SHAHEED BENAZIR BHUTTO UNIVERSITY

SHERINGAL, DIR UPPER, KP, PAKISTAN

Minutes

of

THE 5TH MEETING OF BOARD OF STUDIES OF THE DEPARTMENT OF MATHEMATICS OF SHAHEED BENAZIR BHUTTO UNIVERSITY, SHERINGAL

HELD IN THE COMMITTEE ROOM OF THE UNIVERSITY

ON

04/06/2024 (02:00 PM)

SHAHEED BENAZIR BHUTTO UNIVERSITY

Sheringal, Dir Upper, Khyber Pakhtunkhwa, Pakistan

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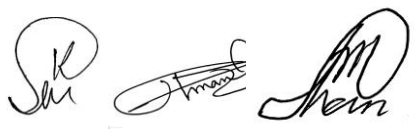
Minutes of the 5th Meeting of Board of Studies (BoS) of the Department of Mathematics

The 5th meeting of the Board of Studies (BoS) of the Department of Mathematics was held on June 04, 2024, at 02:00 PM in the committee room, under the chairmanship of Dr. Muhammad Riaz, Director Teaching and Admissions, Shaheed Benazir Bhutto University. The following members of the BoS attended the meeting.

- Dr. Muhammad Riaz, Assistant Professor (Director Teaching and Admission SBBU)
- Dr. Latif Ahmad, Lecturer (HoD)
- Dr. Sajjad Ali, Lecturer (Faculty Member, Department of Mathematics)
- Dr. Kamal Shah Associate Professor (External Member University of Malakand)
- Dr. Ghaus Ur Rahman Associate Professor (External Member University of Swat)
- Mr. Anwar Shah, Professor (External Member GPG College Khaar Bajuar)
- Mr. Anwar Zada, Deputy Registrar (Academic Shaheed BB University)
- Mr. Intikhab Ullah, Deputy Controller of Examination (Shaheed BB University)

The meeting started with the recitation of the Holy Quran. The Chair then welcomed the participants and thanked them for their timely participation in the meeting. The chair then asked the HoD Department of Mathematics to present the agenda items before the meeting. The HoD accordingly presented the agenda items through Multimedia. Each item then was discussed thoroughly and the following decisions were agreed upon.

Agenda Item No.	**Details of the Agenda Items.**
Item-01	**Confirmation of the minutes of the 4th meeting of BoS held on 18-07-2023.**
	Decision: The minutes of 4th meeting BoS held on 18/07/2023 were confirmed.
Item-02	**Recommendation of the new HEC Policy for Undergraduate Program 2023.**
	Background of the agenda item: As per HEC policy, this department has prepared a new scheme of studies for Undergraduate Program from Fall 2023. The new scheme for BS Mathematics is attached as **Annexure-A (Page Nos. 4-52).**
	Decision: As per the new HEC Policy for Undergraduate, the board recommended the agenda item for approval with the following suggestions: i. Some recommended books are old and may be updated.



	ii. The course "Ordinary Differential Equations" should be shifted to 5th semester. iii. As per HEC Undergrad policy, Field Experience/Internship is mandatory and should be offered in 7th semester.
Item-03	**Recommendation of new courses in M.Phil and Ph.D programs.**
	Background of the agenda item: After splitting the distribution of the both M.Phil and Ph.D courses, the number of courses were too much limited and some new courses with associated course codes are included in the scheme and the updated scheme is attached as **Annexures- B and C (Page Nos. 53-81 and 82-99).**
	Decision: As per the new HEC Policy for Undergraduate and Postgraduate Programs, the board recommended the agenda item for approval with the following suggestions: i. The new courses pre-requisites and objectives should be mentioned accordingly. ii. Updated references books may be provided.
Item-04	**Recommendation of course codes for Quantitative Reasoning Courses in all related departments of the University.**
	Background of the agenda item: As per HEC new undergraduate programs policy, every department must offer six credit hours quantitative reasoning courses. The course designed by HEC and the same are related to Department of Mathematics. This department has prepared a detail structure of codes with contents and is attached as **Annexure- D (Page No. 100).**
	Decision: As per the new HEC Policy for Undergraduate, the board recommended the agenda item for approval with the following suggestions: i. The course codes for "Quantitative Reasoning I & II" with same contents should be uniformed for all disciplines/departments, throughout this University. ii. The courses should be offered in the first two semesters, respectively.

Annexure-A

SCHEME OF STUDIES/COURSE CONTENTS FOR BS IN MATHEMATICS

SCHEME OF STUDIES FOR BS/ASSOCIATE DEGREE IN MATHEMATICS

(HEC New Policy for 2023 Undergraduate and Postgraduate Programs)

Degree Awarded: BS Mathematics and Associate Degree 2 years
Entrance Requirements: **F.Sc (Pre-Engineering, Pre-Medical) or F.A (with Mathematics)** or equivalent with at least 45% marks
Duration of the Program: 4 years (8 Semesters)
Maximum duration allowed-six academic years
Total Credit Hours: 145/(120-144)
Total Marks: 4700

Marks Breakdown for Courses

Item	**Maximum Marks for Courses (without Laboratory)**	**Maximum Marks for Courses with Laboratory (2 + 1)**
Mid-Term Examination	20%	20%
Internal Marks (Assignments, Quizzes, Presentations)	20%	20%
Laboratory	----	20%
Semester Examination	60%	40%
Total	100%	100%

The BS Scheme of Studies: Main Structure

S. No.	**Categories**	**Number of Courses**	**Credit Hours**
1	Non Credit Hours Courses	02	Nil
2	Mandatory Requirements	02	4
3	Allied Courses	04	12
4	General Courses	13	32
5	Major Courses including Research Project and Field Experience	25+Capstone Project+Internship	85
6	Elective Courses within the Major	04	12
Total		**49+** Capstone Project+ Internship	**145**

The BS Mathematics Scheme of Studies: Layout/ Framework

Major Courses including Research Project		**General Courses**	
27 courses		**13 courses**	
81 Credit hours		**32 Credit hours**	
Title	**Credit hours**	**Title**	**Credit hours**
1. Calculus-I	**4**	1. Functional English	**3**
2. Calculus-II	**3**	2. Islamic Studies	**2**
3. Calculus-III	**4**	3. Applications of Information and Communication Technologies(ICT)	**3(2+1)**
4. Algebra-I	**3**	4. Expository Writing	**3**
5. Algebra-II	**3**	5. Ideology and Constitution of Pakistan	**2**
6. Linear Algebra	**4**	6. Quantitative Reasoning-I	**3**
7. Complex Analysis	**3**	7. Social Sciences	**2**
8. Ordinary Differential Equations	**3**	8. Civics and Community Engagement	**2**
9. Integral Equations	**3**	9. Arts and Humanities	2
10. Affine and Euclidean Geometry	**3**	10. Natural Sciences	3(2+1)
11. Number Theory	**3**	11. Quantitative Reasoning-II	3
12. Real Analysis-I	**3**	12. Entrepreneurship	2
13. Real Analysis-II	**3**	13. Pakistan Studies	2
14. Software Packages	**3(2+1)**		
15.Discrete Mathematics	**3**		
16. Mathematical Methods	**3**		
17. Topology	**3**		
18. Differential Geometry	**3**		
19. Classical Mechanics	**3**		
20. Partial Differential Equations	**3**		

21. Functional Analysis	**3**		
22. Numerical Analysis	**4(3+1)**		
23. Probability Theory	**3**		
24. General Topology	**3**		
25. Vector and Tensor Analysis	**3**		
26. Capstone Project	**3**		
27. Field Experience/Internship	**3**		
Total	**85**	**Total**	**32**

Allied Courses		**Electives Courses + Project**	
4 courses		**4 courses**	
12 Credit hours		**12 Credit hours**	
Title	**Credit hours**	**Title**	**Credit hours**
1. Waves and Oscillation	**3**	**1.** Elective-I	**3**
2. Heat, Thermodynamics and Statistical Physics	**3**	**2.** Elective-II	**3**
3. Electricity and Magnetism	**3**	**3.** Elective-III	**3**
4. Computer Programming	**3**	**4.** Elective-IV	**3**
Total	**12**	**Total**	**12**

Note: The revised scheme of study for BS after the inclusion of two non-credit courses (NCs) will takes the form as under:

SECHEME OF STUDIES

(Semester-Wise Breakdown)

1st Semester

S. No.	Course Code	Course Title	Marks	Credit Hours
1	MGC-311	Quantitative Reasoning-I (Elements of Set Theory and Mathematical Logic)	100	3(3+0)
2	MMC-312	Calculus-I	100	4(4+0)
3	MNC-313	Mathematics-I*	Pass/Fail	3(0+0)
4	MAC-314	Waves and Oscillation	100	3(3+0)
5	ENG-101	Functional English	100	3(3+0)
6	ISL-133	Islamic Studies/Ethics	50	2(2+0)
7	CS -134	Applications of Information and Communication Technologies(ICT)	100	3(2+1)
Total			**550**	**18**

2nd Semester

S. No.	Course Code	Course Title	Marks	Credit Hours
8	MAC-321	Heat, Thermodynamics and Statistical Physics	100	3(3+0)
9	MMC-322	Calculus-II	100	3(3+0)
10	MMC-323	Discrete Mathematics	100	3(3+0)
11	MNC-324	Mathematics-II*	Pass/Fail	3(0+0)
12	ENG-102	Expository Writing	100	3(3+0)
13	PS-127	Pakistan Studies	50	2(2+0)
14	PS-104	Arts and Humanities (Islamic History)	50	2(2+0)
15	PS-136	Civics and Community Engagement	50	2(2+0)
Total			**550**	**18**

Note: Mathematics-I* and Mathematics-II* shall be offered for Pre-medical students only.

3rd Semester

S. No.	Course Code	Course Title	Marks	Credit Hours
16	MMC-431	Affine Euclidean Geometry	100	3(3+0)
17	MAC-432	Computer Programming	100	3(2+1)
18	MMC-433	Algebra-I	100	3(3+0)
19	MAC-434	Electricity and Magnetism	100	3(3+0)
20	MGC-435	Quantitative Reasoning-II (Statistics)	100	3(3+0)
21	MMC-436	Number Theory	100	3(3+0)
22	PS-132	Ideology and Constitution of Pakistan	50	2(2+0)
Total			**650**	**20**

4th Semester

S. No.	Course Code	Course Title	Marks	Credit Hours
23	MGC-441	Natural Science (Modern Physics)	100	3(2+1)
24	MMC-444	Software Packages	100	3(2+1)
25	MMC-445	Calculus-III	100	4(4+0)
26	MMC-446	Linear Algebra	100	4(4+0)
27	BBA-135	Entrepreneurship	50	2(2+0)
28	SOC-116	Social Sciences (Social Anthropology)	50	2(2+0)
Total			**500**	**18**

After successful completion of four semesters a student completed
General Courses (GC) = 32 Credit Hrs.
Allied Courses/Interdisciplinary = 12 Credit Hrs.
Department Requirement (Major) = 30 Credit Hrs.
Mandatory Requirements = 04 Credit Hrs.
Total = 78 Credit Hrs.

5th Semester

S. No.	Course Code	Course Title	Marks	Credit Hours
29	MMC-551	Algebra-II (Rings and Fields)	100	3(3+0)
30	MMC-552	Real Analysis-I	100	3(3+0)
31	MMC-553	Vector and Tensor Analysis	100	3(3+0)
32	MMC-554	Differential Geometry	100	3(3+0)
33	MMC-555	Topology	100	3(3+0)
34	MMC-556	Ordinary Differential Equations	100	3(3+0)
Total			**600**	**18**

6th Semester

S. No.	Course Code	Course Title	Marks	Credit Hours
35	MMC-561	General Topology	100	3(3+0)
36	MMC -562	Complex Analysis	100	3(3+0)
37	MMC-563	Classical Mechanics	100	3(3+0)
38	MMC-564	Partial Differential Equations	100	3(3+0)
39	MMC-565	Real Analysis-II	100	3(3+0)
40	MMC-566	Functional Analysis	100	3(3+0)
Total			**600**	**18**

7th Semester

S. No.	Course Code	Course Title	Marks	Credit Hours
41	MMC-671	Numerical Analysis	100	4(3+1)
42	MMC-672	Mathematical Methods	100	3(3+0)
43	----	Elective-I	100	3(3+0)
44	----	Elective-II	100	3(3+0)
45	----	Field Experience/Internship	100	3(3+0)
Total			**500**	**16**

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8th Semester

S. No.	Course Code	Course Title	Marks	Credit Hours
46	MMC-681	Probability Theory	100	3(3+0)

47	MMC-682	Integral Equation	100	3(3+0)
48	----	Elective-III	100	3(3+0)
49	----	Elective-IV	100	3(3+0)
50	----	Capstone Project	100	3(3+0)
Total			**500**	**15**

NOTE:
MGC means Mathematics General Course
MAC means Mathematics Allied Course
MMC means Mathematics Major Course
MEC means Mathematics Elective Course
MNCC means Mathematics Non-Credit Course

ELECTIVE COURSES

S. No	Course Code	Course Name	Credit hours
1	MEC-674	Mathematical Modeling	03
2	MEC-675	Advanced Group Theory	03
3	MEC-676	Optimization Theory	03
4	MEC-677	Measure Theory	03
5	MEC-678	Fluid Mechanics	03
6	MEC-679	Stochastic Processes	03
7	MEC-683	Quantum Mechanics	03
8	MEC-684	Heat and Mass Transfer	03
9	MEC-685	Advanced Number Theory	03
10	MEC-686	Analytical Dynamics	03
11	MEC-687	Difference Equations	03
12	MEC-688	Convex Analysis	03
13	MEC-689	Econometrics	03
14	MEC-690	Fuzzy Set Theory	03

1st SEMESTER

MGC-311 Quantitative Reasoning-I (Elements of Set Theory and Mathematical Logic)

Prerequisite(s): Mathematics at Intermediate level
Credit Hours: 3 + 0
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 injective, surjective and bijective functions from a set to another set. Infinite sets, finite sets. Countable sets, introduction to first and second countable, properties, examples (Z, Q). R is not countable. R, $R\times R$, $R\times R\times R$, have the same cardinal. Operations with cardinal numbers. Cantor-Bernstein theorem.
Relations: Equivalence 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, 2016*
- *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 4th edition, North-Holland Publishing Company, 1976*
- *P. Suppes, Axiomatic Set Theory, Dover Publication, 1972*
- *P.R. Halmos, Naive Set Theory, Springer-Verlag New York Inc., 1997*
- *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, 2006*

MMC-312 Calculus-I

Prerequisite(s): Mathematics at intermediate level
Credit Hours: 4+0
Specific Objectives of the Course:
Calculus is serving as the foundation of advanced subjects in all areas of mathematics. The course, equally, emphasizes the basic concepts and skills needed for mathematical manipulation. This Calculus focus on the study of functions of a single variable.
Course Outline:
Functions, upper and lower bounds of variables and functions, inverses of exponential, circular, hyperbolic and logarithmic functions, one sided and two sided limits of functions, continuity of functions and their graphical representations, properties of continuous function on closed bounded intervals, discontinuity of function and its types. Derivatives: Definition, techniques of differentiation. Derivatives of polynomials and rational, exponential, logarithmic and trigonometric functions, Inverse functions and their derivatives. 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. Mean value theorems. Indeterminate forms and L'Hopitals rule. Anti-derivatives and integrals. Riemann sums and the definite integral. Properties of Integral. The fundamental theorem of calculus. Various techniques of integration. Reduction formulae and use of Gamma Beta Functions for integral.

