese remainder theorem. Divisibility tests. Solving polynomial congruences. Fermat's and Euler's theorems. Wilson's theorem.
Arithmetic functions: Euler's phi-function. The functions of J and sigma. The Mobius function. The sieve of Eratosthenes. Perfect numbers. Fermat and Mersenne primes.
Primitive Roots and Indices: The order of an integer mod n. Primitive roots for primes. Composite numbers having primitive roots. **Quadratic residues:** Legendre symbols and its properties. The quadratic reciprocity law.
Quadratic congruences with composite moduli. Pythagorean triples. Representing numbers as sum of two squares.

Recommended Books:
- D.M. Burton, *Elementary Number Theory*, McGraw-Hill, 2007.
- W.J. Leveque, *Topics in Number Theory*, vols. I and II, Addison- Wesley, 1956.
- S.B. Malik , *Basic Number Theory*, Vikas Publishing house, 1995.
- K.H. Rosen, *Elementary Number Theory and its Applications*, 5th edition, Addison-Wesley, 2005.
- I. Niven, H.S. Zuckerman, H.L. Montgomery, *An Introduction to the theory of Numbers*, John Wiley and Sons, 1991.
- A. Adler, J.E. Coury, *The Theory of Numbers*, Jones and Bartlett Publishers, 1995.

MATH-356: Affine and Euclidean Geometry Cr. Hrs:03

Specific Objectives of course: To familiarize mathematics students with the axiomatic approach to geometry from a logical, historical, and pedagogical point of view and introduce them with the basic concepts of Affine Geometry, Affine spaces and Platonic Ployhedra.

Course Outline:
Vector spaces and affine geometry: Collinearity of three points, ratio AB/BC. Linear combinations and linear dependent set versus affine combinations and affine dependent sets. Classical theorems in affine geometry: Thales, Menelaus, Ceva, Desargues. Affine subspaces, affine maps. Dimension of a linear subspace and of an affine subspace.

Euclidean geometry: Scalar product, Cauchy-Schwartz inequality: norm of a vector, distance between two points, angles between two non-zero vectors. Pythagoras theorem, parallelogram law, cosine and sine rules. Elementary geometric loci.

Orthogonal transformations: Isometries of plane (four types), Isometries of space (six types). Orthogonal bases.

Platonic polyhedra: Euler theorem on finite planar graphs. Classification of regular polyhedra in space. Isometries of regular polygons and regular polyhedra.

Recommended Books:
- E. Rees, *Notes on Geometry*, Springer, 2004.
- M. A. Armstrong, *Groups and Symmetry*, Springer, 1998.
- H. Eves, *Fundamentals of Modern Elementary Geometry*, Jones and Bartlett Publishers International, 1992
- S. Stahl, *The Poincare Half-Plane A Gateway to Modern Geometry*, Jones and Bartlett Publishers International, 1993.

MATH-361:   Numerical Analysis-I   Cr .Hrs: 03

Specific Objectives of course: This course is designed to teach the students about numerical methods and their theoretical bases. The course aims at inculcating in the students the skill to apply various techniques in numerical analysis, understand and do calculations about errors that can occur in numerical methods and understand and be able to use the basics of matrix analysis.

Course Outline:

Error analysis: Floating point arithmetic, approximations and errors.

Methods for the solution of nonlinear equations: Bisection method, regula-falsi method, fixed point iteration method, Newton-Raphson method, secant method, error analysis for iterative methods.

Interpolation and polynomial approximation: Lagrange interpolation, Newton's divided difference formula, forward, backward and centered difference formulae, interpolation with a cubic spline, Hermite interpolation, least squares approximation.

Numerical differentiation: Forward, backward and central difference formulae, Richardson's extrapolation.

Numerical integration: Rectangular rule, trapezoidal rule, Simpson's 1/3 and 3/8 rules, Boole's and Weddle's rules, Newton-Cotes formulae, Gaussian quadrature.

Numerical solution of a system of linear equations: Direct methods: Gaussian elimination method, Gauss-Jordan method; matrix inversion; LU-factorization; Doolittle's, Crout's and Cholesky's methods, Iterative methods: Jacobi, Gauss-Seidel and SOR. The use of software packages/programming languages for above mentioned topics is recommended.

Recommended Books:
- C.F. Gerald and P.O. Wheatley, Applied Numerical Analysis, Pearson Education, Singapore, 2005.
- R. L. Burden and J. D. Faires: Numerical Analysis, latest edition, PWS Pub. Co.