.**Recommended Books:**

- *Martínez-Planell, R., & Trigueros, M. (2021). Multivariable calculus results in different countries. ZDM, 53(3), 695–707. https://doi.org/10.1007/s11858-021-01233-6*
- *J. Stewart, Calculus (5th edition or latest edition), Brooks Cole, 2002*
- *H. Anton, I. Bevens, S. Davis, Calculus (10th edition or latest), John Wiley & Sons Inc., 2012*
- *G. B. Thomas, A. R. Finney, Calculus (11th edition or latest edition), Addison-Wesley, 2005*

MNC-313 Mathematics-I*
Contact Hours: 3(0+0)

Prerequisites: Nil

Course Objectives: The objective of this course is to make student able to understand and formulate real world problems into mathematical statements, develop solutions to mathematical problems at the level appropriate to the course and describe mathematical solutions either numerically or graphically.

Learning Outcomes: This is an introductory course on discrete mathematics. Students will learn:

- Some fundamental mathematical concepts about real and complex numbers;
- How to form a sequence in structure and present its analysis;

Course Contents:
Introduction to set, Real and complex numbers, complex conjugate, modulus, Matrices, results and examples, Determinant results and examples, Vectors definitions, sum, difference and product of vectors, Applications of vectors and related results, sequences, athematic sequence and mean, Geometric and Harmonic Progressions, Geometric and Harmonic means and relationship between them with examples, Series, and tests for convergence, Mathematical induction and Binomial theorem, function and graphs, different types of function and its graph sketching, trigonometric identities, applications of trigonometry, graphs of trigonometric function and inverse trigonometric function,
Recommended Books:

- *Thomas, Calculus, 11th edition. Addision Wesley Publishing Company, 2005*
- *H. Anton, I. Bevens, S. Davis, Calculus (10th edition or latest), John Wiley & Sons Inc. 2012*
- *Hughes-Hallett, Gleason, McCallum, et al, Calculus Single and Multivariable, 3rd Edition. John Wiley & Sons, Inc. 2002*
- *Frank A. Jr, Elliott Mendelson, 7th edition, Calculus, Schaum's outlines series, 2022*
- *C.H. Edward and E.D Penny, Calculus and analytics Geometry, 4th Edition, Prentice Hall, Inc. 1994*

MAC-314 Waves and Oscillation

Prerequisite(s): None
Credit Hours: 3 + 0
Specific Objectives of the Course:
The course aims to demonstrate the utility and limitations of a variety of powerful calculational techniques and to provide a deeper understanding of the mathematics underpinning theoretical physics.
Course Outline:
Harmonic Oscillations: Simple harmonic motion (SHM), Obtaining and solving the basic equations of motions, Longitudinal and transverse Oscillations, Energy consideration in SHM. Applications of SHM, Torsional oscillator, Physical Pendulum, Simple Pendulum, SHM and uniform circular motion, Combination of harmonic motions, Lissajous patterns, Damped harmonic motion, Equation of Damped Harmonic motion, Quality factor, discussion of its solution, Forced oscillations and Resonances, Equation of forced oscillation, discussion of its solution, Natural frequency, Resonance, Examples of resonance, Waves in physical Media: Mechanical waves, traveling waves, phase velocity of traveling waves, Sinusoidal waves, Group speed and dispersion, Waves speed, Mechanical analysis, Wave equation, Discussion of solution, Power and intensity in wave motion, Derivation & discussion, Principle of Superposition(basic ideas), Interference of Waves, Standing Waves, Interference: Coherence of sources, Double slit Interference, Analytical treatment, Adding of electromagnetic waves using phasors, Interference from thin films, Newton's ring(analytical treatment), Diffraction: Diffraction at single slit, intensity in single slit diffraction using phasor treatment and analytical treatment using addition of waves, Double slit Interference & diffraction combined, Diffraction at a circular aperture, Diffraction from multiple slits, Discussion to include width of the maxima, Polarization: Basic definition, Production of Polarization by polarizing sheets, by reflection, by double refraction and double scattering, Description of polarization states, Linear, Circular, elliptical Polarization.
Recommended Book:

- *Halliday, D. Resnick, Krane, Physics, Vol. I & II, John Wiley, 5th edition, 1999*
- *Halliday, D. Resnick, Krane, and Walker, Fundamental of Physics, Extended ed. John Wiley, 5th edition*
- *Ritz and Milford, Introduction to Electromagnetic Field and Waves*

ENG-101 Functional English

Prerequisite(s): None
Credit Hours: 3 + 0
Specific Objectives of the Course:
The course aims at enhancing the language skills and developing critical thinking of the students.
Course Outline:
Basics of Grammar: Parts of speech and use of articles, Sentence structure, Active and passive voice, Practice in unified sentence, Analysis of phrase, clause and sentence structure, Transitive and intransitive verb, Punctuation and spelling Comprehension: Answers to questions on a giventext

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 subjectteachers

Translation skills: Urdu to English

Paragraph writing: Topics to be chosen at the discretion of the teacher**Presentation skills**: Introduction to presentations and deliberations **Note: Extensive reading is required for vocabulary building**

Reference Materials

1. *Thomson, A.J., Martinet, A.V. Practical English Grammar and Exercises Latest Ed. Oxford University Press*
2. *Boutin, M-C., Brinand, S., Grellet, F. Writing. Intermediate and SupplementarySkills. Oxford Fourth Impression Latest Edi.*
3. *Tomlinson, B., Ellis, R. Latest Edition. Reading. Upper Intermediate. Oxford SupplementarySkills. Third impression*

ISL-133 Islamic Studies/Ethics for non Muslims

Prerequisite: None
Credit Hours: 2+0

کورس کے خصوصی مقاصد

اس کورس کا مقصد اسلامیات کے متعلق بنیاد ی معلومات مہیا کرنا، اسلامی تہذیب کے متعلق ان کی معلومات بڑھانا،طلباء کی مہارتوں کو پروان چڑھانا تا کہ وہ نمازیں اور دوسری عبادات بخوبی ادا کر سکیں ۔ایمان اور مذہبی زندگی کے ساتھ متعلقہ مسائل کو سمجھنے کے لئے طلباء کی مہارتوں کو بڑھانا ہے۔

کورس کاخاکہ:

قرآنی مطالعہ کا تعارف:قرآن اور عقیدہ توحید کے بنیادی عقائد،قرآن کی تاریخ،علوم القرآن ،قرآن مجید کے منتخب آیات کا مطالعہ:سورۃ بقرۃ کی آیات(284- 286)ایمان سے متعلق،سورۃ الحجرات کی آیات (1- 18) آدابِ نبویﷺ سے متعلق،سورۃ محمد کی آیات (1-11) ایمان کے اخلاقیات سے متعلق،سورۃ الفرقان کی آیات 63(-77) سماجی اخلاقیات سے متعلق،سورۃ الانعام کی آیات (152-154) احکام سے متعلق،سورۃ احزاب کی آیات(58،57،56،40،21،6)آدابِ نبویﷺ سے متعلق،سورۃ الحشر کی آیات(20،19،18) انصاف کے دن سوچنے کے متعلق،سورۃ الصف کی آیات (1-14) تفکر،تدبرسے متعلق۔حضور صلی اللہ علیہ وسلم کی سیرت: محمد ﷺ کی مکی زندگی و مدنی زندگی(کے بڑے بڑے واقعات)۔سنت کا تعارف:حدیث کی بنیادی،حدیث کی تاریخ ،حدیث کے اقسام،علوم الحدیث ،سنت اورحدیث، سنت کی قانونی حیثیت،منتخب احادیث مبارکہ۔اسلامی قانون اور اصولِ فقہ(اصولِ قانون) کا تعارف۔ اسلامی تہذیب و ثقافت۔ اسلام اور سائنس، اسلام کا معاشی نظام ،اسلام کا سیاسی نظام ، اسلام کا معاشرتی نظام۔

مجوزہ کتب:

اے.حسن،اسلامی فقہ کے اصول،اسلامک ریسرچ انسٹیٹیوٹ،انٹر نیشنل اسلامک یونیورسٹی،اسلام آباد،۱۹۹۳۔
م(محمد). ولی اللہ ، اسلامی فقہ اورجرائم کا قرآنی قانون،اسلامک بک سروس، ۱۹۸۲۔
ایچ.ایس. بھاتیہ،اسلامی قانون کا مطالعہ،ریلیجن اینڈ سوسائٹی،ڈیپ اینڈ ڈیپ پبلیکیشنز،نیا دہلی،۱۹۸۹۔
م.ضیاء الحق،اسلامی شریعت کا تعارف، علامہ اقبال اوپن یونیورسٹی،اسلام آباد،۲۰۰۱۔
م.حمید اللہ ،اسلام کا تعارف۔
کے.احمد، اسلامی نظریہ حیات۔
م.حمید اللہ ، خطباتِ بہاولپور۔
ایس.اے، علی،اسلام کی روح۔

Ethics (for Non-Muslims only)

Specific Objectives of the Course:

It will cover primitive religious concepts and then concentrate on the highly developed and organized religions like Hinduism, Judaism, Christianity and Islam.

Course Outlines

- Defining Ethics; and its relation to Philosophy
- Morality as Compared with other Normative Subjects
- Characteristics of Moral Principle

- The Purposes of Morality
- Cultural Relativism
- Cultural Relativism as a theory of Morality
- Judging a Cultural Practice to be Undesirable
- Ethical Subjectivism
- The First Stage: Emotivism
- Emotivism, Reason and Moral Facts
- The Presumed Connection between Morality and Religion
- The Natural Law Theory
- The Utilitarian Approach: a Revolution in Ethics:
- Mill's Utilitarianism: a modified version
- Implications of Utilitarianism
- Is Happiness the Only Thing That Matters? Are Consequences All That Matters?
- Defense of Utilitarianism
- Kant and the Categorical Imperative
- Absolute Rules and the Duty Not to Lie
- Kant and the Respect for Person
- Retribution and Utility in the Theory of Punishment
- The Ethics of Virtue and the Ethics of Right Action
- Some Advantages of Virtue Ethics
- Business Ethics
- The Nature of Business Ethics
- The Ethics of Advertising and Green Issues in Business
- Environmental Ethics
- Arguments for and against the Use and Exploitation of the Natural Environment
- Bioethics---Ethical Issues in Medicine
- Confidentiality, Guilt and Innocence in Treating Patients, Euthanasia, Ethics andBehavior Control, Genetics

Recommended Books

1. *Reviews, C. T. (2016). The elements of moral philosophy. https://www.amazon.com/Elements-Philosophy-Cram101-Textbook-Reviews-ebook/dp/B008C4NO5Y*
2. *Rachels, J., & Rachels, S. (2012). The Elements of Moral Philosophy 7e. McGrawHill. ISBN: 0-07-247690-7*
3. *Loue, S. (2007). Textbook of research ethics: Theory and practice. Springer Science& Business Media.*
4. *Hendin, J. (1999). The Right Thing to Do. Feminist Press at CUNY.*
5. *Pojman, L. P., & Fieser, J. (2016). Cengage advantage ethics: Discovering right andwrong. Cengage Learning.*
6. *Vaughn, L. (2015). Doing ethics: Moral reasoning and contemporary issues. WWNorton & Company*

CS-134 Applications of Information and Communication Technologies (AICT)

Prerequisite(s): None
Credit Hours: 2 + 1
Specific Objectives of the Course:
This course focuses on a breadth-first coverage of computer science discipline, introducing computing environments, general applications, basic computing hardware and software, operating systems, desktop publishing, Internet, software applications, tools and computer usage concepts. The main objective of this course is to enable the students to practically use computer for learning and apply their computing skills in the field of mathematics.
Course Description
Information technology literacy has become a fundamental requirement for any major. An understanding of the principles underlying digital devices, computer hardware, software, telecommunications, networking and multimedia is an integral part of any IT curriculum. This course provides a sound foundation on the basic theoretical and practical principles behind these technologies and discusses up to date issues surrounding them including social aspects and how they impact everyday life.
Course Objectives
● Understand the fundamentals of information technology
● Learn core concepts of computing and modern systems
● Understand modern software programs and packages
● Learn about upcoming IT technologies
Course Contents
Basic Definitions & Concepts, Hardware: Computer Systems & Components. Storage Devices, Number Systems, Software: Operating Systems, Programming and Application Software, Introduction to Programming, Databases and Information Systems, Networks, Data Communication, The Internet, Browsers and Search Engines, The Internet: Email, Collaborative Computing and Social Networking, The Internet: E-Commerce, IT Security and other issues, IT Project.
Required Skills
These basic competencies are assumed on the first day of class. Students must assume responsibility for learning these skills if he/she does not already possess them. If an instructor finds that you do not have the required skills and knowledge, you may be asked to withdraw from the course.
1. Basic Knowledge of Computers
● Understand basic computer hardware components and terminology
● Understand the concepts and basic functions of a common computer operating system
● Start up, log on, and shut down a computer system properly
● Use a mouse pointing device and keyboard
● Use Help and know how to troubleshoot routine problems
● Identify and use icons (folders, files, applications, and shortcuts/aliases)
● Minimize, maximize and move windows
● Identify common types of file extensions (e.g. doc, docx, pdf, html, jpg, gif, xls,ppt, pptx, rtf, txt, exe)
● Check how much space is left on a drive or other storage device
● Backup files
● Download and install software on a hard disk
● Understand and manage the file structure of a computer
● Check for and install operating system updates
2. Proficiency in Using Productivity Software
● Create documents of various types and save in a desired location
● Retrieve an existing document from the saved location
● Select, copy, and paste text in a document or desired location
● Print a document

● Name, rename, copy and delete files
● Understand and know how to use the following types of software programs:
● Word processing (example: MS Word, Google Doc, and Writer)
● Presentation (example: PowerPoint, Impress)
● Spreadsheet (example: Excel, Calc)
● PDF reader (example: Acrobat Reader, Preview)
● Compression software (example: WinZip, StuffIt, 7-Zip)

3. Electronic Communication Skills

● Email, using a common email program (example: MS
● Compose, Send, Reply, Forward messages
● Add attachments to a message
● Retrieve attachments from an email message
● Copy, paste and print message content
● Organize email folders
● Understand what an electronic discussion list is and how to sign up and leave one (example: Listserv, Listproc)

4. Internet Skills

● Set up an Internet connection and connect to the Internet
● Have a working knowledge of the World Wide Web and its functions, including basic site navigation, searching, and installing and upgrading a Web browser
● Use a browser effectively, including bookmarks, history, toolbar, forward and back buttons
● Use search engines and directories to find information on the Web
● Download files and images from a Web page
● Understand and effectively navigate the hyperlink structure of the Web
● Understand how keep your information safe while using the Internet

5. Moving Files

● Transfer files by uploading or downloading
● View and change folder/document security settings
● Copy files from hard disk to storage devices and vice versa

Recommended Readings

1. *Bruce J. McLaren, Understanding and Using the Internet, West Publishing Company, 610 Opperman Drive, P. 0. Box 64526, St. Paul, MN 55164.*
2. *Computer Applications for Business, 2nd Edition, DDC Publishing, 275 Madison Avenue, New York.*
3. *Nita Hewitt Rutkosky, Microsoft Office Professional, Paradigm Publishing Company, 875 Montreal Way, St Paul, MN 55102.*
4. *Robert D. Shepherd, Introduction to Computers and Technology, Paradigm Publishing Inc., 875 Montreal Way, St. Paul, MN 55102.*
5. *Shelly Cashman Waggoner, Discovering Computers 98, International Thomson Publishing Company, One Main Street, Cambridge, MA 02142.*
6. *V. Wayne Klemin and Ken Harsha, Microcomputers, A Practical Approach to Software Applications, McGraw-Hill Book Company, New York, NY 10016.*

2nd SEMESTER

MAC- 321 Heat, Thermodynamics and Statistical Physics

Prerequisite(s): Physics-I
Credit Hours: 3 + 0
Course Outline:
Heat and temperature: Temperature, kinetic theory of the ideal gas, work done on an ideal gas, internal energy of an ideal gas, Equipartition of energy, Intermolecular forces, Quantitative discussion, Vander waals equation of state, Statistical Mechanics: Statistical distribution and mean values, Mean free path and microscopic calculation of mean free path, distribution of molecular speeds, distribution of energies, Maxwell distribution, Maxwell Boltzmann energy distribution, internal energy of an ideal gas, Brownian motion, qualitative description, diffusion, conduction and viscosity, Thermodynamics: Review of previous concepts, First law of thermodynamics and its applications to adiabatic, isothermal, cyclic and free expansion, Reversible and irreversible processes, second law of thermodynamics, Carnot theorem, and Carnot engines, Heat engine. Refrigerators, Calculation of efficiency of heat engines, Thermodynamic temperature scale: Absolute zero: Entropy, Entropy in reversible process, entropy in irreversible process, Entropy & second law, Entropy & Probability, Thermodynamics functions: Thermodynamic functions (internal energy, Enthalpy, Gibb's function, Entropy, Helmholtz functions), Maxwell's relations, Energy equations and their applications.

Recommended Book:

- *Halliday, D. Resnick, Krane, Physics, Vol. I & II, John Wiley, 5th edition, 1999.*
- *Halliday, D. Resnick, Krane, Walker, Fundamental of Physics, Extended ed: 5th edition John Wiley.*
- *R. A. Hashimi, A Textbook of Engineering and thermodynamics.*
- *M. Zemausty, Heat and thermodynamics, 5th edition, McGraw Hill* **.**

MMC-322 Calculus-II

Prerequisite(s): Calculus-I
Credit Hours: 3+0
Specific Objectives of the Course:
Analytical geometry is serving as the foundation of advanced subjects in all areas of mathematical analysis. The sequence, equally, emphasizes the basic concepts and skills needed for mathematical manipulation. As continuation of Calculus, it focuses on the study of foundation of plane and one, two dimensional geometry.
Course Outline:
Curves and their representation in cartesian, polar and parametric forms, tangents and normal, maxima, minima and points of inflection, convexity and concavity, asymptotes and curve tracing, translation and rotation of axes in one dimension, general equation of the second degree and the classification of conic sections, conic in polar coordinates, tangents and normal, rectangular coordinate system, translation and rotation of axes in two dimension, direction cosines, ratios and angles between two lines, standard forms of equations of planes and lines, intersection of planes and lines, distance between points, lines and planes, shortest distance between lines, symmetry, intercepts and sections of a surface, spherical, polar and cylindrical coordinate systems, standard form of the equations of sphere, cylinder, cone, ellipsoid, parabolid and hyperboloid.

Recommended Books:

- *J. Stewart, Calculus, 8th edition, Cengage Learning, 2016*
- *H. Anton, I. Bevens, S. Davis, Calculus (10th edition or latest), John Wiley & Sons, 2012*
- *G. B. Thomas, AR Finney, Calculus (11th edition or latest), Addison-Wesley, 2005*

MMC-323 Discrete Mathematics

Pre-requisite(s): Mathematics at intermediate level
Credit Hours: 3+0
Specific Objectives of the Course:
This course shall assume background in number theory. It lays a strong emphasis on understanding and utilizing various strategies for composing mathematical proof.
Course outline: Basic methods: product, inclusion-exclusion formulae. Permutations and combinations. Recurrence relations and their solutions. Generating functions. Double counting and applications. Pigeonhole principle and applications. Binary relations, n-array Relations. Closures of relations. Composition of relations, inverse relation. 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. Boolean algebra: Introduction to gates and its types, combinatorial circuit of graphs, Boolean expression, Boolean function and its representation. Graph theory: order and types. Matrix representation of a graph, Graph isomorphism.
Recommended Books:

- *S. E. Susana, Discrete Mathematics with applications, Cengage Learning, 2020*
- *D. P. Acharjya, Sreekumar, Fundamental Approach to Discrete Mathematics, New Age International P Ltd. 2009*
- *K. H. Rosen, Discrete Mathematics and its applications, McGraw Hill, 2018*
- *J. L. Gersting, Mathematical Structures for Computer Sciences, W. H. Freeman and Company, 2014*

MNC-324 Mathematics-II*

Contact Hours: 3(0+0)
Prerequisites: Nil

Course Objectives:
This course covers the concepts of functions, limit, continuity, differentiation, integration of function of one variable; logarithmic, exponential, applications of derivatives and antiderivatives, differential equations, vector and applications, partial derivatives and multiple integration. The objective of this course is to make student able to understand and formulate real word problems into mathematical statements, develop solutions to mathematical problems at the level appropriate to the course and describe mathematical solutions either numerically or graphically.

Learning Outcomes: This is an introductory course on discrete mathematics. Students will learn:

- Some fundamental mathematical concepts about derivatives and integration;
- Will know about the application of these concepts and how to utilize it.

Course Contents:
Introduction, representing function of one variables, Polynomial, Trigonometric, Exponential and Logarithmic functions, range and domain of functions and their graphs. Precise definitions of Limits and Continuity, Limits at infinity, Continuity, Horizontal asymptotes, Tangents and velocity, Rate of change, Review of Derivative, Differentiability of a function, Mean value theorem, Indeterminate forms and L-Hospital Rule, Curve sketching, Review of maxima and minima of one variable, Optimization problems,
Review of Antiderivatives, Rectilinear motion, Indefinite integrals and Net change, Define integral, The fundamental theorem of calculus, Improper integrals, Areas between the curves, Volume of cylindrical cells, Approximate Integrations, Arc length, Area of surface of revolution, Limit and Continuity, Partial and Derivatives, Tangent planes, Maximum and minimum Values, Multiple integrals.

Recommended Books:

- *J. Stewart, Calculus, 8th edition, Cengage Learning, 2016*
- *G. B. Thomas, AR Finney, Calculus (11th edition or latest), Addison-Wesley, 2005*
- *E.W. Swokowski, Calculus with Analytic Geometric, PWS Publishers, Boston, Massachusetts, 1983*
- *M. Liebeck, A Concise introduction to pure Mathematics, CRC Press, 2011*
- *A. Kaseberg, Intermediate Algebra, Thomson Brooks/cole, 2004*

ENG-102 Expository Writing

Prerequisite(s): English Structure
Credit Hours: 3 + 0
Specific Objectives of the Course:
The purpose of this course is to educate the reader and to demonstrates the author's expertise on the subject and in many cases demonstrates how they learned about their subject.

Course Contents

1. Unit 1:
Self Reflection

- Introduction to the basics of the writing process
- Introduction to the steps of essay writing
- Students practice prewriting activities like brainstorming, listing, clustering and free writing
- Students practice outlining of the essay

Unit 2: Personalized Learning

- Students reflect on their learning process
- Group discussion about learning styles based on the reading material provided to students
- Introduction to personalized learning
- Students practice goal setting
- And create a learning plan
- Introduction to the structure and significance of oral presentations
- Class discussion about content selection and slide preparation for oral presentations
- Peer review through a gallery walk

Unit 3: Critical Reading Skills

- Introduce authentic reading (DAWN newspaper and non-specialist academic books/texts
- Conduct classroom reading activities (using strategies skimming, scanning, SQW3R,

previewing, annotating, detailed reading and note-taking) using standard tests (TOEFL and IELTS) Assign books/articles/reports for their individual home assignments.
- Share model review reports and annotated bibliographies

Unit 4: Community Engagement

- Showing short documentaries to students on global environmental issues
- Student-led brainstorming on local versus global issues
- Teacher-led introduction to the unit assignment (using assignment sheet)
- Readings (or other input sources - video, social media) from local news on possible communityissues, letters to editor and op-eds
- Identify research problems
- Begin drafting research questions based on the problems identified
- Facilitating students on developing research questions in groups
- Draft interview or survey questions for community research (in English or L1)
- In-class role-plays of interviews with community members
- Engaging students in critical reading and reflection on the issues found in different communities
- In-class work on understanding interview information, how to present interview or surveyinformation
- Refining the research questions, designing a detailed research plan in groups, dividing the tasksand deciding the timeline for the completion of the project
- Exposure to interview questions and interviewing techniques to develop an in-depth understandingof the issues
- Continued group work on report outline
- In-class lecture and group work on analyzing information
- Discussion based on translating the data from the source language to the target language (English)
- Sharing the experience of field work in class orally
- Teacher feedback on outline of report (globally to entire class and individually to groups as needed)
- Revisions to oral report in groups Engaging students in individual structured reflective writingbased on their experience of working on the project
- Sharing their reflective writing to learn about each other's points of view
- Think-pair-share the findings (group similar issues)
- Individual writing of reflection on the community engagement project and their role in the group
- Brainstorm using creativity for dissemination - cartoons, advertisements for university magazineor beyond, creating posts for FB
- Summarizing/ converting the report to a letter to the editor to highlight the problems explored andtheir possible solutions (homework - connecting activity for week 11 - Unit 5)

Unit 5: Letter to the Editor

- Teacher-directed instruction on genres (types) of writing focusing on letter-writing
- Model-practice-reflect: Introduce types of letters comparing the use of formal and informalvocabulary and phrases in each type
- Introduce the format and purpose of the letter-to-editor explaining with the help of an actual letterfrom a local newspaper
- Group reading of sample letters-to-editor selecting ones that deal with issues familiar to the students
- Invite a guest lecturer (local newspaper editor or faculty from journalism) to talk about what issuesare currently raised in letters-to-editors and what are editors' criteria to accept letters for publication
- Work in groups to continue reviewing letter samples, analyzing the structure of lette

- Each group identifies an issue they want to write about and give a brief oral presentation to theclass
- Submit the first draft of letters (to the teacher and peer-review group)
- In-class peer review of drafts using a checklist focusing on content and structure DUE:
- First draft of letter (to teacher and peer review group)
- Groups revise first draft of letter
- Differentiate among revision, proofreading and evaluation (as sub stages of finalizing documents)
- Discuss critically the draft-letter and implement the 'revision' phase of writing Reading of(DAWN) newspaper and sharing important letters (to editors) on local issues
- Groups revise second draft of letter Explicit instruction (paragraph structure, syntax, diction,grammar, and mechanics)
- Classroom discussion/debrief of activity Discuss critically and finalize the draft-letter as the lastphase of writing

Teacher Manual & Suggested Reading

1. *Expository Writing Course Outline - Sept 2021 -HEC.pdf Detailed Courses - Expository Writing Sept 2021 - HEC.pdf*
2. *Expository Writing Teachers Manual - Sept 21 - HEC.pdf*

PS-127 PAKISTAN STUDIES

Credits: 2(2+0)

Pre-Requisite: Nil

Offering: Undergraduate Degrees

Placement: I- 8 Semesters

Type: General Education

Fields: All

Description

This course is de:šlened to proxi(lc students with a comprehensive exploration of Pakistan's identity, spanning geographical, historical, and cultural dimensions. It delves into the diverse landscapes, ancient civilizations, and rich cultural heritage that define Pakistan. Moreover, it examines the socio-cultural and political transformatlons in Pakistan over time including democratic transitions and military interventions. The aim of this course is to inculcate in students a nuanced understanding of Pakistan's past, present, and potential future trajectories, enabling them to criticallv evaluate the complex dynamics shaping the nation's development.

COURSE LEARNING OUTCOMES

By the end of this course we will:

l . Have enhanced knowledge of the geographical, historical, and political aspects of Pakistan.
2. Understand the society and culture of Pakistan,
3. Understand and explain the socio-economic developments in Pakistan.

4. Explore contemporary issues and challenges faced by Pakistan and their implications for the future.

SYLLABUS

1. Introduction to Pakistan:
   - Geographical location and significance.
   - Historical background: Ancient civilizations in the region. Factors leading to the creation of Pakistan.
2. Political History of Pakistan:
   Formative phase.
   - Military interventions and democratic transitions.
3. Geography of Pakistan:
   - Physiography: Mountains, plains, plateaus, deserts, valleys and coastal areas.
   - River systems: Indus River and its tributaries.
   - Climatic regions of Pakistan.
4. Society and Culture of Pakistan:
   - Socio-cultural diversity.
   - Languages and literature of Pakistan.
5. Economic Development of Pakistan:
   - Agricul re and industrial sectors of Pakistan.

   Eeo mic challenges of Pakistan.
6. Contemporary Issues:
   - Foreign relations of Pakistan.

   e Security challenges: terrorism, extremism, and regional conflicts.
   - Environmental problems and sustainable development (SDGs). Media and social change.

SUGGESTED INSTRUCTIONAL / READING MATERIALS

l . 'Jinnah of Pakistan" by Stanley Wolpert
2. *"The Sole Spokesman: Jinnah, the Muslim League, and the Demand for Pakistan" by Ayesha Jalal*
3. *' t The struggle tur Pakistan" by Ishtiaq Ilusain Qureshi*
4. *"Pakistan, the Formative Phase, 1857-1948" by Khalid B. Sayeed*
5. *"Pakistan Studies: A Book of Readings" by Sikandar Hayat*
6. *"Constitutional and Political History of Pakistan" by Hamid Khan*
7. *"Trek to Pakistan" by Ahmad Saeed and Kh. Mansur Sat-war*
8. *"Pakistan: A Modern History" by Ian Talbot*
9. *"Politics in Pakistan: The Nature and Direction of Change" by Khalid B. Sayeed*
10. *"Physical Geography of Pakistan" by Umar Jahangir*

I l. "A Geography of Pakistan: Environment, People, and Economy" by Fazle Karim Khan

12. *"Pakistan's Foreign Policy: An Historical Analysis" by S. M. Burke*
13. *"Separatism in East Pakistan" by Rizwan Ullah Kokab*
14. *"Being Pakistani: Society, Culture and the Arts" by Raza Rumi*
15. *'Pakistan's Cultural Heritage: Socio-Economic and Technological Aspects" edited by Abdul Jabbar Khan*

16. *"Language and Politics in Pakistan" by Tariq Rahman*
17. *"Sociology" by Horton and Hunt*
18. *"Pakistan in the Twentieth Century: A Political History" by Lawrence Ziring*
19. *"Economic D elopment of Pakistan" by Ishrat Husain*
- *"Issues in Pakistan's Economy" by S. Zaidi*

PS-104 Arts and Humanities (Islamic History)

Objectives of the Course	**ISLAMIC HISTORTY** 1. To educate the students about the Islamic History. 2. To enable the students to find the solutions of current problems of Ummah in the light of glorious period of Muslim Rulers 3. To enable the students to plan for the future in the light of golden period of Muslim Rulers.