- J.H. Mathews, Numerical Methods for Mathematics, latest Edition, Prentice Hall International.
- S. C. Chapra and R. P. Canale: Numerical Methods for Engineers, 6th edition, McGraw Hill.
- W. E. Boyce, R. C. DiPrima, Elementary Differential Equations and Boundary Value Problems, John Wiley \& Sons, Inc., 2001.
- L. Debnath, Nonlinear Partial Differential Equations for Scientists and Engineers, Birkhauser-Boston, 2005.

MATH-362:   Partial Differential Equations   Cr .Hrs: 03

Specific Objectives of course: Partial Differential Equations (PDEs) are at the heart of applied mathematics and many other scientific disciplines. The course aims at developing understanding about fundamental concepts of PDEs theory, identification and classification of their different types, how they arise in applications, and analytical methods for solving them. Special emphasis would be on wave, heat and Laplace equations.

Course Outline:
First order PDEs: Introduction, formation of PDEs, solutions of PDEs of first order, The Cauchy's problem for quasilinear first order PDEs, First order nonlinear equations, Special types of first order equations **Second order PDEs:** Basic concepts and definitions, Mathematical problems, Linear operators, Superposition, Mathematical models: The classical equations, the vibrating string, the vibrating membrane, conduction of heat solids, canonical forms and variable, PDEs of second order in two independent variables with constant and variable coefficients, Cauchy's problem for second order PDEs in two independent variables
Methods of separation of variables: Solutions of elliptic, parabolic and hyperbolic PDEs in Cartesian and cylindrical coordinates **Laplace transform:** Introduction and properties of Laplace transform, transforms of elementary functions, periodic functions, error function and Dirac delta function, inverse Laplace transform, convolution theorem, solution of PDEs by Laplace transform, Diffusion and wave equations
Fourier transforms: Fourier integral representation, Fourier sine and cosine srepresentation, Fourier transform pair, transform of elementary functions and Dirac delta function, finite Fourier transforms, solutions of heat, wave and Laplace equations by Fourier transforms.

Recommended Books:
- Myint UT, *Partial Differential Equations for Scientists and*
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  Engineers, 3 edition, North Holland, Amsterdam, 1987.
- Dennis G. Zill, Michael R. Cullen, *Differential equations with boundary value problems,* Brooks Cole, 2008.
- John Polking, Al Boggess, *Differential Equations with Boundary Value Problems*, 2nd Edition, Pearson,July 28, 2005.
  J. Wloka, *Partial Differential Equations*, Cambridge University press, 1987.

MATH-363:   Complex Analysis-II   Cr .Hrs: 03

Residues and Poles: Residues, Residue theorem, poles, quotients of analytic functions, Cauchy principal value of integrals, Evaluation of improper real integrals, Improper integrals involving Trigonometric functions, Definite integral of Trigonometric functions, Integration around a branch point. Mapping by Elementary Functions: Linear functions, The function, nZ The function Z 1 , the point at infinity. The

linear fractional Transformation, special Linear fractional Transformations, The function 2 1 Z , The transformation zew , The Transformation . sin zw Conformal Mapping: Rotation of tangents, conformal mapping, Conjugate Harmonic functions, inverse function. Transformations of Harmonic functions, Jacobian of a Transformation, Transformation of boundary conditions,

Recommended Books:

1. L.L.Pennisi, Elements of Complex Variables, Holt Rinehart & Winston NY, 1976.

 2. Ruel V.Churchill, Complex Variable and Applications, McGraw-Hill, 1990 (5th Edition).

3. Walter Rudin, Real and Complex Analysis, McGraw-Hill International Edition (1986).

4. M. Iqbal, Fundamental of Complex Analysis, Ilmi Kitab Khana, Kabir Street, Urdu Bazar, Lahore

MATH-364:   Functional Analysis-I   Cr .Hrs: 03

Metric Spaces: A quick review, completeness and convergence, completion. Normed Spaces: Linear spaces, Normed spaces, Difference between a metric and Normed space, Banach spaces, Bounded and continuous linear operators and functionals, Dual spaces, Finite dimensional spaces, F. Riesz Lemma, The Hahn-Banach Theorem, The HB theorem for complex spaces, The HB theorem for Normed spaces, The open mapping theorem, The closed graph theorem, Uniform bound ness principle and its applications Banach-Fixed-Point Theorem: Application in Differential and Integral equations

Recommended Books:

1. A.E.Taylor and D.C. Lay, Introduction to Functional Analysis, John Wiley & Sons, 1980.
2. G.F.Simmons, Introduction to Topology and Modern Analysis,(Revised Edition) McGraw-Hill Book Company.
3. Curtain RF, Pritchard AJ, Functional Analysis in Modern Applied Mathematics, Academic Press, New York
4. Friedman A, Foundations of Modern Analysis, 1982, Dover.
5. Kreyszig E, Introductory Functional Analysis with Applications, John Wiley, New York.
6. Ruddin W, Functional Analysis, 1973, McGraw Hill, New York

MATH-365: Real Analysis-II Cr .Hrs: 03

Specific Objectives of course: A continuation of Real Analysis I, this course will continue to cover the fundamentals of real analysis, concentrating on the Riemann-Stieltjes integrals, Functions of Bounded Variation, Improper Integrals, and convergence of series. Emphasis would be on proofs of main results.

Course Outline:
The Riemann-Stieltjes Integrals: Definition and existence of integrals. Properties of integrals. Fundamental theorem of calculus and its applications. Change of variable theorem. Integration by parts.

   Functions of Bounded Variation: Definition and examples.
Properties of functions of bounded variation.

Improper Integrals: Types of improper integrals, tests for convergence of improper integrals. Beta and gamma functions. Absolute and conditional convergence of improper integrals.

Sequences and Series of Functions: Power series, definition of point-wise and uniform convergence. Uniform convergence and continuity. Uniform convergence and differentiation. Examples of uniform convergence.

Recommended Books:
- S. Lang, *Analysis I, II*, Addison-Wesley Publ. Co., Reading,Massachusetts,1968,1969.
- W. Rudin, *Principles of Mathematical Analysis*, 3rd Ed., McGraw-Hill, 1976.
- K. R. Davidson and A. P. Donsig, *Real Analysis with Real Applications*, Prentice Hall Inc., Upper Saddle River, 2002.
- G. B. Folland, *Real Analysis*, 2nd Edition, John Wiley and Sons, New York, 1999.
- E. Hewitt and K. Stromberg, *Real and Abstract Analysis*, Springer-Verlag, Berlin Heidelberg New York, 1965.
- H. L. Royden, *Real Analysis*, 3rd Edition, Macmillan, New York, 1988.

MATH-471: Numerical Analysis-II Cr .Hrs :03

Numerical Differentiation: Forward formulas, Central Difference formulas, Error in Numerical differentiation, Extrapolation to the limit. Numerical Integration: The rectangular, Trapezoidal and Simpson's One-Third and Three-Eight's, Romberg Integration, Method of undetermined coefficients. Difference and Differential equations: Formation of difference equations, Numerical Solution of Linear (Homogeneous and Non-homogeneous) difference equations with constant coefficients, Euler's methods, Taylor's methods, Runge-Kutta Method, Milne-Simpson method, Adam-Bashforth-Moulton method for solving Initial value problems along with convergence and Instability Criteria, Finite Difference method and the Shooting method for Boundary value problems.

Recommended Books:

1. R. L. Burden and J. Douglas Faires, Numerical Analysis, 2000, Brooks/Cole Publishing Company.

2. C. E. Froberg, Introduction to Numerical Analysis, 1974, Addison Wesley Co.

3. M. K. Jain, Numerical Methods for Scientific and Engineering Computation, 1993, Wiley Eastern Limited.

4. Dr. Faiz Ahmad and M. Afzal Rana, Elements of Numerical Analysis, 1995, National Book Foundation.

MATH-472:   Functional Analysis-II   Cr .Hrs: 03

Hilbert Spaces: Inner product space, Hilbert space, orthogonal and orthonormal sets, orthogonal complements, Gram-Schmidt orthogonalzation process, representation of functionals, Reiz representation theorem, weak and weak* Convergence. Finite Dimensional Spectral Theory: The Definition of Spectrum of an Operator and Some Examples, Spectral Properties of Self adjoint Operators, The Spectral Mapping Theorem for Finite Dimensional Hilbert Spaces.