Course Description

S.No	Topic	Description
1.	**Basics of History**	1. Definition, Types, Sources and Importance of History 2. Introduction to Prominent Muslim Historians and Their Books. (Ibn Ishaq, Ibn Hisham,Tabari,Iabn Kasir,Ibn Khaldoon)
2.	**Geographical, Socio-Economic and Religious conditions of Pre-Islamic World**	3. Geographical, Socio-Economic and Religious conditions of Pre-Islamic Room and Faris 4. Geographical, Socio-Economic and Religious conditions of Pre-Islamic Arabia, especially of Hijaz
3.	**The Prophet Hazrat Muhammad (S.A.W)**	1. Life in Makkah Mukarramah 2. Life in Makkah Mukarramah
4.	**The Prophet Hazrat Muhammad (S.A.W)**	1. Life in Madinah Munawwarah 2. Life in Madinah Munawwarah
5.	**The Prophet Hazrat Muhammad (S.A.W)**	1. Life in Madinah Munawwarah 2. Life in Madinah Munawwarah
6.	**The Pious Caliphs (R.A) Hazrat Abu Bakr Siddiq (R.A) (632-634 AD)**	1. Introduction , Major Challenges 2. Religious, Military and Political achievements.

7.	**The Pious Caliphs (R.A) Hazrat Umar Farooq (R.A) (634-644 AD)**	1. Introduction , Major Challenges 2. Religious, Military and Political achievements.
8.	**The Pious Caliphs (R.A) Hazrat Usman Ghani (R.A) (644-656 AD)**	1. Introduction , Major Challenges 2. Religious, Military and Political achievements.
9.	**The Pious Caliphs (R.A) Hazrat Ali (R.A) (656-661 AD)**	1. Introduction , Major Challenges 2. Religious, Military and Political achievements.
10.	**The Umayyad's (661-750AD)**	1. Introduction (Rise) of Umayyad's , 2. Major Challenges
11.	**The Umayyad's (661-750AD)**	1. Achievements(Cultural, Military and Political) 2. Causes of Fall
12.	**The Abbasid's (750-1258 AD)**	1. Introduction (Rise) of Abbasid's , 2. Major Challenges
13.	**The Abbasid's (750-1258 AD)**	1. Achievements(Cultural, Military and Political) 2. Causes of Fall
14.	**Muslim Rule in Spain**	1. Introduction (Rise) of Muslims in Spain , 2. Achievements & Causes of Fall
15.	**Different Islamic States**	1. Brief Introduction of Khelafat Osmania 2. Brief Introduction of Mughal Empire

Recommended Books

S#	BOOK NAME	AUTHOR
.1	Muhmmad Arabi	Muhmmad Inyatullah Subhani
.2	Al Raheeq Al Makhtoom	Safi Ur Rahman Mubarak Pori
.3	البدایہ ولنہایہ	علامہ ابن کثیر
.4	تاریخ ابن خلدون	عبدالرحمان بن محمد ابن خلدون
.5	تاریخ امت مسلمہ	مولانا اسماعیل ریحان
.6	History Of Islam	Akber Shah Najeebabadi

.7	A study of Islamic History	Prof. K. Ali
.8	سلطنت عثمانیہ	ڈاکٹرعلی محمد الصلابی
.9	The Lost Islamic History	Firas Alkhateeb
.10	جامع تاریخ ہند	محمد حبیب، خلیق احمد نظامی
.11	مختصر التاریخ الاسلامی	محمد عبداللہ عودۃ
.12	الموسوعۃ المیسرۃ فی التاریخ الاسلامی	فریق البحوث والدراسات الاسلامیہ بتقدیم دکتور راغب سرجانی
.13	موسوعۃ التاریخ الاسلامی	ڈاکٹرعلی محمد الصلابی
.14	اٹلس فتوحات اسلامیہ	احمد عادل کمال مترجم محسن فارانی

PS-136 Civics and Community Engagement

Prerequisite(s): the working to make a difference in the civic life of one's community and developing the combination of knowledge, skills, values and motivation to make that difference.

Credit Hours: 2+0

Contents

1. Introduction to citizenship education and Community Engagement
2. Identity, Culture, and Social Harmony
3. Multi-cultural society and inter-cultural dialogue
4. Active Citizen: Locally Active, Globally Connected
5. Human rights, constitutionalism and citizens' responsibilities
6. Social issues in Pakistan
7. Social Action Project
8. Assignment (Formative/Summative)

Recommended Books

1. *John J. Macionis, Lindaa Marie Gerber, Sociology (New York: Pearson Education, 2010)*
2. *Community Development, Social Action and Social Planning by Alan Twelvetrees 12May 2017*
3. *The Constitution of the Islamic Republic of Pakistan (Pakistan: The National Assembly of Pakistan,2012), also available online at the official website of National Assembly of Pakistan (2017). http://na.gov.pk/uploads/documents/13333523681 951.*
4. *Anne Karin Larsen, Participation in Community Work: International Perspectives (Vishanthie Sewpaul, Grete Oline Hole,2013).*
5. *British Council, Active Citizen's Social Action Projects Guide (Scotland: British Council,2017)*

3rd SEMESTER

MMC-431 Affine Euclidean Geometry

Prerequisite(s): Calculus I
Credit Hours:3+0

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 (magnitude) 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, 1988*
- *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*

MAC-432 Computer Programming

Prerequisite(s): Introduction to Computer
Credit Hours: 2 + 1
Specific Objectives of the Course:
The purpose of this course is to introduce students to operating systems and environments.
Course Outline:
Introduction to programming, applications of programming in mathematics, program structure, flow chart, C/C^{++} language, building blocks, variables, data types, input/output, repetition (FOR, WHILE, DO), selection (IF, IF ELSE, ELSE IF) construct switch statement, conditional statement, function that returns a value using argument to pass data to another function, external variable, arrays and strings, pointers, structure, file processing and introduction to object-oriented programming.

Recommended Books:

- *Dietel & Dietel, C^{++} How to program, 7th Edition, Prentice Hall*
- *H. Schildt, C/C^{++} The Complete Reference, 4th Edition, McGraw Hill Osborne media*
- *J. L. Hein, Theory of Computations: An Introduction, Jones and Bartlett, Boston*
- *R. Laffore, Introduction to Object Programming, McGraw Hill, New York*

MMC-433 Algebra-I

Prerequisite(s): Mathematics at intermediate level
Credit Hours: 3 + 0
Specific Objectives of the Course:
This is the first course in groups, matrices and linear algebra, which provides basic background needed for all mathematics majors, is a prerequisite for many courses. Many concepts presented in the course are based on the familiar setting of plane and real three-space, and are developed with an awareness of how linear algebra is applied.
Course Outline:
Basic axioms of a group with examples, subgroups, order of a group, subgroups generated by subset of a group, system of generators cyclic groups, cosets, Lagrange's theorem, introduction to permutations, even and odd permutations, cycles, lengths of cycles, transpositions, symmetric group, alternating groups. Preliminaries, normalizers and centralizers of a group, center of a group, normal subgroup, quotient groups, conjugacy relation between elements and subgroups, homomorphism and isomorphism between groups, homomorphism and isomorphism theorems, finite p-groups, internal and external direct products, endomorphism and automorphism of a group, characteristic and fully invariant subgroups, direct product of groups.
Recommended Books:

- *E. Arnold, Rings, Fields and Groups: An Introduction to Abstract Algebra, 1983*
- *A. Majeed, Group Theory, Ilmi kitab Khana*
- *J. B. Farleigh, A First Course in Abstract Algebra (7th edition), Addison-Wesley*
- *I. D. Macdonald, The Theory of Groups, Oxford Clarendon Press, Ma., USA, 1975*
- *K. H. Dar, Abstract Algebra, ilmi Kitab Khana Lahore.*

MAC-434 Electricity and Magnetism

Prerequisite(s): None
Credit Hours: 3 + 0
Course Outline:
Electric charge and Electric Field: Charge, properties of charges, Coulombs Law, Field due to a point charge: due to several point charges, Electric dipole, Electric field of continuous charge distribution e.g Ring of charge, Disc of charge, infinite line of charge. Point charge in an electric field, Dipole in an electric field, Torque and energy of a dipole in uniform fields, Electric flux: Gauss's law; (integral and differential forms) and its application, Charge on isolated conductors, conductor with a cavity, field near a charged conducting sheet, Field of infinite line of charge, field of infinite sheet of charge, field of spherical shell and field of spherical charge distribution, Electric Potential: Potential due to point charge, potential due to collection of point charges, potential due to dipole, Electric Potential of continuous distribution charge, Poisson's and Laplace equation without solution, Field as the gradient or derivative of Potential, Potential and field inside and outside an isolated conductor, Capacitors and dielectrics: Capacitance, calculating the electric field in a capacitor, Capacitors of various shapes, cylindrical, spherical etc. and calculation of their capacitance, Energy stored in an electric field, Energy per unit volume, Capacitor with dielectric, Electric field of dielectric, An atomic view, Application of Gauss's law to capacitor with dielectric, Magnetic field effects and magnetic properties of Matter: Magnetic force on a charged particle, magnetic force on a current, recall the previous results, Do not derive, Torque on a current loop, Magnetic dipole: energy of magnetic dipole in field, Discuss quantitatively, Lorentz force with its application in CRO, Biot-Savart Law: Analytical treatment and applications to a current loop, force on two parallel current changing conductors, Ampere's law, integral and differential forms, applications to solenoids and toroid's, (integral form),

Inductance: Faraday's Law of electromagnetic induction, review of emf, Faraday law and Lenz's Law, induced electric fields, calculation and application using differential and integral form, inductance, Basic definitions, Inductance of a solenoid, Toroid.

Recommended Books:

- *Halliday, D. Resnick, Krane, Physics, Vol. I & II, John Wiley, 5th edition, 1999*
- *Halliday, D. Resnick, Krane, and Walker, Fundamental of Physics, Extended ed. John Wiley, 5th edition*
- *Ritz and Milford, Introduction to Electromagnetic Field and Waves*
- *R. J. Reitz, and J. M. Fredrick, Foundations to Electromagnetic Theory, 2nd edition, Addison-Wesley Publishing Co. 1970*

MGC-435 Quantitative Reasoning-II (Statistics)

Prerequisite(s): Basic statistics at intermediate level

Credit Hours:3+0

Specific Objectives of the Course:

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

Course Outline: Statistical measures, statistical description and graphical representation of data, introduction to probability theory, permutations and combinations, Sampling theory, events, mutually exclusive and inclusive events, frequency and sampling distributions, sampling procedures, Estimation of parameters, estimation of mean, variance, confidence intervals, decision theory, hypothesis testing and decision making, types of errors in tests, quality control, control charts for mean, standard deviation, variance, range, goodness of fit, chi-square test, Regression analysis, method of least squares and curve fitting, correlation analysis.

Recommended Books:

- *M. H. DeGroot, M. J. Schervish, Probability and Statistics 4th edition, Addison-Wesley, 2012*
- *R. A. Johnson, Probability and Statistics for Engineers, Person Education Limited, 2018*
- *A. Papoulis, Probability, Random Variables, and Stochastic Processes 4th edition, McGraw Hill, New York. 2002*
- *T. Sincich, Statistics by Examples, Prentice Hall, 1993*

MMC-436 Number Theory

Prerequisite(s): Mathematics at intermediate level

Credit Hours: 3+0

Specific Objective of the Course:

This course covers those topics of number theory which are the essential ingredients for a beginner. In this course the students leans the basics concepts of number theory, as the theory of number has always occupied a unique position in the world of mathematics. Because of the basic nature of its problem, number theory has a fascinating appeal for the leading mathematicians as well as for thousands of armatures. This course also familiarizes the students with the applications of some theorems.

Course Outline:

Divisibility, divisibility tests, Euclidean Algorithm, GCD and LCM of integers, prime number, properties of prime numbers, fundamental theorem of arithmetic's, the Tau and sigma functions, congruence relation, solutions of system of linear congruencies, congruence of higher degree, Chinese reminder theorem and its applications, Euler's phi-function and its applications, Fermat's little theorem and its applications, Wilson's theorem and its applications, perfect number and Mersenne's primes, Fermat number, Linear Diophantine equation, reduced residue system, complete residue system.

Recommended Books:

- *K. C. Chowdhury, A First Course in Number Theory, Asian Book Private Limited*
- *T. Koshy, Elementary Number Theory with Applications, Academic Press is an imprint of Elsevier*
- *K. H. Rosen, Elementary Number Theory and its Applications, Addison-Wesley, Publishing Company*
- *M. Mushtaq Suhail, Elementary Theory of Number, Jadeed book depot, Urdu bazaar Lahore*

PS-132 Ideology and Constitution of Pakistan

Prerequisite: None
Credit Hours: 2+0
Specific Objectives of the Course:

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

Course Outline:

I. CREATION OF PAKISTAN

a) Ideology: Conservative and liberal perspectives

i) Significance before and after independence

ii) Quaid-e-Azam's vision about Pakistan

b) POLITAICAL DYNAMICS

i) Democracy and authoritarianism

1. **Political Culture**: Parities and pressure groups

iii) National integration: Resources and distribution

iv) Governance and civil rights

II. ECONOMY

i) Agro-industrial growth

ii) Irrigation projects

iii) Economic development and poverty alleviation

iv) Foreign aid and economic stability

v) Characteristics of developing countries

III. FOREIGN POLICY

Determination of foreign policy, national interests, post-cold war environments of pakistan: new world, order and nuclear non-proliferation

IV. ENVIRONMENT; definition and dimensions, management and natural resources environmental pollutions: industrial; agricultural; land; water; air and space environmental protection

V. POPULATION: Characteristics: Rural; urban; gender; age groups; and population growth, economic indicators: employment; education health and poverty, migration

VI. SOCIETY: Definitions**,** characteristics: multilingual, multi-ethnic and parochial, social stratification and social mobility, social problems

VII. CULTURE: Definitions, social organization; kinships; family; clan and tribe,material and non-material cultures, cultural institutions

Books Recommended

1. *Shahid Javed Burki, State and Society in Pakistan, The Macmillan Press Ltd.1980 (Reprint, 1997)*
2. *Wayne Wilcox The Emergencies of Bangladesh, Washington American Enterprise Institute of Public Policy Research 1972*
3. *Safdar Mehmood Pakistan Kayyum Tooda Idara-Saqafat-e-Islamia, ClubRoad Lahore*
4. *Tahir Amin National Movement of Pakistan Institute of Policy studies Islamabad.*
5. *Lawrence Ziring, Enigma of Political Development, WmDawson and son Ltd.Cannon House Falkstone. Kent England 1980*
6. *Waseem Ahmad Pakistan under Marshal Law, Lahore 2002*
7. *Ansar Zahid, History and culture of Sindh, Karachi Royal Book Company1980*
8. *G.A Allana culture of Pakistan*
9. *Enamery Shamil The Pearls of Sindh*
10. *M Rafique Afzal Political Parties in Pakistan Vol I, II, and III Islamabad National of Historical and culture Research 1998*
11. *Inyatullah Bureaucracy, Development in Pakistan Peshawar 1996*
12. *M Ikram Rabbani Pakistan Affairs Lahore Carwan Book House 1997*
13. *M Ikran Rabbani and Munawar Ali Sayyid An introduction to Pakistanstudies Karwan Book House 1999*
14. *Crompton.S.W. Pakistan (Modern World Nations) (2nd Edition).2006. ChelseaHouse Publications*