Recommended Books:

1. A.E.Taylor and D.C. Lay, Introduction to Functional Analysis, John Wiley & Sons, 1980.

2. G.F.Simmons, Introduction to Topology and Modern Analysis,(Revised Edition) McGraw-Hill Book Company.

3. Curtain RF, Pritchard AJ, Functional Analysis in Modern Applied Mathematics, Academic Press, New York

4. Friedman A, Foundations of Modern Analysis, 1982, Dover.

5. Kreyszig E, Introductory Functional Analysis with Applications, John Wiley, New York.

6. Ruddin W, Functional Analysis, 1973, McGraw Hill, New York

MATH-473:   Mathematical Methods   Cr .Hrs: 03

Specific Objectives of course: The main objective of this course is to provide the students with a range of mathematical methods that are essential to the solution of advanced problems encountered in the fields of applied physics and engineering. In addition this course is intended to prepare the students with mathematical tools and techniques that are required in advanced courses offered in the applied physics and engineering programs.

Course Outline:
Fourier Methods: The Fourier transforms. Fourier analysis of the generalized functions. The Laplace transforms. Hankel transforms for the solution of PDEs and their application to boundary value problems. **Green's Functions and Transform Methods:** Expansion for Green's functions. Transform methods. Closed form Green's functions.
Perturbation Techniques: Perturbation methods for algebraic equations. Perturbation methods for differential equations.
Variational Methods: Euler-Lagrange equations. Integrand involving one, two, three and n variables. Special cases of Euler-Lagrange's equations. Necessary conditions for existence of an extremum of a functional. Constrained maxima and minima.

Recommended Books:
- D. L. Powers, *Boundary Value Problems and Partial Differential Equations*, 5th edition, Academic Press, 2005.
- W. E. Boyce, *Elementary Differential Equations*, 8th edition, John Wiley and Sons, 2005.
- M. L. Krasnov, G. I. Makarenko and A. I. Kiselev, *Problems and Exercises in the Calculus of Variations*, Imported Publications, Inc., 1985.
- J. W. Brown and R. V. Churchil, Fourier Series and BoundaryValue Problems, McGraw Hill, 2006.
- A. D. Snider, *Partial Differential Equations: Sources and Solutions*, Prentice Hall Inc., 1999.

MATH-481: Mathematical Statistics Cr .Hrs: 03

Specific Objectives of course: A prime objective of the course is to introduce the students to the fundamentals of probability theory and present techniques and basic results of the theory and illustrate these concepts with applications. This course will also present the basic principles of random variables and random processes needed in applications.

Course Outline:
Finite probability spaces: Basic concept, probability and related frequency, combination of events, examples, Independence, Random variables, Expected value. Standard deviation and Chebyshev's inequality. Independence of random variables. Multiplicativity of the expected value. Additivity of the variance, discrete probability distribution.
Probability as a continuous set function: sigma-algebras, examples. Continuous random variables, Expectation and variance. Normal random variables and continuous probability distribution. **Applications:** de Moivre-Laplace limit theorem, weak and strong law of large numbers.
The central limit theorem, Markov chains and continuous Markov process.

Recommended Books:
- M. Capinski, E. Kopp, *Measure, Integral and Probability*, Springer-Verlag, 1998.
- R. M. Dudley, *Real Analysis and Probability*, Cambridge University Press, 2004.
- S. I. Resnick, *A Probability Path*, Birkhauser, 1999.
- S. Ross, *A first Course in Probability Theory*, 5th ed., Prentice Hall, 1998.
- Robert B. Ash, *Basic Probability Theory*, Dover. B, 2008.

MATH-482: Integral Equations Cr .Hrs: 03

Specific Objectives of course: Many physical problems that are usually solved by differential equation methods can be solved more effectively by integral equation methods. This course will help students gain insight into the application of advanced mathematics and guide them through derivation of appropriate integral equations governing the behavior of several standard physical problems.

Course Outline:
Linear integral equations of the first kind, Linear integral equations of the second kind. Relationship between differential equation and Volterra integral equation. Neumann series. Fredholm Integral equation of the second kind with separable Kernels. Eigenvalues and eigenvectors. Iterated functions. Quadrature methods. Least square methods. Homogeneous integral equations of the second kind. Fredholm integral equations of the first kind. Fredholm integral equations of the second kind. Abel's integral equations. Hilbert Schmidt theory of integral equations with symmetric Kernels.
Regularization and filtering techniques.

Recommended Books:
- C. T. H. Baker, *Integral Equations*, Clarendon Press, 1977.
- F. Smithies, *Integral Equations*, Cambridge University Press, 1989.
- A. M. Wazwaz, *A first Course in Integral Equations*, World Scientific Pub., 1989.
- W. V. Lovitt, *Linear Integral Equations*, Dover Publications, 2005.