4th SEMESTER

MGC-441 Natural Sciences (Modern Physics)

Prerequisite(s): Physics at Intermediate level
Credit Hours: 2 + 1
Course Outline:
Origin of quantum theory: Black body radiation, Stefan Boltzmann, Wien's and Planck's law, consequences. The quantization of energy, Photoelectric and Compton effect, Line spectra, Explanation using quantum theory, Wave Nature of Matter: Wave behavior of particle (wave function etc) its definition and relation to probability of particle, De-broglie hypothesis and its testing, Davisson-Germer Experiment and J.P. Thomson experiment, Wave Packets and particles, localizing a wave in space and time, wave function, Normalization, expectation value, Atomic Physics: Bohr's theory (review), Frank-Hertz experiment, energy levels of electron, Atomic spectrum, Angular momentum of electrons, vector atom model, Orbital angular momentum. Spin quantization, Bohr's Magneton. X-ray spectrum (Continuous and Discrete) Moseley's law, Pauli's exclusion principle and its use in developing the periodic table, Nuclear Physics: Basic properties of a nucleus, Mass and Atomic Numbers, Isotopes, mass and size of a nucleus, Nuclear force (Basic Idea), Nuclear Radii, Nuclear masses, Binding energy, mass defect, Nuclear Spin and Magnetism, Natural Radioactivity: Laws of radioactive decay, half-life, mean life, chain disintegration; Alpha- Beta and Gamma decays (Basics idea), Measuring ionizing radiation (units i.e. Curie, Rad etc.), Nuclear Reactions: Basic Nuclear reaction, Q-value, Exothermic, Endothermic Nuclear model , Nuclear Fusion, Thermonuclear Fusion.
Recommended Books:

- *Halliday, D. Resnick, Krane, Physics, Vol. I & II, John Wiley, 5th edition, 1999*
- *Halliday, D. Resnick & Walker, Fundamental of Physics, Extended ed. John Wiley 5th Ed*
- *A. Beiser, Concepts of Modern Physics, 4th edition McGraw-Hill book Company, 1987*

MMC-444 Software Packages

Prerequisite(s): Introduction to Computer
Credit Hours: 3(2+1)
Specific Objectives of the Course:
The purpose of this course is to teach students the use of mathematical software's like MATLAB, MAPLE, and MATHEMATICA for solving computationally-difficult problems in mathematics. The students shall become well-versed in using these mathematical software's and shall learn a number of techniques that are useful in calculus as well as in other areas of mathematics.
Course Outline:
The contents of the course are not fixed, however the following points should be kept in mind while teaching the course. The course should be taught in a computer lab setting. Besides learning to use the software, the students must be able to utilize the software to solve the computationally difficult problems in calculus and other areas of mathematics. At the end of the course, the students should have a good command on at least two of the three programs mentioned above. Introduction to simulations by using the mentioned software.
Recommended Books:

- *D. M. Etter, D, Kuncicky, D. Hull, Introduction to MATLAB, Prentice Hall, Englewood Cliffs,NJ, USA, 2001*

- *F. Garven, The Mapple Book, Chapman & Hall/CRC, 2002*
- *S. Kaufmann, Mathematica As a Tool, An Introduction with Practical Examples, Springer, New York, 1994*

MMC-445 Calculus-III

Prerequisite(s): Calculus –I and II
Credit Hours: 4+0
Specific Objectives of the Course:
Multivariate calculus is serving as the foundation of advanced subjects in all areas of mathematics. The sequence, equally, emphasizes the basic concepts and skills needed for mathematical manipulation. The main focus will be on the study of functions having two, three or more variables.
Course Outline: Function of several variables, limit and continuity, derivability and differentiability, chains rules, properties of several variable function, Euler's theorem, total differentials and explicit and implicit functions, extreme values: maxima and minima with or without constraints, Tayler's theorem in multi variable and its various form, chain of variables, functions of functions, double and triple integrals with applications (area of surfaces and volumes of revolution using double and triple integrals) line integrals, integration on R^2 : integrals over a region, the Green's, the divergence and the Stokes theorems with applications.
Recommended Books:
- *J. Stewart, Calculus, 8th edition, Cengage Learning, 2016*
- *H. Anton, I. Bevens, S. Davis, Calculus (10th edition or latest), John Wiley & Sons, 2012*
- *G. B. Thomas, AR Finney, Calculus (11th edition or latest), Addison-Wesley, 2005*

MMC-446 Linear Algebra

Prerequisite(s): Basic Algebra
Credit Hours: 4(4 + 0)
Specific Objectives of the Course:
This is a course in abstract linear algebra. The majority of follow up courses in both pure and applied mathematics assume the material covered in this course.
Course Outline: Algebra of matrices, determinants, matrix of a linear transformation, row and column operations, rank, inverse of matrices, solution of homogeneous and non-homogeneous equations, orthogonal transformation. Vector spaces, subspaces, linear dependence and independence, linear span of a subset of a vector space, bases and dimensions of a vector space, sums and direct sums of subspaces of a finite dimensional vector space, dimension theorem, linear transformation, null space, image space of linear transformation, rank and nullity of a linear transformation, relation between rank, nullity and dimension of the domain of a linear transformation, matrix of linear transformation, change of basis, inner product spaces, orthogonal and orthonormal basis, similar matrices and diagonalization of a matrix, Home (V,W), dimension and basis of Home (V,W), dual space and dual basis, annihilators, Eigen values and Eigen vectors and minimal polynomials.
Recommended Books:
- *S. Axler, Linear Algebra Done Right, Undergraduate Texts in Mathematics, Springer, 2015*
- *G. Birkhoff, S. Maclane, A Survey of Modern Algebra, AKP*
- *W. L. Perry, Elementary Linear Algebra, McGraw-Hill, 1988*

BBA-135 Entrepreneurship

Prerequisite(s): There are no specific educational requirements to become an entrepreneur. Some of the most important skills and traits that are helpful for entrepreneurs include critical thinking, creativity, risk-taking, problem-solving, networking, leadership, and communication skills
Credit Hours: 2+0

Course Description

This course is designed for the students to understand that Starting & amp; operating a new business which involves considerable risk & an effort to overcome the inertia against something new. In creating and growing a new venture, the entrepreneur assumes the responsibility and risks for its development & survival and enjoys the corresponding rewards. In the end the students will be able to develop business plans to start and initiate their own ventures.

Chapter-01

Introduction

Entrepreneurship and the Entrepreneurial Mind-Set Entrepreneurial Intentions and Corporate Entrepreneurship Entrepreneurial Strategy: Generating and Exploiting New Entries

Chapter-02

From Idea to Opportunity

Creativity and the Business Idea

Identifying and Analyzing Domestic and International Opportunities

Intellectual Property and Other Legal Issues for the Entrepreneur

Chapter-03

From the Opportunity to the Business Plan

The Business Plan: (Creating and Starting the Venture)

The Marketing Plan

The Organizational Plan

The Financial Plan

Chapter-04

From the Business Plan to Funding the VentureSources of Capital

Informal Risk Capital, Venture Capital, and Going Public Strategies for Growth and Managing the Implication of GrowthAccessing Resources for Growth from External Sources

Succession Planning and Strategies for Harvesting and Ending the Venture

Suggested Readings

1. *Entrepreneurship by Robert d Hisrich 10th edition McGra Hill publicationsEntrepreneurship by Donald F. Kuratko and Richard M Hodgetts.*

SOC-116 Social Sciences (Social Anthropology)

Prerequisite(s): Nil
Credit Hours: 2(2+0)
Specific Objectives of the Course:
The course aims to the study of human society and cultures through a comparative lens. Social anthropologists seek to understand how people live in societies and how they make their lives meaningful.
Course Outline:

1. **Introduction**
   a. Definition, Concept and Branches: physical, social, archaeology, liguisitics
   b. Relationship of anthropology with other social sciences,
   c. Relation between sociology and anthropology
   d. Anthropological research techniques
   e. Growth of anthropological theories
2. **Evolution**
   a. Evolution of Evolution
   b. Mendel's Law of Segregation
   c. Mitosis & Meiosis
3. How we discover Past
   a. Kinds of evidence
   b. Analyze & dating the evidence
   c. Site creation
4. The Living Primates
   a. Common features of primates
   b. Classification of primates
   c. Hominoids
5. Primates Evolution: From Early Primates to Hominoids
   a. Eon, Eras & Epochs
   b. SsCenozoic Era In detail
6. The first Hominoids
   a. Australopithecus Anamensis
   b. Australopithecus afarensis & africanus
   c. Australopithecus Robustus
   d. Homo *heidelbergensis/neanderthalensis*.
   e. Homos habilis
   f. Homo erectus
   g. Homo Sapiens
7. **The Stone Age**
   a. Paleolithic
   b. Mesolithic
   c. Neolithic
8. Culture
   a. The nature of culture
   b. Definition, Properties and Taxonomy
   c. the evolution and growth of culture
   d. universal aspects of culture
   e. Material and Non-Material aspects
   f. Cultural Diversity and Integration
   g. Globalization and culture
9. **Origin of Cities & States**

10. Origin of Food Production & Settled Life

11. Language and Communication

a. Origin of language
b. Structure of language
c. Socio-linguistics
d. Nonverbal communication

12. Marriage

a. Kinship
b. Types of Marriage
c. Concept of Incest Taboo
d. Kinship systems,
e. Rule of decent
f. Types of decent system

13. Political System

a. Kind of political systems
b. Political system and economic system

14. Religion

a. Origin, functions of religion
b. Religion and cultural ecology
c. Religion and social control
d. Kinds of religion
e. Witchcraft and Sorcery

Recommended Books:-

2. *Bernard, H. Russel. 1994. Research Methods in Anthropology, Qualitative and Quantitative Approaches. London: Sage Publications*
3. *Ahmad, Akbar S. 1990. Pakistani Society, Karachi, Royal Books Co.*
4. *Bodley, John H. 1994. Cultural Anthropology, California: Mayfield Publishing Co.*
5. *Brogger, Jan. 1993. Social Anthropology and the Lonely Crowd. New Delhi: ReliancePublishing*
6. *Ember, Carol R. & Ember Melvin. 1990. Anthropology, 6th ed. Englewood Cliffs: PrenticeHall, Ince. Harper and Row*
7. *Harris Marvin. 1987. Cultural Anthropology. New York: Harper and Row*
8. *Harris Marvin. 1985. Culture, People, nature; An Introduction to General AnthropologyLondon: Harper and Row*
9. *Hertzler J. O. 1981. The Social Structure of Islam. Cambridge: Cambridge University Press*
10. *Kennedy, Charles H. 1992. Pakistan London: Westview Press, Oxford*
11. *David Pocock, (1998) "Understanding Social Anthropology". The athlone press London;*
12. *Eliotd Chapple & Carletons S. coon (2004) Principles of Anthropology cosmo publications, India;*
13. *Fellmann/Getis/ Fellmann (1985) Human Geography (Land scope of human activates).*

5th SEMESTER

MMC- 551 Algebra-II (Ring Theory and Fields)

Pre-requisite(s)**:** Algebra-I
Credit Hours: 3+0
Specific Objectives of the Course: a ring will be defined as an abstract structure with a commutative addition, and a multiplication which may or may not be commutative. This distinction yields two quite different theories: the theory of respectively commutative or non-commutative rings.
Course Outline: Introduction to Ring theory and Field and their structure, Quotient Rings, Integral domain, Homomorphism of a Ring, Kernel of a Ring, Isomorphism of a Ring, Maximal ideals, Prime ideals, Euclidian rings, or Euclidian domain, Polynomial rings over a unique factorization domain, the field of quotients of an integral domain, Field structure, Ordered ring and field, introduction to extension field, Algebraic extensions, Finite field.
Recommended Books:

- *R.B.J.T. Allenby (1991). Rings, Fields and Groups. Butterworth-Heinemann. ISBN 0-340-54440-6.*
- *Atiyah M. F., Macdonald, I. G., Introduction to commutative algebra. Addison-Wesley Publishing Co., Reading, Mass.-London-Don Mills, Ont. 1969, pp 128.*
- *T.S. Blyth and E.F. Robertson (1985). Groups, rings and fields: Algebra through practice, Book 3. Cambridge university Press. ISBN 0-521-27288-2.*
- *Faith, Carl, Rings and things and a fine array of twentieth century associative algebra. Mathematical Surveys and Monographs, 65. American Mathematical Society,*

MMC-552 Real Analysis-I

Prerequisite(s): Calculus-I, Calculus-II and III
Credit Hours: 3 + 0
Specific Objectives of the Course:
This is the first rigorous course in analysis and has a theoretical emphasis. It rigorously develops the fundamental ideas of calculus and is aimed to develop the students' ability to deal with abstract mathematics and mathematical proofs.
Course Outline:
Real number system and extended real number system, convergence of sequence, sub-sequences, Cauchy sequences and completence, sequence and series and various test for the convergence of the series, Cauchy general principle of convergence, continuous functions and their properties, discontinuity, monotonic functions, differentiation, and uniform continuity, term by term differentiation and integration, intermediate value and Darboux theorem, definition and existence of the integral, the integral as a limit of sum, Riemann integration theory, functions of several variables, continuity and total differentials, extreme values (maxima and minima), implicit function theorem, Jacobian's, improper integrals and their convergence.
Recommended Books:

- *R. G. Bartle, DR. Sherbert, Introduction to Real Analysis (3rd edition), 1999, John Wiley.*
- *W. Rudin Introduction to Mathematical Analysis.*
- *Apostal, Mathematical Analysis.*
- *E. G. Philips, A course of Analysis.*

- *W. Kaplan, Advance Calculus.*
- *W. Fulks, Advanced Calculus, John Wiley, New York.*
- *S. C. Malik, Mathematical Analysis.*

MMC-553 Vector and Tensor Analysis

Prerequisite(s): Calculus and Analytical Geometry
Credit Hours: 3 + 0
Specific Objectives of the Course:
This course shall assume background in calculus. It covers basic principles of vector and tensor analysis which are frequently used in applied mathematics.
Course Outline:
Vectors in 3 dimension, the dot and the cross products, triple products, vector differentiation, vector integration, the gradient, divergence, curl, and their applications, the divergence theorems of Gauss, Stokes's theorem, and Green's theorem in the plane, curvilinear coordinates, introduction to tensor analysis, summation convention, kronecker delta, contra variant and covariant vectors and tensor, Fundamental operations with tensors, symmetric, and skew symmetric tensors, Metric tensor, conjugate or reciprocal tensors, christoffel's symbols, Geodesics, Geodesics equation, Covariant derivatives, permutation symbols and tensors, tensors form of gradient, divergence and Curl.
Recommended Books:
- *Bourne D. E, Kendall PC, Vector Analysis and Cartesian Tensors (2nd edition).*
- *N. A. Shah, Vector and Tensor Analysis, 2005, A-One Publishers, Lahore.*
- *G. D. Smith, Vector Analysis, Oxford University Press, Oxford.*
- *M. R. Spiegel, Vector Analysis, 1974, McGraw Hill, New York.*

MMC- 554 Differential Geometry

Prerequisites: Calculus-II
Credit Hours: 3 + 0
Specific Objectives of the Course:
In this course the students will be familiarizing with planes and planes curves and the action of total and partial differentials on varies planes.
Course Outlines:
Space Curve, The moving trihedral Curvature, Torsion and skew curvature, Serret-Frenet formula, Osculating circle and sphere, Curves of constant slope or cylindrical helices, The spherical indicaterices and their curvature and torsion, Concepts of surface. Tangent plane, Envelope and characteristics relating to one parameter family of surfaces, Edge of regression, Developable surfaces and developable associate with a space curve, Parametric curves, Two fundamental forms, Meosnier's theorem, Principal directions and principal curvature, Lines of curvature, Euler's theorem, Geodesics and Geodesic equations.
Recommended Books:
- *C. E. Weatherburn, Differential Geometry of three Dimensions, Cambridge University Press.*
- *D. J. Struik, Lecture on classical Differential Geometry, Addison Wesley Publishing.*
- *T. J. Wilmore, An Introduction to Differential Geometry, Clarendon Press, Oxford.*

MMC-555 Topology

Prerequisites: Calculus and Set Theory
Credit Hours: 3 + 0
Specific Objectives of the Course:
This course provides a simple concept of set and the action of functions on various sets. It also gives the detailed what is topology and metric spaces and how they are formed from specific sets. It also discusses the continuity rule upon the topological and metric spaces. In this course a brief introduction is discussed about closed, derived open set exterior, interior, neighborhood, sphere, open sphere and closed sphere.
Course Outlines:
Topological spaces, limit points (or accumulation points), derived set, closure of a set, interior, exterior and boundary points, sub-space and relative topology, real line topology and its examples, metric spaces, limit point, adherent point, closure of a set, sequences in metric space, complete metric spaces and its basic theorems and examples, Bairs category theorems and Cantor intersection theorem, continuity and homeomorphism: continuous functions, continuous functions in topological spaces, convergent sequences, homeomorphism, open function, closed functions, bases and sub-bases, definitions of base and sub-bases of topological and metric spaces and fundamental results and examples.
Recommended Books:

- *M. Iqbal, Introduction to Topology*
- *Dr. A. Majeed, Introduction to general Topology and Functional Analysis*
- *C. Adams, R. Franze, Introduction to Topology pure and Applied*

MMC-556 Ordinary Differential Equations

Pre-requisite(s)**:** Calculus
Credit Hours: 3+0
Specific Objectives of the Course:
This course will provide the foundation for all advanced subjects in Mathematics. Strong foundation and applications of Ordinary Differential Equations is the goal of the course.
Course Outline:
Basic definition of differential equations, formation of differential equations, initial and boundary value problems, differential equations of the first order and first degree, equations with separable variable, homogeneous differential equations, equations reducible to homogeneous form, exact differential equations, integrating factors, rules for determinations of integrating factors, linear equations of the first order, Non-linear equations of the first order, linear differential equations of high order, solution of homogeneous linear equations, principle of superposition and Wronksian, determination of particular integral, short methods for finding particular integral, orthogonal trajectories, Cauchy-Euler equations, 2^{nd} order linear differential equations, reduction of order method, undetermined Coefficient method, variations of parameters method.
Recommended Books:

- *D.G. Zill, M.R, Cullen, Differential Equations with Boundary-Value Problems, (latest Edition), PWS Publishing Company.*
- *D.G. Zill, Advanced Engineering Mathematics, Jones and Bartlett Publishers, 2005.*
- *Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley and Sons (9^{th} edition).*
- *G.E. Andrews, R. Askey, and R. Roy, Special Functions, Cambridge University Press.*

6th SEMESTER

MMC-561 General Topology

Prerequisite: Basic Topology
Credit hours: 3+0
Specific Objectives of the Course:
This course deals with the topological properties of figures with the help of which we can study complicated geometrical figures by decomposing them into simplest geometrical figures. It is used in Geography, Physics, Computer and studying different crystal structure and Allotropic forms of various elements in Chemistry.
Course Outlines:
Separation Axioms, introduction of T_0, T_1, T_2, T_3 and T_4 spaces, normal and regular and completely regular spaces, Urysohn's lemma and metrization theorem, hereditary properties, Bair's Category theorems, Cantor set and Canter intersection theorem, compactness, covers and open covers, compact set and compact subset, Hein Borel theorem for compactness and sequentially compact sets and locally compact sets, connectedness, connect and separated sets and spaces, connectedness on the real line, components, locally connectedness, Path and arc wise connectedness, product spaces, product topology and product of metric spaces, base for finite product topology examples of product spaces.
Recommended Books:

- *A. Majeed, Introduction to general Topology and Functional Analysis*
- *S. Willards, General Topology Adison Wesley N.Y. 1970*
- *C. Adams, R. Franze, Introduction to Topology pure and Applied*
- *G. F Simmon, Introduction to Topology and Modern Analysis, McGraw Hill book*

MMC-562 Complex Analysis

Prerequisites: Calculus and Analytical geometry
Credit Hours: 3 + 0
Specific Objectives of the Course:
This is an introductory course in Complex Analysis, giving the basics of the theory along with applications, with an emphasis on applications of complex analysis and especially conformal mappings. Students should have a background in real analysis (as in the course Real Analysis I), including the ability to write a simple proof in an analysis context.
Course Outlines:
The algebra and the Geometry of complex numbers, Cauchy-Riemann equations, harmonic functions, elementary functions, branches of logarithm, complex exponents, Contours and contour integrals, the Cauchy-Goursat theorem, Cauchy integrals formulas, the Morera theorem, maximum modules principle, the Liouville theorem, the Roche theorem, fundamental theorem of Algebra, Convergence of sequences and series, the Taylor series, the Laurent series, uniqueness of representation, zeros of analytic functions, Residues and poles and the residue theorem, evaluation of improper integrals involving trigonometric functions, integrals around a branch point, the argument principle, Special function Beta, Gamma functions and hyper geometric and Legender functions.
Recommended Books:

- *R. V. Churchill, J. W. Brown, Complex Variables and Applications (5th edition), 1989*
- *Complex Analysis, Schaum's Outlines Series*
- *Ablowitz, M. J., & Fokas, A. S. Introduction to complex variables and applications. (2021). https://doi.org/10.1017/9781108961806*

MMC-563 Classical Mechanics

Prerequisite(s): Vector and Tensor Analysis
Credit Hours: 3 + 0
Specific Objectives of the Course:
This course builds grounds in principles of classical mechanics, which are to be used while studying quantum mechanics, statistical mechanics, electromagnetism, fluid dynamics, spaceflight dynamics, astrodynamics and continuum mechanics.
Course Outline:
Particle kinematics, radial and transverse components of velocity and acceleration, circular motion,newtonian mechanics, the Newtonian model of gravitation, calculus of variations, Hamilton's principle, lagrangian and hamiltonian dynamics, symmetry and conservation laws, central-force motion, two-body problem, orbit theory, Kepler's laws of motion (the law of ellipses, the law of equal areas, the harmonic law), satellite motion, geostationary and polar satellites, kinematics of two-particle collisions, Basics of special theory of relativity, motion in non-inertial reference frame, rigid-body dynamics,3-D-rigid bodies and mechanical equivalence, center of mass and gravity, motion of a rigid body, inverted pendulum and stability, gyroscope), coupled oscillations, vibrating strings, wave equation in one dimension.

Recommended Books:

- *A. Bedford, W. Fowler, Dynamics: Engineering Mechanics, Addision-Wesley, Reading,*
- *T. L. Chow, Classical Mechanics, 1995, John Wiley, New York*
- *H. Goldstein, Classical Mechanics (2nd edition), 1980, Addison-Wesley, Reading*
- *J. B. Marion, Classical Dynamics of Particles and Fields (2nd edition), 1970, New York*
- *J. L. Synge, B. A. Griffith, Principles of Mechanics, McGraw Hill, New York*

MMC-564 Partial Differential Equations

Pre-requisite(s)**:** Ordinary Differential Equations
Credit Hours: 3+0
Specific Objectives of the Course:
This course will provide a strong foundation to solve different kinds of PDEs using different techniques.
Course Outline:
Classification of PDEs, First-order linear PDEs, The method of characteristics, General constant coefficient first-order linear PDEs, Variable coefficient first-order linear PDEs, Two-Point Boundary Value Problems, Fourier series, The Fourier Convergence Theorem, Even and Odd Functions, Separation of Variables; Heat, Wave and Laplace equations and its solution by the method of separation of variable in rectangular, polar, cylindrical and spherical coordinates
Recommended Books:

- *Lokenath Debnath, Tyn Myint-U, Linear Partial Differential Equations for Scientists and Engineers*
- *William E. Boyce, Richard C. DiPrima, Elementary Differential Equations and Boundary Value Problems*
- *Nakhle H.Asmar, Partial differential Equation with Fourier Series and Boundary Value Problem, New Jersey*
- *Richard Haberman, Elementary Applied Partial Differential Equations with Fourier Series and Boundary Value Problems, 1997*

- *Dennis G. Zill, Differential Equations with Boundary Value Problem, PWS Publishing Company*

MMC-565 Real Analysis-II

Prerequisite(s): Real Analysis-I
Credit Hours: 3 + 0
Specific Objectives of the Course:
A continuation of real analysis, this course rigorously develops integration theory. Like real integral calculus and real analysis emphasizes on proofs.
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:
- *R. G. Bartle, D. R. Sherbert, Introduction to Real Analysis (3rd edition), 1999, John Wiley, New York*
- *W. Rudin, Introduction to Mathematical Analysis*
- *Apostal, Mathematical Analysis*
- *E. G. Philips, A Course of Analysis*
- *W. Kaplan, Advance Calculus*
- *W. Fulks, Advanced Calculus, John Wiley, New York*
- *S. C. Malik, Mathematical Analysis*

MMC-566 Functional Analysis

Prerequisite(s): Linear Algebra and Basic Topology
Credit Hours: 3 + 0
Course Outline:
Normed spaces: Definition and examples of Normed spaces, convergent sequences, Cauchy sequences in norm spaces, equivalent norm, quotient norm, and theorems on normed space, Banach Spaces: Definition and examples of Banach spaces, Characterization of Banach spaces, Bounded Linear Transformations, Functional and their examples, Various characterizations of bounded (continuous) linear operators, The space of all bounded linear operators, The open mapping and closed graph theorems, principle of uniform boundedness. Hahn-Banach theorem on norm spaces. Some important consequences of the Hahn-Banach theorem, Hilbert Spaces: Inner product spaces and their examples, The Cauchy-Schwarz inequality, Hilbert spaces, Orthogonal complements, The projection theorem, The Riesz representation theorem. Bounded linear operators in Hilbert spaces. Spectral properties of bounded linear operator in Hilbert spaces.

Recommended Book:

- *E. Kreyszig, Introductory Functional Analysis with Applications, John Wiley, 1978*
- *J. Maddox, Elements of Functional Analysis, Cambridge, 1970*
- *G. F. Simmon, Introduction to Topology and Modern Analysis, Mc-Graw-Hill, N.Y.1983*
- *W. Rudin, Functional Analysis, Mc-Graw-Hill, N.Y., 1983*

7th SEMESTER

MMC-671 Numerical Analysis

Prerequisite(s): Calculus and Basic Algebra
Credit Hours: 3 + 1
Specific Objectives of the Course:
This course is designed to teach the students about numerical methods and their theoretical bases. The students are expected to know computer programming (i.e. Matlab, Mathcad etc.) to be able to write program for each numerical method. Knowledge of calculus and linear algebra would help in learning these methods and to form basic Matlab codes for these.
Course Outline:
Introduction to error analysis, method for the solution of nonlinear equation and their convergence, bisection method, Regula Falsi method, fixed point iteration method, Newton-Rapson method, Secant method, interpolation and polynomial approximation, Lagrange's interpolation, Newton's divided difference, Forward difference and Backward difference formulae, Laplace and Bassel formula of interpolation, numerical integration and error estimates, Rectangular, Trapezoidal and Simpson rule, numerical solution of system of algebraic linear equation: Gauss elimination method, Gauss Jordon method, matrix inversion, Cramer's rule, LU decomposition, Choleski's factorization method, Tridiagonal method, Jacobi and Gauss Seidal methods. The method of characteristics, Eigen value problems; Estimation of Eigen values and corresponding error bounds, Gerschgorins theorem and its applications Schurs theorem, Power method, Shift of origin, Deflation method for the subdominant Eigen values.
Recommended Books:

- *K. E. Atkinson, An Introduction to Numerical Analysis (2^{nd} edition), 1989, John Wiley,*
- *R. L. Burden, J. D. Faires, Numerical Analysis (5^{th} edition), 1993, PWS Publishing*
- *S. C. Chapra, R. P. Canale, Numerical Methods for Engineers, 1988, McGraw Hill, New*
- *N. Bhatti, Numerical Analysis with C^{++} 5^{th} edition*

MMC-672 Mathematical Methods

Prerequisite(s): Ordinary differential equations and Partial Differential Equations
Credit Hours: 3+0
Specific Objectives of the Course:
The purpose of this course is to teach students, various methods and techniques for solving differential equations of applied nature and applications.
Course Outline:
Introduction to power series, series solutions, solutions about ordinary point, singular points and regular points of ordinary differential equations, Frobenius methods; Case-I, Case-II, solutions of Bassel and Legendre equations, kinds of Basel equations and applications, Harmit and Hyper geometric differential equations, Sturm-Liouville problems and boundary value problems, 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. and its properties, applications of Laplace transform in solutions of differential equations, solutions of systems of differential equations by Laplace equations, heat, wave and Laplace equations and its solution by Laplace transform.

Recommended Books:

1. *D. G. Zill, M.R. Cullen, Differential Equations with Boundary-Value Problems, (latest Edition), PWS Publishing Company*
2. *A. K. Sharma, Advanced Differential Equations, Discovery Publishing House, 2010*

8th SEMESTER

MMC-681 Probability Theory

Pre-requisite(s): Calculus
Credit Hours: 3 + 0
Specific Objectives of the Course:
This course is designed to teach the students how to handle data numerically and graphically. If data are influenced by chance effect, the concepts and rules of probability theory may be employed, being the theoretical counterpart of the observable reality, whenever *chance* is at work.
Course Outline: Probability, random and continuous variables, probability distributions, mean, standard deviation, variance and expectation, Mathematical expectation, Discrete distribution: Moment generating and cumulative distributions, Discrete probability distribution, The Binomial distribution, Hyper geometric distribution, Negative Binomial distribution, the Poisson distribution, Geometric distribution, Uniform distribution, Continuous distribution: Uniform distribution, the normal exponential distributions, Gamma and Beta distributions, Cauchy distribution, Log-Normal distribution, Weibull distribution.
Recommended Books:

- *M. H. DeGroot, M. J. Schervish, Probability and Statistics (3rd edition), 2002, Addison-Wesley, Reading, Ma, USA*
- *Papoulis, Probability, Random Variables, and Stochastic Processes, (3rd edition), 1991, McGraw Hill, New York*
- *T. Sincich, Statistics by Examples, 1990, Dellen Publishing Company.*

MMC- 682 Integral Equations

Prerequisite(s): Differential Equations
Credit Hours: 3 + 0
Course Outline:
Introduction to Integral equation, their origin and classification, some important identities, Laplace, Fourier and other Transforms, Volterra Integral equation, Volterra Integral equation of first kind and second kind, Numerical solution of Volterra integral equation, Fredholm Integral equation, Fredholm Integral equation with degenerate kernel, and with symmetric Kernel, Fredholm Integral equation of the second kind with numerical Solution, the Green's function of Fredholm Integral equation and the Green's function existence of the solution.
Recommended Books:

- *Abdul J. Jerri, Introduction to Integral Equations with Applications, 1985*
- *W. V. Lovitt, Linear Integral Equations, Dover Publications 1950*
- *F. Smith, Integral Equations, Cambridge University Press*
- *F. G. Tricomi, Integral Equations, Interscience, 1957*

CONTENTS OF ELECTIVE COURSES

MEC-674 Mathematical Modeling

Prerequisite(s): Differential Equations
Credit Hours: 3 + 0
Specific Objectives of the Course:
Mathematics is used in many areas such as engineering, ecological systems, biological systems, financial systems, economics, etc. In all such applications one approximates the actual situation by an idealized model. This is an introductory course of modeling, consisting of three parts: modeling with ordinary differential equations and their systems; partial differential equations; and integral equations. The course will not be concerned with the techniques for solving the equations but with setting up the equations in specific applications. Whereas the first two types of equations have already been dealt with, the third type has not. Consequently, solutions of the former will be discussed but of the latter will barely be touched upon.
Course Outline:
Concepts of model, modeling and simulation functions, linear equations, linear-differential equations, nonlinear differential equations and integral equations as models, introduction to simulation techniques ordinary differential equations: modeling with first order differential equations: Newton's law of cooling; radioactive decay; motion in a gravitational field; population growth; mixing problem; Newtonian mechanics. Modeling with second order differential equations: vibrations; Modeling with periodic or impulse forcing functions, Modeling with systems of first order differential equations; Partial Differential Equations: Methodology of mathematical modeling; objective, background, approximation and idealization, model validation, compounding, Modeling wave phenomena (wave equation); Modeling the heat equation and some application to heat conduction problems in rods, Modeling the potential equation (Laplace equation), Applications in fluid mechanics, gravitational problems, Equation of Continuity.
Recommended Books:

- *F. R. Giordano, MD.Weir, Differential Equations: A Modeling Approach, 1994, Addison-Wesley, Reading, Ma, USA*
- *K. K. Tung, Topics in Mathematical Modeling*
- *U. T. Myint, L. Debnath, Partial Differential Equations for Scientists and Engineers (3rd edition), 1987, North Holland, Amsterdam*
- *S. Robert, An Introduction to Programming and Numerical Methods in MATLAB*

MEC- 675 Advanced Group Theory

Pre-requisite(s)**:** Basic Algebra
Credit Hours: 3+0
Specific Objectives of the Course: The advance algebra is the extention of Abstract algebra which has many applications in structure analysis, etc.
Course Contents: Sylow theory**,** applications of Sylow theory, generating systems for finite symmetric and alternating groups. Simple groups, simplicity of An for 5, Zassenhaus lemma, Normal series, Composition series, Jordan Holder theorem, Solvable groups, The derived series of a group, The lower and upper Central series of a group and Nilpotent groups.

Recommended Books:

1. *E. Arnold, Rings, Fields and Groups: An Introduction to Abstract Algebra, 1983*
2. *A Majeed, Group Theory, Ilmi kitab Khana*
3. *Zia-Ul-Haq, Mathematical Techniques, Carvan Books Publishing Company*
4. *J. B. Farleigh, A First Course in Abstract Algebra (7th edition), Addison-Wesley, Reading, Ma., USA*
5. *I. D. Macdonald, The Theory of Groups, 1975, Oxford Clarendon Press, Ma., USA*
6. *Kiramat Husain Dar, Abstract Algebra, ilmi Kitab Khana Lahore.*

MEC-676 Optimization Theory

Prerequisite(s): Basic Algebra, Real Analysis
Credit Hours: 3 + 0
Specific Objectives of the Course:
The main objective is to teach the basic notions and results of mathematical programming and optimization. The focus will be to understand the concept of optimality conditions and the construction of solutions. Students should have a good background in analysis, linear algebra and differential equations.
Course Outline:
Linear programming: simplex method, duality theory, dual and primal-dual simplex methods, Unconstrained optimization: optimality conditions, one-dimensional problems, multi-dimensional problems and the method of steepest descent. Constrained optimization with equality constraints: optimality conditions, Lagrange multipliers, Hessians and bordered Hessians. Inequality constraints and the Kuhn-Tucker Theorem, The calculus of variations, the Euler-Lagrange equations, functional depending on several variables, variational problems in parametric form, transportation models and networks.
Recommended Books:

- *L. Elsgolts, Differential Equations and the Calculus of Variations, 1970, Mir Publishers, Moscow*
- *B. S. Gotfried, J. Weisman, Introduction to Optimization Theory, 1973, Prentice Hall, Englewood Cliffs, NJ, USA*
- *D. G. Luenberger, Introduction to Linear and Non-Linear Programming, 1973, Addision-Wesley, Reading, Ma, USA*

MEC-677 Measure Theory

Prerequisite(s): Real analysis and Basic topology
Credit Hours: 3+0
Specific Objective of the Course:
This course is devoted to Lebesgue integration and related topics, a basic part of modern analysis. There are classical and abstract approaches to the integral, and we have chosen the classical one. The classical approach is based on the theory of measure. Measure can be defined and studied in various spaces, but we will primarily consider n-dimensional Euclidean spaces.
Course Outlines:
Limit superior , Limit inferior, Measure, Outer measure, Lebesgue measure, Counting Measure, Lebesgue Measurable set, Measurable functions, Elementary properties of measurable function, Lebesgue integral, Riemann integral, Relationship between Riemann and Lebesgue integral, Properties of the Lebesgue integral, The integral of arbitrary measurable functions, Relation between Riemann–

Stieltjes and Lebesgue integrals, L^p spaces, Properties of L^p spaces, Holder inequality, Minkowski inequality.

Recommended Books:

- *Richard L. Wheeden and Antoni Zygmund, Measure and Integral, An Introduction to Real Analysis*
- *Elias M. Stein & Rami Shakarchi, Real Analysis Measure Theory, Integration and Hilbert Spaces, Princeton University Press Princeton and Oxford*
- *N. L. Carothers, Real Analysis, Cambridge University press*

MEC-678 Fluid Mechanics

Prerequisite(s): Calculus, Basics of Physic
Credit Hours: 3 + 0
Course Outline:
Real and ideal fluids, Force , Pressure, Density, Specific volume, Specific weight, Stress and strain, Young's modulus, Viscosity, Surface tension, Steady and unsteady flow, turbulent flow, laminar flow, two-dimensional flow, three-dimensional flow, Eulerian and Lagrangian Flow Descriptions, Path line, Streamline, stream tube, Stream filament, Stream surface, Streak line, The equation of continuity, The acceleration field, The Euler equation, The total derivative, Bernoulli's theorem, Flow of dry water continued, Flux, Vorticity and rotation, The velocity potential, Laplace's equation, Uniform flow, Source and sink, Viscosity, Deformation, The equations of motion for viscous (wet) fluids, The Navier-Stokes equation, Viscous, incompressible, laminar flow, A. channel flow (2D counterpart of pipe flow), No-Slip Condition, Channel flow, Laminar flow in a pipe, Viscous flow past a circular cylinder, Reynolds number, Reynolds number.

Recommended Books:

- *Buffler, Introduction to fluid mechanics PHY2009S, Department of Physics, University of Cape Town*
- *Kundu and Cohen, Fluid Mechanics, 4th Edition, by Academic Press, NY. 2008*
- *G. K. Batchelor, An Introduction to Fluid Dynamics, 2nd Edition, by Cambridge University Press, Cambridge. 2000*
- *F. M. White, Fluid Mechanics, 7th Edition, McGraw Hill, NY, 2011*

MEC-679 Stochastic Processes

Prerequisite(s): Calculus and Mathematical Statistics
Credit Hours: 3+ 0
Specific Objectives of the Course:
The objectives of this course is to make certain that each student knows the theoretical methods of probability models and stochastic processes including Markov chains, Brownian Motion, Queuing theory, and stochastic differential equations.
Course Outline:
Review of probability theory with main emphasis on conditional probability and conditional expectation, Theory of Markov chains, Continuous-time Markov chains, Renewal theory and its application, Queuing theory, stochastic processes, stopping times, continuous times martingales, the Doob-Meyer Decomposition theorem, continuous square-integrable Martingales, Random Walk, Brownian motion, the strong Markov property and the reflection principal, Brownian Filtration, the Brownian sample path, stochastic integrals, The Ito rule, The Girsanov's Theorem, stochastic

differential equations, strong solutions, weak solutions, Gauss-Markov processes, the general one dimensional linear equation, connections with partial differential equations.

Recommended Books:

- *H. Taylor and S. Karlin, An Introduction to Stochastic Modeling, 3rd edition, 1998*
- *Sheldon M. Ross, Introduction to Probability Models, 10th edition, 2010*
- *N. Shiryaev, Probability, Springer, New York, 1995*
- *Karatzas, St. Shreve, Brownian Motion and Stochastic Calculus, Springer-Verlag, New York 1992*

MEC-683 Quantum Mechanics

Prerequisite(s): Modern Physics
Credit Hours: 3+0
Course Outline:
Wave-Particle, Plan-Einstein relation, Debroglie relations, Schrodinger equation, Normalization of wave function, Waves-Pocket, Heisenberg indeterminacy or UIXCER Taint principal, Phase velocity, Group velocity, Stationary states, Properties of a waves function, Linear operators, Orthogonal basis in waves equation, Closure relation, Parseval relation, Orthonormalization relation, Delta functions, Ketand Bro vectors, the adjoint operators, Eigen value equations and observables, Projection operation, Basic postulates of Quantum theory, Implementations of the Schrödinger Equations, Conservative system, Angular momentum, Time-Energy Uncertainty, Raising operators, Spin Observable, Hormonic oscillator, Hydrogenic atoms, Pauli Exclusion Principal.

Recommended Books:

- *D. J. Griffiths, Introduction to Quantum Mechanics, latest edition*
- *R. L. Liboff, Introductory Quantum Mechanics, 4th edition*
- *Quantum Mechanics, Schaum Outline series*

MEC- 684 Heat and Mass Transfer

Pre-requisite(s)**:** Ordinary and Partial differential equations
Credit Hours: 3+0
Specific Objectives of the Course:
This course will provide the basic concepts of conduction, convection and radiation heat transfer. It will help the students to understand how to formulate and be able to solve one and two dimensional conduction heat transfer problems. Solution techniques will include both closed form and numerical methods. Convection effects will be included as boundary conditions. Moreover, the students will understand the fundamentals of the relationship between fluid flow, convection heat transfer and mass transfer and will apply empirical correlations for both forced and free convection to determine values for the convection heat transfer coefficient. They will then calculate heat transfer rates using the coefficients. In addition to this, students will understand the basic concepts of radiation heat transfer to include both black body radiation and gray body radiation and will be able to evaluate radiation view factors using tables and the view factor relationships.
Course Outline:
One-dimensional heat conduction problem, Two-dimensional heat conduction problem, Transient heat conduction, Principles of convection heat and mass transfer, Equations of forced convections, Equations of free convections, Principles of radiation heat transfer, Radiation exchange between surfaces, Heat exchanger analysis, Mass transfer.

Recommended Books:

1. *Incropera and DeWitt, Fundamentals of Heat Mass Transfer, 6th edition.*

MEC- 685 Advanced Number Theory

Prerequisite(s): Number Theory
Credit Hours: 3+0
Specific Objective of the Course:
This course contains some advance topics of number theory, this course enable the students to solve higher degree congruence's. In this course the students also learn to solve an equation containing three variables using modulo concepts etc. This course also familiarize the students with the solutions of an equation in Z_n where n is prime or composite. This subject covers some topics of graduate level.
Course Outline:
Primitive roots, The order of appositive integer, Theory of indices, Lagrange theorem, Polynomials congruence, Quadratic congruence Divisibility in rings, Solutions of Congruence using indices, Quadratic residues, Quadratic residues of primes, Euler Criteria for quadratic residues, Legendre's symbols, Quadratic reciprocity law, The Jacobi symbol, Solution of the problem of the type $ax+by+c=0$, Farey sequences, Continued fractions, Finite continued fraction, Infinite continued fraction, Quadratics congruence with composite moduli, Composites with primitive roots.
Recommended Books:

- *I. Niven, H. S. Zuckerman and H. L. Montgomery, An Introduction to the Theory of Number, John Wiley & Sons, Inc.*
- *K. C. Chowdhury, A First Course in Number Theory, Asian Book Private Limited*
- *T. Koshy, Elementary Number Theory with Applications, Academic Press is an imprint of Elsevier Kenneth*
- *H. Rosen, Elementary Number Theory and its Applications, Addison-wesley*

MEC- 686 Analytical Dynamics

Pre-requisite(s)**:** Classical Mechanics and PDEs
Credit Hours: 3+0
Course Outline:
Dynamics of a Rigid Body; Moments and product of inertia, D' Alembert's principle, Motion about a fixed axis, Linear Momentum and Kinetic energy of a rigid body, Compound pendulum, Motion in two dimension, Finite forces; impulsive forces, Lagrange's equations in generalized coordinates, Dynamics of a Particle; Uniplanar motion, acceleration parallel to fixed axes, polar coordinates, moving axes, central forces, stability of orbits, acceleration varying as the inverse square of the distance, Kapler's laws, Planetary motions, Tangential and Normal accelerations, Motion in a resisting medium, Angular momentum and rate of change of angular momentum for a system of particles.
Recommended Books:

- *S. L. Loney, Dynamics of a particle and Rigid Bodies*
- *F. Charlton, A Text Book of Dynamics*

MEC-687 Difference Equations

Prerequisites: ODEs, PDEs and Numeric and symbolic computations
Credit Hours: 3+0
Aims and objectives: Many problems in probability give rise to difference equations. Difference equations relate to differential equations as discrete mathematics relates to continuous mathematics. Anyone who has made a study of differential equations will know that even supposedly elementary examples can be hard to solve. By contrast, elementary difference equations are relatively easy to deal with. Aside from probability, computer scientists take an interest in difference equations for a number of reasons. For example, difference equations frequently arise when determining the cost of an algorithm in big-O notation. Since difference equations are readily handled by program, a standard approach to solving a nasty differential equation is to convert it to an approximately equivalent difference equation.
Course Contents: Introduction to difference equations**,** classification of difference equations, homogeneous and inhomogeneous, linear and nonlinear difference equations of order one, two and n-order. Difference equations with variable and constants coefficients. Solutions of difference equations by undermined coefficient method. Characteristic polynomial of the equation. Complementary and particular solutions of difference equations. Some Applications of difference equations to real world problems.
Recommended Books:

- *Mathematical Methods, Ilmi Kitab Khana, Lahore*
- *Chiang, Alpha. Fundamental Methods of Mathematical, Economics, McGraw-Hill, 3rd Ed*
- *Baumol, William. Economic Dynamics, Macmillan, third edition, 1970*

MEC-688 Convex Analysis

Prerequisite: Real and Complex Analysis
Credit Hours: 3+0
Specific Objectives of the Course: This course will focus on fundamental subjects in convexity, duality, and convex optimization algorithms. The aim is to develop the core analytical and algorithmic issues of continuous optimization, duality, and saddle point theory using a handful of unifying principles that can be easily visualized and readily understood.
Course Contents: Basic convexity concepts, Definition of a Convex Set, Examples of Convex Sets, Convex Cones Supporting Hyperplane, Hyperplanes and conjugacy, Separation of Disjoint Convex Sets, Convex Functions, Definition of a Convex Function, Properties of Convex Functions, Convexity of Level Sets, Continuity of Convex Functions, Generalizations of Convex Functions, Quasiconvex Functions, Pseudo convex Functions, Relationship Among Various Types of Convexity, Convexity at a Point, Convexity and optimization, Polyhedral convexity, Lagrangian duality, Fenchel duality, conic duality, saddle point theory. Convexity in Hilbert spaces and its applications.
Recommended Books:

- *Bertsekas, Dimitri.* Convex Optimization Theory. *Athena Scientific, 2009*
- *Rockafellar, Ralph.* Convex Analysis. *Princeton University Press, 1996.*
- *Boyd, Stephen, and Lieven Vandenberghe.* Convex Optimization. *Cambridge University Press, 2004*
- *Kreyszig - Introductory Functional Analysis with Applications, latest edition.*

MEC-689 Econometrics

Prerequisite (s): Introduction to Economics and Mathematical Statistics
Credit Hours: 3+0
Specific Objectives of Course:
The course provides a foundation to estimate econometric models with special emphasis on ordinary least square method.
Course Outline:
Introduction, definition and scope of econometrics, econometric models vs. statistical models, ingredients of econometric modeling, specification, estimation, verification or evaluation and forecasting, The classical linear regression model, the simple linear regression model (SLRM), estimation of SLRM by ordinary least squares (OLS) interpretation of estimated coefficients and their economic meanings, hypothesis testing and analysis of variance, the multiple linear regression model (MLRM), estimation of MLR model by OLS and its assumptions interpretation of estimated coefficients and their economic meanings, regression through origin, double log estimation and computation of elasticities, using R-square and adjusted R-square as a measure of 'Goodness of Fit' and some problems with its use, testing the significance of individual coefficients, testing the significance of the model as a whole, analysis of variance.
Recommended Books:

- *D. Gujrati, Basic Econometrics, Mc-Graw Hill, (latest edition)*
- *Koutsoyiannis, Theory of Econometrics, McMillan, (latest edition)*
- *G. M. K Madnani, Introduction to Econometrics Principles and Applications*
- *R.J. Wonnacot, Econometrics, John Wiley, New York*
- *Wonnacot, E. Pindyck, Econometric Models & Economic Forecasts, 3rd edition*
- *Griffiths, Judge, The Theory and Practice of Econometrics, John Willey and Sons.*

MEC-690: Fuzzy Set Theory

Credit Hours: 3+0
Specific Objective of the Course
At the end of the course the readers will be able to learn about classical Sets via Fuzzy Sets, Types of Fuzzy Sets, Operations on Fuzzy Sets, Zadeh's Extension Principle, Fuzzy Relations and Possibility theory.
Course Outlines: Introduction and history of Fuzzy sets with their properties and operations, triangular norms and co-norms, Archimedean t-Norm and t-Conorm, Algebraic t-Norm and t-Conorm, Einstein t-Norm and t-Conorm, Fuzzy Implications, Fuzzy Equivalence, Fuzzy Numbers and their properties, Type of fuzzy numbers, L.R Fuzzy Numbers, Fuzzy Relation, Cardinality of Fuzzy Relation, Operations on Fuzzy Relations, Properties of Fuzzy Relations, Fuzzy Equivalence Relations, Fuzzy Cartesian Product, and Composition, Properties of Composition, Fuzzy Arithmetic, Zadeh's Extension Principle, The Sum and Scalar Multiplication , The Product of Two Fuzzy Numbers, Difference of Fuzzy Numbers, Extensions of Fuzzy Set Theory, Intuitionistic Fuzzy Sets, Interval-valued Intuitionistic Fuzzy Sets, Interval Type II Fuzzy Sets, Fuzzy Set of Type 2, Cubic Sets, Bipolar Fuzzy Sets.
Books Recommended:

1) *Fuzzy Logic with Engineering Applications3rd Edition, 2010, Wiley, India*
2) *Bede, B, Mathematics of Fuzzy sets and Fuzzy Logic, 2013, Springer, New York, USA*

Annexure-D

Quantitative Reasoning and Supporting Courses Codes and Contents for Different Departments of SBBU

The following course codes and contents are suggested for an approval for different Department of Shaheed Benazir Bhutto University, Sheringal Dir (U).

Department	Semester	Course Title	Suggested Course Code	Credit Hours
Computer Sci.	1st	Quantitative Reasoning-I (Calculus and Analytical Geometry)	GQC-311	03
	2nd	Linear Algebra	CAC-321	03
	3rd	Multivariate Calculus	CAC-431	03
	4th	Numerical Computing	CAC-442	03
	1st	Mathematics A for Medical Students	MNC-317	03
	2nd	Mathematics B for Medical Students	MNC-327	03
	2nd	Probability & Statistics	CAC-331	03
	2nd	Applied Physics	CAC-332	03
Biotechnology	1st	Quantitative Reasoning-I (Exploring Quantitative Reasoning)	MGC-130	3+0
	2nd	Quantitative Reasoning-II (Tools for Quantitative Reasoning)	MGC-131	3+0
Sociology	1st	Quantitative Reasoning-I (Exploring Quantitative Reasoning)	MGC-130	3+0

	2nd	Quantitative Reasoning-II (Tools for Quantitative Reasoning)	MGC-131	3+0
Botany	1st	Quantitative Reasoning-I (Exploring Quantitative Reasoning)	MGC-130	3+0
	2nd	Quantitative Reasoning-II (Tools for Quantitative Reasoning)	MGC-131	3+0
Zoology	1st	Quantitative Reasoning-I (Exploring Quantitative Reasoning)	MGC-130	3+0
	2nd	Quantitative Reasoning-II (Tools for Quantitative Reasoning)	MGC-131	3+0
Chemistry	1st	Quantitative Reasoning-I (Exploring Quantitative Reasoning)	MGC-130	3+0
	2nd	Quantitative Reasoning-II (Tools for Quantitative Reasoning)	MGC-131	3+0
Geology	1st	Quantitative Reasoning-I (Exploring Quantitative Reasoning)	MGC-130	3+0
	2nd	Quantitative Reasoning-II (Tools for Quantitative Reasoning)	MGC-131	3+0
Forestry	1st	Quantitative Reasoning-I (Exploring Quantitative Reasoning)	MGC-130	3+0
	2nd	Quantitative Reasoning-II (Tools for Quantitative Reasoning)	MGC-131	3+0
Environmental Sci.	1st	Quantitative Reasoning-I (Exploring Quantitative Reasoning)	MGC-130	3+0
	2nd	Quantitative Reasoning-II (Tools for Quantitative Reasoning)	MGC-131	3+0
Islamic Studies	1st	Quantitative Reasoning-I (Exploring Quantitative Reasoning)	MGC-130	3+0
	2nd	Quantitative Reasoning-II (Tools for Quantitative Reasoning)	MGC -131	3+0
Management Sci.	1st	Quantitative Reasoning-I (Exploring Quantitative Reasoning)	MGC-130	3+0

	2nd	Quantitative Reasoning-II (Tools for Quantitative Reasoning)	MGC -131	3+0
Agriculture	1st	Quantitative Reasoning-I (Exploring Quantitative Reasoning)	MGC-130	3+0
	2nd	Quantitative Reasoning-II (Tools for Quantitative Reasoning)	MGC-131	3+0
English	1st	Quantitative Reasoning-I (Exploring Quantitative Reasoning)	MGC-130	3+0
	2nd	Quantitative Reasoning-II (Tools for Quantitative Reasoning)	MGC-131	3+0
Pakistan Studies	1st	Quantitative Reasoning-I (Exploring Quantitative Reasoning)	MGC-130	3+0
	2nd	Quantitative Reasoning-II (Tools for Quantitative Reasoning)	MGC-131	3+0

Note:

GQC=General Course for Computer Science

CAC=Computer Science Allied Course

MGC= Mathematics General Course

Higher Education Commission

Quantitative Reasoning-I: Exploring Quantitative Skills

(Model Course)

 Credits: 03

Pre-Requisite: Nil
Offering: Undergraduate Degrees (including Associate Degrees)
Placement: I -4 Semesters
Type: Mandatory

DESCRIPTION
Quantitative Reasoning (l) is an introductory-level undergraduate course that focuses on the fundamentals related to the quantitative concepts and analysis. The course is designed to familiarize students with the basic concepts of mathematics and statistics and to develop students' abilities to anal) ze and interpret quantitati\e information. Through a combination of theoretical concepts and practical exercises, this course will also enable students cultivate their quantitative literacy and problem-solving skills while effectively expanding their academic horizon and breadth of knowledge of their specific major / field of study.
COURSE LEARNING OUTCOMES
By the end of this course, students shall have: l . Fundamental numerical literacy to enable them work with numbers, understand their meaning and present data accurately; 2. Understanding of fundamental mathematical and statistical concepts; 3. Basic ability to interpret data presented in various formats including but not limited to tables, graphs, charts, and equations etc.
SYLLABUS

1. Numerical Literacy

Number system and basic arithmetic operations;

- Units and their conversions, dimensions, area, perimeter and volume; Rates, ratios, proportions and percentages;

Types and sources of data;

- Measurement scales;
- Tabular and graphical presentation of data;
- Quantitative reasoning exercises using number knowledge.

2. Fundamental Mathematical Concepts

- Basics of geometry (lines, angles, circles, polygons etc.); Sets and their operations;
- Relations, functions, and their graphs;

Exponents, factoring and simplifying algebraic expressions;

- Algebraic and graphical solutions of linear and quadratic equations and inequalities;

Quantitative reasoning exercises using fundamental mathematical concepts.

3. Fundamental Statistical Concepts

Population and sample;

Measures of central tendency, dispersion and data interpretation;

Rules of counting (multiplicative, permutation and combination); Basic probability theory;

Introduction to random variables and their probability distributions;

Quantitative reasoning exercises using fundamental statistical concepts.

Fiel
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SUGGESTED INSTRUCTIONAL / READING MATERIALS

I "Quantitative Reasoning: Tools for Today's Informed Citizen" by Bernard L. Madison, Lynn and Arthur Steen.

2. Quantitative Reasoning for the Information Age" by Bernard L. Madison and David M. Bressoud.
3. "Fundamentals of Mathematics" by Wade Ellis.
4. "Quantitative Reasoning: Thinking in Numbers" by Eric Zaslow.
5. "Thinking Clearly with Data: A Guide to Quantitative Reasoning and Analysis" by Ethan Bueno de Mesquita and Anthony Fowler.
6. "Using and Understanding Mathematics: A Quantitative Reasoning Approach" by Bennett, J. O. , Briggs, W. L. , & Badalamenti, A.
7. "Discrete Mathematics and its Applications" by Kenneth H. Rosen.
8. "Statistics for Technology: A Course in Applied Statistics" by Chatfield, C.
9. "Statistics': Unlocking the Power of Data" by Robin H. Lock, Patti Frazer Lock, Kari Lock Morgan, and Eric F. Lock.

Higher Education
Commission

Quantitative Reasoning-II: Tools for Quantitative Reasoning

(Model Course)

Credits: 03
Pre-Requisite: Quantitative Reasoning (I)
Offering: Undergraduate Degrees (including Associate Degrees)
Placement: 2 - 4 Semesters
Type: Mandatorv
Fields:

DESCRIPTION

Quantitative Reasonin o (Il) is a sequential undergraduate course that focuses on logical reasoning supported with mathematical and statistical concepts and modeling / analysis techniques to equip students with analytical skills and critical thinking abilities necessary to navigate the complexities of the modern The course is designed to familiarize students with the quantitative concepts and techniques required to interpret and analyze numerical data and to inculcate an ability in students the logical reasoning to construct and evaluate arguments, identify fallacies, and think systematically. Keeping the pre-requisite course of Quantitative Reasoning (I) as its base, this course will enable students further their quantitative, logical and critical reasoning abilities to complement their specific major / field of study.

COURSE LEARNING OUTCOMES

By the end of this course, students shall have:

1. Understandin o of logic and logical reasoning;
2. Understandin u of basic quantitative modeling and analyses;
3. Logical reasoning skills and abilities to apply them to solve quantitative problems and evaluate arguments;
4. Ability to critically evaluate quantitative information to make evidence based decisions through appropriate computational tools.

SYLLABUS

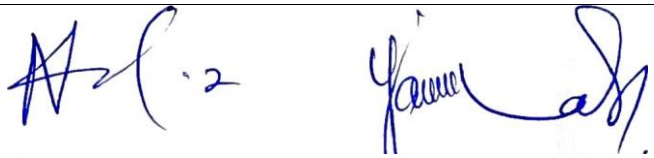
1. Logic, Logical and Critical Reasoning
   Introduction and importance of logic;
   - Inductive, deductive and abductive approaches of reasoning;
   - Propositions, arguments (valid; invalid), logical connectives, truth tables and propositional equivalences;
   - Logical fallacies;

   , Venn Diagrams;
   - Predicates and quantifiers;

   Quant itative reasoning exercises using logical reasoning concepts and techniques.
2. Mathematical Modeling and Analyses
   I n troduction to determ in istic models;
   - Use of linear functions for modeling in real-world situations;
     Modeling with the system of linear equations and their solutions;
     Elementary introduction to derivatives in mathematical modeling;
   - Linear and exponential growth and decay models;

   Quantitative reasoning exercises using mathematical modeling.
3. Statistical Modeling and Analyses
   - Introduction to probabilistic models;

- Bivariate analysis, scatter plots;



Simple linear regression model and correlation analysis;
Basics of estimation and confidence interval;
Testing of hypothesis (z-test; t-test);
Statistical inference in decision making;
Quantitative reasoning exercises using statistical modeling.

SUGGESTED INSTRUCTIONAL / READING MATERIALS

l . 'Using and Understanding Mathematics: A Quantitative Reasoning Approach" by Bennett, J. 0., Briggs, W. L. , & Badalamenti, A.
2. 'Discrete Mathematics and its Applications" by Kenneth H. Rosen.
3. "Discrete Mathematics with Applications" by Susanna S. Epp.
4. 'Applied Mathematics for Business, Economics and Social Sciences" by Frank S Budnick.
5. 'Elementary Statistics: A Step by Step Approach" by Allan Bluman.
6. "Introductory Statistics" by Prem S. Mann.
7. "Applied Statistical Modeling" by Salvatore Babones.
8. 'Barrons SAT" by Sharvon Weiner Green, M.A and Ira K. Wolf.